

# Ensuring safety during the demolition and dismantling of buildings

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**Abstract.** In the presented study, an analysis of issues related to the technology of construction processes during the demolition and dismantling was carried out. The article provides a technical and economic analysis of the technologies for performing work during the demolition and dismantling of buildings and structures. Demolition and dismantling operations are extremely dangerous to the life and health of those involved in the liquidation of the facility, as well as to residents living or located in close proximity to the construction site, and may also pose a risk of harm to the environment, personal and corporate personal and real property, persons, and engineering infrastructure. Therefore, to ensure the safety of the work to be carried out, it is necessary to have a set of standards that establish rules for the organizational and technical documentation design for demolition and dismantling, the execution of work during the liquidation of facilities, and strict control over the implementation of technology and safety. One of the most common hazardous production factors is the falling of objects from buildings and also the falling of workers from the installation horizon. An effective solution to this problem is to use protective catch systems that prevent falling objects.

**Keywords.** Work technologies, demolition and dismantling of buildings, conditions for the organization of construction works, efficiency improvement, construction safety.

## Introduction

The development of the construction industry entails the development of technologies used in the process of erecting buildings and structures. In addition to the traditional ways of performing, managing and controlling of works, flexible technologies are also emerging that prove their practical effectiveness in conditions of dynamism and intensification. The concept of renovation refers to the demolition of old dilapidated housing and the construction of a new one to replace the old one. The active development of the construction industry develops the latest technologies. However, construction practically does not focus on improving demolition technologies. The intensive development of new technologies, purposeful investments in the economy, the transformation of the industrial, transport, energy and housing and communal framework of fixed assets set a new pace for construction. Its ultimate goal is to create a real estate sector that ensures balanced spatial development. In the face of increasing competition for high-quality human resources necessary for the development of modern civilization, the requirements for the quality and

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comfort of residential premises are undergoing dramatic changes. At the same time, one of the main objectives of this study is to provide some insight into the principles of integrated approaches to the formation of a viable urban environment. Based on the theory of sustainable development, economic theory, design and structural approaches, the authors propose a system of principles for the formation of a viable urban environment. Their novelty lies in taking into account the cyclical dynamics of the urban planning process in management, facilities and resources. Integrative use of structural approaches. The use of the proposed comprehensive principles will contribute to a significant acceleration of the urban development process. The study of questions devoted to the cyclical development of real estate has been considered in many studies [1-5]. However, many questions remain for further study.

Demolition and dismantling of buildings is directly related to the risk of exposure to harmful and hazardous production factors, among which the fall of objects from the building under construction is one of the most common and dangerous. When carrying out construction works related to the impact on employees harmful and hazardous production factors, the employer is obliged to take measures to eliminate them or reduce them to an acceptable level of impact of such factors. The construction industry is the most traumatic among the various sectors of the national economy. Reducing the level of injuries and improving the safety of construction is the most important task in any construction project. Protective-catching systems are the most cost-effective and efficient tool, creating a safe zone around the perimeter of the building and preventing the impact on workers of the dangerous factor. The system includes a protective - trapping grid and trapping screens mounted along the mounting horizon. Protective screens are an effective means of protecting people living and working in high-rise urban buildings. Another effective way to improve safety when performing this type of work is to mark the boundaries of hazardous areas on the territory of the construction site [6].

## **Methods**

Object of study: construction processes during the demolition and dismantling of buildings. Subject of study: technological solutions ensuring safety during construction work in the performance of work. The purpose of study: Develop a methodology for choosing effective technologies for the production of works during the demolition and dismantling of buildings. The methods of theoretical analysis of scientific and normative-technical literature, general scientific methods and the method of expert assessments were used in the work. Scientific and technical hypothesis: the possibility of implementing renovation plans with the help of a cost-effective mechanism that allows you to reasonably make decisions on the demolition and dismantling of buildings. The theoretical and methodological basis were the works of scientists in the field of liquidation of construction buildings. Regulatory and legislative acts, methodological documents on the issues of repair, reconstruction, housing construction, as well as scientific publications of the periodical press on the problems of liquidation of capital construction projects were used. To substantiate the provisions put forward in the dissertation, methods of logical and economic-mathematical analysis were applied, elements of a systematic approach and mathematical methods for processing statistical data, the method of multiple correlation and the method of expert assessments were used. The information base for the evidence of the main provisions of the study, the reliability of the conclusions and recommendations were statistical and analytical materials, specialized reports, as well as information, analytical, statistical materials published in the scientific literature, periodicals.

## **Results**

When performing construction work on the demolition and dismantling of buildings, certain dangerous factors arise that affect workers and others. The type of factors and their influence depends on the applied technologies for performing work. Let's take a closer look at the technologies used.

When developing project documentation for demolition, the following methods of demolition of a capital construction object can be adopted:

- manual;
- mechanical;
- explosive;
- special (hydraulic fracturing, thermal, electro-hydraulic, hydro-fracturing).

Manual demolition method. It is used when neighboring objects are close. For dismantling, jackhammers, hydro wedges are used. This method is considered difficult to perform. Dismantling of objects and use of manual labor. This method involves the analysis of the upper floors of buildings manually. The lower floors are being dismantled using special construction equipment. The main advantage of this method is the preservation of building material, which can then be reused or properly disposed of.

The mechanical method involves the felling of building structures, structures with an excavator with various attachments. The breakdown of the surviving structures into smaller parts can be carried out with jackhammers. Under the mechanical method of collapse is meant such work in which the collapse of structures occurs with the help of an excavator equipped with attachments of various types. For example, bucket, wedge hammer, ball hammer, hydraulic gripper, hydraulic shears. Specialized equipment is used to carry out work in this method. Dismantling of objects using construction equipment is the most efficient and fastest. This method uses various construction equipment, such as a demolition excavator, excavator, etc. A demolition excavator is equipment used for the dismantling of buildings and structures, reinforced concrete structures, and asphalt concrete pavements. The main advantage of this special equipment is the ability to preserve utilities and neighboring buildings. Semi-mechanized elimination method. This method combines manual and mechanical methods. The upper part of the building is dismantled manually, the lower floors are dismantled using specialized equipment.

Explosive method of elimination. In this method, explosive technology is used, so that the fragments of the dismantled objects do not harm the environment, it is necessary to properly perform the work. Dismantling of objects with the use of explosion. With the explosive method of liquidation, the explosion wave must be directed so that the fragments of the object being exploded do not damage the surrounding objects. The explosion starts on the top floor, so the building collapses. This method is used extremely rarely, due to the lack of highly qualified specialists. The explosive method is used to destroy or crush stone, concrete and reinforced concrete structures. The destruction of an object by the explosive method is carried out using charges in boreholes. The charges can be placed in the interior of the building, as a result of which the collapse occurs on the base of the building, forming a collapse.

The following methods are special methods for the collapse of capital construction objects:

- 1) hydraulic explosive method;
- 2) thermal method;
- 3) electrohydraulic method;
- 4) hydro-shearing method.

The hydraulic blasting method is used to destroy box-shaped structures, tanks, etc. The difference from the explosive method is that in the process of performing the work, the free space of the boreholes is filled with water or clay solution.

The thermal method is effective in the destruction of monolithic concrete and reinforced concrete structures by melting concrete by the combustion products of iron in a jet of oxygen entering the combustible pipe in an amount sufficient for combustion and removal of slag from the structure being cut.

The electrohydraulic method is used for the destruction of monolithic concrete and stone massifs, rubble concrete and masonry. This method is characterized by the absence of an explosive wave and the expansion of fragments.

The hydrosplit method is used to destroy monolithic concrete and brick structures in cramped conditions [7,8].

In conditions of dense urban development or areas with specific features, the demolition project may provide for combined methods or use other technical solutions for the liquidation of buildings and structures. In conditions of dense urban development of high-rise buildings, advanced technologies for dismantling buildings and structures have been developed and implemented.

When choosing a method for liquidating an emergency facility, it is necessary to take into account such factors as the conditions of the construction site, the features of the liquidation object, the main architectural and structural characteristics, the risk of fire or explosion. To liquidate buildings with no more than 2 floors, hydraulic excavators are mainly used, the main advantage of which is the ability to control the elements of the building being destroyed. For buildings with a height of up to 5 floors, excavators with universal hydraulic grippers are used. For buildings with a height of up to 25 m, made of reinforced concrete, an excavator with hydraulic or mechanical scissors is used. Selection of method depends on the state of the object being dismantled and the technological features of its construction. After the liquidation of capital construction objects, it is necessary to carry out measures for the disposal of construction waste [9,10].

The advantages and disadvantages of the main methods of performing work are presented in the table 1.

**Table 1.** An approximate estimate of the duration and cost of the main stages of the life cycle of a capital construction object (by the example of the life cycle of standard series buildings)

Method	Advantages	Disadvantages
1	2	3
Mechanized way	Simple, many materials can be reused after dismantling, and the cost of the process itself is somewhat lower than other methods	Long, laborious, accompanied by a lot of noise and dust
Directional explosion	Simple and fast used to destroy large structures such as skyscrapers that are closely surrounded by other buildings	Dangerous method (explosive wave, in debris that fly through the air, in unstable structures that did not collapse).
Hydroexplosive method	The reinforcement hidden in the material remains intact. High adhesion rates. Possibility of repair of fittings. No vibration. No dust from destructible concrete. Selective replacement	The main problem of hydrojet dismantling remains the organization of water drainage. High price
Thermal method	The speed of work with a small thermal cutting machine is quite high. In addition, thermal cutting does not	With this method of melting, the concrete

	cause strong vibrations, noise, it is not as laborious and expensive as mechanical cutting.	structure loses strength over a distance
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Disassembly of an object can be complete or partial. With complete dismantling, the complete elimination of the structure is implied, and with partial dismantling, it is understood that changes are made to the constructive space-planning solutions of the object. In the process of dismantling the structure, demolition, dismantling, complete or partial destruction of structures are carried out. It is advisable to dismantle the structure element by element in cases where there is a need to preserve materials and structural elements for reuse. For small volumes of work, manual dismantling is possible. When dismantling multi-storey buildings, dismantling is usually carried out by floors, individual sections or along the length of the entire building. When dismantling low-rise buildings, both sectional and element-by-element disassembly are used. Dismantling of buildings and structures is carried out element by element, ensuring the safety of structures, or in separate blocks. The main technique for carrying out dismantling work is lifting machines and mechanisms. The element-by-element method of performing dismantling works, in comparison with the demolition of buildings and structures, is characterized by a higher labor intensity and long periods of work, a certain sequence of their production. The main advantage of this method is the possibility of reusing dismantled elements and structures.

Efficient work performance depends on the competent choice of the method, the correct selection of equipment (machines, mechanisms) and compliance with the requirements of labor protection, sanitary and environmental standards. Reducing the costs and terms of demolition (dismantling) of buildings and structures is achieved through the rational use of modern organizational and technological solutions.

Mechanical dismantling of buildings is carried out by attracting and using appropriate specialized equipment. These include the following: excavators with a destructive function, as well as bulldozers, hydraulic hammers and much more. In accordance with generally accepted technology, the structure is demolished directly from top to bottom. Particularly significant is the aspect of preventing the collapse of parts of the structure. Today, one of the most productive methods is the combined demolition of various structures and buildings. This method refers to the simultaneous use of both the mechanical method and the manual method. It is worth emphasizing that the manual method, in this case, acts as an auxiliary method. It should be noted that the demolition of various obsolete structures means the use of all kinds of tools and technical equipment. Organizations specializing in this are able to offer their customers all sorts of options for construction work. A significant role in the implementation of the demolition is played by the availability of specialized equipment, and most importantly, the availability of high-quality vehicles. It is also worth focusing on the fact that in order for the dismantling of the walls to be carried out efficiently and safely, loaders, bulldozers, dump trucks and many other specialized equipment should be used. Consequently, exceptionally large organizations have the ability to carry out the demolition of structures of any complexity. For these purposes, a large number of special equipment is used, such as: bulldozers, cranes, excavators and excavators designed specifically for the demolition (dismantling) of buildings. To date, the main machines in the technologies for dismantling buildings are caterpillar excavators with elongated and extra-long booms with various attachments: buckets, grabs, cutters, hydraulic hammers or shears, concrete breakers or concrete grinders, etc. During the demolition work (dismantling) of buildings, the excavator occupies a place outside the danger zone, but in such a way that its boom can reach the required maximum remote elements of the building at a given parking. The excavator, starting to work, with a movement "from itself" brings down the parapet or frieze panel into the building itself. With hydraulic scissors, the

excavator bites through the lintel above the window of the last floor, after which the entire wall begins to collapse. In the same sequence, the walls of the lower floors are collapsed. After the collapse of a part of the building within a given parking lot, the excavator moves to a new location for the subsequent and / or final destruction of the building. To prevent the formation and spread of a dust cloud, the collapsed elements of the building must be irrigated with high-pressure water from a hydraulic gun. Destroyed structures or elements of the building, as they accumulate, are selected and moved by a loader for loading into dump trucks for signage for disposal.

The choice of mechanization in the production of dismantling or demolition is diverse [9, 10], almost every well-known manufacturer of special equipment has in its assortment machines for the production of dismantling works. So, for example, some companies have six models of excavators for the demolition (dismantling) of buildings of the series, having a working length of arrows of 20-41 m and powerful hydraulic scissors that are capable of destroying the most complex structures. A feature of these models is the ability to use them for excavation during earthworks. To do this, a monoboom with a handle and an earth-moving bucket is installed on the base adapter. As a result, the machine can first carry out demolition (dismantling) of the object, and then dismantle the rubble, sort and load construction waste into the vehicle. Other companies offer several options for demolition excavators with boom lengths from 21 m to 40 m, with cabins made of impact-resistant metal. A feature of these machines is a video camera mounted on the boom, which transmits working operations to the screen in the cab. Other manufacturers offer a whole line of demolition excavators (dismantling) of buildings. The cabs of these machines have a transparent sunroof, as well as the ability to change the angle of inclination for a better view of the working area. Also, these models have cab windows protected by a metal grate and means for limiting the angle of rotation of the boom. Some represent special equipment for the production of dismantling works, which can be controlled remotely, characterized by compact size, low weight, mobility, and high cross-country ability. Remote control of machines allows you to carry out work operations at the maximum safe distance. Thus, the use of a mechanized method of demolition and dismantling of buildings and structures, as well as an explosive method, is one of the most common practices for the liquidation of objects, which has a significantly large number of positive characteristics, such as: high productivity, no need for manual labor, independence from weather conditions. conditions, absence or insignificant need to replace the main attachments, in comparison with its disadvantages: limited demolition height and insignificant sorting of materials, dismantled structures, etc. By analyzing the above technology for dismantling buildings in a mechanized way, which has significant advantages and a small number of disadvantages, and the possibility of its use in modern domestic conditions, we can conclude that it is admissible and even expedient to use this technology for the following reasons:

- the mechanized method allows minimizing the use of manual labor during dismantling work, and new special equipment ensures the safety of the driver through video surveillance and design features of the machine, which undoubtedly affects the overall safety of the work;
- modern specialized equipment with various attachments allows you to save money and reduce the time of work due to the high degree of its productivity and the reduction of the mechanization tools used;
- wide availability in the modern market of construction equipment and the possibility of using specialized machines and mechanisms for the production of dismantling works in any urban and weather conditions, on an unprepared territory;
- the possibility of crushing and crushing building materials and structures for preliminary sorting, and loading into a vehicle for the removal of waste from the construction site to processing enterprises or landfills for disposal.

Each design is designed for a certain service life. Due to the long-term operation of buildings and structures, the cost of repairs and maintenance increases, the overhaul interval decreases, the building structures wear out and fail. If the technical condition of the building complies with the standards, then from an economic point of view it is beneficial to demolish it.

The estimated cost of dismantling capital construction projects is calculated in accordance with price documents or in the form [11].

The calculation of the cost of dismantling the object is carried out in various ways, presented below:

- by the area of the object - the cost is calculated based on the demolition price per 1 sq.m.;

- according to the volume of structures to be demolished - the demolition price of 1 cubic meter is calculated. based on the theoretical calculation of dismantling costs and multiplied by the volume of structures being destroyed;

- according to calculations for the time spent using equipment, the amount of fuel and electricity needed, and the people involved in these works. In this case, the costs for a certain type of work are specified by the relevant regulatory document.

The cost of demolition work varies greatly depending on various parameters:

- object type;

- materials used in construction and their quantity;

- the area of the object;

- use of special equipment;

- features of the location of the object: building density, availability of communications;

- presence of hazardous materials;

- volumes of construction waste disposed of after demolition works [12].

The pricing of dismantling works is associated with various categories of costs:

- the time spent on the same work, depending on the equipment used and the type of construction equipment used;

- qualification of workers performing dismantling;

- overhead costs, for example, security of the demolition site, communications, transport to deliver employees to the site if it is far away, and more;

- expenses for administrative staff.

The calculation of the cost of demolition of objects consists of the following items:

- calculation of the volume of the dismantled building;

- calculation of the amount of garbage for removal;

- calculation of the mass of garbage (for the selection of equipment);

- calculation of the need for machines and mechanisms;

- calculation of the number of working personnel.

Only after that the exact amount of the cost of the demolition project is announced.

To reduce the cost of dismantling, full mechanization of stages is used. The work is carried out using various types of high-performance special equipment: excavators-destroyers with a standard set of equipment, which includes a bucket, hydraulic shears, hydraulic hammer; loaders and dump trucks with different carrying capacity for the removal of construction waste. A mobile crushing station is used for processing construction waste directly at the demolition site to reduce transportation costs.

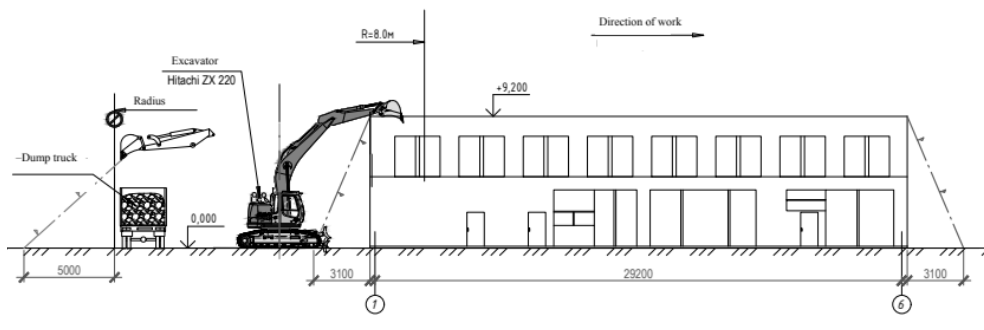
To reduce the estimated cost of dismantling, construction debris obtained during dismantling is reused, for example, crushed stone, sand, metal structures, cullet, concrete blocks, bricks. Recycled materials are cheaper and reduce waste transportation costs. The demolition of a building generates a large amount of construction waste and, therefore, it becomes necessary to carry out the dismantling works in such a way as to reduce the cost of the work and minimize the environmental impact of the demolition [13,14].

Mechanical demolition is beneficial from an economic point of view, but this method has a strong impact on the environment.

The dismantling of structures into parts has a lower cost, while this method is dominated by labor costs. The building is being dismantled so that the materials can be reused and recycled. A smaller part of the dismantled building structures is sent to a landfill. Reuse and recycling of building materials depends on their quality, the price of new material and existing market conditions. A contractor undertakes a demolition project based on profitability, so demolition economics plays an important role in construction waste management.

The main goal of selective demolition is to recover the maximum amount of primarily reusable and recyclable material.

Selective demolition at first glance seems to be an expensive, lengthy and complex process, but in reality it allows you to save money, reduce the cost of removing waste material to a landfill, and save time. Thanks to evolving technology, all demolition materials can be shredded, screened and reused directly on site, reducing transport and waste disposal costs.



**Fig. 1.** Technological map-scheme of the sequence of the demolition of the building

When performing work, hazardous production factors are associated with falling objects. For this purpose, safety nets can be used to protect against falling materials. The grid systems is an important element that needs to be given special attention in the design of the works, highlighting it in a separate unit. Calculation of the requirements on the construction site must be made on the basis of the perimeter of the building. The design needs to ensure:

- maximum convenience and safety during installation, dismantling and operation;
- possibility of installation and dismantling manually by forces of no more than three specially trained workers without use of load-lifting cars and mechanisms;
- the weight of the individual parts, moved manually, should not exceed 20 kg;
- the geometrical sizes of parts needs to ensure the possibility of their displacement manually on a standard ladder marches and platforms or supply of lifting-mechanisms to external sites.

Movement of components of system is made by the crane, the loader, or in manual. During installation, do not allow mechanical damage to the elements of the protective-catching system. Installation of structures should be carried out according to the approved project of installation works. The production of subsequent construction and installation works is allowed to begin only after the complete completion of all works on Assembly, welding, bolt installation in this section. Installation of steel structures should be carried out with complex mechanization of both main and auxiliary processes of transportation, storage and installation of structures [15,16].



The supports are mounted on the horizontal beam ceilings of the building located one above the other and fixed to them with anchor bolts. The bracket is mounted on the support by means of a bolt connection. The upper part of the bracket is fixed by a rope to the upper support. The mesh is attached to the upper support and to the bracket using a rope and carabiner. Brackets adjacent fences Conn-applied to each other with a rope through the bottom support. The network cloth fastens to above-located overlapping by means of anchor bolts with a hook.

In the construction of buildings and structures used materials, temporary equipment with different sizes and weights. For more effective use of protective netting, it is necessary to analyze the characteristics of these objects, in case of their falling from the mounting horizon. The table shows the analysis of dimensional and weight characteristics of the materials used.

When operating the grid is subject to wear, therefore, requires periodic monitoring of the state of the structure. For this purpose it is necessary to check the following condition of conformity of the perceived energy of the mesh safety coefficient and wear coefficient caused by aging of the mesh. During the inspection test, it must be shown that the test grid has sufficient resistance to the effects of the tensile forces, taking into account the aging factor. The dynamic strength of the systems must meet the normative values [17,18].

Employers, in accordance with the specifics of the work undertaken needs to be organized control over the conditions and labor protection:

1) constant control of serviceability of the used equipment, adaptations, equipment, availability and integrity of protections, protective grounding and other means of protection before the beginning and in the course of work on the workplaces performed by works (the first level);

2) operational control over the state of conditions and labor protection, conducted by managers (producers) of works together with authorized representatives of workers (the second level);

3) the periodic control of the condition and labor protection in structural divisions and on sites of construction production which is carried out by the employer (his authorized representatives, including experts of service of labor protection) compatible with representatives of the primary trade-Union organization or other representative body of workers according to the approved plans (the third level) [19,20].

As perspective directions it is necessary to use stationary guides on which metal racks will be fastened and at installation easily rearranging on directing, as it is necessary to apply the facilitated materials for metal racks that will essentially reduce weight of a design and reduce time of manticazh. For maximum protection, two or three grids should be used simultaneously with different cells in order to increase the rigidity of the structure as a whole and prevent the penetration of small building materials through the mesh.

## Conclusions

Thus, the regulatory and legal support of organizational and technological their dismantling parameters are represented by a complex of interrelated regulatory, legal and methodological documentation that ensures efficiency, safety and quality at each stage of dismantling operations (survey, design, liquidation of the facility, waste disposal). The study of the processes of demolition and dismantling of buildings for civil purposes in the conditions of urban areas showed that there are many unresolved issues related to the organization of this type of construction work. In order to preserve the urban structure and the integrated development of the living environment, it is necessary to carry out work on the phased renovation of the urban territory. When organizing this process, it is necessary to solve many problems and make scientifically based decisions. The feasibility study is based on taking into account the influence of various factors on the construction industry and

evaluating a set of solutions for planning the execution of work. The development of an organizational and economic mechanism for the demolition and dismantling of buildings for housing and civil purposes in the conditions of renovation of urban areas is necessary in modern conditions. The study of this issue will reduce the costs of organizing this type of work and make science-based decisions. The development of a technical and economic mechanism is a necessity for the development of the modern construction industry.

Based on the foregoing, it is possible to present proposals and practical recommendations for the introduction of dismantling works into domestic production as follows:

- the use of modern and special equipment to increase labor productivity, safe performance of work and reduce costs for the additional use of various machines, mechanisms and devices;

- production waste should be sorted by type of materials, starting with the decommissioning of the facility and up to the moment of their processing at the relevant enterprises, in order to be able to reuse them;

- it is necessary to carry out the introduction of new technologies, experience and achievements in full or their individual elements, with direct adaptation to country conditions, in order to achieve indicators for increasing productivity, quality of performance and safety of work;

- when using introduced and adapted new technologies, the processes of which are extremely complex and responsible, they should be carried out in cooperation and under the direct control of construction control and technical supervision services, as well as representatives of foreign organizations whose experience and achievements are used in the work;

- the possibility of using the explosive method of demolition and dismantling of buildings and structures would be more efficient and expedient not in urban areas with dense buildings, with the potential to cause harm to the population, but in an open area, outside the city or on the territory of industrial enterprises, where it is possible to minimize all risks;

- the creation of a public service or the empowerment of one of the existing services, which would plan, organize, manage and carry out explosive work, as a state structure, would itself conduct training, certification and advanced training of its employees, obtain permission and coordinate the use, transportation, storage of explosives with the relevant authorities - would deal with all activities that are somehow related to blasting and explosives.

In the course of studying and analyzing the application of protective-capture systems in construction, it is established that it is necessary to develop new organizational and technological documents for their use. Increasing technological reliability is necessary to reduce labor costs and improve the safety of construction.

Unlike the initial stages of construction, the end-of-life stage of buildings does not receive sufficient scientific attention. The organization and technology of demolition of construction objects is based on various factors, such as: the design features of the building, the condition of the site, the economic feasibility and location of the building, taking into account adjacent infrastructure facilities. It is necessary to approach the dismantling of objects with responsibility in order to avoid damage to the population, buildings and structures located in the immediate vicinity of the object to be demolished. Also, do not forget about the need to minimize the risks of causing damage to the environment as a result of the dismantling of facilities.

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