

Prevention of Adverse Environmental Effects During Restoration Works

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Abstract – The paper describes the environmental problems arising during restoration works in construction. The paper concludes and proves that problem of dust pollution of the environment, as well as the effects of dust emissions on workers during restoration works related to dismantling of destroyed and damaged buildings is relevant.

Keywords – construction; repair; restoration; dust; ecology.

I. INTRODUCTION

The regional scale of environmental losses during restoration works in construction can be typically observed during various functional disturbances, damages, accidents and other malfunctions caused by:

- design and production defects of structures (errors during survey and design, violation of construction technology, low quality of materials, equipment and components);
- impact of industrial technological processes;
- violation of operation rules [10];

The factors to be considered during restoration of construction sites are classified as follows:

1. Reboot due to underestimated current load (mismatch between actual structure masses and the projected ones, dynamic effect of the load, temperature effects, etc.);

2. Instability (general and local):

- errors in calculations, drawings, violation in design;
 - preparation works;
 - poor experimental development of design solutions;
 - flexibility of erection joints;
 - untimely or incorrect support anchoring;
3. Unsuccessful design solutions and deviations from the project:
- unsuccessful design scheme (inconsistency between the design and actual operation);
 - low accuracy of calculation;
 - defects of the joint
 - underestimated calculated load compared to the real one;
 - underestimated joint rigidity;
 - insufficient rigidity, strength and stability;
 - replacement of some profiles by others;
 - low qualification of performers;
 - lack of control and technical supervision.
4. Poor manufacturing and installation of structures:
- low-quality materials;

- low quality manufacturing structures;
 - wrong choice of the technique and procedure for installation;
 - poor-quality welding;
5. Defects of the bases used to install the structures:
- uneven settlement of structures and columns;
 - defects of brickwork;
 - skewed embedded blocks;
 - unstable base;
 - aggressive groundwater;
 - groundwater flooding;
 - errors in engineering and geological surveys.
6. Unforeseen (unpredictable) reasons:
- accidents caused by failures, landslides, flow slide and collapses of overlying structures;
 - seismic effects;
 - washout of foundation, excessive moistening of the bases.

These factors make the basis for rational design and construction of both civil and industrial vital facilities. These design and construction are currently implemented in environmental regulation [1,4,5].

Environmentally responsible design holds a special place among a number of the formation stages of the engineering-ecological cycle since the required environmental protection potential at this stage largely determines the level of environmental hazards and, hence, possible material costs for its stable preservation during natural-engineering geosystem (NEG) activities [2,3,6].

Objective criteria should be developed to assess environmental friendliness of the design and production and technical solutions (in both industrial production and construction). In the future, this will help to eliminate the dominance of administrative and business interests that pursue narrow-minded goals, extensive forms of production development, and subjectivism in assessing and predicting possible environmental effects.

Ecologically rational design of restoration works in construction should provide sustainable standardized reserves relative to the limit values of the anthropogenic properties of the natural environment.

Any interaction of the construction flow with the environment within the NEG boundaries implies energy-mass transfer processes, and their qualitative and quantitative state predetermines the type of interaction and its final result.

The structure of the construction project passport (CPP) includes the following sections: organizational and technical, economic planning, socioeconomic, financial and legal, and

engineering training by type of regulation and activity and temporary maintenance.

At the stage of preparation of construction organizations that includes acceptance of construction documents for restoration works, work plan development, conclusion of sub-contracts, development of the plan for organization of work, preparation of plans (works) to supply material and technical resources and opening of the spigots on.

A timely environmental impact assessment of the design and estimate documentation is very important since in conditions of tightened administrative and financial (and perhaps criminal) responsibility for environmental damage, the main fault rests with the builders who accepted an environmentally insufficient project.

The general contractor must conclude the first subcontract agreement with the environmental protection design and production organizations for development of the plan for organization of work and design and preparation works for engineering and environmental preparation and its implementation.

The stage of preparation of production and technological processes will become more clear and obvious when all technical processes are environmentally assessed.

This document imposes certain restrictions on the use of different technologies in each case. In general, it provides an environmentally safe (clean) full technological cycle.

This characteristic of the ecological efficiency of technological processes can be used along with technical and economic indicators during competitive conclusion of subcontracts.

Another stage of the CPP is training of personnel of construction organizations to the level of brigades, and it should include certification of workers at all levels of both technical and environmental issues of construction [7, 8, 11].

A more progressive method in terms of environmental safety, which has an environmental effect, is a continuous and speedy restoration works in construction.

The features of the continuous and speedy methods include:

specialization of the flow (and in the flow) by stages of technological processes, which increases the degree of continuity and synchronization of the work performed, and increases the pace of work;

functioning on principles of self-financing and lease, that is, the flow is economically interested in minimized non-production losses, for example, the cost of elimination of the excess environmental damage. The flow becomes highly susceptible to new technologies and progressive forms of production organization.

Environmentally, the most preferable will be the methods of work organization that minimize the time of direct technogenic contact of the construction process with the natural environment.

Environmental monitoring units hold an important place in environmental organization of construction, and its main functions are not only to assess the quality and to perform special environmental protection, but to provide continuous and environmental monitoring during the period of basic construction and transport operations.

At the beginning of the preparatory restoration stage, the production process should employ methods and techniques that meet the requirements of the Federal Law on Ecological Expertise (Federal Law No. 65, dated April 15, 1998) [9].

Construction and restoration works can have negative effects on the environment.

The following objects in buildings and structures are to be restored:

- metal and stone structures destroyed;
- paints destroyed and fade;
- the color design of the outer fence changed;
- ornaments of ancient monuments and sculptures destroyed;
- trusses and roofs corroded;
- constantly increasing cost of cleaning facades and their coloring;
- constantly increasing costs of building repairing [7,11].

In this regard, construction is one of the main obligatory parts of urbanization requiring sound and reasonable approaches. Until recently, the main task of construction was creation of an artificial environment to provide conditions for human activity. The environment was considered only in terms of protection against its negative impacts.

A reverse process of construction impact on environmental safety has been recently reviewed. In the context of practical necessity, only certain aspects of this problem were studied and considered:

- disposal and removal of garbage;
- focus on air purity in settlements only.

Meanwhile, at the present stage, construction is one of the powerful anthropogenic factors to impact the environmental safety.

The impact of construction and restoration works occurs at all construction stages from extraction of construction materials to exploitation of ready-made objects.

Thus, the impact of restoration works in construction on the environment should be distinguished as the construction – the most important sector of the national economy, on the one hand, and on the other hand, as the production of this industry – highways, urbanized territories, etc.

Like any branch of the national economy, construction and restoration works require a large amount of various raw materials, construction materials, water, energy and other

various resources, and pre-production and production of these have a powerful impact on the environmental safety.

Disruption of landscapes and pollution of the environment are caused by restoration works performed at the construction site. These processes occur at the very beginning when the construction site is cleaned, the vegetation layer is removed or damaged, and earthworks are carried out. When the area is cleaned for both construction and restoration works, a significant amount of waste is generated, which pollute the environment when incinerated or when it clutters up landfill areas. These impacts change the morphology of the areas, worsen geographical conditions, which enhances erosion development. The degree of impact on the environment depends primarily on:

- construction materials;
- construction technology for buildings and structures
- technological equipment of the construction industry;
- type and quality of construction equipment, mechanisms and transport and other factors.

The area of construction sites becomes a source for pollution of the nearby areas with exhaust and noise.

Water is abundantly used as the component of solutions in restoration works, and after that, it is discharged and pollutes soil and water. Construction refers to transient processes, however, its impact on the environment is not well understood, and most of the environmental measures are recommendatory.

At present, negative effects of restoration works in construction include:

- increased tree logging;
- water pollution;
- soil pollution due to waste disposal and waste accumulation;
- increased dusting, gas and thermal air pollution;
- changed level of radiation;
- changed level of precipitation;
- changed air temperature and wind patterns.

The most important step in EIA preparation is the indicating result of the assessment of the planned changes in the environment and their effects. The assessment involves correlation of the predicted or established indicators with the regulatory states of individual components of the landscape or the landscape as a whole. There are currently five stages of the environmental impact assessment caused by the proposed economic activity:

1. natural assessment;
2. special natural assessment;
3. technological evaluation;
4. economic evaluation;

5. social assessment.

A methodical complex with averaged indicators of the environmental safety and restoration works should cover all levels of its interaction with the environment. The system of criteria of a methodical complex with averaged indicators of the environmental safety of restoration works can be practicable if it is based on the existing information and regulatory framework. The absence or lack of any source information makes practical application of the proposed calculations with the indicators difficult or impossible.

A complex of characteristics and indicators of environmental safety restoration works should provide the ability to:

1) assessment of safety of restoration works in construction in normal conditions (three basic environmental, social and environmental-economic aspects should be covered);

2) estimates of danger probability in emergency conditions.

The safety of restoration works in construction should include the following group of natural and conditional indicators that characterize harmful effects of restoration works:

- the amount of actual discharges and emissions of harmful substances into the atmosphere;
- the amount of waste disposal;
- levels of harmful physical impacts;
- calculated and actual fields of average and maximum concentrations of harmful substances in various environments;

The construction of environmentally clean residential buildings and other industrial objects requires careful consideration of a wide range of issues of environmental quality. The residential estate is to a greater or lesser degree subject to technogenic geochemical effects due to the entry of significant amount of harmful substances into various components (soil, air, surface, and groundwater) [10].

Timely inventory of pollution sources allows not only to determine the maximum permissible emissions, but also to identify effective measures to prevent them.

The 1994–1996 war and the 1999–2004 war in the Chechen Republic led to the destruction of the entire construction infrastructure, which caused changes in the state (degradation) of the environment.

Deterioration of the ecological situation dictates the need to rehabilitate the environment through the application of environmentally friendly building materials and environmentally sound management decisions. Timely monitoring and investigation of these parameters enables development and reasonable use of the criteria for the environmentally clean design and the entire recovery process in the construction of residential or industrial facilities.

Of the complex of environmental and economic problems associated with the treatment of industrial and consumer waste, the problems of construction and demolition waste are the most

relevant. These include waste (except for hazardous from demolition, disassembly, reconstruction, repair or construction of buildings, structures, utilities and industrial waste facilities and demolition of dilapidated housing). Most of the construction and demolition waste in the maximum possible amounts should be sent for recycling and subsequent use.

Construction and demolition waste is not recycled due to the lack of appropriate technologies and capacities. The waste is used for backfilling of depleted pits and other hollows, which require a list of disposal facilities for construction and demolition waste located in the region of construction works.

In this case, construction and demolition waste should be collected at the sites of their formation separately with similar items [7,11].

The composition of the construction waste is diverse, and, as practice shows, it contains harmful substances such as asbestos, waste material with increased radioactivity, bitumen, tar, paint, etc.

The main types of the construction waste are concrete breakage remained after demolition of buildings, asphalt breakage, and steel slag. Over the last 15 years, the Chechen Republic exhibits a steady trend (as a result of known events) to an increase in waste generation. At the stage of rapid construction works, the volume of construction waste increased in the form of:

- brick breakage;
- concrete breakage;
- reinforcement rods;
- roofing material, etc.

To date, there is no information on waste management in the Chechen Republic with regard to:

- type of waste;
- volume of waste;
- accumulation;
- movement;
- needs and possibilities of using waste as secondary raw materials.

The main target of construction companies and organizations is to export waste to depleted pits. The disposal of construction and demolition waste is not carried out in the region, which will further lead to environmental problems. One of the problems that need to be addressed at the level of the government of the Chechen Republic is the creation of a technogenic complex to recycle construction and demolition waste and to receive secondary raw materials.

Organizations and institutions concerned together with scientific experts, specialists involved in construction, transport and recycling of construction and demolition waste should develop a government program to provide qualified accounting, end-to-end control using economic measures to provide profitable recycling of construction and demolition waste, and

guarantees for the use of the whole recycling complex in the Chechen Republic [2,8].

The concepts of building ecology are implemented through a system of complex engineering and environmental support, which is applied to restoration processes of construction to develop a number of subsystems. These are as follows: scientific and methodological support (general principles of decision making, regulatory documents, optimization of management criteria, consideration of environmental problems, etc.); design and engineering support (formation of computational models and structures); technological support (ways and means of environmentally sound use of design solutions, regulatory and technological regulations for environmental restoration); organizational and methodological support (optimal organizational and methodological structures of production, principles of ensuring environmental efficiency of production, optimal forms of organization of labor processes, etc.); feasibility of this restoration with regard to functioning, preparation of proposals on possible conversion of production; compliance with environmental requirements for construction materials and production technologies; assessment of the environmental impact of the restored objects at all construction stages.

An important factor in the development of environmentally sound construction standards is a differentiated approach to assessment of geological, geocryological, geographical and other conditions for construction restoration, both in terms of minimum loads on natural landscapes and choice of the most environmentally friendly and time reliable engineering solutions.

These involve comprehensive environmental monitoring of restoration works (environmental expertise of scientifically-methodical, design-engineering and organizational-technological solutions, industrial ecology, monitoring, etc.); information support (principles of accumulation, transfer, storage and use of environmental information, criteria for quality of information and indicators of its effectiveness); quantitative assessment and forecasting (methodology of objective assessment of environmental situation at the regional and planetary scale, multilevel identification, engineering and technical aspects of marginal forecasts; optimal management (substantiation of permissible boundaries, regulation of labor processes and management of natural and technical geosystems, social-methodological aspects of the formation of ecological knowledge and culture of labor collectives, general principles of ecologically optimal management, etc.) [1,4,10].

The listed components of the integrated engineering and environmental support provide the methodological basis for planning and management of environmental protection at all stages of restoration, both industrial and civil engineering.

In addition to the listed components of the complex ecological support for restoration works, the ecological reconstruction and green building must be observed. This involves not only the development of such programs, but also ensures the creation and implementation of competitive projects that include production and consumption ecosystems, environmentally friendly resources and manufactured products, volumetric-constructive layout of the living environment,

management of its functioning, financial and other support systems.

II. METHODS AND MATERIALS

A. Choosing the area of research

As noted above, the problems of the environmental safety of restoration works in construction are particularly relevant since renovation of the housing stock located in the city is significant. To perform the tasks on restoration of the housing stock, it is necessary to prepare the areas for future construction. A significant number of buildings and structures that cannot be restored due to critical damage or destruction, or which are at the stage of deep deterioration, require dismantling and removal of construction waste.

Dismantling of damaged and destroyed buildings is inevitably accompanied by the formation of a significant amount of waste. Construction waste formed by the remnants of construction materials and structures can be both large fragments and dust particles. The formation of dust particles occurs at almost all stages of dismantling works. The process of destruction of building structures caused by mechanical interaction of structural components with various tools and instruments leads to mechanical grinding. Due to the fact that most building materials (brick, concrete, cement, plastering and finishing materials) are made from powdered raw materials, any mechanical action is accompanied by dust formation.

Dismantling is accompanied by a vertical movement of the dismantled components, which, when moving down, eject air masses, thus forming a dusty air mixture capable of spreading over considerable distances. This can cause damage to the air quality and harm the health of builders involved in restoration works and residents of houses located nearby.

In addition to the work directly related to dismantling of damaged and destroyed buildings and structures, transportation of waste generated during this process also causes significant dust emission. Mechanical grinding of transported materials occurs during loading of vehicles to transport waste to the place of burial or recycle.

Thus, the problem of dust pollution of the environment, as well as the effects of dust emissions on workers during restoration works related to dismantling of destroyed and damaged buildings is relevant.

To solve this problem, it is necessary to solve a number of interrelated problems, the most important of which are:

- determination of the amount of dust generated during demolition/dismantling of standardized buildings;
- study of the physico-chemical properties of dust particles generated during demolition/dismantling of standardized buildings;
- development of technical solutions for localization and purification of dust emitted during dismantling.

III. CONCLUSION

1. The problems of the environmental safety of the restoration work in construction are particularly relevant since renovation of the housing stock located in the city is significant.

2. During preparation of the sites for construction, a significant number of buildings and structures require dismantling and removal of construction waste since they cannot be restored due critical damage or destruction, or are at the stage of deep deterioration,.

3. Dismantling of destroyed and damaged buildings is followed by intensive formation of dust waste.

4. In addition to the work directly related to dismantling of damaged and destroyed buildings and structures, transportation of the resulting wastes is also characterized by significant dust emission.

5. The problem of dust pollution of the environment, and the effects of dust emissions on workers during restoration works associated with dismantling of destroyed and damaged buildings is relevant.

6. To solve the problem of dust emissions, it is necessary to determine the amount of dust emission, to study physico-chemical properties of dust particles, and to develop technical solutions for localizing and cleaning dust released during dismantling of buildings.

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