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ВДОСКОНАЛЕННЯ РОЗРАХУНКОВИХ ПРОЦЕДУР ЕКОЛОГІЧНИХ РИЗИКІВ БУДІВНИЦТВА

Н. А. Рубек, О. В. Шеліхова, О. Д. Гладка
Донбаська національна академія будівництва і архітектури,
2, вул. Державіна, м. Макіївка, Донецька обл., Україна, 86123.
E-mail: manage_nasa@mail.ru

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Анотація. У статті розглянуто теоретичні та практичні аспекти процедур оцінки та розрахунків екологічних ризиків будівництва. Визначено поняття «ступінь екологічного ризику», її склад та особливості оцінювання. Проаналізовано стан та проблеми управління екологічними ризиками при будівництві об'єктів та нормативне забезпечення цих процедур. Встановлено, що нормативів щодо визначення ступеня екологічних ризиків у відповідності до міжнародних документів в Україні немає. Запропоновані рекомендації щодо підвищення якості розрахункових процедур екологічних ризиків на основі комплексного інформаційного забезпечення, яке дозволяє пов'язати між собою різні аспекти прийняття управлінських рішень, а також дає можливість використання як типового, так і диференційованого підходу до управління екологічними ризиками будівництва.

Ключові слова: екологічний ризик, управління безпекою, розрахункова оцінка ризику, класифікація екологічно небезпечних об'єктів, економічні збитки.

СОВЕРШЕНСТВОВАНИЕ РАСЧЕТНЫХ ПРОЦЕДУР ЭКОЛОГИЧЕСКИХ РИСКОВ СТРОИТЕЛЬСТВА

Н. А. Рубек, Е. В. Шелихова, Е. Д. Гладкая
Донбасская национальная академия строительства и архитектуры,
2, ул. Державина, г. Макеевка, Донецкая обл., Украина, 86123.
E-mail: manage_nasa@mail.ru

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Аннотация. В статье рассмотрены теоретические и практические аспекты процедур оценки и расчетов экологических рисков строительства. Определено понятие «степень экологического риска», его составляющие и особенности оценки. Проанализированы состояние и проблемы управления экологическими рисками при строительстве объектов и нормативное обеспечение этих процедур. Установлено, что нормативов по определению степени экологических рисков в соответствии с международными документами в Украине нет. Предложены рекомендации относительно повышения качества расчетных процедур экологических рисков на основе комплексного информационного обеспечения, которое позволяет увязать между собой различные аспекты принятия управленческих решений, а также дает возможность использования как типового, так и диференцированного похода к управлению экологическими рисками строительства.

Ключевые слова: экологический риск, управление безопасностью, расчетная оценка риска, классификация экологически опасных объектов, экономический ущерб.

DEVELOPMENT OF THE CALCULATION PROCEDURES OF CONSTRUCTION ENVIRONMENTAL RISKS

Natal'ya Rubek, Elena Shelikhova, Elena Gladkaya
Donbas National Academy of Civil Engineering and Architecture,
2, Derzhavina Str., Makiyivka, Donetsk Region, Ukraine, 86123.
E-mail: manage_nasa@mail.ru

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Abstract. The article deals with the theoretical and practical aspects of the construction environmental risk assessment and calculation. There is given a definition of the concept «degree of environmental risk»; its components and peculiarities of assessment are determined. The present state and problems of the environmental risk management in the construction of projects as well as the normative support of these procedures were analyzed. It has been found that in Ukraine there are no standards to determine the degree of environmental risks which are in agreement with the international documents. There are proposed the recommendations on improving the management of environmental risks basing on the complex informational support which allows coordinating different aspects of making management decisions and makes it possible to apply both the typical and differential approaches to the management of the construction environmental risks.

Keywords: environmental risk, safety management, calculation assessment of risk, classification of environmentally hazardous projects, economic damage.

Introduction

The last one and a half decades in Ukraine a greater attention has been paid to the solution of problems of environmental safety in Ukraine. This is conditioned by the changed nature of environmental threats and scales of their impact on a human being vital activity and by a necessity of further development of legal and economic mechanisms which would stimulate the development of environmentally safe technologies and projects, effective methods of management and control of how the environmental legislation is observed by business subjects.

The legal bases and demands on the ensuring of environmental safety in the allocation, design, construction, reconstruction, putting into operation and operation of enterprises, structures and other objects are stated in the Laws of Ukraine «On the Environmental Protection», «On the National Security», «On the Environmental Expertise», «On the Environmental Audit», «On the Protection of People and Territories of Anthropogenic and Natural Emergency Conditions», «On the Hyper-dangerous Objects», «On Insurance», «On the Town Planning Control» as well as in the Decision of the Cabinet of Ministers of Ukraine No. 554 of 27.07.95 «On the List of Activities and Environmentally Dangerous Objects», «On the Public Building Specifications» and in other standard legal acts, sanitary regulations and building acts and standards.

Thus, a new conception of environmental safety as a component of the national security of the state is being legislatively formed in Ukraine.

The purpose of the article

The purpose of the article is the development of recommendations to improve the design estimation procedures and the systems of environmental risk management in construction on the base of the static data on the environmentally meaningful events: accidents, failures, catastrophes.

The significance of the research material

The effectiveness of the legislation as to the technogeneous and environmental safety is conditioned by the development of the system technique of analyzing environmental situations. In this connection the modern methodology of risk analysis used in many countries as a dominating mechanism of developing and substantiating the optimal forms of safety management assumes a special topicality [1–3].

The world-recognized methodology of risk analysis was used in Russia when estimating the risk of polluting chemicals impact on people's health [4].

Ukraine hasn't still got such a normative document which specifies environmental risks in accordance with the international document. The national legislative and normative base to protect the environmental safety has the foundations laid for the differentiation of the environmental risks when studying and estimating their danger degree. Thus, according to the Law of Ukraine «On the Hyper-dangerous Objects» the risks are divided into anthropogenic (as to their impact on the personnel and population) and environmental (as to their impact on the environment). The Law of Ukraine «On the Environmental Expertise» (Article 5) points out that the main task of the environmental expertise is the determination of the degree of an environmental risk and the safety of planned and carried out activity. The State Building Standards DBN (SBS) A.2.2.1 «Composition and content of the materials to assess their impact on the environment in the design and construction of enterprises, buildings and structures» contains the demands as to the determination of an environmental risk of the planned activity and its impact on the conditions of a human being's vital activity.

At the same time, the order of classification and accounting of environmentally dangerous objects has not been determined, the procedure of identifying environmental risks has not been specified, the basic methodical principles of analysis and assessment of environmental risks have not been drawn up and the methodical support of estimating environmental risks has not been worked out yet in Ukraine. Besides there are no common approaches to the procedures of environmental audit and expertise, no assessment of impact on the environment and proclaiming safety of hyper-dangerous objects by the assessment and analysis of environmental safety of different objects from the viewpoint of the methodology of estimating risks.

Nowadays the basic normative-methodical document for estimating impacts on the environment is the Manual for estimating impacts on the environment (to DBN (SBS) A.2.2.1-2003) [5]. But this Manual does not contain any guidelines on the assessment of environmental risks, neither does the «Technique of determining risks and their acceptance level for proclaiming safety of hyper-dangerous objects» [6] which was developed by the Gospromgornadzor (State Service of Supervision over the Town Industry) of Ukraine.

Thus, the development of the methodical principles of estimating environmental risks and their acceptance level in the construction and operation of objects, the improvement of the procedures of identifying environmental risks and calculation procedures of environmental risks are more than usual actual.

Nowadays, the procedure of estimating risks is the only analyzing instrument which allows determining the impact of risk factors and their relationship on people's safety and, against this background, evaluating the operation priorities to minimize the risks. So, the management of risk provides the analysis of a risk situation, development and substantiation of a management decision (often in the form of a normative act) which is to minimize the risk.

On the whole the stages of environmental risk assessment and management in the construction and operation of objects and their content are given in Table.

Completing the risk management process this algorithm simultaneously unites the risk stages and the stages of a risk assessment into a single decision-making process, into a single conception of risk. A model sequence a risk assessment is this: a primary identification of a risk; description of the risk source and the damage cause by this risk; the risk assessment under the normal conditions of operation; the risk assessment at the moment of hypothetical accidents and object damages; a range of possible scenarios of an accident development; statistical assessment and a probabilistic risk analysis.

An environmental risk assessment can be done on the base of the available scientific and statistical data of the environmentally meaningful events: accidents, damages, catastrophes and an environmental factor contribution to the sanitary and environmental welfare of the population, influence of the environmental pollution on the state of biocenoses etc. The statistical assessment (on the base of the experience obtained from the investigation of similar situations) or the expert judgment was generally accepted [7, 8]. The statistical approach means the use of the probability theory apparatus and this approach is used when a meaningful experience of realization of the projects of this kind was accumulated.

If a project is realized for the first time one should use the expert assessment. The method of expert assessment means that a group of experts (engineers,

Table. Stages of environmental risk assessment and management in construction

Stages of risk assessment	Stage content
Detection of risks, determination of risk sources and factors as well as the objects of their potential impact, the basic forms of such an impact.	At the initial stage they make a comparative analysis of risks to determine the priorities and risk level (harmfulness).
Estimation of object susceptibility to impact, i. e. estimation of a real impact of a risk factor on a human being and environment.	Determination of risk acceptance. A risk is compared with some social and economic factors (benefits of an object operation; losses conditioned by the restraint of the object operation; availability and possibilities of regulating measures for decreasing a negative impact on the environment and population health).
Analysis of risk factor impact on the population and environment, determination of a human being resistance to the impact of a definite destabilizing factor.	Determination of the management proportions means a choice of one of the «standard» models of estimating a risk.
A full risk characteristic with the use of the qualitative and quantitative parameters.	Making a controlling decision, i. e. specification of the normative acts (laws, decisions and guidelines) and their conditions corresponding to the realization of that «standard» model which was determined for the previous stage.

specialists in the sphere of the environmental protection) makes up a list of possible accidents. Engineers pass their independent opinions about accident risks and then these opinions are averaged. In the same way expert-ecologists suggest their opinions on the cost to remove consequences of each accident impact on the environment. An environmental risk is calculated as a net current value of the losses caused when removing consequences of a possible accident impact on the environment.

Let's dwell on the essence of the statistical method of estimating a risk degree, the assessment being based on the probability theory of random distribution. Here, to calculate the degree of a definite risk one should know the law of its distribution, i. e. one should know under what conditions this law can be realized, how its realization will impact the economic activities of a developer.

The mathematical expectation of an environmental risk is a sum of the products of all its possible values and probability of their occurrence:

$$M(X) = X_1P_1 + X_2P_2 + \ldots + X_nP_n, \qquad (1)$$

where $M(X)$ are a risk mathematical expectation; X_1, X_2, X_n are the values a parameter under study can accept depending on the concrete conditions; P_1, P_2, P_n are probabilities of accepting these values.

Thus, a probability meaning of the mathematical expectation of a special parameter of environmental accidents occurrence is that it is approximately equal to the arithmetic mean of its observed (possible) values. But a mathematical expectation is not a complete characteristic of a random quantity. To get its more complete characteristic, one should also use the parameters of diffusion of the values of the parameter chosen from its average predicted value (i. e. of the mathematical expectation), i. e. dispersion. According to the probability theory dispersion is as mathematical expectation of the squared deviation.

$$D(X) = M(X) - [M(X)^2]. \qquad (2)$$

Thus, from the viewpoint of the risk theory the economical idea of the mean square deviation is that it is a characteristic of a concrete risk to show the maximum possible variation of a definite parameter from its mean-expected value. This statement allows using the mean square deviation as a risk index from the viewpoint of its realization probability.

Noteworthy also is a definite complexity of the estimation of the mathematical expectation and environmental risk dispersion. The authors suggest using the essentials of the fuzzy-set theory.

Thanks to the investigations by the fuzzy-set theory [9, 10] it was found out that for the values of fuzzy functions close to some constant parameter (for example, a normative or allowed value) the membership function is close to the Gaussian curve

describing the normal distribution of continuous random quantity.

$$F(x) = \frac{1}{\sigma\sqrt{2\pi}} exp^{-\frac{(x-a)^2}{2\sigma^2}}, \qquad (3)$$

where x is a continuous random quantity; a is a mathematical expectation of the continuous random quantity; σ is a root-mean-square deviation (standard) of quantity x.

Strict statistical data being absent, equation (3) allows determining the grade of membership of the parameter under study in the admitted region. To proceed to the dimensionless relative value of the differential function, let's find out its maximum value. If $x=a$; $e^0=1$, then

$$F(x)_{max} = \frac{1}{\sigma \cdot \sqrt{2\pi}}. \qquad (4)$$

If the admitted region is described by interval [0; 1], then the grade of membership of the parameter is determined by the ration:

$$f(x) = \frac{F(x)}{F(x)_{\max}} = \exp^{-\frac{(x-a)}{2\sigma^2}}. \qquad (5)$$

The risk level is a relative value of this or that key parameter deviation from the normative or accepted value. Then, the grade of membership of each key parameter in the admitted region will look like:

$$f(u) = \exp^{-\frac{(u_r-u_p)^2}{2(u_{\lim})^2}}, \qquad (6)$$

where u_r is a real value of the key parameter at the risk assessment; u_p is the key parameter value determined in accordance with the requirements of the normative documents; u_{lim} is the limit value of the key parameter, its overriding leading to an environmental accident.

In (6), the value of u_p, as well as the mathematical expectation, is the center of the distribution of random values of the key parameter when structural imperfections appear; the value of u_{lim} is accepted as the mean square deviation.

Thus, analysis of an environmental risk for each object is a comparison of design, real and limit values of key parameters. Such an approach makes it possible to increase the reliability of a risk assessment if there are not enough statistical data.

Conclusions

The quality of the environmental expertise of projects is also important as the systems of integrated assessment of all probable environmental and social and economic consequences of the project implementation of the construction and reconstruction of large objects as this expertise is to prevent the negative influence of these consequences on the environment and to solve the assigned tasks at the least expenditure of resources and minimum unwanted consequences.

A further development of the calculation procedure of risk assessment will make it possible to improve the environmental expertise for the benefit of the present and future generations to insure protection, scientifically substantiated rational use of land and its interior, water resources, flora and fauna, to keep air and water clean, to reproduce natural resources and to improve the human environment. The similar procedures allow detecting and eliminating errors in the nature management and protection and decreasing economies losses when eliminating the consequences of risk situations at the stage of object planning and design.

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Рубек Наталія Антоновна – асистент кафедри економіки підприємств Донбаської національної академії будівництва і архітектури. Науковий напрямок: розвиток виробничо-господарських комплексів міста.

Шеліхова Олена Вікторівна – к.т.н., доцент кафедри економіки підприємств Донбаської національної академії будівництва і архітектури. Науковий напрямок: підвищення економічної ефективності інженерних рішень в будівництві.

Гладка Олена Дмитріївна – асистент кафедри економіки підприємств Донбаської національної академії будівництва і архітектури. Науковий напрямок: підвищення ефективності використання ресурсів в будівництві.

Рубек Наталья Антоновна – ассистент кафедры экономики предприятий Донбасской национальной академии строительства и архитектуры. Научное направление: развитие производственно-хозяйственных комплексов города.

Шелихова Елена Викторовна – к.т.н., доцент кафедры экономики предприятий Донбасской национальной академии строительства и архитектуры. Научное направление: повышение экономической эффективности инженерных решений в строительстве.

Гладкая Елена Дмитриевна – ассистент кафедры экономики предприятий Донбасской национальной академии строительства и архитектуры. Научное направление: повышение эффективности использования ресурсов в строительстве.

Rubek Natal'ya – an Assistant Professor; Economy of Enterprises Department, Donbas National Academy of Civil Engineering and Architecture. Scientific research: development of city production complexes.

Shelikhova Elena – PhD (Economics), Associate Professor; Economy of Enterprises Department, Donbas National Academy of Civil Engineering and Architecture. Scientific research: improvement of economic efficiency of engineering decisions in construction.

Gladkaya Elena – an Assistant Professor; Economy of Enterprises Department, Donbas National Academy of Civil Engineering and Architecture. Scientific research: improvement of resources efficiency in construction.