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<https://doi.org/10.23947/2541-9129-2019-3-12-16>**HAZARD ANALYSIS AND ASSESSMENT
OF PROFESSIONAL RISK IN THE
MANUFACTURE OF CONSTRUCTION
MATERIALS***Staseva E. V., Gorbatkova A. V.,
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The article considers the question of assessment of professional risk of workers. The analysis of conditions and safety of work in production of construction materials is carried out. The method of assessment of professional risk on the basis of integrated indicators of conditions and safety of work is offered. Interpretation of characteristics of working conditions on indicators of qualitative and quantitative standard of professional risk is given. Calculation of professional risk for the former of reinforced concrete structures is presented.

Keywords: production factors, harmful and dangerous working conditions, professional risk, risk assessment.

Introduction. The economic development of our country at the present stage is accompanied by an increase in the need of building materials. These industries are part of the structure of the manufacturing industry — a branch of industry in which as raw materials we use products of different purposes and the results are both means of production and consumer goods. The number of people employed in this production is increasing every year. According to the statistics for 2017, about 12% of all workers were employed in the manufacturing industry of Russia. Production of construction materials is characterized by complex and traumatic working conditions. This is confirmed by the published data of Rostrud. For example, in 2017 the number of workers in the production amounted to 25,400 people, the manufacturing industry accounted for about 6,000 people, which accounted for 23% of the total number of injured people [1-3].

Problem statement. The paper proposes a method for occupational risk assessment based on integrated indicators of conditions and safety.

Theoretical part. In order to increase the level of safety in production, it is necessary to analyze all production factors and determine the level of occupational risk of workers based on the data obtained [4]. Production of construction materials includes manufacture of materials, parts and structures for all types of construction (reinforced concrete blocks, slabs, trays, non-pressure pipes, foundation blocks, staircases, piles, platforms and steps, lintel blocks). Technological processes of such industries are ac-

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<https://doi.org/10.23947/2541-9129-2019-3-12-16>**АНАЛИЗ ОПАСНОСТЕЙ И ОЦЕНКА
ПРОФЕССИОНАЛЬНОГО РИСКА ПРИ
ПРОИЗВОДСТВЕ СТРОИТЕЛЬНЫХ
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Рассмотрен вопрос оценки профессионального риска работников. Проведен анализ состояния условий и безопасности труда при производстве строительных материалов. Предложен метод оценки профессионального риска на основе интегральных показателей состояния условий и безопасности труда. Дана интерпретация характеристик условий труда по показателями качественной и количественной оценки профессионального риска. Представлен расчет профессионального риска для формовщика железобетонных изделий.

Ключевые слова: производственные факторы, вредные и опасные условия труда, профессиональный риск, оценка риска.

accompanied by the presence of both harmful and dangerous factors; therefore, there is the risk of injury and the development of occupational diseases. Occupational risk assessment is a process that is carried out stage-by-stage, taking into account the production factors that arise during operation [1, 5]. All production factors by the nature of the impact can be conditionally represented in the form of two main indicators:

- "HARM" — an indicator that characterizes the influence of labor conditions;
- "DANGER" — an indicator that characterizes the state of injury risk of production.

The influence of all production factors on workers during their working life occurs in their combination (complex). Therefore, for the assessment of occupational risks it is necessary to take into account the risk levels for each of the indicators of working conditions and safety [6]. Assessment of occupational risk based on integrated indicators "DANGER" and "HARM" is determined by the formula (Fig.1).

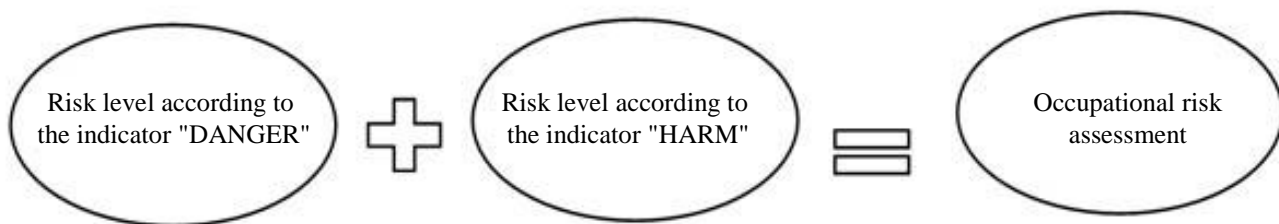


Fig. 1. Determination of occupational risk based on risk levels in terms of "DANGER" and "HARM"

The indicator "HARM" reflects the level of risk of influence of working conditions. It characterizes the possibility of development of chronic or acute diseases. To determine the level of risk in terms of "HARM", it is necessary to use the map of special assessment of working conditions of the workplace and to determine the level of risk on this indicator according to table 1 [7, 8].

Table 1

Risk level value according to the indicator "HARM"

Final class of working conditions	1	2	3.1	3.2	3.3	3.4	4
Risk level	1	2	3	4	5	6	7
Risk	Low	Acceptable	Minor	Significant	High	Very high	Catastrophic

The indicator of "DANGER" reflects the level of injury risk at the working place, characterizing the possibility of injury of workers from the influence of various hazards, leading to negligible injuries and to the fatal injuries [7, 8]. To assess the level of risk for the indicator "DANGER" they use data from the accidents statistical reports of the enterprise. The level of risk in terms of "DANGER" will be equal to the coefficient of injury frequency $K_{q.T.}$, which is determined by the formula:

$$K_{q.T.} = N \frac{1000}{P}, \quad (1)$$

where N — the number of recorded occupational accidents with loss of labour capacity for one or more days during the reporting period; P — the average number of employees for the reporting period.

After determining the coefficient of injury frequency according to table 2, we determine the level of risk for this indicator.

Table 2

Risk level value according to the indicator "DANGER"

$K_{q.T.}$	Risk level	Risk
≤ 1	1	Low
1–4	2	Acceptable
5–9	3	Minor
10–13	4	Significant
14–16	5	High
1–720	6	Very high
≥ 20	7	Catastrophic

Assessment of the occupational risk level based on integral indicators "DANGER", "HARM" and the formula from fig. 1 is according to table 3.

Table 3

Assessment of the value of occupational risk level based on integral indicators

Occupational risk		Risk level according to the indicator "HARM"						
		1	2	3	4	5	6	7
Risk level according to the indicator "DANGER"	1	2	3	4	5	6	7	8
	2	3	4	5	6	7	8	9
	3	4	5	6	7	8	9	10
	4	5	6	7	8	9	10	11
	5	6	7	8	9	10	11	12
	6	7	8	9	10	11	12	13
	7	8	9	10	11	12	13	14

The interpretation of the characteristics of working conditions by indicators of qualitative and quantitative occupational risk assessment is presented in table 4.

Table 4

Interpretation of characteristics of working conditions by indicators of qualitative and quantitative occupational risk assessment

Quantitative assessment of occupational risk level	Qualitative indicator of occupational risk level	Working conditions characteristics of the occupational risk level
from 2 to 4	Minimal	Absence of harmful and dangerous factors in the workplace, injury is unlikely.
from 5 to 7	Low	No exceedance of the hygienic standards of MPC (maximum permissible level) of harmful factors in the workplace; hazards are securely locked, microtraumas are possible.

Quantitative assessment of occupational risk level	Qualitative indicator of occupational risk level	Working conditions characteristics of the occupational risk level
from 8 to 11	Moderate	Harmful factors at the working place exceed acceptable levels of MPC (maximum permissible level); there are dangerous factors with the possible occurrence of a slight accident.
from 12 to 13	High	Harmful factors significantly exceed the MPC (MPL); there is a high probability of an accident with a severe outcome.
14	Ultrahigh	Harmful factors significantly exceed hygienic standards so that they can lead to acute poisoning; there is a high probability of a group accident or death.

Example. Let us carry out hazard analysis and occupational risk assessment at the workplace of a concrete products moulder of a construction materials plant. In accordance with the data of special assessment of working conditions card of the concrete products moulder the final class of working conditions — 3.2. According to table 1, we determine the value of the risk level in terms of "HARM". Risk level — 4 (significant risk). At the workplace, there are high levels of noise, vibration and harmful substances [9].

The initial material for the calculation of the indicator "DANGER" is the data of the report of the enterprise on accidents. The risk level according to the indicator "DANGER" depends on the injury frequency coefficient, which is determined by formula 1:

$$K_{q.t.} = 2 \frac{1000}{149} = 13$$

According to table 2, we determine the value of the risk level by the indicator "DANGER" — 4 (significant danger). In table 3, we determine the value of occupational risk level for concrete products moulder — 8 (moderate). According to table 4, the level of occupational risk at the workplace of the concrete products moulder according to the integrated indicators "DANGER" and "HARM" indicates the presence of harmful factors, the values of which exceed the permissible levels, as well as there are dangerous factors that contribute to the occurrence of a light accident. Mutual influence of indicators in their joint action can strengthen the influence of each of them. It is necessary to develop measures to reduce the impact of harmful factors and possible injury [7].

Conclusion. The proposed method of occupational risk assessment based on integrated indicators allows us to characterize working conditions at the workplace, taking into account the joint action and interaction of industrial factors in terms of hazard and danger. The results of risk calculations for each workplace are proposed to be used in the development of preventive measures to improve the conditions and safety of the employees of enterprises for the production of construction materials, as well as in other industries.

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