

Safety at Work at Height in Construction

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Abstract

In the last decade, there has been an increase in the number of industrial accidents with many casualties and significant material losses. According to the International organization for labor protection (ILO), as a result of industrial accidents in the world in 2018, about 350,000 people died, more than 2 million people died from occupational diseases. As for injuries without lethal outcome, the statistics are even more depressing: 330 million workers are injured every year, 160 million are ill with occupational diseases [13].

In Russia in 2017, 25,400 people suffered from accidents at work, including 1138 people with fatal outcome, the number of people with occupational disease established in the reporting year was 4756 people [1].

Out of 136435 registered enterprises in the Russian Federation, 11454 are construction companies. Construction all over the world is one of the dangerous anthropogenic factors affecting the environment, a source of irreparable negative consequences for the ecological balance of ecosystems [14]. And at the same time, the construction industry is important in the development of the national economy: the economic efficiency of related sectors of the economy is largely ensured by the intensive development of construction. Construction meets the rapidly growing needs of economic systems and meets the demands of conventional construction, renovation, operation and dismantling of buildings in all countries.

Keywords: risk factors, occupational injuries at work at height in construction, the conditions of construction labor, occupational safety and health at work at height in construction, measures to improve working conditions, monitoring of working conditions, harmful and dangerous working conditions, temporary disability

1 INTRODUCTION

The construction industry is important in the development of the national economy: the economic efficiency of related sectors of the economy is largely ensured by the intensive development of construction. Construction meets the rapidly growing needs of economic systems and meets the demands of conventional construction, renovation, operation and dismantling of buildings in all countries. The successful implementation of all construction tasks depends largely on the preparation of the technological sequence of certain types of work, which includes: engineering training; work on the development of pits and trenches, with the movement of soil and installation of the Foundation; the construction of buildings and structures; finishing work. Implementation of all stages of construction requires quite complex organizational, technical operations and increased attention to safety.

In modern conditions of formation of market economy and ensuring sustainable development in Russia new requirements to the organization of work at the enterprises are imposed. In this regard, an important issue in accordance with the conventions and recommendations of the International Labour Organization is the creation of effective working conditions. The conditions of work depend on the result of work, total life expectancy, working capacity, physical health, the period of social activity.

The purpose of this work is to analyze the main causes of injuries and new rules when working at height in construction, as well as the assessment of professional risk in the performance of finishing works.

2 THEORY

In the last decade, there has been an increase in the number of industrial accidents with many casualties and significant material losses. According to the International organization for labor protection (ILO), as a result of industrial accidents in the world in 2018, about 350,000 people died, more than 2

million people died from occupational diseases. As for injuries without lethal outcome, the statistics are even more depressing: 330 million workers are injured every year, 160 million are ill with occupational diseases [13].

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Out of 136435 registered enterprises in the Russian Federation, 11454 are construction companies. Construction all over the world is one of the dangerous anthropogenic factors affecting the environment, a source of irreparable negative consequences for the ecological balance of ecosystems [14]. And at the same time, the construction industry is important in the development of the national economy: the economic efficiency of related sectors of the economy is largely ensured by the intensive development of construction. Construction meets the rapidly growing needs of economic systems and meets the demands of conventional construction, renovation, operation and dismantling of buildings in all countries. In accordance with the concept of sustainable development, a comprehensive indicator of sustainable development of the object includes environmental and social indicators, including occupational safety and occupational risk assessment, as well as technical and functional indicators that affect each other.

3 DATA AND METHODS

The successful implementation of all construction tasks depends largely on the preparation of the technological sequence of certain types of work, which includes: engineering training; work on the development of pits and trenches, with the movement of soil and installation of the Foundation; the construction of buildings and structures; finishing work. Implementation of all stages of construction requires quite complex organizational, technical operations and increased attention to safety.

According to Rosstat in the construction industry, the number of victims with disability for one working day in 2017 amounted to 2,100 people, of whom 200 people died, 215 workers received occupational diseases [1]. The number of deaths due to accidents in the construction industry amounted to 23.6 % of the total number of fatalities.

Analysis of the typology of accidents with severe consequences shows that in 2017, almost every fourth employee was seriously injured or died as a result of falling from a height, and every fifth – as a result of the impact of moving, flying, rotating objects, machine parts [4].

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Falling from a height is a serious professional risk in several professions in the construction industry. Such dangerous professions include the work of masons, roofers, installers, concrete workers, finishing work. Falling from a height causes injuries and deaths.

Falling from a height is one of the main causes of industrial injuries and accidents at work in construction. The main causes of industrial injuries in the performance of work at height are associated with poor content and shortcomings in the organization of workplaces, faulty condition of forests, scaffolding, devices, protective equipment and tools, structural defects and malfunction of construction machines, mechanisms and equipment; insufficient qualification of workers, the non-use of personal protective equipment, as well as the lack of constant and effective control of safety, shortcomings in the training of workers for labor protection, etc. Analysis of the causes of severe injuries in construction shows that up

to 70 % of all cases of severe injury to workers are organizational reasons and are associated with the shortcomings of direct managers of works on construction sites [15].

Injuries in the performance of work at height in the whole of the Russian Federation occupies a significant share. Therefore, in 2015 the Ministry labour and social protection of the Russian Federation were tightened safety requirements in the performance of such work. These requirements are spelled out in the "Rules on labor protection at work at height" (Rules) [16]. In them, the legislator, in addition to changing the parameters of the height, which increased from 1.3 to 1.8 m, added new organizational and technical and technological measures when working at an altitude [17]. Note that employers have the right to set their own safety standards when working at height, if they do not contradict the new regulations. Many large companies have left the norm of 1.3 meters, thus strengthening the requirements for work at a height for themselves and their contractors.

The new Rules significantly expanded the requirements for medical examinations and training of workers when working at height. If earlier to works at height the workers who passed medical examination without contraindications to performance of works at height were allowed, in new Rules it is specified on need to pass obligatory preliminary and periodic medical examinations.

The requirements for the training of workers engaged in work at height have been tightened. In addition to instructions, now the employee must have a qualification, the level of which is confirmed by the document on vocational education and qualifications. The new rules introduce three groups of safety workers, depending on the specific type of work at height. Periodic training of workers of 1 and 2 groups in safe methods and methods of performance of work at height is carried out at least 1 time in 3 years, and 3 groups at least 1 time in 5 years.

In accordance with the new Rules, the employer must organize technical, technological and organizational activities prior to the start of work at height. These activities include the development of a plan to produce works at height, approval of technological maps for the production of works, fencing of the place of production of works, hanging warning and prescribing posters or signs, the use of collective and individual protection.

No safety concept and no safety action plan will operate:

— without the allocation of specific responsibilities among specific people; — without the identification of specific tasks to be completed by a certain date.

The concept of safety and the plan of actions for safety measures should be consistently brought to all workers their safety is urged to provide this plan [10]. A significant innovation is that the employer appoints persons responsible for the organization and safe conduct of work at height, for the issuance of the work permit, as well as conducting maintenance and periodic inspection of personal protective equipment.

The new Rules include labor protection requirements for the performance of certain types of construction and installation works. Construction and installation works include the following types of work: work at height in a confined space, glass work, concrete work, stonework, finishing work, etc.

Table 1 - Possible hazards (risks) during finishing works arising from hazardous and harmful production factors

Hazardous and harmful production factors [18]	Hazards (risk) [19]
Location of the workplace near the height difference of 1.8 m or more;	Fall from height
Increased dust and gas content of the working area air	Injury of the respiratory tract, the eye, poisoning, allergies, drop
Fires and explosions caused by paints containing flammable solvents,	Burns, poisoning, falling from a height, death
Sharp crumbs, burrs and roughness on the treated surface;	Wounds, cuts
Increased voltage in the electrical circuit	Electrical shock
Insufficient illumination of the working area.	Falling from a height, injuries, cuts

4 METHODS

Finishing works that give the building or structure a finished look and protect the structure from moisture, corrosion, mechanical damage, are the final stage of construction. These include plastering, cladding, painting, glass work.

In this study, an analysis of occupational risks associated with exposure to hazardous and harmful production factors in the performance of finishing works was carried out.

The main operational steps to be performed for finishing work, and possible danger (risk), given in table.1.

A comprehensive assessment of working conditions on the basis of special studies of the factors of the working environment is carried out in the certification of workplaces. According to the normative documentation, certification of workplaces on working conditions is carried out once every 5 years by a special Commission, which includes the main specialists of the enterprise, employees of personnel departments, labor protection, medical workers. Studies of sanitary and hygienic factors of the working environment, the severity and intensity of the labor process are carried out at specific workplaces through laboratory studies, instrumental measurements and calculations. Results of instrumental measurements of parameters of harmful and dangerous production factors are made out by protocols and are entered in cards of certification of working conditions at a workplace. Further analysis and comparison will be based on maps of working conditions in the workplace.

5 RESULTS

Risk assessment (R) of harm (loss) to health by analyzing the probability and consequences of exposure to hazardous and harmful production factors during finishing works was performed using the method of semi-quantitative risk assessment [8] and is presented in table 2.

In addition to the harmful and dangerous production factors described in table 1, the worker is affected by noise levels, increased levels of vibration, heating and cooling microclimate and chemical factors. Assessment of occupational risk from physical and chemical factors by indirect method, based on the class of working conditions, requires a special assessment of working conditions, the results of which are presented in tables 3 and 4.

After analyzing these data, we can say that the main danger for the manifestation of injuries on the construction site during finishing work is the danger of falling from a height. The increase in occupational risk is affected by dustiness of the working area, poor lighting, malfunction of scaffolding, lack of collective and individual protection. Low qualification of workers and low level of culture in occupational safety is the main cause of injuries in the construction industry. The level of risk (R) as a result of the assessment of occupational risk by semi-quantitative method for workers in finishing work is high enough when working at height and is 72 points. The probability of falling from the height of the employee leads to the loss of working capacity for 1 day or more, up to death.

Table 2 - Semi-quantitative assessment of the risk of harm (loss) to health

Hazards (risk)*	Severity (p) on a 9-point system**	Category of accident***	the Likelihood of an accident (W) 9-point system**	Risk (R) on 80 point system
the fall of a person from a height(1,2, 3,6)	injury (8 - 2)	severe	9 - 6	72 - 12
	death (9)	severe	5 -3	45 - 27
injury (2,6)	injuries (9 – 2)	severe-mild	9 - 7	81 - 14
	eye injury (8 – 3)	severe-mild	7 - 4	56 - 12
	choking	severe-mild	9-7	81-14
	injury of the respiratory tract (8 – 2)	severe-mild	9-6	72-12
injury (3)	death (9)	тяжелый	5 - 3	45 - 27
	burns (8-5)	severe-mild	8-5	64-25
	poisoning (8-6)	severe-mild	8-4	64-24
injury (5)	death (9)	severe	3 - 1	27 - 9
	burns (8-5)	severe	8 - 5	64 - 25

Hazards (risk)*	Severity (p) on a 9-point system**	Category of accident***	the Likelihood of an accident (W) 9-point system**	Risk (R) on 80 point system
	electrocution (4 – 2)	severe-mild	4 - 2	16 - 4
injury (2,3)	cancer (8)	severe	9-6	72-48
	death (9)	severe	3-1	27-9
	skin rash, dermatitis, allergy (4 – 3)	severe-mild	7 - 6	28 - 18
* in brackets – the number of the description the working action at the table.1; ** at the table.1 based on medical indications [2] *** On determining the severity of health damage from industrial accidents. The Order of The Ministry Of Health. Russia of February 24, 2005 №160				

Thus, the production of finishing works are potentially dangerous works, as it is associated with technological processes and work at height. To prevent the employee from falling from a height, it is necessary for the employer to carry out technical, technological and organizational measures before the start of finishing work at a height. Workers performing work at a height of finishing work, must have a qualification corresponding to the nature of the work performed, the level of which is confirmed by the document on vocational education and qualifications. Occupational health and safety specialists should monitor those responsible for working at height and their training.

Table 3 - Indirect method of risk assessment based on the class of working conditions

Factor	Reason	Recommendations SanPiN [20]	Amount of risk	
Physical factors				
The noise is periodic, impulsive	Equipment, earth moving machines	(> 85 dB)	Risks in accordance with the class of working conditions (table. 3)	
Microclimate				
Temperature in the working environment in the open area	Temperature (-40 ...+40 °C)			
The heating microclimate		18-31 °C		
A cooling microclimate		-30...60°C		
Natural light: Coefficient of natural light, KEO, %		0,6...< 0,1		
Artificial lighting: Illumination of the working surface (E, lx) for the categories of visual works:		< EH		
Vibration local (on hands)	Work with mechanical equipment	up to 12 maximum permissible level		
Chemical factors that can lead to poisoning, choking, allergies, skin and other infectious diseases				
Chemicals	Dust and gases from preparatory and painting works		Risks in accordance with the class of working conditions (table. Three)	
Dust		up to 10 maximum permissible concentrations		
Harmful substances of hazard class 1-2		up to 20 maximum permissible concentrations		
Carcinogen		up to 10 maximum permissible concentrations		

Factor	Reason	Recommendations SanPiN [20]	Amount of risk
Allergens		up to 10 maximum permissible concentrations	
Ergonomic factors			
Workplace	Work standing		
Working posture	Forced posture	Periodic presence in an uncomfortable, fixed position 25...50% or more of the shift time	
Methods of work	Non-monotonic		

Table 4 - Dependence of occupational risk on classes of working conditions (P 2.2.2006-05)

Class of conditions labor management P 2.2.2006-05	index occupational disease	The category of professional risk	Urgency of risk reduction measures
optimal - 1	-	There is no risk	No action required
permissible - 2	< 0,05	Negligible (tolerable) risk	No action is required, but vulnerable persons need additional protection *
harmful - 3.1	0,05 - 0,11	Small (moderate) risk	Measures are required to risk reduction
harmful - 3.2	0,12 - 0,24	Average (significant) risk	Risk reduction measures are required in a timely manner
harmful - 3.3	0,25 - 0,49	High (intolerable) risk	Urgent needs risk reduction measures
harmful - 3.4	0,5 - 1,0	Very high (intolerable) risk	Work cannot be started or continued until risk reduction
Dangerous (extreme)	> 1,0	Ultra-high risk and risk to life inherent in the profession	Work should be carried out only under special regulations **

* Vulnerable groups of workers include minors, pregnant women, nursing mothers, disabled persons.
** Departmental, branch or professional regulations of works with monitoring of the functional state of the organism of the worker before or during change.

Instructing of workers of the enterprises shall be carried out according to GOST 12.0.004-90 "the Organization of training of safety of work". Programs of instructing are developed by specialists in labor protection taking into account requirements of standards, rules, norms, taking into account features of work at height in construction. O make an entry in the log of instructions at the workplace, as well as in the documents of employment (personal card). An indirect method of risk assessment based on the results of a special assessment of working conditions will make it possible to influence the organization and improvement of the workplace of workers in finishing works related to technological and organizational functions. The proposed measures will reduce injuries when falling from a height during finishing works in construction organizations.

6 SUMMARY

1. Statistics on the level of industrial injuries in the construction industry in Russia indicates a lack of motivation and responsibility of employers for serious attitudes to safety.
2. The new rules of work at height tighten the requirements of work at height and increase the responsibility of employers for labor protection.
3. Improving professional education, skills and culture in the safety of work in the construction industry will reduce injuries when falling from a height.

4. It is necessary to direct all means on financing of actions for labor protection to improvement of working conditions and on training of workers in methods of safe work.

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