



## Review of an occupational risk assessment at a construction site

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### ABSTRACT:

For years, the construction industry has been characterized by a high number of accidents at work, often with serious or fatal consequences. Therefore, it is necessary to search for new solutions and improve the existing ones in the area of accident prevention. Ensuring an appropriate level of safety in the construction industry is determined by properly targeted risk prevention activities and occupational risk assessment at individual positions. As indicated by the data of the National Labour Inspectorate, the correct performance of occupational risk assessment is often problematic for employers. This study aims to present the methodology of occupational risk assessment for selected positions in the construction industry and to emphasize the role of occupational health and safety in this sector of activity.

### KEYWORDS:

occupational risk assessment; occupational health and safety at the construction site

## 1. Introduction

For years, the construction industry has been the most accident-prone sector of activity, with accidents having the most serious, fatal consequences. According to inspections carried out by the State Labor Inspectorate (PIP), irregularities in the area of health and safety requirements are identified in these enterprises. As a result of these deficiencies, it sometimes happens that work is organized in unsafe conditions, which exposes workers and other people on the construction site to accidents. It is necessary to identify the causes of such situations and take effective corrective measures aimed at ensuring safety on construction sites. One of the identified problems, which translates into the level of safety in the construction industry, is the incorrect determination of occupational risks. According to the authors' experience and data presented by the PIP, the correct execution of occupational risk assessment (ORZ) is still a problem, particularly in terms of hazard identification. Among 839 inspections of occupational risk documentation, the PIP found irregularities in 54% of cases. In 2020, the number was 59% and in 2019, the number was 65% [1]. The decreasing number of irregularities in this area proves that the direction of change is positive although the speed with which progress is being made unsatisfying. Therefore, it is necessary to promote knowledge of the methodology of occupational risk assessment and its key importance in occupational safety management and accident prevention, which is one of the objectives of this study. Therefore, improving the level of safety on construction sites has

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become a point of interest for scientists who have been conducting research in this area in recent years [2].

## 2. Occupational risk assessment

The obligation to carry out an occupational risk assessment in the workplace stems from Labor Code (LC) [3]. According to Article 226 of the Labor Code, the employer is required to assess, document and inform employees of the results of the ORZ. In practice, the ORZ is a complex process, preceded by an analysis of the evaluated position, identifying the hazards associated with the tasks performed. In the next stage, it is necessary to select an appropriate method of risk assessment, its analysis and determination of acceptability. According to the PN-N-18002 standard, risk is defined as the combination of the frequency and probability of occurrence of an event causing danger and the consequences associated with that event [4]. According to International Labor Organization guidelines [5], occupational risk is understood as "the combination of the probability of occurrence of a hazard event and the severity of injury or impairment to workers caused by that event". The ORZ is the starting point for the selection of preventive measures, methods and organization of work, which should ensure an increase in the level of safety and health protection of workers and be integrated into the activities carried out by the employer at all levels of the organizational structure of the workplace [6].

### 2.1. Team performing the risk assessment

The regulations of the Labor Code and implementing acts indicate that "The employer assesses the occupational risk occurring in the performed work, in particular, in the selection of equipment for workstations and workplaces, used chemical substances and mixtures, materials containing biological, carcinogenic or mutagenic factors and when changing the organization of work. During the occupational risk assessment, all factors of the working environment occurring in the performed work and the ways of performing the work shall be taken into account" [6]. The content of the cited provision means that the employer is responsible for carrying out the ORZ, however, in practice, he may outsource the duty to carry out this assessment to an external entity or a team of people, which should include an occupational physician, a person in charge of employees or an employee of the occupational health and safety service. The PN-N-18002 standard [4], on the other hand, recommends that the risk assessment process be carried out by a team of people, which may include: the employer, employees designated by the employer or specialists from outside the organization. Due to the lack of rigid rules regarding the selection of assessment methodologies, the knowledge and experience of those performing the ORZ is important. The team performing ORZ should have knowledge about labor protection, both in terms of occupational safety and ergonomics, as well as in the field of labor law [7].

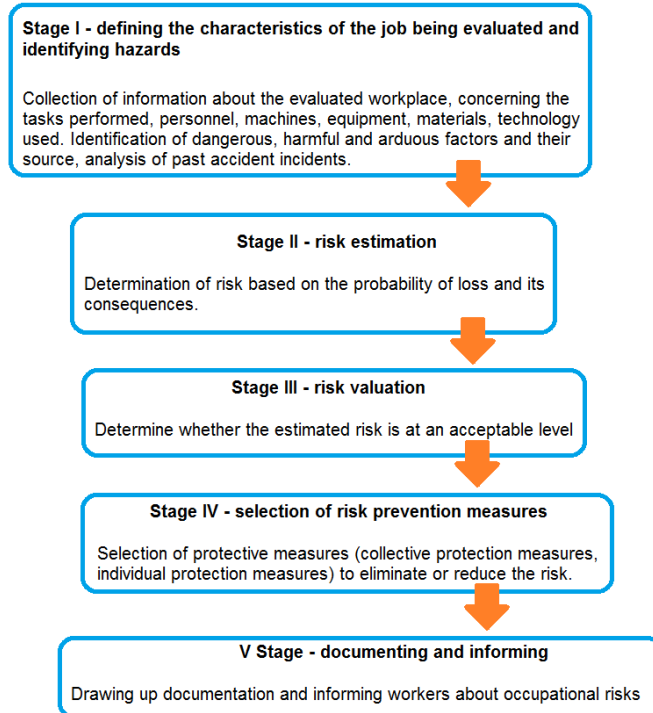
### 2.2. Stages of occupational risk assessment

Occupational risk assessment is a multi-stage task involving the activities of analyzing and determining an acceptable level of risk. Figure 1 shows the stages of ORZ with their brief characteristics.

### 2.3. Methods of occupational risk assessment

The prevailing view in the literature is that hazard analysis and ORZ are an essential component of efforts to ensure safe and healthy working conditions [8-11]. Many methods of risk assessment are known, which differ in particular in the level of detail adopted [9]. The most common ORZ methods used in practice are: PHA [7], RISC SCORE [12], PN-N-18002 [4]. The employer can choose any method for estimating occupational risk that best suits the needs of the organization and the risks. With regard to the construction industry, it is crucial that the method used allows for the possibility of frequent updating of the risk assessment, since this is an industry in

which workers change the location of their tasks. Thus, it is necessary to bear in mind the necessity of updating the assessment and linking it to the performance of construction work, including particularly hazardous tasks, i.e. work at height, demolition, repair and installation work carried out without stopping the operation of the workplace or part of it [13].



**Fig. 1.** Stages of occupational risk assessment

#### 2.4. Identification of risks in the construction industry

One of the key steps of the ORZ is the characterization of the workplace and working conditions and the identification of hazards [14, 15]. In the construction industry, we may encounter many different types of jobs, tasks performed and conditions of construction work. Thus, it is important to approach hazard identification on a case-by-case basis. Therefore, it is important to approach the identification of threats individually. A special source of information on hazards in construction may be information from the analysis of accidents that occurred in the past. Valuable sources of data on working environment conditions can be found in studies prepared by the Central Statistical Office, the National Labor Inspectorate, and the European Agency for Safety and Health at Work (EU-OSHA) [16]. Cases analyzed in 2021 by the PIP indicate that a construction site (new construction, demolition, renovation) is the place where fatal accidents occur most often - 34.6% of the fatalities studied [1]. The hazards that led to these incidents are most often from working at height - falls from height, for example; when working on scaffolding installation; exposing rain protection elements before installing new roof skylights; dismantling the steel structure of a concrete batching plant; climbing onto a roof with a slope of about 45 degrees without any fall protection; climbing with a ladder onto the ceiling of a garage or the roof of a building under repair; moving on a locomotive under repair; climbing the steps leading to the cab of a backhoe loader (51 victims - 21%). The literature [17] emphasizes that among

the irregularities identified as the causes of falls from heights on construction sites, an important role is played by the lack of collective protective equipment in the form of balustrades at the edges of ceilings, along staircases and landings around technological openings in ceilings and at external walls. Another nearly 12% of the injured were injured as a result of a worker being struck by a falling object, including being struck by: a pipe falling from a pile, a lump of earth, a suspended or felled tree, a steel tank weighing 6,000 kg; a folded boom arm, ceiling rocks in an underground excavation, a sheet of metal, a wall during demolition work and earth in an excavation [1]. In principle, hazards should be identified in four groups of factors, i.e. among physical factors (noise, ultrasonic noise, mechanical vibrations, cold and hot microclimates, ionizing radiation, moving elements, objects falling from heights); biological factors (viruses, bacteria, fungi, parasites or other living organisms capable of causing disease in humans); chemical factors (substances with toxic, irritating allergenic, carcinogenic, showing biological activity); psychophysical factors (monotony, monotypicality, mental strain, physical strain).

When construction work is carried out by several companies at the same time on a construction site, it is necessary for employers to work together in applying health and safety provisions and identifying risks [7]. For this purpose, the occupational health and safety coordinator is extremely helpful, as he plays a key role in maintaining safety at work of several entities working simultaneously [18]. The construction site health and safety plan required by law also provides support in this respect. The construction manager is obliged to prepare or ensure its preparation before the commencement of construction of such a plan, taking into account the specific nature of the building and the conditions for carrying out construction works, including the planned simultaneous conduct of construction works and industrial production [19]. In the case of construction works, in addition to the occupational risk assessment, it is necessary to prepare instructions for the safe performance of construction works (IBWR) and familiarize employees with it [20]. IBWR is another document that aims to define how to prevent threats related to the performance of construction works and actions in the event of these threats occurring. Particular attention should be paid to construction works where there is a risk of being covered with earth or falling from a height; carried out near high-voltage lines or active communication lines; carried out in wells, underground and in tunnels; using explosives; assembly and disassembly of heavy pre-fabricated elements (large-sized elements of steel or reinforced concrete structures, e.g. walls, beams, columns). To identify threats, you can use help in the form of checklists for construction, developed e.g. by the National Labor Inspectorate [19].

## *2.5. Risk assessment for the position of a excavator operator*

### *2.5.1. Job characteristics*

The occupation of backhoe loader operator involves carrying out specialized earthworks and auxiliary work related to construction and mining with an excavator. The excavator operator is engaged in excavation, loading and moving of earth masses, excavating and transporting the excavated material, as well as sorting and placing materials on the landfill. In addition, the work of the excavator operator involves auxiliary work: handling, transportation and cleaning. The excavator operator can travel on public roads in special situations. Work with earthmoving equipment is carried out in built-up and developed areas, which may involve the risk of electric and telecommunications network cables, gas and water supply systems in the work zone [21].

### *2.5.2. Tasks and working activities*

The tasks performed as an excavator operator include: leveling the terrain; excavating trenches, shoveling off soil; deploying and segregating work products; controlling the quality of work performed; performing work in accordance with the technological requirements specified for the process and the type of machine; reliably following the machine's surroundings to avoid collisions with other vehicles and objects and facilities; verifying the efficiency of the excavator and reporting any irregularities. In the most general terms, it can be pointed out that the respon-

sibilities of the machine operator include driving the machine, but also a number of activities related to the operation of the vehicle. Operational use includes technological and technical processes performed from the transfer of the machine through operation to its scrapping. When a machine is used in production processes, it should be used in accordance with the manufacturer's recommendations, i.e. maintained and properly stored, undergo technical inspections and necessary repairs. All processes related to the use of the machine are extremely important in maintaining an adequate level of occupational safety, for this reason, each participant in the various operations must conscientiously comply with the applicable arrangements and rules of operation.

### *2.5.3. Working environment*

The working environment of the backhoe loader operator includes construction sites, gravel pits, sand pits, quarries, mines and places where the machine is garaged. The excavator operator works both, inside and outside the cab, hence he is exposed to variable weather conditions. It should be emphasized that the ambient temperature has a major impact on working conditions and the quality of work performed. The remedy for too low temperatures is cabin heating systems. On the other hand, high temperatures in the summer are very inconvenient for the operator, and only the most modern machine models are equipped with air conditioning systems. In addition to atmospheric factors, the excavator operator is often exposed to excessive noise levels and dusty air. Dust contains harmful substances [22], and their inhalation may lead to respiratory diseases such as pneumoconiosis, asthma, acute respiratory infections and chronic obstructive pulmonary disease (COPD). Additionally, the operator's work is monotonous, which is related to the repeatability of movements of the machine control levers [23]. Hazards also include vibration, uneven, slippery surfaces, which can cause falls at the same level or from a height; moving parts of the vehicle – with which a worker can be crushed, caught or hit; ground – breaking off a wedge of debris, as a result of which the operator can fall into an improperly secured excavation.

### *2.5.4. Predispositions and qualifications*

The expected qualities from employees in this profession are responsibility, prudence, caution, accuracy, imagination and the ability to anticipate the consequences of their actions. The operator should have the ability to concentrate on specific activities and at the same time be aware of what is happening around him on the construction site. At the same time, the operator should be resistant to the monotony of work. Each operator must familiarize himself with a number of issues related to work methodology before starting work. The level of knowledge and skills will determine the proper and safe performance of the assigned tasks. The document confirming the authorization to operate working machinery is the Operator's Book issued by the Institute of Mechanization of Construction and Rock Mining, the possession of which allows its owner to independently perform work with the use of machinery and technical equipment for earthmoving, construction and roadworks, to the appropriate extent in accordance with the documentation contained in the book. To operate on the road, one must additionally have a driver's license in accordance with the requirements of traffic regulations. The operator is required to have knowledge of earthmoving technology including information on soil properties, angle of natural slope and wedge of breakaway. Knowledge of the wedge of soil breakage prevents the machine from slipping along with the soil by positioning the vehicle at a suitable distance to guarantee safety [8, 24].

### *2.5.5. Risk assessment sheet for the position of excavator operator – three-stage method in accordance with PN-N-18002*

The occupational risk at the evaluated workstation of the excavator operator after the implementation of preventive measures is at an acceptable level.

**Table 1**  
Occupational risk assessment using the three step method in accordance with PN-N-18002

No	Risks	Source risks	Possible effect	Severity of damage	Probability	Risk	Activities preventive
1	Falling on the same level, stumbling	Slippery, uneven surfaces, walkways, thresholds	Sprains, contusions, fractures, abrasions, cuts	medium	probable	medium	Use of appropriate footwear, exercise caution
2	Falling to a lower level	Tripping during entering and exiting the cabin	Sprains, contusion, fractures, abrasions, cuts	medium	probable	medium	Using proper footwear, entering/exiting the cabin properly, being careful
3	Impact on immovable elements	Protruding, rough sharp parts of the machine and its equipment (such as doors)	Abrasions of the skin, bruising, cuts	medium	probable	medium	Increased attention and control, adherence to instructions, not performing prohibited work with the machine running
4	Impact, getting caught by moving parts	Moving parts of the excavator or its equipment	Injuries, fractures, bruising, disability, death	medium	probable	medium	Increased attention and control, adherence to instructions, not performing prohibited work with the machine running
5	Crushing by machine	Rollover of an excavator	Injuries, fractures, bruising, disability, death	medium	probable	medium	Use of safety belts, proper positioning of the excavator during earthmoving operations, prohibiting the operator from being between the excavation wall and the excavator, following procedures and instructions
6	Being hit by other means of transport (traffic accident)	Other vehicles on the road or its side, careless movement on public roads	Injuries, fractures, contusions, disability, death	medium	probable	medium	Exercising special caution on the road, observing traffic regulations, observing the rules of transporting the machine, paying attention to the behavior of other road users, daily inspection of the machine, periodic inspection of the technical condition of the machine
7	Chemical substances	Machine consumables, cleaning products	Allergies, irritation of the mucous membranes of the eyes, throat, larynx, headaches, malaise, poisoning	medium	probable	medium	Personal protective equipment (goggles, respiratory protection)
8	Dusting	Dust from construction sites	Allergies, irritation of the mucous membranes of the eyes, throat, larynx, headaches, malaise	small	unlikely	small	Personal protective equipment individual protection measures
9	Noise	Noise from machinery and other traffic vehicles, sounds from construction sites	Fatigue, headache, concentration problems, hearing damage	medium	probable	medium	Systematic measurement of noise, control of cabin soundproofing, use of hearing protectors
10	Vibrations	Vibrations transmitted by the working machine and its auxiliary equipment (such as a jackhammer)	Fatigue, decreased concentration, pain in the limbs, changes in the nervous system, sleep problems, vibration sickness	large	unlikely	medium	Systematic inspection of the shock absorbing system
11	Lighting	Insufficient lighting in the machine cab or excavator work areas	Faster fatigue, headaches, tearing and reddening of the conjunctiva, decreased ability to accommodate the lens of the eye, decreased visual acuity, worsened mood, increased work accidents, decreased productivity at work	large	unlikely	medium	The cabins should not have devices that cause glare from their surface.
12	Fire	Gas damage, unexploded ordnance, use of electrical appliances	Burns to the body, asphyxiation, disability, death	large	unlikely	medium	Comply with fire regulations, exercise special caution, carry out work in accordance with the project, refrain from further work in case of encountering unexploded ordnance or damage to installations
13	Electricity	Use of electricity-powered equipment	Burns, paralysis, dysfunction of nervous, respiratory, circulatory organs, loss of consciousness, death	large	unlikely	medium	Inspect and maintain electrical machinery and equipment according to manufacturer's guidelines
14	Overloading of the musculoskeletal system (static)	Forced (sitting) body position	Diseases of the musculoskeletal system	large	unlikely	medium	Maintaining correct posture, using ergonomic principles – proper positioning of the chair, mirrors, use of short breaks, staff rotation
15	Variable microclimate	Variable weather conditions	Variable weather conditions weather	large	unlikely	medium	Appropriate work clothes, refreshments
16	Stress	Interpersonal conflicts, working under time pressure	Neurosis, decreased productivity, decreased concentration	medium	unlikely	small	Proper organization of work, no rush

## 2.6. Documentation of occupational risk assessment

In addition to carrying out the ORZ, it is necessary to keep its documentation. Developed documents must include, in particular, a description of: the evaluated workstation, including the tasks performed, the machinery, equipment, materials used, hazardous, harmful and burden – some factors occurring at the workplace, the collective and individual protection measures used, the people working at the position; the results of the occupational risk assessment for each of the factors of the work environment and the necessary preventive measures to reduce the risk, as well as the date of the assessment and the data of the person(s) making the assessment [6].

## 3. Conclusions

Construction works are works for which the legislator has stipulated specific requirements for eliminating hazards. A number of obligations in this regard arise from the provisions of the Construction Law [24] and implementing acts [20, 23]. The ORZ is one of the tools for professionally identifying risks to health and life and taking appropriate measures for the prevention of accidents and occupational diseases.

On the other hand, in order to achieve sustainable improvements in universal compliance with OSH regulations, it is particularly important to directly involve employers in the process of managing occupational health and safety. It is necessary to take effective measures to change the awareness of employers, as well as employees, as to how the positive development of safe working conditions translates into comfort and productivity at work and the economic aspects of the operation of enterprises. The PIP is taking initiatives in this regard and is carrying out promotional, inspection and prevention activities on large and small construction sites in 2022-2024 entitled "Inspection and Prevention Strategy in Construction". Particular attention should be paid to accident hazards associated with working at height, including from scaffolding and ladders, as well as hazards in earthwork, including construction machinery and technical equipment, and work in excavations.

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## Przegląd oceny ryzyka zawodowego w branży budowlanej

### STRESZCZENIE:

Branża budowlana od lat charakteryzuje się wysoką liczbą wypadków przy pracy, często ze skutkiem ciężkim lub śmiertelnym, dlatego niezbędne jest poszukiwanie nowych rozwiązań oraz doskonalenie funkcjonujących w obszarze profilaktyki wypadków. Zagwarantowanie odpowiedniego poziomu bezpieczeństwa w branży budowlanej determinowane jest przez właściwie ukierunkowane działania profilaktyki zagrożeń i ocenę ryzyka zawodowego na poszczególnych stanowiskach. Jak wskazują dane PIP, prawidłowe wykonanie oceny ryzyka zawodowego przez pracodawców niejednokrotnie jest dla nich problematyczne. Niniejsze opracowanie ma na celu przedstawienie metodyki postępowania przy ocenie ryzyka zawodowego na wybranych stanowiskach w branży budowlanej i podkreślenie roli bezpieczeństwa i higieny pracy w tym sektorze działalności.

### SŁOWA KLUCZOWE:

ocena ryzyka zawodowego; bezpieczeństwo i higiena pracy na budowie