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RISK ASSESSMENT USING EXPANDED POINT METHOD IN CIVIL ENGINEERING

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Nowadays, there are increasing discussions concerning an extensive area of occupational safety and health, whether is it within the territory of the Slovak Republic or in other Member States of the European Union. Every organization prepares independently its own policy of occupational safety and health using applicable legislation. The objective of this work was to minimize the errors resulting not only from the human factor but also from incorrect working procedures, from failing to observe legal requirements, and from an incorrect use of personal protective equipment. After evaluating the risk level in working activities of employees on site, we have proposed measures to reduce the risk by means of defining correct working procedures and using personal protective equipment. That enables reducing occupational injuries, which will directly improve the overall level of occupational safety and health on a selected site.

Keywords: risk, civil works, occupational safety

To achieve an acceptable level of safety, it is necessary to create the policy of occupational safety and health (OSH) (Korenková, 2008) and to determine the objectives and procedures of its implementation within a company (Bujna et al., 2011). However, the awareness of OSH must be further built in all employees (Višňovský and Korenková, 2004; Korenková, 2012); this procedure is performed from the top management, through all levels, up to employees (Feszterová, 2013). Also a good mutual communication between employers and employees as well as their motivation to safe work in company is important, which significantly contributes to the level of corporate culture (Hulínová, 2005). The highest priority of improving the human performance is in avoiding human errors during working activities (Korenko et al., 2010; Korenko et al., 2010). In every working activity, it is important to correctly define and analyze all errors that may occur with these activities, even if only theoretically (Korenko, 2012). The assessment of risks forms a basis of every approach to managing OSH and is a core element when establishing a sound workplace (Pačaiová et al., 2009). The strategy of the European Community in the field of OSH for the time period of 2007 – 2012 recognizes the importance of assessing risks and calls for creating simple tools that would simplify the process of assessing risks. The objective of this work was to minimize the errors resulting not only from the human factor but also from incorrect working procedures, from failing to observe legal requirements, and from an incorrect use of personal protective equipment (PPE).

Material and methods

The subject of our examination is assessing the achieved level of OSH in civil works. We have focused on determined objectives of the selected building company in the field of OSH and assessed their level of fulfilment during the construction of a specific building.

We proceeded according to the following methodology:

- collecting documents concerning the building safety documentation,
- determining the schedule and performing checks in cooperation with a site manager,
- selecting a suitable method for assessing risks on site,
- identifying risks using an expanded point method,
- proposal of safety measures to reduce the risk identified.

When assessing the risk, we have used the 'extended point method', which belongs to the most frequently used methods in the field of assessing risks. The greatest benefit of this method is the process of assessing and evaluating risks, which is fast and effective thanks to point evaluation. This assessment was performed having regard to all work-related circumstances so that the workplace, machines, equipment, implements, tools, materials, working procedures, working aids, the layout of working places, and the organization of work do not endanger the safety and health of employees. Assessment included all employees and other persons that could be exposed to risk. The assessment of risk that could arise at work was determined by visual inspection and was evaluated using the above-mentioned point method by which the risk rate was determined and safety measures were proposed. Identified shortcomings were documented graphically. Persons involved were informed of risks resulting from their working activities.

Risk assessment using expanded point method

Risk is a mutual relationship between the probability of occurrence of a negative phenomenon and its consequence. Risk assessment was performed using the expanded point method, within the meaning of definition:

$$R = P \cdot D \cdot V \quad (1)$$

where:

- P – probability of occurrence of a given event (Table 1)
- D – consequence of the monitored event (Table 2)
- V – opinion of assessors (Table 3)
- R – risk rate (Table 4)

Table 1 Probability of event incidence

Value	Defining the event incidence in terms of probability
1	Improbable – undesirable event is almost eliminated
2	Random – undesirable event is hardly probable, but possible
3	Probable – undesirable event could occur
4	Very probable – undesirable event will probably occur
5	Permanent – undesirable event will occur very frequently

Table 2 Consequence of event occurred

Value	Defining the consequence of event
1	Negligible – small injury – less than light injury, negligible financial and material losses
2	Least significant – light injury, disease, beginning of occupational disease, low financial and material losses
3	Significant – a more severe injury requiring hospitalization, higher financial and material losses
4	Critical – severe injury with permanent consequences, occupational disease, high financial and material losses
5	Catastrophic – fatal, mass accident, irretrievable losses, losses leading to liquidation

Table 3 Opinion of assessors

Value	Defining the importance of effect on probability and consequences
1	Negligible effect on probability and consequences
2	Least significant effect on probability and consequences
3	Important effect on probability and consequences
4	Significant, high effect on probability and consequences
5	Several significant effects on probability and consequences

Table 4 Risk rate

Value	Defining the risk rate
1–4	Negligible – acceptable safety
5–10	Moderate – acceptable risk at increased attention
11–50	Serious – risk cannot be accepted without protective measures
51–100	Undesirable – insufficient safety, high risk of accidents and undesirable events
101–125	Inacceptable – permanent threat of accident, irretrievable losses

Results and discussion

Inspections in the field of OSH were performed in cooperation with a safety coordinator – in this case, an authorized safety officer who is competent for performing inspections of meeting OSH. Regularly performed inspections focused on meeting the legal regulations and directives for performing works on site. During inspections, we verified whether workers were acquainted with risks arising with certain activities on site. Identified shortcomings were documented by preparing graphical records (photographs) that were subsequently evaluated using the expanded point method. After evaluating the risk rate that influences workers, we proposed safety measures to reduce the risk. Identified shortcomings, risk rate and proposed safety measures were communicated to managers and persons executing given works. Graphical records of performed inspections and determined values of risks are recorded in the building safety documentation. Risk evaluation and its correct documentation are of high importance for the subsequent determination of

meeting the established objectives and safety level in the given company. Identified shortcomings:

- As shown in Figure 1, the worker in height is not secured against fall.
- The workers below the workplace in height do not use personal protective equipment to protect their heads; a similar risk evaluation is shown in Table 5.

Proposed measures:

- The worker at the border of workplace in height must be secured at least by a safety belt with a jumper anchored to a fixed structure.
- PPE must unconditionally be used in height to protect the head.
- Enclosing the space and avoiding the access of persons below the workplace in height.

Figure 1 Assembling the formwork of Doka system type for horizontal structures

Table 5 Assembling the formwork of Doka system type for horizontal structures

Danger	Threat	Threat identification	Risk calculation				Safety measures
			P	D	V	R	
Works during disassembling formwork structures	worker's fall from height	<ul style="list-style-type: none"> worker's fall from height – from free unsecured borders of the formwork structure, i.e. especially at disassembling and handing the parts of the formwork structure and formwork components missed fall when failing to use personal securing means (PSM) 	3	4	1	12	<ul style="list-style-type: none"> the worker at the border of workplace in height must be secured at least by a safety belt with a jumper anchored to a fixed structure, and PSM must be used correct use of PSM, using allowed combinations of PSM, inspections and tests of PSM, following the instructions for use correct choice of a suitable and reliable anchoring point of PSM so that the worker secured with PSM could not freely fall when catching the kinetic energy from an eventual free fall of the worker
	possible hitting of workers by falling objects	<ul style="list-style-type: none"> fall of an object and material on a person, with endangering and injuring the head (i.e. by a part of the formwork structure or formwork components, material fragments) fall of the structure and individual parts of mounted formwork 	2	3	1	6	<ul style="list-style-type: none"> PPE must unconditionally be used below the workplace in height to protect the head protecting the space below the workplace in height from endangering by falling objects by delimiting and enclosing the endangered space (using a barrier with a minimum height of 1.1 m, with rods fixed on supporting poles with sufficient stability) avoiding the access of persons below the workplace in height

Table 6 Disassembling the formwork of Doka system type for horizontal structures

Danger	Threat	Threat identification	Risk calculation				Safety measures
			P	D	V	R	
Works during disassembling formwork components	possible hitting of workers by falling objects (released components are not removed from the ceiling)	<ul style="list-style-type: none"> fall of an object and material on a person with endangering and injuring the head (i.e. by a part of the formwork structure, formwork components, material fragments) fall of an intentionally dropped part of the structure and individual parts of the disassembled formwork 	3	3	1	9	<ul style="list-style-type: none"> when disassembling the formwork, PPE must unconditionally be used to protect the head and sight following the correct technological procedure during disassembling the formwork and formwork components removing released components of the formwork from time to time protecting the space below the formwork disassembling workplace from falling objects by delimiting and enclosing the endangered space avoiding the access of persons below the formwork disassembling workplace

Table 7 Assembling the soil moisture vertical insulation

Danger	Threat	Threat identification	Risk calculation				Safety measures
			P	D	V	R	
Works in the excavation pit	hitting by incursion of falling soil	<ul style="list-style-type: none"> hitting the persons in the excavation pit by falling soil from the excavation pit wall, stewing, injuries to head and legs (fractures) 	2	4	1	8	<ul style="list-style-type: none"> to prepare the lining of the excavation pit wall to use PPE to protect the head at works in the excavation pit to enter only into the excavation pits secured by lining against soil slip
	possibility of hitting the head by falling fractures from the excavation pit wall	<ul style="list-style-type: none"> hitting the persons in the excavation pit by fractures falling from the excavation pit wall, injuries to head, sight, and legs 	2	2	1	4	<ul style="list-style-type: none"> to use PPE to protect the head, sight and legs to restrict working activities above the excavation pit when working in the excavation pit securing or removing stone blocks and residues of building structures in the excavation pit walls
Gas bottle	possible burning by flame	<ul style="list-style-type: none"> when working with gaseous equipment, operators can be burnt due to failing to observe correct working procedures 	2	3	1	6	<ul style="list-style-type: none"> to use PPE to protect the head, sight and legs when working with open flame professional competence for servicing gaseous equipment regular revision and inspection of gaseous equipment

Figure 2 Disassembling the formwork of Doka system type for horizontal structures

Figure 3 Assembling the soil moisture vertical insulation

Figure 4 Number of identified shortcomings in year 2010

Identified shortcomings:

- Figure 2 illustrates that the workers do not use PPE at work to protect the head and sight, whereby there is a high probability that the disassembled material will fall; a detailed risk assessment is shown in Table 6.

Threat:

- Hitting a worker (especially the head) by a falling object.
- Released components of the disassembled formwork are not removed from the ceiling.

Proposed measures:

- Using PPE to protect the head and sight.
- Following the correct technological procedure when the formwork is disassembled.
- Removing released formwork components from time to time.

Identified shortcomings:

- As can be seen in Figure 3, the workers do not use PPE to protect their heads near the excavation pit wall.
- Unsecured excavation pit stability; the detailed assessment of the resulting risk can be seen in Table 7.

Proposed measures:

- Preparing the lining of the excavation pit wall.
- Using PPE to protect the head when working in the excavation pit.
- Securing or removing stone blocks and residues of building structures in the excavation pit walls.
- Professional competence for servicing gaseous equipment.

All building companies should remember that every site as well as conditions of given premises and their surroundings is unique and unrepeatable. Therefore, it is clear that the plan of OSH as well as the assessment of risks cannot be elaborated schematically, but must be tailored to a given situation, conditions of a given site, and mutual relationships.

Evaluation of meeting OSH during block of flats construction

During the construction of a block of flats, the persons who performed works on this building were informed about identified shortcomings and the risk resulting from them. Furthermore, these workers were

instructed in proposed correcting measures. During subsequent inspections of meeting OSH, the degree to which the proposed measures to reduce risks were met was also verified. Identified shortcomings were documented, recorded, and evaluated graphically.

Figure 4 illustrates the evaluation of shortcomings identified during inspection of meeting OSH for individual months of year 2010. However, it should be noted that several sub-contractors took part in the construction of the building during the inspection of meeting OSH, and works were performed according to the schedule of works with respect to technological procedures. That directly influenced the volume of performed works and the number of workers on site during one month, and subsequently, also the number of identified shortcomings in the given month.

Conclusion

When assessing risks, it is necessary to care especially about the safety of workers who should be familiar with their own occupational health and safety. When performing their works, they should be very particular primarily about their safety, use suitable protective equipment, meet prescribed working procedures, and should not consider OSH as a burden but as the protection of their health at work. However the company may strive to ensure a safe working environment for its employees, it will be vain if every employee alone does not realize that they must observe determined regulations they were instructed in, and so they will reduce the rate of risks they are put at.

It is necessary to constantly and regularly perform checks of the state and meeting of OSH. It is important to identify how and why employees fail to meet, or even violate safety regulations. In order to prevent from any unnecessary accidents and occupational diseases, OSH should also be checked randomly.

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