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THE HAZARDS OCCURRING DURING THE CONSTRUCTION AND RECONSTRUCTION OF METAL STRUCTURES

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Abstract: The variability of hazards occurring during the construction and expansion of temporary metal structures is the result of many factors. It mainly depends on the environment in which the structure is to be built and the ground on which it is to be located. The fitter generates the most threats during work related to the transfer of elements of a given metal structure as well as assembly and disassembly, and therefore the fitter is the most exposed person to any threats related to the construction of a metal structure.
Keywords: Hazards, Safety, Accident rate

1. INTRODUCTION

There are many threats during the construction and expansion of metal structures, where the fitter of metal structures is the most exposed to all dangerous and harmful factors. Its basic task is to prepare, assemble and disassemble metal structures that are made of various types of elements or prefabricated elements (Zhou L et al.,2019). The work of the fitter can take place on three levels. The first one includes all tasks related to the processing of sheets supplied from steel mills and the processing of rolled sections of various types (Yang et al., 2019). Such action is aimed at obtaining components enabling the assembly of the structure at the destination, this is the second of the assembly planes (Wu et al., 2022) To achieve the intended effect, fitters use various types of equipment, devices, and machines such as press brakes, drills, grinders and welding machines and similar elements of machines and devices (Chong et al., 2022). The prepared elements are often numbered, which greatly facilitates subsequent assembly and disassembly (Fang, 2020). Often, the purpose of increasing the efficiency of the work performed is to keep technical documentation in the form of technical drawings. Where all elements and subassemblies are described in accordance with a predetermined numbering. Such activities are aimed at both increasing the efficiency of the fitter and preventing potential mistakes and potential accident situations. The last element of assembly is the connection of all previously prepared elements in accordance with the technical documentation into a compact whole (Yadav et al., 2022). Before starting dismantling works, it is first necessary to develop a plan of individual dismantling activities to eliminate potential threats that may arise because of demolition of a given structure (Shatiet et al., 2022). In

the case of expansion of metal structures, it is first necessary to familiarize yourself with the existing object and correctly calculate its load capacity and the possibility of further expansion (Liao P et al., 2021) You should also become familiar with the infrastructure and the environment in which the structure is to be built due to the bearing capacity of the soil or the possibility of its attachment to the existing infrastructure (Mallakpour et al.,2021).

Risk in construction is among the highest within industrial sectors, which is inevitable when manipulating large masses of considerable dimensions in close proximity to workers (Chrzan, 2021). A similar albeit slightly lower level of risk is encountered in railway transportation (Radek and Dwornicka, 2020). The presented approach to analysis can be useful in many related areas of management (Bajwoluk, 2021), including the machinery industry (Krynke et al., 2022), such as automotive (Mazur, 2018) and railway (Kuzior and Staszek, 2021), as well as in the forging industry (Ulewicz et al., 2020). Risk reduction can also be achieved by employing enhanced materials (Ulewicz et al., 2013; Kuciel et al., 2019) and methods of their acquisition (Pietraszek et al., 2020) and implementation in work practices (Kuzior and Zozul'ak, 2019; Warzocha, 2021; Kuzior, 2022). In conjunction with sustainable development, this leads to ecological solutions (Kasner et al., 2019) geared towards reducing energy consumption (Cieśliński and Malaga-Toboła, 2021; Twaróg, 2023a; Twaróg, 2023b) and avoiding environmental pollution (Ormaniec and Mikosz, 2023).

2. METHODOLOGY

The work of the fitter takes place in changing conditions, both in open space and in enclosed spaces. Part of the work may be carried out at the headquarters of a given workplace or directly at the construction site of a given metal structure. As a finished metal structure, we can only consider an object whose all work related to assembly has been completed and all acceptance has been made. Due to the nature of the tasks performed at the fitter's position, various harmful factors are generated that directly affect the unit. The main harmful factors are noise, vibrations, and thus the changing microclimate occurring in each work environment. The variability of the microclimate is often conditioned by the atmosphere due to the work carried out outdoors, and therefore employees must adapt to the conditions prevailing outside (Nnaji et al., 2020). Various types of electric welding machines are often used, which can cause ultraviolet radiation, which is extremely harmful to vision. Other types of hazards are all dust suspended in the air arising because of locksmith work, grinding, and drilling (Develi, 2019). Other threats include all electrical devices whose moving and rotating elements can be extremely dangerous with carelessness (Hou et al., 2020). It should also be paid special attention that these devices largely work with the use of electricity (Okapala et al., 2020). Therefore, care should be taken, especially in the case of outdoor work, to properly protect electrical wires and any elements exposed to water (Uddin et al., 2020).

In terms of social conditions, special attention should be paid to working in teams. Usually, all works related to the construction and extension of metal structures are carried out in teams of 5 to 7 people. Therefore, it is very important for employees to keep themselves informed about the progress of work and tasks performed to reduce accidents during their performance. The position requires the unit to concentrate on individual elements and focus attention to correctly perform a given metal structure (Sun et.al., 2022).

Worker of metal structures is included in the group of construction workers. His main duties include both assembly and disassembly of metal structures. It can also perform work in the field of reconstruction or extension of existing metal structures (Sergey et al. 2021). The scope of his duties is also to perform all works in accordance with the previously prepared technical drawing of a given metal structure (Zhang et al., 2020). This work must be carried out in accordance with the previously established numbering of individual elements of a given metal structure, and these activities are aimed at preventing the possibility of a potential accident (Bartlett, et al.,2019). This profession is burdened with a high degree of occupational risk.

Risk matrices (Knutson and Huettel, 2015). This method considers the type of effect of the dangerous significance and the probability of its occurrence. To correctly determine the risk analysis with this method, it is good practice to determine the individual components in advance:

- characteristics of the workplace for which the risk assessment will be performed,
- drawing up a list of hazards present in each work environment,
- risk assessment, including determination of possible effects and needs, the likelihood with which they may occur in each workplace,
- risk valuation understood as the product of the effects of a hazard and the probability of occurrence of a given hazard and reading its value of the schema presented in Table 1.

Tabele 1
Risk assessment using the risk matrix

	Probability		
Effect	S-Small	M-Medium	L -Large
S - Small	S	M	M
M – Medium	M	M	L
L- Large	M	L	L

Source: Own study

In the case of an occupational risk defined as low, the introduction of corrective or corrective actions is voluntary. In the case of medium risk, it is recommended to reduce the risk to an acceptable level by introducing corrective actions or applying additional protective measures. When there is a high risk, it is necessary to take measures to reduce the level of risk. In a situation where the risk is high, the employee cannot be allowed to work until it is reduced to an acceptable level. To this end, absolute corrective or corrective action must be taken to reduce the risk, or organizational or technical measures must be taken that can eliminate its occurrence in the work environment. Table 2 presents occupational risk analyses for metal fitters using the risk matrix (Niciejewska and Klimecka-Tatar, 2016)

Table 2
Classification of hazards at the position of metal construction fitter along with the ocean of occupational risk.

Hazard (possible dangerous event)	Causes of danger	Possible effects of the hazard	The significance of the impact of the threat	Probability of hazard occurrence	Occupational risk	How to reduce risk	Risk after reduction
Fall at the same level	Slippery and uneven surfaces at the work site, both in the office and on the construction site)	Bruises, fractures of limbs, sprains, sprains, internal injuries.	M	M	M	The use of appropriate footwear depending on the tasks performed, maintaining order in the workplace, complying with the instructions, regulations and procedures in force at the construction site, exercising extreme caution.	S
Level difference (fall to a lower level).	Poor technical condition of scaffolding, unsecured structural openings, poorly selected and improperly used ladders and rises, carelessness.	Severe injuries, disability, death.	L	M	L	Use scaffolding, ladders and rises in accordance with technical requirements, carry out their systematic inspection, exercise extreme caution, use appropriate protection of structural openings (m.in. safety barriers), if necessary, use equipment to protect against falls from heights, use appropriate footwear, maintain order.	M
Moving objects, moving parts of machines and devices (hitting an object, being caught by moving parts of a machine).	Carelessness, lack of guards for construction machinery and equipment, failure to use personal protective equipment	Injuries, injuries, death, disability.	L	M	L	Compliance with applicable regulations, instructions and procedures, exercise extreme caution, use of appropriately selected personal protective equipment (helmets),	M
Noise and vibration	Machinery and equipment used on the construction site, means of transport to a lesser extent office equipment.	Lack of concentration, neuroses, circulatory problems, hearing impairment.	M	S	S	Use of equipment that meets technical standards, use of collective protection measures (soundproofing screens, etc.) use of hearing protectors, shortening the time of exposure to harmful agents as much as possible	S
Impact by moving objects	Moving transport and construction vehicles.	Serious injuries, death, disability	L	M	L	Exercise extreme caution when performing inspections at the construction site and when moving by means of transport, appropriate marking of the construction site, compliance with the regulations, instructions and procedures in force at the construction site.	M

Hazard (possible dangerous event)	Causes of danger	Possible effects of the hazard	The significance of the impact of the threat	Probability of hazard occurrence	Occupational risk	How to reduce risk	Risk after reduction
Dynamic physical loads (osteoarticular system overload)	Carrying too much weight.	Pain, joint or spinal damage.	M	S	S	Compliance with individual transport standards,	S
Variable weather conditions	Rainfall, cold, solar radiation.	Colds, overheating, sunburn	M	S	S	The use of appropriately selected footwear and work clothing by employees, shortening as far as possible the time of exposure to factors that may be a threat.	S
Dusts (dustiness).	Work of construction equipment and machinery, dust occurring at controlled workplaces, construction transport.	Respiratory diseases, allergies, allergies	M	S	S	Reduction of exposure time to dust, use of half masks and safety glasses	S
Electric current (electric shock)	Inadequate electrical installation of equipment, electrical breakdown of machines and devices.	Burns, death	L	S	M	Application of protection against shock and their systematic control, ongoing control of the insulation of current supply wires and checking the condition of electrical equipment	S
Inadequate lighting.	Poor natural lighting, poorly selected light points depending on the work performed, work with insufficient lighting.	Injuries caused by accidents at work, rapid fatigue, visual impairment.	M	M	M	Adjusting the level of lighting to the type of work performed, in accordance with applicable standards.	S
Chemical agents – irritating and sensitizing,	Means used in construction. (leaks, splashes, fumes).	Burn and allergic wounds of upper and lower limbs, face, eyes, poisoning	M	M	M	Follow instructions and procedures, exercise caution, use personal protective equipment if necessary.	S

Source: Own study

An employer can take a few measures to reduce the risk. One of them is the elimination of sources of hazardous and harmful factors through the selection of both machines and devices that do not pose a threat to physical and chemical factors in the working environment. Selection of substances or materials that do not have a harmful effect on the health and/or life of the employee Klimecka-Tatar and Matevž,2020). Another method of risk mitigation may be to move a person away from the danger area or prevent access to the danger zone. Such actions can be ensured by various types of barriers, shields, or light curtains, which turn off the machine when the light beam is interrupted. If it is not possible to reduce the risk through collective protection measures, the employee should be equipped with personal protective equipment that is designed to reduce the risk of accidents at work (Nedeliaková et. al., 2022). A very important aspect in the case of individual protective equipment is the correct matching of it to the anthropometric data of a given unit (Klimecka-Tatar, D et. al. 2023).

3. CONCLUSION

There are many hazards in the working environment of both assembly and disassembly of metal structures. In addition, their variability is largely determined by external factors. Because the construction of a metal structure takes place in changing conditions, both atmospheric and the shape of the terrain itself and the load-bearing capabilities of a given substrate. A metal fitter must consider all variable factors to work safely. This requires a lot of knowledge about the structures themselves as well as the specifications of the environment in which it will be built. This is an extremely responsible job, because in the case of metal structures, the correct and load-bearing capacity are mainly determined by the connecting elements. Reading the full specification of a given structure and making it in accordance with all parameters determines the appropriate level of safety. In addition, the monitor must have extensive knowledge of reading technical drawings, as well as have knowledge of how to correctly read a given technical specification of the structure being built. One of the main and greatest hazards that occur during the construction of metal structures is falling from a height (Klimecka-Tatar and Ingaldi, 2022). That is why personal protective equipment in the form of harnesses or safety ropes to protect the employee from falling from a height is very important. It is also important to train the employee frequently, because such a large variability of the conditions in which he performs his work requires him to have extensive knowledge of occupational health and safety (Ciecińska and Oleksiak, 2023). This is not required by law, but it is good practice to minimize the risks in the work environment. The issue of additional training is the responsibility of the employer. However, it should be remembered that it is better to protect the employee against the risk of an accident and prevent it from occurring, because human life is a paramount value. Considering other conditions, for example, economic protection of an employee against an accident is much cheaper than his absence and costs related to all the consequences of an accident at work (Ingaldi and Dziuba, 2016).

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