Overview of Safety Risk Perception in Construction

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Abstract: Construction industry is a generally risky business; it remains one of the most dirty, difficult and dangerous with poor working conditions. Despite recent efforts to improve site safety, it still accounts for a disproportionate number of occupational-related fatalities what is supported by statistics. According to the International Labour Organization, it accounts for 30–40% of the world's fatal injuries. In The European Union around thirteen employees out of every one hundred thousands are killed each year. Hence, construction site safety is a matter of global concern. However it is not easy to describe and define how to deport safely at some actual site because the workers are exposed to many safety risks varying in connection with conditions of the construction realization and with technologies using. The paper provides a brief knowledge from the study comparing the construction safety in Europe and North America referencing to presented statistics. There are also analyzed, described and systemized the principal groups of construction safety risks; described the interdependencies among safety risks, affecting by spatial, technological and time parameters of the building process, as well as by the site conditions.

Key words: Occupational safety and health, construction safety, safety risk, construction site, fatal injury, work accident.

1. Introduction

The construction as important one in the world economy employs around 180 million people, or 7% of global employment [1]. Even though it has a world reputation for the quality, it is a generally risky business. Although there is a distinct improvement on the safety performance in the sector, it is still a high risk occupational area over the world and suffers from very high accident rates when comparing to other industries. The most common results of accidents are absenteeism, loss of productivity, permanent disability and even construction site fatalities. The majority of construction fatalities results from falls from height, struck by a moving vehicle, motor vehicle accident, burial by earth collapse during excavations, etc. Another problems on occupational health and safety usually occurred at the sites are: stroke by falling objects or materials, stepping on objects, injuring by hand tools, injuring whilst lifting or carrying, slipping, tripping or falling on same level, striking against moving objects, exposure to or contact with harmful substances, etc. It is caused by many reasons: high-risk nature of construction work, low knowledge and a lack of trade risk awareness of tradesmen, building terms decreasing, insufficient health and safety solutions in phase of construction preparation, low demands on site facility according to law, complicated contractor system with big amount of subcontractors, thin exertion of collective protection and technical safety by reason of the building costs increasing, low level and absence or malfunction of safety management and control systems especially in small construction companies and tradesmen, etc.[1]. Almost all production processes within the construction come through different, more difficult conditions as in other industries. Most construction sites are small without sufficient storage spaces and spaces for auxiliary works. In the site, different tradesmen have to work close together within limited spaces. Due to diversification of activities, the large number of subcontractors is common within the construction site. With higher numbers of subcontracting, the chances of accidents occurrence become more frequent [2].

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2. European and American Construction Health and Safety

The European construction industry [3] with its annual output more than 900 milliards € and almost 15 million people working in belongs to the most important economic sectors and represents 7.2% of Europe’s total employment. Unfortunately, in spite of its important role in all member states economics, it still accounts for one of the worst health and safety balancing when comparing with other sectors. The construction sector in Europe has the second highest incidence of accidents which means 1.4 times the EU average. The first most risky sector (fishing) records 2.43 times the EU occupational average and other sectors (health and social welfare and agriculture) around 1.3 times the EU average. In the 10 acceding countries in 2003 (include Slovakia), it is estimated that construction accounts for 20% of all work-related accidents [11]. In part this relates with fact that more than 99% of construction firms in Europe are small and medium and 47% of all construction workers work in businesses with fewer than 10 staff. In small firms the problems of safety and health are managed at by much lower level than in big companies. The states with the worst fatal cases rate in construction in last 15 years are Malta, Lithuania, Czech Republic and Romania.

The attention of European Agency for Safety and Health at Work (EASHW) in its safety prevention [9] is also concerning data shown paid primarily to the most distinguished risks those construction workers in EU face. The extension of these risks: Falling from heights, such as scaffolding, is one of the biggest problems, along with accidents involving transport, both on and off site and earth collapses during excavations. The considerable respect from the agency side is centered to negative impact of construction works to workers health. Allowing the incidence of musculoskeletal disorders is significantly above EU average. Several construction workers (from 48 to 23%) report backache, claim muscular problems in the neck and shoulders and complain of upper and lower limbs muscular problems. Respiratory problems are widespread whereas 600 thousands workers are exposed to asbestos each year that causes fatal diseases as well as breathing in dust from cutting or handling crystalline silica-based products, such as sand. Then carpenters have a great risk of contracting nasal cancer because of breathing in wood dust. All the same frequent contact with liquid-based substances, such as oils, resins and cement-based products containing Chromium, exacerbate the likelihood of skin problems. Studies have shown an increased risk of early retirement among painters and floor layers due to “solvent syndrome” associated with excessive exposure to organic solvents, such as glycol ethers and esters. These symptoms can include memory loss, severe fatigue and other problems of the central nervous system. Among other most frequent risks of EU construction workers, following the statistics, belong excessive contact with lead, damaging the central nervous system, high noise level increasing hearing difficulties and hand-arm vibration syndrome among workers using hand-operated power tools.

According to the U.S. Bureau of Labor Statistics, the construction industry, the largest single — service industry in the U.S., consistently employs approximately 7 million workers that present 5% of the U.S. workforce. Data assembled by the National Safety Council (2003) indicates that the construction industry accounts for approximately 12% of the United States’ occupational fatalities and has the third highest fatality rate of all U.S. industries after Mining and Quarrying; Agriculture, Hunting, Forestry and Fishing [7]. In 1992–2002 approximately 13.1 from 100 000 workers on the average died within the U.S. construction [10]. In Canada, the construction is the largest single industrial activity directly employed more than 750 000 people, representing more than 5% of all jobs in Canada [13]. After fishing and mining it is the third most risky industry in country [14].

As Figs. 1–2 indicates, the fatality figure in European and U.S. construction is almost the same, decreasing in time is bigger in EU.
The high rise buildings remain predominant in the U.S.A.. Many hazards are associated with working at heights and with the vertical transportation of materials, such as falling objects or the fall of person. At once the U.S. construction has been identified as one of the most hazardous industries and the occupational falls from height have been identified as the most common cause of fatal injury in the sector [4]. In more than a half of fatalities in 1992–2001 (6912 from 10834) the source of the injury has been the work in height and the reason has been the fall. Next the most often reasons of deaths were: vehicle accidents in the site, struck by falling object, struck by moving equipment, exposition of dangerous substances, fire or explosion in the site and physical exhaustion of worker [11].

Concerning the alarming amount of fatalities coming from fall from height (Fig. 3), all institutions focused at occupational safety prevention within the section “construction” are in the last years aimed mainly to solving of problems connected with works in height. They usually suggest that about falls also musculoskeletal diseases present one of the most often phenomenon of the construction workers health fault.

The information from the statistical data made by the BLS (Bureau Labor Statistics) and NIOSH (National Institute for safety and Health) in the U.S.A. and Eurostat, the statistical office of the EU could become the benefit for predicting high-risk construction activities and thus preventing accidents occurred based on a set of historical accident data.
3. The Safety Risk Management as the Base of Accidents Prevention

The most effective way to improve safety level on construction sites is [1] preventing accidents and reducing uncertainty before their happen. According to forward research many construction injuries and fatalities occurred as the result of bad decisions in phase of the building project planning, before construction works beginning. Key players at this phase include architects, designers, contract managers and those procuring goods and services for the building phase. The prevention requires knowledge about where hazardous exposures create problems, and in which way construction workers are exposed to trauma risks. Root causes of accidents have to be identified in order to take preventive and remedial actions to minimize accidents occurrence. When safety aspects and variables significantly affecting construction safety are well managed, the frequency of accidents occurrence may be reduced [2]. The systematic and effective analysis of safety risk and risk assessment is the foundation upon which safety management is built and risk assessment becomes a critical task which forms a part of safety management system [1].

All the same the safety legislation has a great impact upon the safety level of a construction site. The construction safety is enshrined in legislation that forms a framework in which site safety is managed. All employers, project managers and investors have to follow the rules and regulations and punishments to be meted out to those who flout them [2]. In 1992 the EU Council published the Construction Sites Directive (Directive 92/57/EEC). The member states had to introduce to improve safety at construction sites. The directive initiated two important points. The first is a concept of health and safety based on a new chain of responsibility including the owner “Safety Coordinator for design and Coordinator for Construction” and the second is presented by new health and safety document “Health and safety plan”. Following the Directive (Article 4) [6], the owner shall take account of the general principles of prevention during various stages of designing and preparing the project, particularly when architectural, technical and organizational aspects are being decided, in order to plan the various items or stages of work which are to take place simultaneously or in succession and when estimating the period required for completing such work or work stages. Prior to the beginning of construction works, the owner shall complete The Health and Safety Plan which will notably manage the identified risks of individual project.
4. The Analysis of Health and Safety Risks in Construction

Unlike other industries it is not easy to undertake risk assessment on construction site, due to its complexity and diversity in job tasks, climatic conditions and work environments, as well as the work nature of construction industry is quickly changing and workforce is highly dynamic [1]. In this industry, the workplace changes daily and the type of work varies greatly, from new construction, repairs or renovations to existing facilities, demolition of buildings and structures, and hazardous waste abatement to cleanup and reconstruction following natural disasters. Also the sector is known by high numbers of unskilled and temporary workers. Construction sites undergo changes in topography, topology and work conditions (including weather conditions) throughout the project duration. These are the reasons why in construction is needed the different approach to identify hazards and risks and prevent accidents [5]. For example timber of the roof mounting is a common well understood and known trade activity. But the safety risk level associated with the task depends on its context. Once it can be performed in the beginning of the day, when no other activities are being performed or in another case it might be performed at the phase of the day where many other workers performing else activities are located nearly the roof.

Generally, the safety risk analysis consists of three main stages [7]: identification of all possible hazards that may cause some accidents at the workstation during the all stages of performed activities, evaluation of relative level of risk for all identified hazards (safety risk quantification), control the risk by taking sufficient measures to reduce or eliminate it. According to one of the most common methods of safety risk quantifying, the risk is composed of three primary components: probability, severity and exposure. The probability refers to the chance of a potential event (e.g., number of events per day), severity represents the potential outcome of an event (e.g., money or loss of days per event) and exposure describes the duration of potential contact with a potentially hazardous situation (e.g., days). The presented method for health and safety risk analysis has proven to be enough effective for planning the safest way to perform an activity. But for the construction industry it is rather impractical. As it was stated before, the construction projects are highly dynamic unlike other industries. Moreover, construction products are unique (almost prototypical), standardized procedures that may be considered safe in one project may be hazardous in another one environs. For the sector is typical, that workers usually endanger other workers who may perform a different activity at a different location within the site. This is next reason for individual perception of construction safety risk unlike the standard method presented in advance, which is focused on production activities in isolation at predetermined workstations. The best way should be using of an improved technique in which risk analysis may be performed independently of space and time consideration. In this regard the group of construction safety risks connected with particular activity performance (e.g., masonry, facing tiling, concreting, roof tiling, etc. ...) is not just one in the structure of possible site safety risks. In decomposition of constructions safety risks significantly enter these other risk groups:

- Risks connected with construction site conditions
- Risk connected with construction site neighbourhood
- Risk connected with coordination of building processes

The construction safety risks specified within these four groups may be sub-decomposed in order to create an extensive scale of site safety risks. The risks of the scale express specifically the events which may occur. For all that more risks of second-rate
decomposition within each particular risk exist in parallel. The difference among them is in probability of loss as well as in possible danger severity. For example the risks coming from the weather conditions (in group of risks connected with construction site conditions) may be represented by: unfavoured work in extremely high or low temperature, insufficient water taking, bad visibility in terms of rain, hazardous work in fog, slip on wet floor, fall on frozen floor, etc., ...

As the sites develop with progress of work hence the working environment is altering hour by hour. The time plays an important role in the analysis of construction safety risk and their synergies during the building process. From point of threat duration within the building process life, the mentioned risk group can be characterised by this means:

Risks connected with particular activity performance — they rise just at the moment of these activities performance. It is necessary to have the building process schedule in order to be prepared for these risks. Within the particular building process can cumulate various risks of different rates. For example in assembly production come on force fall from height, limb contusion, interference by load on crane, etc., … All the same the manipulation with material connected with the process performance presents some risk. As well as the using of the building machines and equipments in the construction activities performance is the potential danger resource.

Risk connected with construction site conditions — exists during all the building-up period. But their intensity oscillates. The biggest are in the phase of frame work (earthworks, foundations, framework concreting, roofing …) where the activities are performed in the exterior. In phase of completion works (cross walls, installations, plasters, flooring…) which are performed in the building interior the dangers may be lesser, even though the accident probability can be bigger because of more tradesmen working in almost every building part.

Risk connected with construction site neighbourhood — exists too during all the building-up period and their intensity also oscillates. The significant are for example in earthwork because of excavated soil removal by the public road or in assembly production when the load carried by the crane can present the danger for people near the site. Unfortunately not only the construction workers themselves suffer injuries and deaths. In Great Britain in the past decade of 20th Century, 102 people not employed in the industry were killed because of construction related activities [9].

Risk connected with coordination of building processes — risks come from relativities and joins between the particular work processes. The biggest are in the case of more activities overlay, the threat is multiplied as every activity is characterised by various risks connected with particular activity performance.

Regarding the synergism of time and space, in construction safety risk analysis these two variables are continuous, interacting. That is because the construction process may be characterised as the set of operations which interlock, are in progress at continual place and in continual time. As for the construction risk analysis from point of time the building process can be divided according to specific construction phases (from earthworks, through foundations, under framework, framework, roofing … to facade), from point of space come on force: the building space, the site and the site neighbourhood. Fig. 4 presented one of the possibilities to construction safety risks expression by three parameters: time, space and the risk exposure (risk level). The time sequence of risks decomposition is visible by specific construction phases (from earthworks to facade) and space in which these risks exist is characterised by the site neighbourhood, by the site and by the objects where
the building operations are performed, it means building space. This can be considered as a type of time-spatial map. Following such presentation, the contractor can easily understand the levels of safety risks affecting construction in particular construction phase (from earthworks to facade) and in particular space (building space, site or site neighbourhood).

5. Conclusions

As stated the European and American construction stand out among all other industries with disproportionate numbers of severe and fatal accidents and deserve attention. Although significant progress has been made in improving occupational safety conditions in the industry, there is still much that can and needs to be done. The EASHW in EU and the Occupational Safety and Health Administration and National Institute of Occupational Safety and Health in the U.S.A. as establishments responsible for tracking and compiling injuries which occur on worksites are aimed to make European and U.S. workplaces safer and healthier and act as the catalysts for developing, collecting, analyzing and mainly disseminating information by printed publications and websites that improves the state of occupational health and safety state in resident region. The problems of risks connected with particular activity performance are sidelong the institutes solved very precisely and much like risks connected with site conditions are usually mentioned. But there is a lack of challenge from the institutes’ side about the fact that within the sites exist many risks connected with particular activities coordination as well as each site in character is risky for people in its neighbourhood.

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Reference

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