Hazards and occupational risk assessment in the bricklayer's workplace

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Abstract. The purpose of the research – hazard analysis and calculation of the level of occupational risk at the bricklayer's workplace. The scientific task that was solved in the course of the study was the analysis of the dangers associated with each other by various technological processes during stone work. The result of the study is to determine the level of professional risk by the method of a three-level scale of damage based on the analysis of the main characteristics. For this study, the main hazards in the workplace were identified and categorized. A register has been compiled based on the identified hazards. For clarity of the final data, a table was formed.

1. Introduction
The modern concept of the development of industrial relations in the field of labor protection is aimed at the health of workers, which is based on the prevention of hazards at the initial stage. Special assessment of working conditions (SAWC) [1-3] and the procedure for assessing and managing professional risks [1, 4], are one of the main components of the labor protection system in Russia. Occupational risk management using accident analysis is one of the most effective ways to solve the problem of injury at work. Correct identification of hazards is an important tool of the OSH management system at the enterprise.

2. Research relevance
According to official statistics, construction in Russia is one of the most difficult and traumatic types of economic activity in terms of the number of fatal injuries and identified occupational diseases. Injuries in the construction industry are usually severe and often fatal. About 70% of injuries at construction sites occur with workers, and the most common causes are violations of safety requirements and dangers of construction production [3, 5].

According to a special assessment of working conditions at workplaces of construction production, there are a large number of harmful and dangerous factors of working conditions, such as: noise, vibration, the severity of the labor process, aerosols of predominantly fibrogenic action (APFA). The specificity of production does not provide an opportunity for complete automation of the technological process, as the use of personal protective equipment is not always effective. The complexity also lies in the schedule of the established work, which assumes a tight deadline and an incomparable amount of work [4, 6].
3. Discussion
Workers are central to efficient and productive work on a construction site. Protecting employees from the influence of production factors, improving working conditions, maintaining health is a priority. A correct analysis of existing hazards and the consequences of their impact makes it possible to manage occupational risks in the construction industry.

The purpose of the study is to identify hazards and determine the level of occupational risk when performing masonry. The calculation was made for the technological process - masonry, according to Unified tariff and qualification reference book of jobs and professions [7, 9]; these works are carried out by bricklayers of the 2nd-6th grade. According to the Federal Service for Labor and Employment, the profession of a bricklayer is one of the most widespread and demanded construction professions at the present time.

The following materials are used for the construction of stone structures: various types of bricks, natural processed stones, and artificial small and large blocks. To reinforce and give strength to the masonry, masons use metal nets, basalt-plastic reinforcement [8, 10].

The lifting of materials necessary in the process of erecting stone structures is carried out using lifting mechanisms: cranes (tower, automobile, boom), winches. To conduct masonry, paving means are used, such as: scaffolding, scaffolding (rack, string). Masonry is a building structure consisting of bricks, blocks, interconnected with mortar.

The subject of the study is to analyze the technological process to determine the main hazards that can cause injury, accident or occupational disease [9, 4, 15].

4. Materials and methods
Identification (detection) of hazards and determination of the consequences of their possible manifestations was carried out on the basis of the following sources of information:

- regulatory and local acts;
- SAWC data;
- practical observation of the technological process.

Based on the studied data, a register of hazards was compiled and identifiers of hazardous events were assigned.

Table 1 provides a systematization of hazards, a description of the hazardous event and assignment of identification numbers to each of the events. According to the specifics of the work, the hazards at the bricklayer's workplace were divided into the following types: mechanical (Mc identifier); electrical (El identifier); chemical (Cm identifier); APFA (Af identifier); the severity and intensity of the labor process (Lp identifier); noise (Ns identifier); vibration (Vb identifier); transport hazards (Tr) [1, 4].

| Threat event identifier | Name and description of the hazardous event |
|-------------------------|--------------------------------------------|
| Mc 1                    | Falling by stumbling and/or slipping        |
| Mc 2                    | Work at height                             |
| Mc 5                    | Bumping into a piercing surface             |
| Mc 8                    | Hit under a vehicle and other means of mechanization |
| Mc 9                    | Drop of cargo                              |
| Mc 10                   | Cutting off body parts                     |
| Mc 11                   | Body parts cuts                            |
| El 1                    | Electricity                                |
| Cm 1                    | Chemical substances                        |
| Af 1                    | Dust in the eyes                           |
| Af 2                    | Respiratory trauma from dust               |
| Af 3                    | Danger of dust on skin                     |
In this study, for the convenience and simplicity of the calculation, the damage scale was used (Table 2), which represents three levels: small, medium and large [10, 11]. Corresponding coefficients are assigned for each level 5, 10, 15.

**Table 2. Damage scale.**

| Severity of damage | Coefficient | Description of damage          |
|--------------------|-------------|--------------------------------|
| Small (S)          | 5           | No medical attention required  |
| Middle (M)         | 10          | Medical assistance required    |
| Big (B)            | 15          | Disability or death            |

The probability of the occurrence of damage to the j-th hazard is determined by dividing the i-th coefficient (A) by the sum of the coefficients assigned to the hazards and the outcome not related to the occurrence of damage (formula 1):

\[ P_j = \frac{A_j}{\sum_{i=1}^{k+1} A_j} \]  

The next step is to determine the likelihood of a hazard. The probability scale is presented in Table 3.

**Table 3. Probability scale.**

| Probability | Coefficient | Description of the probabilities of hazards and damage |
|-------------|-------------|-------------------------------------------------------|
| Low (L)     | 1           | Danger does not arise                                  |
| Average (A) | 3           | Danger arises at certain times                         |
| High (H)    | 7           | Danger arises constantly                               |

5. Results

Calculations have been made based on the analysis of identified hazards, data on accidents and work-related injuries, and the results of the SAWC. Numerical values are calculated according to formula 1.

For each identified hazard, it is necessary to determine the level of risk, for this it is necessary to multiply the probability by the corresponding coefficient. To calculate the total risk, it is necessary to add the risks for each of the identified hazards. And using the significance scale (Table 4) to determine the level of risk and the corresponding interval.

**Table 4. Risk significance scale.**

| Range of risk values | Significance of risk |
|----------------------|----------------------|
| 0<R≤5                | Low (L)              |
| 5<R≤10               | Moderate (M)         |
| 10<R≤15              | High (H)             |

The calculation results are presented in the table 5.
The overall level of risk in a bricklayer's workplace on a scale of importance is moderate. To eliminate or reduce the level of occupational risk, it is necessary to provide for methods of dealing with each of the possible identified causes of hazards. Only in this way can effective work on labor protection be built and positive dynamics achieved.

At the construction site, it is important to pay great attention to the prevention of hazards. A clear understanding of the reasons will help maintain the health of workers and can guarantee the safety of work. This, in turn, will contribute to the development of the correct model of labor protection management at the enterprise. [2, 10, 12].

The method of a three-level scale of damage makes it possible to take into account the hazards associated with each other by the technological process and subsequently develop the correct methods of dealing with them. According to the existing legislation, the employer can independently determine the hazards that may have a negative impact on his employees. In addition, it is important to develop an individual register of hazards for each enterprise.

| Hazard identifier | Potential damage | Damage weighting factor | Probabilities of damage | Weighting coefficient of the probability of occurrence of damage | Numerical value of the probability of damage |
|-------------------|------------------|-------------------------|-------------------------|---------------------------------------------------------------|---------------------------------------------|
| Mc 1              | Middle           | 10                      | Average                 | 3                                                             | P1=3/86=0.03                                |
| Mc 2              | Big              | 15                      | High                    | 7                                                             | P2=7/86=0.08                                |
| Mc 5              | Middle           | 10                      | Average                 | 3                                                             | P3=3/86=0.03                                |
| Mc 8              | Middle           | 10                      | Average                 | 3                                                             | P4=3/86=0.03                                |
| Mc 9              | Middle           | 10                      | Average                 | 3                                                             | P5=3/86=0.03                                |
| Mc 10             | Small            | 5                       | Average                 | 3                                                             | P6=3/86=0.03                                |
| Mc 11             | Middle           | 10                      | Average                 | 3                                                             | P7=3/86=0.03                                |
| El 1              | Middle           | 10                      | Average                 | 3                                                             | P8=3/86=0.03                                |
| Cm 1              | Middle           | 10                      | Average                 | 3                                                             | P9=3/86=0.03                                |
| Af 1              | Middle           | 10                      | Average                 | 3                                                             | P10=3/86=0.03                               |
| Af 2              | Middle           | 10                      | Average                 | 3                                                             | P11=3/86=0.03                               |
| Af 3              | Middle           | 10                      | Average                 | 3                                                             | P12=3/86=0.03                               |
| Lp 1              | Middle           | 10                      | Average                 | 3                                                             | P13=3/86=0.03                               |
| Lp 2              | Middle           | 10                      | Average                 | 3                                                             | P14=3/86=0.03                               |
| Lp 3              | Middle           | 10                      | High                    | 7                                                             | P15=7/86=0.08                               |
| Lp 4              | Middle           | 10                      | Average                 | 3                                                             | P16=3/86=0.03                               |
| Ns 1              | Middle           | 10                      | Average                 | 3                                                             | P17=3/86=0.03                               |
| Vb 1              | Middle           | 10                      | Average                 | 3                                                             | P18=3/86=0.03                               |
| Tr 1              | Middle           | 10                      | High                    | 7                                                             | P19=7/86=0.08                               |
| Tr 2              | Middle           | 10                      | High                    | 7                                                             | P20=7/86=0.08                               |
| Tr 3              | Middle           | 10                      | High                    | 7                                                             | P21=7/86=0.08                               |
| -                 | 0                | 0                       | Average                 | 3                                                             | P22=3/86=0.03                               |

Table 5. Occupational risk assessment at the bricklayer's workplace.

6. Conclusions
The overall level of risk in a bricklayer's workplace on a scale of importance is moderate. To eliminate or reduce the level of occupational risk, it is necessary to provide for methods of dealing with each of the possible identified causes of hazards. Only in this way can effective work on labor protection be built and positive dynamics achieved.
Thus, ensuring the safety of work at a construction site is one of the most pressing topics in the organization of a labor safety management system in construction production. Professional risk management and, directly, the stage of "risk assessment", should be a fundamental element in the creation of SAWC at enterprises of various directions [1, 2, 4, 15].

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References
[1] Staseva Y V, Pushenko S L Materials for a special assessment of working conditions as a basis for preventive work to protect a person in production Bulletin of the Volgograd State Architectural and Construction University. Series: Building and architecture № 46 (65), pp 110-117
[2] Staseva E V, Pushenko S L 2012 Fundamentals of a methodological approach to improving the organization of labor protection in construction based on a risk management system Engineering Bulletin of the Don № 4-1 (22). FROM. 165
[3] Chang C C, Chang W R, Matz S 2005 The effects of straight ladder setup and usage on ground reaction forces and friction requirements during ascending and descending, Safety Science, Vol 43, Issue 7 pp 469-48, https://doi.org/10.1016/j.ssci.2005.08.002.
[4] Sazonova A, Kopytenkova O, Staseva E 2018 Risk of pathologies when exposed to fine dust in the construction industry IOP Conference Series: Materials Science and Engineering 21, Construction - The Formation of Living Environment pp 032039
[5] Omelchenko E V, Trushkova E A, Sidelnikov M V, Pushenko S L, Staseva E V 2017 Algorithm research exposure dust emissions enterprises of building production on the environment IOP Conference Series: Earth and Environmental Science Current Problems and Solutions. Ser. "Ecology and Safety in the Technosphere: Current Problems and Solutions" pp 012018
[6] Staseva E V, Kvitkina M V, Litvinov A E, Kobzeva N 2019 The effect of noise on the human body, in particular, on cardiovascular diseases E3S Web of Conferences. Topical Problems of Green Architecture, Civil and Environmental Engineering 01028.
[7] Theoretical studies on the calculation of the noise of impact equipment in blacksmith shops. /
[8] Staseva E, Larin D, Demchenko S, Kobzev K 2019 E3S Web of Conferences Topical Problems of Green Architecture, Civil and Environmental Engineering pp 01030
[9] Larin D, Staseva E, Khetsuriani E 2019 Objectives of increase of capacity and lifetime of municipal solid waste dump according to density index study IOP Conference Series: Materials Science and Engineering Collection of materials of the XV International Scientific - Technical Conference. Don State Technical University pp 012016
[10] Larin D, Staseva E, Pchelnikov I 2019 Analysis of build-up of pollutants in bottom deposits and their environmental impact IOP Conference Series: Earth and Environmental Science The conference proceedings. Far Eastern Federal University 022228
[11] Kobzev K, Chukarin A 2019 Principles of improving the smoothness of the working mechanism in forging and stamping machines IOP Conference Series: Earth and Environmental Science, 403,012145
[12] Pushenko S L, Bozhko E S, Zolotuhina I A 2020 Methods for reducing vibrations generated by shock equipment E3S Web of Conferences. Topical Problems of Green Architecture, Civil and Environmental Engineering. pp 01026.
[13] Pushenko S L, Bozhko E S, Zolotuhina I A 2020 Soundproofing presses by placing its nodes in a soundproof casing, including drive components E3S Web of Conferences. Topical Problems of Green Architecture, Civil and Environmental Engineering pp 01027
[14] Kobzev K O, Bozhko E S, Mozgovoi A V, Kostromina E I, Babenko L G 2019 The study of the use of multi-disc safety friction clutches in the working bodies of crank presses IOP Conference Series: Materials Science and Engineering, Vol 680,012013
[15] Kobzev K O, Sergey A, 2018 Method and description of dynamic vibration reduction in cabins of gantry cranes. MATEC Web of Conferences, 226, 01022

[16] Kobzev K O, Sergey A 2018 Substantiation of the parameters of vibration systems in the cab of the gantry crane at the workplace of crane operators. MATEC Web of Conferences, 226, 01023