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Measures to Prevent Emergency Situations during the Construction of Pits

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Abstract: The paper analyzes the errors and the causes of their occurrence in the construction of pits. A classification of accidents according to the costs of their liquidation has been developed. The importance of site surveys and the design process is emphasized, and some of the potential risks are outlined. The main causes of accidents are identified and recommendations are proposed to reduce the risks of their occurrence.

Keywords: pits, accidents, enclosing and supporting structures of pits, designers' mistakes, builders' mistakes, risks, geotechnical monitoring.

The construction of deep pits and the construction of semi-underground structures in large cities has recently taken on a mass character. The need for active use of the underground space of cities is associated with the need for the development of transport infrastructure, engineering systems and the provision of parking spaces for personal vehicles, taking into account the growing shortage of urban areas[1,2,3]. Along with the increase in the intensity of the development of the underground space of cities, various emergency situations occur more and more often during the construction of pits[4,5]. Restoration of accident development scenarios, identification of the most frequently repeated mistakes and miscalculations in design and construction, as well as the study of factors and impacts that are not taken into account by regulatory documents, play a very important role in preventing new emergencies in the construction of excavations[6,7].

The design and installation of pits is very often carried out in conditions of severe cost and time savings. At the same time, most of the funds in the development of project documentation are spent on the ground part of the building, and “remains” are allocated for the underground[8,9]. Therefore, it is not surprising that even today construction work causes damage to buildings located in the neighborhood. Statistical assessment of insured events shows that in almost half of the cases this is due to miscalculations made at the design stage, and in a quarter of cases - already at the stage of work. Accidents must always be considered in terms of added value to the project. The following financial costs associated with the likelihood of an emergency can be distinguished[10,11]:

- the cost of restoration work in the event of an emergency, which includes direct financial costs for the restoration of the construction site, losses associated with delaying the project, costs associated with damage to the property of the project owner, costs associated with damage to the property of third parties, costs associated with injury of varying degrees (compatible with life or not compatible) by people both directly involved in the production process and third parties, as well as other costs;

- the cost of measures to prevent the occurrence of an emergency or reduce the degree of its negative manifestation, which include improving the quality of engineering surveys, improving the quality of design work, the use of appropriate building materials, strict quality control of work performed, both at the design and construction stages, instrumental monitoring of the state of structures and deformations of the rock mass, as well as other measures that will reduce the likelihood of accidents[12,13,14].

Those, the total cost of the project consists of the cost of work, taking into account the possibility of emergencies and the cost of measures to reduce the likelihood of emergencies. In general , the cost of work in the event of an accident is directly proportional to the probability of an accident, while the cost of measures to prevent accidents is inversely proportional to the probability of an accident[15,16,17]. The development of measures to prevent the likelihood of any even minor types of emergency situations is not the best economic solution for the customer. By accepting the risks of the likelihood of minor emergencies, the costs of constructing geotechnical facilities can be significantly reduced. Of course, the consequences of the probable occurrence of an emergency should not be associated with a danger to specialists or random people[18,19,20]. Thus, three engineering approaches to the consideration of the project can be distinguished:

- the optimal solution - is to find a solution that provides minimal costs for the implementation of the project. Such a solution assumes the likelihood of occurrence of minor emergencies, which involves finding a balance between measures to reduce the likelihood of accidents and the cost of eliminating the consequences in the event of such accidents;
- conservative solution - is to reduce the risk of emergencies through the use of a wide range of measures aimed at reducing them.

Typically, such measures are unnecessary and significantly increase the cost of the project, since they are not aimed at preventing the serious consequences of possible geotechnical accidents, but lay a huge reserve in the geotechnical structure, aimed at minimizing risks, the results of which do not have serious consequences, but at the cost of their elimination, less than the cost of measures to prevent them[21,22,23]:

- risky decision - is the adoption of engineering decisions that can potentially lead to serious consequences in the event of an accident. The reduction in the cost of organizing the event applied at various stages of the project is usually not enough to cover the costs as a result of emergency situations[24,25,26].

Thus, in addition to direct losses, another important circumstance is that accidents throw the project far back and greatly increase the duration of construction, which can be regarded by the customer as lost social or financial benefits[27,28]. Therefore, the fight against the possibility of emergency situations during construction in excavations is a task not only for geotechnical engineers [29,30,31], but also for professional managers and risk management specialists who must make informed and justified decisions [32,33,34].

Reducing the likelihood of emergencies can be achieved by increasing the level of knowledge of students in higher and special educational institutions, increasing the responsibility of performers in the implementation of various stages of the project, both at the design stage and construction of structures, increasing their level of qualification and professionalism[35,36,37,38]. Obviously, the scientific direction in the field of geotechnical analysis should also be developed, solutions should be searched that allow adequate representation of geomechanical processes in the rock mass and reliably solve the tasks set, and the knowledge gained during the performance of scientific research should be transferred to practicing engineers in a form that is convenient and understandable for their qualifications[39,40,41].

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