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MODELS OF THE CIVIL PROTECTION SYSTEM DEVELOPMENT USING ENGINEERING INFRASTRUCTURE PROJECTS

Abstract. Task of developing a model of the system of civil protection using engineering major infrastructure projects is considered in the scientific article. Sample engineering accompaniment of infrastructure project of stadium construction is represented. Models of the timing of evacuation of the stadium as one of the main factors of the viability of the project are developed

Keywords: civil protection system, engineering, infrastructure projects, evacuation time, stadium

Introduction.. In modern realities the life cycle of any complex organizational and technical system is saturated of bifurcation points This leads to the fact that only those system can remain competitive which implement innovative models of development. The system of civil protection is a complex organizational and technical system with varying number of extrinsic functions for itselves. Thus, everyday functions include its direct processes related to the prevention and elimination of emergency situations. At the same time, there are indirect functions such as the implementation of measures with the commissioning the product of infrastructure projects. System of Civil Protection in fact, performs engineering services. We take as a basis the infrastructure project of stadium construction. For commissioning the product of infrastructure project requires coordination with civil protection system the main issues related to the safety of people in the stadiumIn fact, representatives of the civil protection system have to calculate the parameters of operation the product of infrastructure project. In our opinion it is this process of engineering of infrastructure project is actual.

Statement of the problem. The aim of this work is to develop models of civil protection system based on the involvement of engineering projects. Consider an engineering project based on development of the model of calculation the evacuation of the stadium which is a key factor of the stadium commisioning and hence the point of viability of product of project

Results. Each object type sports and entertainment, including a stadium, in a fault to have such technical execution to evacuate people from the building was safe and limited time to 8 minutes [1]. Therefore, the number, size and design of evacuation routes and exits are determined depending on the required evacuation time, ie time during which people should leave the premises without succumbing dangerous to life and health of emergency events. Data on the required evacuation time is the initial information for calculating the level of security of people in extreme events at the stadium. Incorrect determination of the required evacuation time can lead to adoption of wrong design decisions and increase the value of buildings or insufficient security of people in emergency situations.

Required evacuation time is calculated as the product of the critical length for a man of extraordinary events by a factor of safety. During the critical period of extraordinary events refers to the time after which there is a dangerous situation due to reaching a Hazard maximum permissible value for humans.

Therefore, the main directions of this research is to analyze all elements-agents, which are in operation to evacuate people, the development of mathematical models of the process of evacuation, study criteria and on this basis the development of methodology for determining optimal time of evacuation.

The safe evacuation of people depends on many unpredictable factors and is a random variable. Therefore, in determining the success of the first stage of evacuation, we will use the notion of probability (in determining which once laid a possible risk factor), leaving the successful people.

We have reviewed the main methods of making. The position of the proposed approach together the main methods of the theory of the adoption of technical solutions and its practical application to the analysis of the effectiveness of evacuation crowded.

The decision is a choice of a certain set of options considered: $E_i \in E$. In general, an infinite number of options $E_1, E_2, ..., E_i, ...$. However, in practice we are dealing with a limited number of options.

Each acceptable alternative solution E_i due to different external conditions may meet different external conditions F_j and results e_{ij} of decisions. Family of solutions described by the matrix.

However, in practice we are dealing with a limited number of options. When a decision e_{ij} consider the numerical evaluation that meets the requirements E_i and options and F_j characterizes the economic effect (gain), the usefulness, reliability, security, etc..

This result is called decision usefulness. To arrive at a definitive and best opportunity for finding solutions when some of solutions can meet the various external conditions, you must consider the totality of estimators . This introduces the concept of Appraisal (target) function. The task of evaluating functions - described by one numerical value of all the possible consequences of decisions E_i . This decision matrix $\|e_{ij}\|$ is reduced to one column, and the decision process - the search option with the highest value result e_{ir} .

One option that is selected according to most criteria, and is an option that searched.

Concerning the problem of safe evacuation of people finding solutions $E_1, E_2, ..., E_i, ..., E_n$ can be formed as different cases of combination of collective rescue. When external conditions F_j to understand the situation in which there is a need to use means of collective rescues ion for its intended purpose (stewards, equipment, etc.). When the decision e_{ij} understand quantify utility variant solution in the considered external conditions. In this case - is the successful evacuation of the stadium with the use of collective deliverance (stewards, hardware, etc.).

In the quantitative assessment should take the likelihood of a successful evacuation of all or parts that are included in the overall integrated circuit. The disadvantage of using a probabilistic result only option is provided because it does not take into account the economic cost of achieving this goal.

Therefore the choice of functions for evaluating alternative solutions is quite complex, but it kind of depends largely on the case:

$$e_{ij} = f_{ij}(P, W, m, L, B, T, ...) \quad (1)$$

where

P - probabilistic setting;

W- cost option;

m ,*L*, *B*, T – indicators that include wide doorways and escape routes, evacuation routes length, density, intensity, speed of movement of the human flow.

The accumulated statistical material on the conditions of evacuation of people with spectacular buildings like different purposes depending on the size requires the development of probabilistic methods phased-integral approach for calculating the probability and risk level.

Thus, quantitative assessment of this stage is its probability Rэ. Since events that are part of the evacuation process, independent, then $P_э$ is the product of the probability of occurrence of its components:

$$P_э = P_1 \cdot P_2 \cdot P_3 \cdot P_4 \cdot (1-P_5) \cdot P_6 \cdot P_7, \quad (2)$$

where

P_1 - the likelihood of setting off the alert;

P_2 - probability that the movement of the human stream (T_θ), will not exceed the exit of people (T_{ev}): $T_\theta \geq T_{ev}$;

P_3 – probability uptime stewards;

P_4 – favorable regime excitement;

P_5 – probability of hitting the passage minor;

P_6 – probability of a successful transition into the distribution buffer zone evacuation;

P_7 –probability of a successful transition into the distribution buffer zone evacuation.

On the basis of queuing theory and the specifics of the operation of separation and union for people in the free zone was obtained by the law of distribution of time separation and integration of people T_{sb+n} as a function of time association t_{sb} [2]:

$$T_{cb+n}\begin{cases} 0 & when\ t_{cb} \le 0 \\ \dfrac{N_b}{n\mu}+\dfrac{1}{N_v}\cdot t_{cb} & when \quad 0 \le t_{cb} \le t^*{}_{cb} = \dfrac{N_v}{n\mu}, \\ t_{cb}+\dfrac{1}{n\mu} & when \quad \dfrac{N_v}{n\mu} = t^*{}_b < t\ \infty \end{cases} \tag{3}$$

where

μ - service rate (the flux density of service);

n – number of ways of service;

N_v – number of people belonging to the appropriate evacuation routes;

t_{cb} – while collecting the total number of people N_v, appropriate evacuation path.

As the argument t_{cb} is a random variable, distributed by normal law with parameters (mathematical expectation of time gathering of people that linearly depends on the length of the evacuation path) $\sigma_{tcб}$ and (standard deviation of time of collection, which linearly depends on the number of people who are at the stadium) to describe the distribution of a random variable was used by the normal law and the general form of the density distribution of time separation and integration of people into a free zone *f*(t_{cb+n}) defined on the basis of probability theory and queuing theory. It looks like this:

$$F(t_{cb+n}) = \begin{cases} \dfrac{\alpha \cdot N_v}{\sigma_{tcb}\sqrt{2\pi}} \cdot e^{-\dfrac{\left(t_{cb+n} - \left(\frac{N_v}{n\mu} + \frac{1}{N_v} \cdot m_{tcb}\right)\right)^2}{2\sigma_{tcb}^2 \cdot \left(\frac{1}{N_v}\right)^2}} & then \quad 0 < t_{cb+n} \le \dfrac{N_v + 1}{n\mu} \\ \dfrac{\alpha}{\sigma_{tcb}\sqrt{2\pi}} \cdot e^{-\dfrac{\left(t_{cb+n} - \frac{1}{n\mu} - m_{tcb}\right)^2}{2\sigma_{tcb}^2}} & then \quad t_{cb+n} > \dfrac{N_v + 1}{n\mu} \end{cases} \tag{4}$$

where

$$\alpha \int_0^\infty f(t_{cb}) dt_{cb} = \frac{\alpha}{\sigma_{tcb}\sqrt{2\pi}} \cdot \int_0^\infty (e^{-\frac{(t_{cb} - m_{tcb})^2}{2\sigma_{tcb}^2}}) dt_{cb} = 1 \tag{5}$$

α - normalizing factor - $\alpha > 1$, that is the condition:

Based on theoretical calculations were performed calculations of probability of separation and union people to stadiums with different rescue agents (stewards, hardware, etc.) that allows you to use the results to design practice.

Given that the evacuation of people from the sport - entertainment facilities during emergency situations relating to complex systems. We have analyzed the critical path of evacuation of the most loaded sector with a view to streamlining and developed a systematic approach to solving problems of management time on evacuation of buildings with the mass stay of people.

Consider the process of operative evacuation of the stadium as a flexible production line, bring the concept of critical path, critical areas and will analyze different topologies evacuation schemes.

To calculate the evacuation time on a free zone, first find the most labor-intensive areas of evacuation path (critical area) and apply them to the operations division of parallel flows (parallel), creating conveyor and duplication.

After analysis of the sector top and bottom tiers of the stadium into account the complexity of human traffic flow and number of people define the most loaded.

In the method of evacuation of spectators from the lower and upper tiers promenades taken into account as the slope and geometric parameters of the stairs.

The plot, which is steep and geometric parameters of the stairs, stood out in graphics system computer modeling and mass media was asked option: in this passage evacuation path goes to speed ratio, which considers this option.

Conclusions. Task of developing a model of the system of civil protection using engineering projects is considered in the scientific article. Obtained the following results:

1. The system of civil protection is considered as executor of engineering projects of infrastructure development on the example of the project of stadium construction. Necessity to involve infrastructure projects to develop system as a whole is justified.

2. The calculation of the stadium evacuation as the key factor of commissioning the product of infrastructure project is done, and therefore the viability of the project.

Literature

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