UDC 614.844.6

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METHODOLOGY FOR DETERMINING THE LENGTH OF EVACUATION ROUTES FROM INDUSTRIAL BUILDINGS USING REGULATORY DOCUMENTS

Abstract. This article discusses the safety problems during the rapid evacuation of people from industrial buildings, in case of the occurrence and spread of fire in buildings and structures. The parameters and factors influencing the evacuation process are being investigated. Based on the analysis of safe evacuation, a graphical dependence of the traffic intensity on the density of the human flow is made. On the basis of regulatory documents, the determination of the parameters of the length of evacuation routes for industrial buildings is shown.

It is concluded that it is necessary to comply with regulatory requirements, as well as that when some evacuation parameters change, how does the calculated data change.

Key words: fire safety, evacuation, traffic intensity, density of human flow, escape routes.

To ensure the safety of people in buildings and structures, first of all, it is necessary to take into account safe zones, as well as the necessary conditions for rapid evacuation. Here it is necessary to take into account all the factors and parameters affecting the evacuation process. It cannot be said that these conditions of movement during evacuation were not studied, scientists from near and far abroad such as Roitman M.Ya., Kholshchevnikov V.V., Samoshin D.A. and others dealt with these problems. But nevertheless, there are a lot of questions about the evacuation of people in case of fires. First of all, this is non-compliance with regulatory requirements and fire safety rules during the operation of buildings and structures.

The study of the evacuation process has shown that safe evacuation from a building or premises primarily depends on the space-planning solution, which must comply with the regulatory requirements of fire safety. In addition, it is necessary to take into account other measures, such as ergonomic, constructive, engineering and technical measures, organizational [1]. When making space-planning decisions, it is necessary to take into account a number of factors: the shortest distances to evacuation exits, their sufficient width, isolation of evacuation routes from fire and explosive premises, the possibility of movement to several evacuation exits, etc. [2]. Currently, there are two principles of rationing evacuation routes, exits and the length of evacuation routes [3]. In the first principle, we will determine the size and length by calculation according to the set of rules of the Joint Venture of the Republic of Kazakhstan 3.02-127-2019 "Production buildings" of the Republic of Kazakhstan.

The second principle consists in ready-made standards in the form of figures in regulatory documents.

At the same time, it should be noted that according to the general requirements of fire safety to ensure the safe evacuation of people should be:

- the required number, dimensions and appropriate design of evacuation routes and evacuation exits have been installed;

- unhindered movement of people along evacuation routes and through evacuation exits is ensured;

-notification and control of the movement of people along evacuation routes (including the use of light signs, sound and speech alerts) are organized.

Let's consider the basic concepts defining fire safety during evacuation, according to the definition of the technical regulations "General fire safety requirements"

Evacuation path (evacuation path) - is the path of movement and (or) movement of people leading directly outside [4].

An evacuation exit - is a path of movement and (or) movement of people leading directly outside [4].

Human flow – people walking along a common section of the path in one direction. It is described by the following parameters: D – the density of the human flow, people / m^2, V – the speed of movement, m /min, q – the intensity of movement, people / min) (or m^2 /min), P – the magnitude of the human flow, people / min (or m^2/min). Q – the capacity of the track section, person/min (or m^2/min).

The ways of movement should provide the required level of comfort of movement of people in the process of work, life, recreation and the possibility of timely safe evacuation in emergency situations.

According to the Code of Rules of the Republic of Kazakhstan JV RK 3.02-127-2019 "Industrial buildings" p.4.2.2.9 The density of the human flow (D_i) is defined as the ratio of the number of people evacuating (N_i) along the common passage (S_i) having a width of b_i and a length of l_i.

$$D_i = N_i / b_i l_i, \text{ people/м}^2$$

The density of the human flow is an important initial characteristic that allows you to determine the speed and intensity of movement. The speed of movement in the stream depends on the type of path and the density of the human flow, Figure 1.

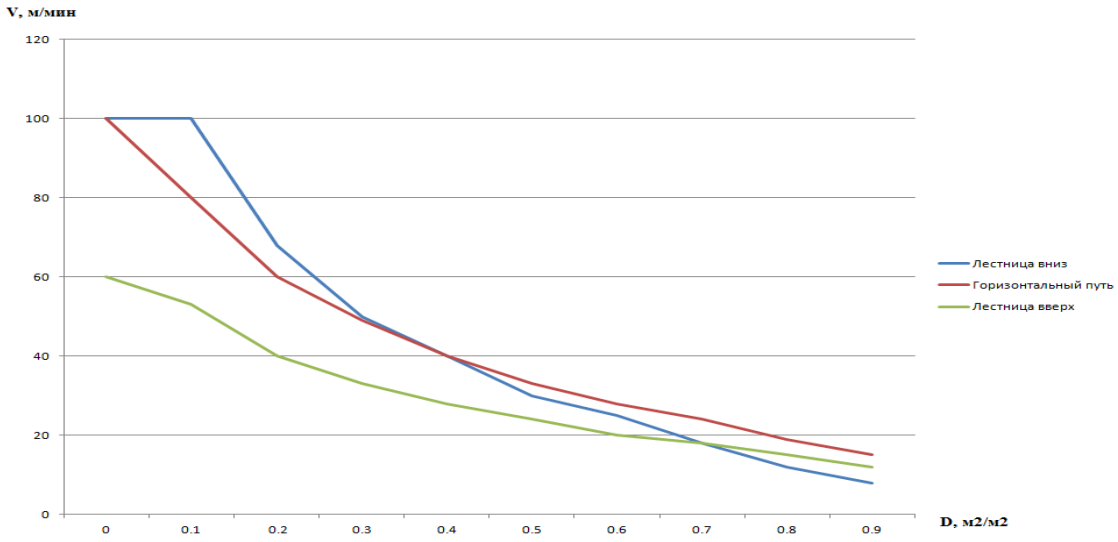

Figure 1 – Graph of the dependence of velocity on density

The practice of designing various types of buildings and structures shows that the dimensions of communication paths are determined in most cases precisely by the requirements for the safe evacuation of people, i.e. the requirements imposed on them as evacuation routes. These requirements are also the most stringent among the requirements of other functional processes affecting the structure of buildings. Therefore, the rationing of evacuation routes actually determines the geometric boundaries within which the space-planning solution of buildings and structures can be carried out. With insufficient justification, it becomes an obstacle to progressive solutions. Thus, the rationing of evacuation routes combines the solution of two major problems: social - improving the safety of people - and increasing the technical, economic and architectural level of design solutions.

According to world statistics, the share of evacuation routes accounts for a lot of victims and material damage in fires. At the same time, the culprits of the "death", apparently, of more than one project of a modern building were unreasonable restrictions on the length of evacuation routes.

Thus, the object of research in this article will be the length of the evacuation route. In order to calculate the length of evacuation routes from the premises of industrial buildings, we need to use the regulatory document set of rules of the Republic of Kazakhstan "Industrial buildings" clause 4.2.2.8, according to which we need to determine the volume of the room, the density of the human flow, the degree of fire resistance, the category of production [5]. The initial data for the calculations are given in Table 1. In the code of rules of the Joint Venture of the Republic of Kazakhstan 3.02-127-2019 "Industrial buildings", after all the values mentioned above, we determine the greatest distance from any point of the room to the evacuation exit.

Table 1 [5] shows the values of the parameters of the most remote point of the room from the evacuation exit from the code of rules of the Republic of Kazakhstan

Table 1 – Distance to the evacuation exit

The volume of the room, thousand m^3	Room category	The degree of fire resistance of the building	Structural fire hazard class of the building	Distance, m, with the density of the human flow in the general passage, people/m^2		
				up to 1	St. 1 to 3	St. 3 to 5
Up to 15	А, Б	I, II, IIIa	C0	40	25	15
	В1-В3	I, II, III, IIIa,	C0	100	60	40
		IIIб, IV	C1	70	40	30
		IVa, V	C2, C3	50	30	20
30	А, Б	I, II, IIIa	C0	60	35	25
	В1-В3	I, II, III, IIIa IIIб, IV	C0 C1	145 100	85 60	60 40
40	А, Б	I, II, IIIa	C0	80	50	35
	В1-В3	I, II, III, IIIa	C0	160	95	65
		IIIб, IV	C1	110	65	45
50	А, Б	I, II, IIIa	C0	120	70	50
	В1-В3	I, II, III, IIIa	C0	180	105	75

continuation table 1

60 or more	А, Б	I, II, IIIa	C0	140	85	60
	В1-В3	I, II, III, IIIa	C0	200	110	85
80 or more	В1-В3	I, II, III, IIIa	C0	240	140	100
Regardless of the volume	В4, Г,	I, II, III, IIIa	C0	Not limited to		
		IIIб, IV	C1	160	95	65
		IVa, V	C2, C3	120	70	
Too	Д	I, II, III, IIIa	C0, C1	Not limited to		
		IV, IVa, V	C2, C3			

When determining the parameters of the most remote point of the room, as we indicated above, the volume, category, degree of fire resistance of the room, as well as the density of the human flow are determined. But here we must take into account that the volume of the room does not always coincide with the tabular data, in these cases it is necessary to make calculations using the interpolation method.

In turn, the accepted parameter values remain if the spill of flammable liquids does not exceed 50 m^2, with larger values it increases by a factor of 50 divided by the area of a possible spill.

Based on regulatory calculations, we can determine whether the evacuation exit is located correctly in this facility, most importantly, it is important not to violate regulatory requirements. The above-mentioned methodology for determining the length of evacuation routes makes it possible to evacuate people in emergency situations in time. By examining various fires, it is possible to come to a conclusion about how in this case time and path affect the evacuation of people to a safe zone.

As a result of the study of the evacuation process, it is possible to observe characteristic differences, the dependence of the parameters of movement and the density of flows. The method of calculating the size of escape routes and exits from the premises of industrial buildings, on the basis of which the tables are given in the design standards, are based on the following basic prerequisites:

- The definitions of regulatory requirements for the distances of the most remote point of the room to the evacuation exit are given, this is one of the indicators of fire safety.

In practice, this means that the parameters affecting safe evacuation must comply with regulatory requirements, otherwise the building will not meet fire safety requirements. Thus, the presence of only one violation of regulatory requirements will lead to a high probability of loss of life in the event of a fire.

It should be noted that the expediency of carrying out systematic studies of the necessary distance to the evacuation exit from the building for various purposes is revealed.

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НОРМАТИВТІК ҚҰЖАТТАРДЫҢ КӨМЕГІМЕН ӨНДІРІСТІК ҒИМАРАТТАРДАН ЭВАКУАЦИЯЛАУ ЖОЛДАРЫНЫҢ ҰЗАҚТЫҒЫН АЙҚЫНДАУ ӘДІСТЕМЕСІ

Аңдатпа. Бұл мақалада ғимараттар мен құрылыстарда өрт туындаған және тараған жағдайда адамдарды өндірістік ғимараттардан тез эвакуациялау кезіндегі қауіпсіздік мәселелері қарастырылады. Эвакуация процесіне әсер ететін параметрлер мен факторларға зерттеулер жүргізіледі. Қауіпсіз эвакуацияны талдау негізінде қозғалыс қарқындылығының адам ағынының тығыздығына графикалық тәуелділігі жасалады. Нормативтік құжаттардың негізінде өндірістік ғимараттар үшін эвакуация жолдарының ұзындығының параметрлерін анықтау көрсетілген.

Нормативтік талаптарды сақтау қажеттілігі туралы, сондай-ақ эвакуацияның кейбір параметрлері өзгерген кезде есептік деректерде өзгеріс қалай болатындығы туралы қорытынды жасалды.

Түйінді сөздер: өрт қауіпсіздігі, эвакуация, қозғалыс қарқындылығы, адам ағынының тығыздығы, эвакуация жолдары.

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МЕТОДИКА ОПРЕДЕЛЕНИЯ ПРОТЯЖЁННОСТИ ПУТЕЙ ЭВАКУАЦИИ ИЗ ПРОИЗВОДСТВЕННЫХ ЗДАНИЙ С ПОМОЩЬЮ НОРМАТИВНЫХ ДОКУМЕНТОВ

Аннотация. В данной статье рассматриваются проблемы безопасности при проведении быстрой эвакуации людей из производственных зданий на случай возникновения и распространения пожара в зданиях и сооружениях. Проводятся исследования параметров и факторов, влияющих на процесс эвакуации. На основе анализа безопасной эвакуации сделана графическая зависимость интенсивности движения от плотности людского потока. На основе нормативных документов показаны определение параметров протяжённости путей эвакуации для производственных зданий.

Сделан вывод о необходимости соблюдения нормативных требований, а также о том, что при изменении некоторых параметров эвакуации как происходит изменение в расчётных данных.

Ключевые слова: пожарная безопасность, эвакуация, интенсивность движения, плотность людского потока, пути эвакуации.

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