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Early Calculation of Forces and Means to Reduce the Risk of Emergencies (Fires)

Ruziev Suxrob Toirovich
is a senior lecturer at the Department of Labor Protection and Health Engineering at Samarkand State University of Architecture and Construction,E-mail: ruzievsukhrob88@gmail.com Tel (+99899 285-55-33)
Yasakov Zikrilla Xayrullaevich
is a senior lecturer at the Department of "Labor Protection and Health Engineering" at the Samarkand State University of Architecture and Construction, E-mail: zikrillo87@mail.ru Tel (+99899 310-03-22)
Achilov Anvar Mamarasulovich
Samarkand State University of Architecture and Construction, teacher of the Department of "Labor Protection and Health Engineering", E-mail: anvarachilov2023@mail.ru Tel (+99897 922-61-69)

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Abstract: The article conducts research on preventing and eliminating the consequences of an emergency (fire), in particular, substantiating problems that are becoming one of the most pressing issues in the field of fire safety through solutions based on research results.

Key words: changes in the burning process of substances and materials, aspiration, fire, evacuation corridors, wind speed, temperature rise, expansion, compression.

Introduction. Today, in the world, many scientific researches have been conducted to find solutions to the problems of life and health protection in emergency situations, emergency situations and fire prevention. Based on the data of CTIF International Association of Fire and Rescue Services, "When analyzing the fire disasters of the last five years, taking into account that 7-8 million fires occurred in an average year and about 80-90 thousand people died, it is effective in preventing the rapid spread and development of fire." system development is an important task.

Taking into account the causes of fires, their serious danger to human life and health, and the possibility of serious consequences, we can find solutions to current and problematic situations as a result of creating alternative fire extinguishing tools and conducting modern research.

The results of the research conducted in the world show that as a result of the continuous expansion and complexity of the scope of scientific research, the calculations of the system for determining the coefficient of aspiration flows in the combustion process have not yet been fully resolved.

The purpose of the study: In this scientific work, it is possible to prevent a possible fire and reduce the amount of material damage caused by a fire.

Fire losses depend not only on the time factor, but also on the direction and speed of the wind, the development of fire depends on a number of other factors, and first of all on the temperature regime in the fire zone.

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The composition of the air in the environment where the fire occurred changes significantly, the amount of toxic gases released as a result of the burning of products increases, and the amount of oxygen decreases. (Table 1).

Table 1

Change in air composition during a fire (%).

Fires:	CO	CO_2	O_2
In the basements	0,04÷0,65	0,1÷3,4	17÷20
On the floors	0,01÷0,4	0,3÷10,1	9,9÷20,8
In attics	0,01÷0,4	0,1÷0,7	17,9÷20,7

For this purpose, the study of the mechanics of the aspiration flow during combustion provides additional necessary information.

The practical results of the research are as follows:

It allows to pre-calculate forces and means to reduce the risk of emergency situations as a result of exposure to dangerous factors leading to emergency situations (fires).

1.Thus, the mechanics of studying the formation process of the aspiration flow during the localization of the consequences of emergency situations showed that the time allocated for the localization of the consequences of an emergency situation (fire) can be divided into three constituents by the following formula.

$$t_{fv} = t_1 + t_2 + t_3 = \sum_{i=1}^{3} t_i \qquad (1)$$

where tfv is the existing period of time, that is, until point "H" (it can be assumed that the consequences are localized);

ti is the period of time spent on each stage (where (i 1,2,3)):

t1 – period of detection of an operational situation;

t2 – period of making a management decision;

t3 – period of intervention in the immediate situation.

$$\mathbf{t_{ф.х.} = \sum t_1 + \sum t_2 + \sum t_3} \qquad (2)$$

- (∑t1) is the sum of the times spent to determine the operational status;

-(∑t2) is the sum of times for making a management decision;

- (∑t3) is the sum of communication times to the operational situation.

These short-term collections can be approved by fulfilling the following conditions:

$$g(t_1) > 0 \text{ if } t_1 \in [a,b];\ \varphi(t_3)>0;\ \text{if } t_3 \in [c,d]^1 \qquad (3)$$

$$g(t_1) = 0 \text{ if } t_1 \notin [a,b];\ \varphi(t_3)=0;\ \text{if } t_3 \notin [c,d] \qquad (4)$$

$$g(t_2) > 0 \text{ if } t_2 \in [b,c];\ \varphi(t_3)>0;\ \text{if } t_3 \in [c,d] \qquad (5)$$

$$g(t_2) = 0 \text{ if } t_2 \notin [b,c];\ \varphi(t_3)=0;\ \text{if } t_3 \notin [c,d] \qquad (6)$$

g(t1) is a function for determining the operative state;

g(t2) is a function to accept the control solution;

[1] $g(t_1)$, $g(t_2)$, $\varphi(t_3)$ – time-varying functions, $g(t_1)$, $g(t_2)$ – growing features, $\varphi(t_3)$- limit functions.

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φ(t3) is a function of mixing the operative situation.

In this case, when t1+t2 □ lim ∑t1+∑t2, it is possible for t3 to be max ∑t3. The main mass of developments designed to fight against crisis realities is directed to the redistribution of temporary periods, primarily to the increase of ∑t3 at the expense of ∑t1 and ∑t2. Then, it can reach t2 □ max ∑t2 and t3 □ max ∑t3 when t1 lim ∑t1.

2. If we consider the indicated three time periods consisting of the specific actions described above, which require time for their implementation, then these three time periods can be written with the following precision: 1) for a detailed examination of the fire scene and the period of determining the situation, it is possible to enter the number of all possible incidents in the 1st period as

$$t_1 = \sum_{J_1=1}^{N_1} t_{1j_1} \quad j_1;$$

2) during the emergency management decision-making period, $t_2 = \sum_{J_2=1}^{N_2} t_{2j_2} \quad j_2$ includes all possible situations in period 2;

3) forces and means for the period of direct intervention. $t_3 = \sum_{J_3=1}^{N_3} t_{3j_3}$ contains the number of all possible measures of j_3 in period 3.

As a result of determining the components of the existing t_{fv} three time periods, we derived a detailed formula for the value of the time period:

$$t_{fv} = t_1 + t_2 + t_3 = \sum_{j_1=1}^{N_1} t_{1j_1} + \sum_{j_2=1}^{N_2} t_{2j_2} + \sum_{j_3=1}^{N_3} t_{3j_3} = \sum_{i=1}^{3} \sum_{j_1=1}^{N_1} t_{ij_1} \qquad (7),$$

where t_{1j_1} is the duration of actions to determine the situation leading to fire, t_{1j_1} = 1, 2, 3, ..., , – the number of these actions;

t_{2j_2} -is the duration of management decision-making measures,

j_2 = 1,2, 3, ..., , - the number of these actions;

t_{3j_3} - measures to implement the management decision (direct direct intervention) j_3 = 1,2, 3, ..., N3, N3 - the number of these actions.

Quantity (1) can be confirmed. (8)

$$\begin{cases} g\ (t_1) = 0, \text{ if } t_1 \not\in [a, b], \\ \varphi\ (t_3) - 0, \text{ if } t_3 \not\in [c, d], \\ g\ (t_2) > 0, \text{ if } t_2 \not\in [b, c], \\ \varphi\ (t_3) > 0, \text{ if } t_3 \not\in [c, d], \end{cases}$$

if (2) where g (t1) is the function of determining the working environment;
g (t2) is a management decision-making function;
φ(t3) is a direct function of ∉ interference.

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(2) in the system, parameters a, b, c and d describe preventive, tactical measures that bring significant effectiveness to forces and assets in the third phase. They can be done in any of the three phases and even before the first phase begins.

Preventive measures are usually carried out before the start of the first phase, although they can be manifested or carried out in the first, second and third phases, in which case the command of the operational headquarters can leave one or another available means to change the temporary distribution provided for preventive, tactical decisions, depending on the situation.

Therefore, the predusmotren symbol $\notin$ and $\notin$ is presented in a system that allows the appearance of a, b, c, and d to be taken into account at any stage considered.

In the real situation, t_i , i = 1, 2, 3, the duration of these three periods can vary significantly, depending on how and when the manager uses the free time and if he uses it.

If the manager effectively uses time t1 to determine the operational situation, which includes organizational and technical measures (for example, inviting consultants, more experienced staff, maps and plans, specially installed data), then the value of this time is reduced. This allows more time to make a decision, which means that the time t2 increases.

If the manager has used the time t2 effectively, there will be more time for the events of the period t3 of direct intervention, for example, to rescue the victims.

In the language of formulas, this means that

$$t_1 + t_2 \to min(t_1 + t_2) \text{ opportunities to be } t_3 \to max(t_3). \quad (9)$$

In addition, there is a high probability of such cases when the measures implemented by the operative headquarters lead to a chain of states.

$$t_1 \to min(t_1) \Rightarrow t_2 \to max(t_2), t_3 \to max(t_3). \quad (10)$$

A chain of states is also acceptable.

$$t_2 \to min(t_2) \Rightarrow t_3 \to max\,(t_3). \quad (11)$$

The operational headquarters' specific functional obligations (created in extreme and crisis situations) include the necessity of mandatory redistribution of time, including the last two of these options.

As a result of research, the main part of the anti-crisis work is focused on the redistribution of these periods, in most cases, the increase in value due to the amount of $\sum_{j_1=1}^{N_1} t_{1j_1}$ and $\sum_{j_2=1}^{N_2} t_{2j_2}$ depending on the amount of $\sum_{j_3=1}^{N_3} t_{3j_3}$.

It can be concluded that the probability of the sum of the first two additions is equal to the third addition. Therefore, the following condition is fulfilled.

$$\mathbf{P(\Delta t_1) + P(\Delta t_2) = P\ (\Delta\ t_3)} \quad (12)$$

(1) We will consider the components of the formula in the following spreads:

$$t_1 = t_1^1 + t_2^1 \quad (4) \quad \text{ва } t_2 = t_1^2 + t_2^2 \quad (13)$$

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t1 is the time spent on learning the operational state; $\mathbf{t_1^1}$ – time spent on obtaining the necessary information; $\mathbf{t_2^1}$ – time spent on information delivery; t2 is the time to develop a solution; $\mathbf{t_1^2}$ is the time to develop a correct solution; $\mathbf{t_2^2}$ is the time to deliver information.

Conclusion. Due to the combustion of oxygen around the burning material, a pressure difference is observed, as a result of which air is sucked in from the environment, and this state is recorded separately through the middle and lower anemometers. It is shown that the noted additional aspiration flow is due to the suction of missing air directly into the combustion zone from below.

Let us denote the lower and middle readings of the anemometer as H1 and H2, and determine the aspiration coefficient using the formula H1.

The real meaning of this obtained coefficient is explained by the following:

the rate of burning of oxygen required for the combustion of the material;

activity level of air absorption from the environment required for the combustion of experimental material;

Experiments show that there is a coefficient characterizing the burning rate for combustible materials, and these coefficients increase to a maximum when the device is brought closer to the fire.

Measurement of additional convection currents in a special ceramic tube allows for a correct assessment of the situation. This, in turn, makes it possible to use available forces and tools more effectively during emergency situations.

The conducted experiments confirmed that there is a clear connection between the fire hazard that occurs during the combustion of substances and materials and the occurrence of aspiration currents during the test process.

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