Experimental Study on Avoidance Behavior Against a Flame in the Fire Room Development of Evacuation Simulator Based on Potential Method Part 2

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1. INTRODUCTION

The purpose of this research is to investigate human evasion behavior to the flame under evacuation, and to introduce it in the evacuation simulation under development. The investigation item is the following two points.

- Flame evasive behavior of fire occurrence point around (It turns, it crowds, and act about the flame.)
- Flame evasive behavior when staying exit (evasive action movement of exit stay)

As for the former, the walking movement line and the latter when the flame exists in the direction of evacuation are related to the exit selection when staying the exit in the fire occurrence room.

2. EXPERIMENT METHOD

It was a fire source doing to the center with the laboratory shown in *Figure 1*, and the scale line was described on the floor radially. In the fire source and the heptane fuel wick case, to change, the size of the formed flame has changed the fire source and the height of the side (*Table 1*).

It approached the fire source from the direction of NE in "Flame evasion experiment when walking" the subjects by one person, it evaded counterclockwise to be of a fire in the state of the fire source, and it walked for the flame in the place where the face position of the radiometer.

It approached the fire source from the direction of E in "Flame evasion experiment when staying" the subjects by one person, it stayed before the exit when it was an fire source, do geostationary by the isolation distance that was able to be allowed, and the position was decided.

26 men in the first half in one's twenties and total 36 of the ten women chiefly wore the long sleeve and the helmet for the subjects.

The survey of the questionnaire of the action for the action by the action that chiefly received heat (Thickness was felt) especially against or watching for the behavior of the flame (danger of externals) and both parties was done to the subjects everybody for the flame evasive behavior at each experiment.

Figure 1 Experiment outline

Table 1 Fire source list(* From the weight decrease speed)

No.	Cross section of fire source	Height of side from fire source	Heat release rate [kW] ※
1	Heptane(15L) Water	425mm	934
2	707.1	765mm	1,009
3	Inside round pulling out Heptane(9L) Water	375mm	304
4	700 1000 Fire source of doughnut type	775mm	637
5	内側角形抜き Heptane(6.5L) Water	375mm	304
	707.1 1000 Fire source of doughnut type		

3. RESULT OF EXPERIMENT AND CONSIDERATION

It divided whether to originate roughly from the fire source into subjects flame evasive action (thermal reaction to the feeling of hot), (sight reaction to the flame behavior) based on the result of obtaining.

In "Flame evasion experiment when walking", the tendency where the fire source No.2 took and the fire source No.3~5 had taken the flame evasive action as "Sight reaction" was obtained.

In "Flame evasion experiment when staying", tendency where the fire source No.1 and 2 took and the fire source had taken the flame evasive action as "Sight reaction" was obtained.

Here, the answer "Sight reaction" is thought to be an absolute isolation distance to the flame from the answer "The ignition of clothes is worried when approaching any further" of the reaction it and the questionnaire to the small fire source.

It is thought that "Thermal reaction" from the increase of the radiant heat style because of being the extension of the flame is predominant though it was expected that "Sight reaction" was predominant from the flame of the house where the fire started under the ceiling at the design of experiment.

"Walk" becomes *Figure 2* if the mean value of each fire experiment of the height of the flame and the isolation distance of "Sight reaction" is plotted, and "Stop" becomes *Figure 3*.

This relation can approximate by exponential, sees "Stop", and the tendency for the height of the flame to take some isolation distances in the rather short is seen compared with "Walk".

When the histogram of an incidence radiant heat of "Thermal reaction" is made for the subjects face, *Figure 4* and *Figure 5* are obtained.

The reaction that was able to be endured for a strong radiant heat was shown, and moreover, some subjects showed lognormal distribution in consideration of this and showed the application probability density curve in figure.

This is judged that both do not have a significant difference by being thought that it is a cause that the experimental data of "Walk" of the result of each scale line is arranged and the number of specimens is large though is seen some differences in the distribution shape on the face of things.

However, both should use the measurement result noting that the object that should be treated is different. "Stay" doesn't have the degree of freedom though For instance, it walks" comparatively has degree of freedom in the reference by location in the person's keeping the isolation distance with the flame.

Therefore, it is necessary to evaluate the action of the selection of the judgment and other exits of causing the obstacle in evacuation. Then, when the isolation distance to the generation of heat speed is requested, *Figure 6* (Walk) is *Figure 7* (Stop).

Isolation distance R_h (m) here to the radiant heat calculated by the next expression, added to the isolation distance in simple prediction type [1] of the radiant heat as fire source radius r (m) was expedient, and operated the safety side.

$$R_h = r + \sqrt{\chi_f Q_f / 4\pi q}$$

χ_f (·) is radiant heat flow plural that q (kW/m²) that becomes a radiant heat of Q_f (kW) at the generation of heat speed ratio (=1/3) can be endured only in the above equation. Moreover, the height of the flame used Equation of Zukoski [2]. There are differences of 600kW the origin of fire it of about 1m in the prediction result of causing.

Figure 2 Average isolation distance of subjects answered as height of flame of average at each experiment fire source and sight reaction(Walk)

Figure 4 Scale line in experiment fire source while walking experimenting. Radiation heat flow plural that does person I to subjects face of each 2.-5. (Scale line 1.6 is excluded)

Figure 6 Isolation distance from fire source center evasion walk, according to heat release rate of fire source

Figure 3 Average isolation distance of subjects answered as height of flame of average at each experiment fire source and sight reaction (stay assumption)

Figure 5 It is an experiment fire source and shining Radiation heat flow plural in subjects face at the stay limit position. (No.1-2)

Figure 7 Isolation distance from fire source center exit stay, according to heat release rate of fire source

4. SUMMARY

It experimented on the subjects of the flame evasion behavior in the fire source room, and the reaction to the radiant heat obtained a predominant result. Moreover, what had to decide the value to the difference in consideration of was pointed out though a remarkable difference was not seen in limit to the radiant heat in "Walk", "Stop".

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