EXPERIMENTAL STUDY ON EVACUATION FROM UNDERGROUND SPACE IN URBAN FLOOD

TAISUKE ISHIGAKI[1], YASUYUKI BABA[2], KEIICHI TODA[3] and KAZUYA INOUE[4]

[1] Professor, Faculty of Engineering, Kansai University,
3-3-35 Yamate-cho, Suita, Osaka, 564-8680, Japan
(Tel: +81-6-6368-0901, e-mail:ishigaki@ipcku.kansai-u.ac.jp)
[2] Research Associate, Disaster Prevention Research Institute, Kyoto University,
Ujigawa Hydraulics Laboratory, Yoko-oji, Fushimi, Kyoto, 612-8235, Japan
(Tel: +81-75-611-4391, Fax: +81-75-612-2413, e-mail: baba_y@mbox.kudpc.kyoto-u.ac.jp)
[3] Professor, Disaster Prevention Research Institute,
Kyoto University, Gokasho, Uji, Kyoto, 611-0011, Japan
(Tel: +81-774-38-3348, Fax: +81-774-38-4030, e-mail: toda@taisui5.dpri.kyoto-u.ac.jp)
[4] Professor, Disaster Prevention Research Institute,
Kyoto University, Gokasho, Uji, Kyoto, 611-0011, Japan
(Tel: +81-774-38-3348, Fax: +81-774-38-4030, e-mail: inoue@sabom.dpri.kyoto-u.ac.jp)

Many Japanese cities in alluvial plains are prone to floods every year. Some cities are fully urbanized and underground shopping arcades and subway stations are there. These underground spaces are also flood-prone area. Recent urban floods such as Fukuoka flood in Japan in 1999 and Seoul flood in Korea in 2001 have induced inundation into underground space and have caused heavy damages. Therefore, it is very significant to study the inundation and evacuation system from the view points of the hydraulics and disaster prevention.

Such urban floods have been investigated by using numerical models. However, there are not enough data to verify those models. In order to get precise data for the improvement of numerical models and to investigate the behavior of flood flow in an urban area with underground space, hydraulic model tests by using a city model with 1/100 scale and an underground-space model with 1/30 scale have been performed [Ishigaki et al. 2003]. Then a two dimensional shallow flow model with unstructured mesh and a storage pond model were applied and verified with experimental data [Ishigaki et al., 2004 and Toda et al., 2004]. From the results, it is found that huge amount of water will intrude into underground space through staircases, and it is very difficult to evacuate through staircases because of the high velocity of the flow. In this paper, the evacuation from underground space in urban flood has been investigated by using a real scale model of staircase (Photo.1), and the evacuation from basement is also tested by using a real scale model of door.

Evacuation from underground space has been investigated by using two real size models of staircase and door. From the results, it is found that the water depth of 0.3m on the ground level is the limit of evacuation through staircases (Fig.1), and that the water depth of 0.4m in front of the door is the limit to open it. As water depth would reach the limits in a short time, people in the underground space should evacuate from there as soon as possible. The evacuation tests were conducted under best conditions, but people should evacuate in the real situations of blackout and no information and so on. It is an urgent subject to establish the evacuation plan and the rescue system from underground space.

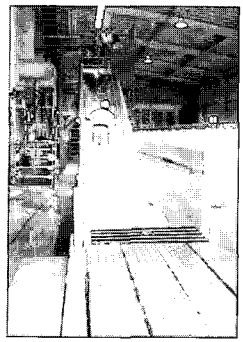

Photo1. Evacuation test by using real size model of staircase.

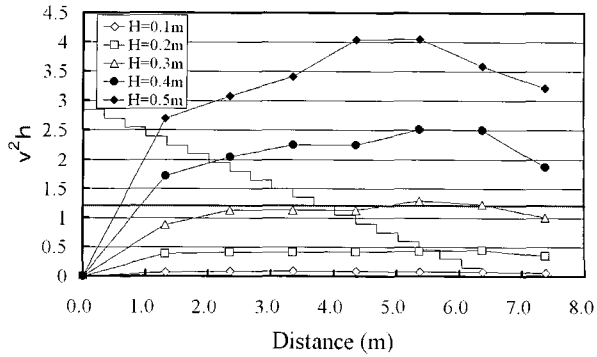

Fig.1 Distribution of momentum v^2h. The horizontal line, $v^2h=1.2$, shows the limit of evacuation.

REFERENCES

Ishigaki, T., Toda, K. and Inoue K. (2003). "Hydraulic model tests of inundation in urban area with underground space", *Proc. of 30th IAHR Congress*, Greece, B, pp.487-493.

Ishigaki, T., Nakagawa, H. and Baba, Y. (2004). "Hydraulic model tests and calculation of flood in urban area with underground space", *Proc. of 14th Congress of APD-IAHR*, Hong Kong, Vol.2, pp.1411-1416.

Toda, K., Inoue, K., Nakai, T. and Oyagi, R. (2004). "Hydraulic model test of inundation water intrusion in underground space", *Proc. of 14th Congress of APD-IAHR*, Hong Kong, Vol.2, pp.1403-1409.