Numerical Model Study on Tsunami-Induced Driftage

Taisei Corporation Member ○*D.P.C. Laknath*
Taisei Corporation Member *Takayuki Hashimoto*
Taisei Corporation Member *Takahide Honda*
Taisei Corporation Member *Kazunori Ito*

1. INTRODUCTION

The devastating 2004 Indian Ocean Tsunami triggered to widen the various research areas such as mechanism of tsunami generation, propagation and inundation processes, linking the field of tsunami science and coastal engineering. Further, after the Great Tohoku Earthquake and Tsunami in 2011, it has been stressed to scrutinize the understanding of tsunami related processes which occur in the coastal regions, using state of the art numerical modeling techniques. Since tsunami-induced drifting objects, such as wreckage and debris in the inundated coastal area cause to expand the existing damages as well as to block the immediate rescue routes, it is important to further investigate about the behavior of tsunami drifting objects in terms of understanding the additional potential damages and to identify about the safer rescue routes during the evacuation period. Further, for the preparation of optimal business continuity plans (BCP) under the immediate tsunami recovery and restoration programs, predicted behavior of drifting objects is important. In the scientific literature, Hashimoto et al. (2010) have investigated about the ship drifting under the hydrodynamic forces of tsunami currents, considering 2004 Indian Ocean tsunami. In their study, they have focused on larger floating objects (ships) drifting on waterfront area. Since more comprehensive and precise study is required for the detailed understanding of the drifting paths of the floating objects like tsunami damaged wooden houses and debris, in water ways (approach channels), ports and inundating areas, this study was carried out. In order to that, the objective of the present study is to investigate about the behavior of tsunami-induced driftage in a port area using modern numerical modeling methods.

2. METHOD

Ishinomaki Port area, one of the most tsunami-prone coastal regions in the Miyagi Prefecture in Japan was selected as the study area. At the time of 2011 Tohoku tsunami was striking the northeast region of the Japan, Ishinomaki city, including the fishing port was severely hit. Therefore, the hydrodynamic effect, induced by Tohoku tsunami in 2011 was considered for the simulation. For the detailed understanding of the hydrodynamic characteristic of the area of interested, tsunami propagation and successive land area inundation were simulated using Delft3D-Flow. Further, simulation of motion paths of the drifting objects (damaged wooden houses) under the tsunami flow was simulated using a drifting path motion model. Since drifting paths are mainly governed by the flow currents directions, flow characteristics calculated by Delft3D-Flow were used as an input for the drifting path motion model. Further, on the basis of water level calculated by Delft3D-Flow model, inception of the motion of the drifting objects was included for the drifting path motion model according to the Shuto (1992) (see Fig. 1). Finally, numerically simulated results were qualitatively validated by comparing the displacement of the drifting objects in the port area before and after the tsunami (see Fig. 3).

3. RESULTS AND DISCUSSION

On the basis of calculated results, final positions of the drifted locations are agreed with the available field observation results (photographs) around the area "R" (river) (see Fig. 2 & 3). According to our computed results, drifting objects around the coastline of "R" (river) area followed reasonable motion paths towards the mountain area and finally settled around the sea side face of the mountain. In case of drifting objects around the area "P" (port), drifting objects were drifted considerable distance towards the road side as a result of concentrated tsunami flow directed towards the port area. However, movements of drifting objects around the area “L” are not significant due to the morphological features and resultant weaker tsunami influence.

4. CONCLUSIONS

Numerical simulation for the tsunami induced driftage using Delft3D-Flow and driftage path simulation model give reasonable results.

Keywords: Tsunami, Numerical simulation, driftage, inundation
Contact address: Taisei Corporation, 344-1, Nase-Cho, Totsuka-ku, Yokohama, 245-0051, Japan, Tel: 045-814-7234

REFERENCES
Takayuki HASHIMOTO, Shunichi KOSHIMURA, Eiichi KOBAYASHI, Naoki FUJII and Makoto TAKAO; "Development of Hazard Map in Waterfront Area by Ship Drifting and Grounding Model in Tsunami", Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), Vol. 66, No. 1, pp.236-240, 2010.
Nobuo SHUTO; "Tsunami Strength and Damage", Tsunami Engineering Technical Report, No.9, pp.101-136, 1992.
http://www.pref.miyagi.jp/jigyokanri/daisinsaikirokusi/zanteibankirokusi-hyousi.pdf

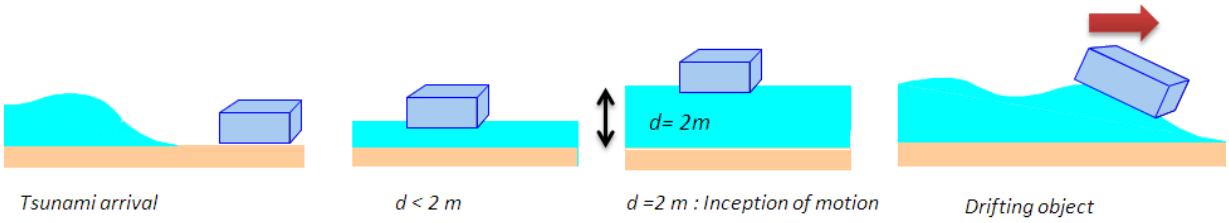

Fig.1. Inception of motion of the tsunami driftage

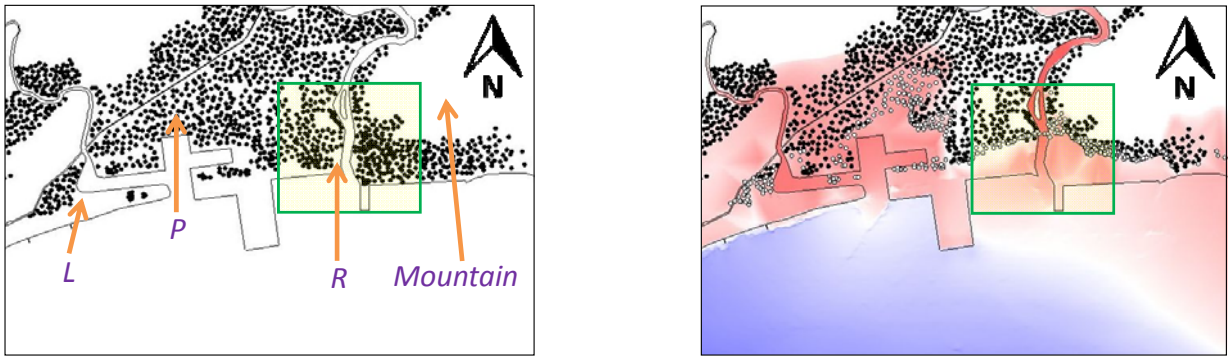

Fig.2. Computer simulated results for the drifting objects: "Left" side picture shows initial position of the drifting objects (black color dots)."Right" side picture shows final locations of the drifted objects (white color dots).

Fig.3. Comparison of field observed drifted objects in area "R" (river) before (September 2001) and after tsunami (April 2011)
(Source: http://www.pref.miyagi.jp/jigyokanri/daisinsaikirokusi/zanteibankirokusi-hyousi.pdf)