Capturing the Behavior of Ships During a Tsunami

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1. Introduction

When the Great East Japan Earthquake occurred, tsunami caused ships to drift about, and this led to increased damage in ports. In order to reduce such damage, when a tsunami is expected, it is necessary to take measures such as emergency evacuation. In this study, we analyzed the behavior of ships at the time of tsunami using Automatic Identification System (AIS) data.

2. Analysis Overview

In many cases, AIS data were not captured due to the power outages after the Great East Japan Earthquake, but we conducted analysis using the data available, from Kashima Port, Tomakomai Port, and the Tokyo Bay area. The behavior of ships in each port at the time of the earthquake was tracked over time to grasp the situation of evacuation.

3. Situation at Each Port

Kashima Port, which is near to the epicenter, was hit by large tsunamis several times, and about half of the ships drifted. Only relatively small ships that could leave the pier within about an hour after the earthquake were able to evacuate outside the port. After the tsunami warning was issued in Tokyo Bay ports, ferries and medium-sized ships capable of leaving the pier by themselves first evacuated outside the ports. Since large vessels such as container ships usually leave the pier with tugboat support, the time that these vessels evacuated depended on the time when tugboats arrived. There were a number of vessels that chose to continue mooring, but these did not drift. In Tomakomai Port, first of all, ferries and RORO ships, which were capable of leaving the pier by themselves, evacuated, and then many cargo ships left the pier by themselves. At this time, it was confirmed that ships were evacuating at regular intervals in order, and there was no significant decrease in ship speed and collisions between ships were not observed.

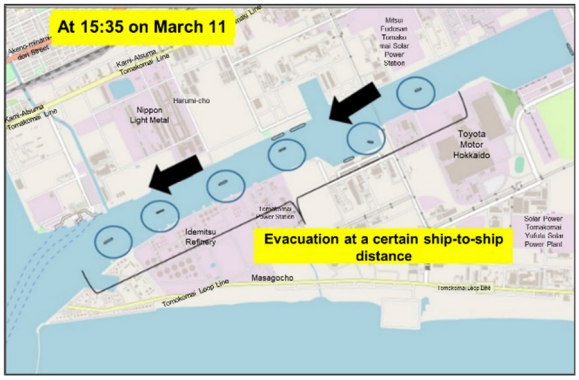

Figure: Emergency evacuation situation (Tomakomai Port)

4. Suggestions for Facilitation of Future Emergency Evacuation

First of all, whether or not a vessel of a certain size or larger can quickly obtain the support of a tugboat is a necessary factor for rapid evacuation. However, tugboats also need to avoid tsunami damage, so it is advisable for these vessels to leave the pier by themselves whenever possible. Therefore, it is also worth considering ways to secure a turning basin of sufficient size and shift to mooring head out (a mooring method in which turning is performed at the time of arrival at piers to eliminate the need for turning at the time of departure).

Second, not only emergency evacuation but also strengthening of mooring facilities to withstand tsunami can be considered as an option, so technical studies such as considering tsunami flow as external forces in design are necessary. Third, it is expected that emergency evacuation will take place when the water depth decreases due to backwash before a spilling wave arrives, and it is necessary to evaluate the water depth allowance of harbor facilities. From now on, at each port an assessment of tsunami risks after a large-scale earthquake will be conducted, and we will continue to conduct analysis to accumulate knowledge.

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