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Possible mass and long distance ferry transportation for health and humanitarian logistics at a disaster scene.

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Abstract

During the east Japan great earthquake and tsunami disaster on March 11, 2011, long distance ferry engaging in the coastal linking of east Japan area demonstrated their high seaworthiness against the tsunami waves. For the initial response operations for saving affected people's life and maintaining their health and humanity, the ferry also committed the emergency relief logistics (ERL) by transporting personnel, vehicles and heavy equipment of search and rescue parties which were deployed to the disaster site. This paper reviews ERL activities undertaken by the ferry at the time of Great East Japan Earthquake, and identifies the strength and weakness of the ferry in the context of ERL operations. Policy implications for further mobilizing ferry to cope with the possible large scale disaster in future are discussed and concluded based on a numerical model simulation.

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Keywords: *Emergency relief logistics; seamless transportation; long distance ferry; numericul model; large scale disaster*

1. Introduction

On March 11, 2011, unprecedented large scale earthquake and tsunami, which is called as the Great East Japan Earthquake and tsunami (hereinafter express "GEJE") attacked Tohoku and Kitakanto regions of the east part of Honshu island, Japan. Immediately after a withdrawal of the tsunami alert, masses of search and rescue parties were deployed to the disaster area, where the main force was transported from Hokkaido area by sea. This paper highlights

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advantages and possible future role of the long distance ferry as an efficient and effective mass transportation means at the disaster scene. Here long distance ferry is defined as a roll-on roll-off type car and passenger carrier, and characterized by the function of multimodal seamless transportation from land to sea and sea to land with a loading capacity of 200- 300 vehicles and up to 900 passengers.

Only few academic papers have discussed on the capacity of water surface transportation as an emergency relief logistics (ERL) means. Majima *et al* (2006) discussed a possibility of developing ERL system though coastal and river shipping by multi-agent simulation. Kawada *et al* (2007) showed effectiveness of ERL by mobilizing water surface transport. These researches suggested significance of shipping sub-sector for further efficient and effective implementation of ERL, however, advantages of ro-ro type vessels have not yet been identified.

Notable performance of the long distance ferry in the area of ERL drew an attention at the GEJE scene. Suzuki (2013) reported transportation of search and rescue personnel and equipment undertaken by the long distance ferry at the early stage of the GEJE. Ono *et al* (2013, 2015) discussed on advantages and possible commitment of the long distance ferry for the ERL operation to cope with the future large scale disaster such as the Nankai-trough great earthquake in the west part of Japan.

Based on the previous reports and discussions, this paper starts by reviewing current operations of the long distance ferry in Japan and its performance demonstrated during and after the GEJE. Particular focus is placed on its high performance as transportation means of search and rescue parties of Japan Self-defense Forces (JSDF), police departments (PD) and fire department (FD). The ship size, tonnage, and transportation capacity of long distance ferry currently under operations for the coastal links of Japan is reviewed in the context of possible ERL commitment.

For evaluating efficiency and effectiveness of the ERL operation by the long distance ferry, the authors undertake numerical modeling of the ferry operations between the off-site supporting ports and the disaster area. Targeted ports selected for the case study are ports of Kyusyu and Tokyo as off-site supporting ports and the port of Kochi as a bridgehead in the disaster area. The authors consider it appropriate to select Kochi prefecture as a case study target because Kochi is currently facing a serious risk of strong seismic shaking and massive tsunami due to the Nankai-trough great earthquake.

Limitation and issues to be discussed for further commitment of the long distance ferry to the ERL operation is identified and examined. In conclusion, policy implications for facilitating future ERL ferry operation is discussed and concluded. Necessary policy development will be recommended accordingly.

2. Experiences from the Great East Japan Earthquake

2.1. Characteristics of hazard and exposures

The GEJE caused a huge quake with moment magnitude (Mw) of 9.0 which was followed by four Mw 7 class earthquakes on March 11, 2011. The biggest quake occurred at 2:46 in the afternoon of the day with an epicenter in offshore Miyagi prefecture and three Mw 7 class quakes consecutively occurred within 40 minutes. The mainly affected areas by the strong ground motion and tsunami were Tohoku and the north Kanto regions of Japan (hereinafter refers "the east Japan"), however, long periodic ground motions were widely observed even in the part of west Japan such as Osaka, which is 1,000 kilometer away from the epicenter. Figure 1 shows geographical view of the east Japan, which includes six prefectures from Tohoku (prefectures of Akita, Aomori, Fukushima, Iwate, Miyagi and Yamagata), and four prefectures from the north Kanto (Ibaraki, Gunma, Tochigi and Chiba). The buildings and structures including transportation and logistics facilities, in particular those in coastal areas, were badly damaged by seismic shaking and tsunami inundation.

Seismic intensity defined by Japan Meteorology Agency (JMA) of up to 7 was recorded in Kurihara city of Miyagi Prefecture and those of JMA intensity 6 stronger was widely observed in 37 municipalities of Miyagi, Fukushima, Ibaraki and Tochigi prefectures.

The observed huge tsunami with the run-up height up to 40 meters in Miyako city, Iwate prefecture was what had never experienced before in the Japanese modern history. Inundation depth of the tsunami reached about 10 meters even at the port of Ofunato, and exceeded eight meters at the ports of Kuji, Kamaishi and Soma. (See a right section of figure 1) Inundation areas reached 58 square kilometers in Iwate, 327 square kilometers in Miyagi, and 112 square kilometers in Fukushima. Cities, communities, local industries and transportation facilities including major ports and