

Guidelines for Ship Evacuation from a Tsunami Attack

Eiichi Kobayashi

Graduate School of Maritime Sciences, Kobe University
Kobe, Japan

Syunichi Koshimura

Graduate School of Engineering, Tohoku University
Sendai, Japan

Shouta Yoneda

Imabari Shipbuilding Co.,Ltd.
Marugame, Japan

ABSTRACT

Earthquakes have continuously occurred along the Nankai trough off Kii Peninsula for more than 1000 years. The tsunamis that are generated by these earthquakes, and reach Osaka Bay within approximately one hour of the earthquake. A tsunami causes the slow phenomenon of coming and going of the horizontal water flow, and the rise and descent of the water level. Many oil-related facilities, power plants and petrochemical complexes are located in the landfill area along the Osaka Bay coast, and many cargo vessels transporting hazardous materials navigate the bay. Such ships should be moved outside the port area in the event of an earthquake and a tsunami is expected. However, specific procedures for such evacuation measures have not been developed. In this study, evacuation guidelines for an LNG carrier, representative of a hazardous cargo carrier, were considered in the case of the ship entering Sakai Senboku Port, where many power plants and chemical complexes are located.

KEY WORDS: tsunami; ship; evacuation; maneuver.

INTRODUCTION

Large earthquakes, such as Keichou in 1605 with a magnitude of M7.9, Houei in 1707 (M8.6), Tou-Nankai in 1944 (M8.4), and Nankai in 1946 (M8.4), have occurred for at least one thousand years along the Nankai Trough. The Nankai Trough is located off the Toukai area, Kii peninsula and Shikoku area in Japan, where the Philippine plate subducts the Eurasian plate, as shown in Fig. 1(Watanabe1985). As of January 1st, 2007, the probability of occurrence of the next Nankai and Tou-Nankai earthquakes in the next 30 years is estimated at 50% and 60% to 70%, respectively (Web site of the Headquarters for Earthquake Research Promotion; <http://www.jishin.go.jp/main/choukihyoka/kaikou.htm>). The tsunamis that will be generated by these earthquakes will arrive at Osaka Bay within one and half hours after earthquake occurrence. The general characteristics of tsunamis in Osaka Bay are the receding and approaching of the horizontal water flow associated with the sea surface slowly rising and falling.

There are also numerous petroleum, power and chemical plants on the reclaimed land along the coast of Osaka Bay. In particular, there are key industries such as petrochemical refineries, factories, power stations, and their associated industries, companies and facilities in the adjoining area of Sakai-Senboku Port, which runs 10 km north to south, 10 km east to west, and covers an area of 9000 ha. The port is an particularly important harbor, and it extends over Sakai City, Takaishi City and Izumiootsu City and numerous ships enter the port transporting raw materials that are hazardous.

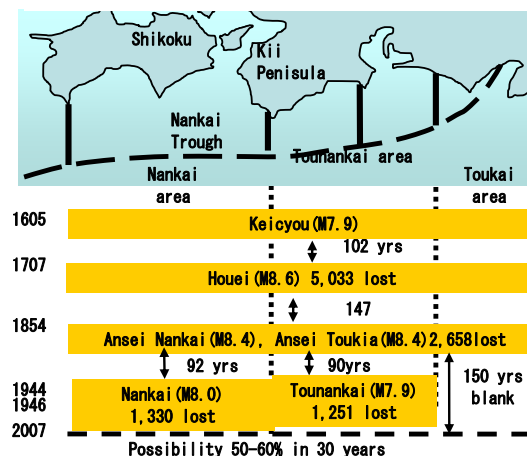


Fig. 1 Historical occurrence of earthquakes along the Nankai Trough.

When an earthquake occurs, and a tsunami is expected, ships are basically required to remain outside those ports. However, specific procedures for evacuation procedures for these areas have not yet been developed. A ship transporting liquefied natural gas (LNG carrier) and entering the Sakai-Senboku Port area is the focus of this study, and is used as an example of a cargo ship transporting hazardous materials. Although the depth of the water in the area near Sakai-Senboku port is