Ship-to-Ship Mooring Analysis of LNG Jetty Terminal

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ABSTRACT

The ship-to-ship transfer of cargo is often regarded as a high-risk operation due to the need to maintain control and coordination between the two adjacent vessels. Understanding the hydrodynamic interaction between two adjacent vessels under wave-excitation is therefore essential for terminal layout design and safe operations. The proposed LNG berth terminal is designed to be an open sea terminal with separated berthing dolphins and mooring dolphins used for anchoring both FSRU and LNGC. The FSRU is to be berthed on the seaward side of the unloading platform and the LNGCs will be moored ship-to-ship with FSRU. The LNG terminal is designed as a pile supported structure. The piles may be installed vertically or on a batter, and their heads may be fixed, pinned, or elastically restrained by the concrete pile cap. The worst loading condition that assumes the overload of several mooring lines attached to one of the vessels in an unavoidable circumstance is considered. The predicted vessel movement, fender reaction on both lines attached to one of the vessels, and the maximum forcing acted on the fast release mooring hook are provided.

KEY WORDS: FSRU; LNGC; LNG terminal; ship-to-ship mooring.

INTRODUCTION

With the fast growth of economy in Southeast Asian countries, energy demand is increasing with each passing day. For supplying this demand, many different kind sources of energy such wind, nuclear and thermal are utilized. Natural gas is one of the most important energy sources due to its relatively low cost and environmentally friendly nature. Also diversification of energy source, like natural gas and the liquid form of natural gas which is called as LNG, among different sources is an important issue for an energy dependent country. Transportation and storage of natural gas in liquid form is gaining importance parallel with the increase in international trade of natural gas as well. The location of LNG terminal and FSRU plays a significant role for the logistics of LNG. Kartal et al (2014) identified the major components used for transportation and handling of LNG by sea, such as marine terminals, floating storage and re-gasification units (FSRU).

As the technology of processing LNG has developed substantially and the costs of utilizing LNG infrastructure both in the terms of shore facilities like LNG terminals, maritime LNG Carriers and also FSRU become more feasible. Offshore LNG terminal, LNG ships, gasification and regasification units can be counted as the main legs of maritime LNG logistics. LNG Carriers are used to transport the cargo from the floating LNG-FP(S)O to the shore or from terminal to terminal. Offshore floating LNG systems become a more and more viable economic solution. The need for an accurate assessment of the hydrodynamic performance of LNG offloading systems is an important issue. Compared with some traditional terminals that need the coastal protection against wind, waves and current, LNG jetty terminal could be sited in open sea areas, saving shoreline resources.

Safety of cargo transfer operations between side-by-side vessels depends on accurate modeling of hydrodynamic behavior, especially in terms of predicting the gap free surface elevations between the two vessels. The common industry practice of using linear potential flow models to study these interactions over-predicts the free surface elevations, due to the fact that potential flow does not include viscous dissipation effects such as flow separation at hull corners and skin friction. This may result in inaccurate projections of the time-window when these operations can safely take place. This is an important aspect for developments such as Floating Liquefied Natural Gas (FLNG) platforms, where side-by-side cargo offloading is an essential operation.

A comparison between model basin experiments and results of diffraction computations on side-by-side moored LNG carriers is presented (Pauw, et al., 2007). The computations are based on a new lid method in diffraction codes to suppress non-realistic high wave elevations between the two floating objects. The epsilon parameter has a much greater effect on the drift forces than on the first order quantities.

Two types of side-by-side hull configurations were investigated, the first using rectangular barges with sharp bilge corners at varying gap distances and the second using barges with rounded bilge corners of varying radii at a fixed gap distance (Chua, et al., 2016). By combining use of the component energy dissipation approach and the modified dissipative potential flow model, better predictions of gap hydrodynamic interaction can be obtained, compared to using conventional potential flow. The comparison of results serves both as a validation of the modified potential flow model, and to highlight the importance of including viscous dissipation when analyzing hydrodynamic interactions.