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Experimental Analysis of the Seakeeping Response of a Double-barge Float-over System for Topside Transportation

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In this paper, an experimental investigation of the seakeeping behavior relative to a newly developed float-over concept by TechnipFMC Rome Operating Centre (ROC) for transportation, installation, and decommissioning of an offshore platform topside is presented. A scaled rigid model of the twin-barge system has been tested in the wave basin to determine the main seakeeping features and the towing forces in head and following waves. Comparisons with single-barge and flexible model tests are also provided. In the perspective of identifying the range of safe sea-state conditions for topside transportation, the present analysis is the first stage of a more extensive investigation that involves the testing of different scale models as well as numerical simulations for which the collected data will provide a validation database.

INTRODUCTION

The topside deployment over the jacket has been typically carried out using lifting cranes equipping special vessels. To find reliable and affordable alternatives, floating systems based on the use of single or twin barge arrangements have been also exploited for transportation, installation, and decommissioning of offshore platform topsides for jacket structures (see, e.g., Kurian et al., 2012). An interesting market segment for this kind of operation includes topsides whose weight is in the range of 1,000–3,000 tons, for which it is uncommon using float-over systems, especially with two barges in a catamaran arrangement. For this reason, the TechnipFMC Rome Operating Centre (ROC) has been developing a reliable and innovative float-over concept based on the use of not-identical barges and properly redesigning the supporting structure, increasing the usability of this concept so as to be a valid alternative in areas characterized by lack of lifting capabilities. This concept will be named catamaran float-over (CFO) for short in the following. Nonetheless, the transportation and installation procedures still require preliminary analysis of the seakeeping and station-keeping response of the considered float-over configuration because of the strict and narrow margins for safe operations. For the case of a single barge, Duquesnay et al. (2013) investigated the approach to the slot under the action exerted by the tug towing lines, the mooring lines, and the cross lines. There have been also some attempts to employ a CFO method to install large topsides. In these cases, the catamaran configuration is usually provided by two barges supporting the topside structure, and optionally, additional elements such as linking cables or stiffening bridges are employed to tighten the whole structure. Technip used this technique for the installation of the Murphy Kikeh Spar (Edelson et al., 2008). The CFO technique indeed provides some advantages with respect to the single-barge float-over system (Luo et al., 2013); for instance, the catamaran layout can be adapted to different jacket geometries by properly redesigning the supporting structure. This is crucial in particular for small-sized topsides where the small dimension of the jacket makes it impractical to perform the docking operations using a single-barge layout.

On the other hand, the topside has to play as a catamaran deck connecting the two demi-hulls, sustaining loads for which the topside has not been designed, especially during the transportation phase. Recently, Kim et al. (2017) and Kwon et al. (2017) performed numerical simulations and model tests to study the float-over and mating operations of a 26,000-ton topside using a T-shaped single barge. During the basin tests, including the deployment of the jacket structure, the vessel motion, the line tensions, the fender forces, and the loads acting on the leg mating units (LMUs) and the deck support unit (DSU) were measured under various wave headings and amplitudes, requiring special measuring devices. Zhu et al. (2017) recorded the successful float-over installation of the mega topside in the South China Sea using field measurements techniques aimed at providing real-time data useful for fast and safe operations and for validation of future numerical simulations. For the above reasons, an experimental investigation of the response of the CFO system has been carried out at a CNR-INM towing-tank basin using three different physical models: (i) a twin-barge model with barges rigidly connected, (ii) an elastic model scaling the flexibility of the topside (Dessi et al., 2017b), and (iii) a variable configuration model for reproducing the sequence of mating operations over the jacket. All three models are based on two barges of slightly different length and width, representing what might occur in real operations when two identical barges are not available. In particular, in this paper, we consider the response of the "rigid" model in head and following waves during transportation as a limit case (no flexibility allowed between the barges) to obtain data for validation of the seakeeping simulations. Indeed, even if the geometry of the barges is rather simple, their blunt shape poses some difficulties for the seakeeping codes when the amplitude of the waves is

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KEY WORDS: Twin-barge float-over, topside installation, asymmetric barges, rigid physical model, seakeeping tests, towing system.