Numerical Investigation on the Coupling Dynamic Response of the Twin Barges-Topsides during the
Floatover Installation

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ABSTRACT

Twin-barge floatover method can utilize two barges to install the topsides and is a promising method for the mega topsides installation. However, the complex connections between the twin barges and topsides pose great difficulties for floatover operation. The installation process involves the hydrodynamic and structural interactions of multiple bodies. In this study, a numerical model for predicting motions and loads during the floatover operations is proposed. The model considers the effects of multi-body hydrodynamic interaction, DSU and LMU structural connections, mooring systems, and fenders. The motion equations of the multiple bodies, together with the coupled stiffness matrix of the two barges and topside, are derived. The in-house code is developed to predict the coupled motions of two barges and topside, loads on DSU and LMU during different load transfer stages in time domain. The numerical results are compared with the experimental results in beam wave. Good agreement is obtained. Results indicates that the proposed numerical model can provide an accurate and reasonable predictions of the twin-barge floatover installation.

KEYWORDS: Twin-barge floatover; multiple bodies; numerical model; load transfer

INTRODUCTION

With the develop of the offshore oil and gas industry, offshore platforms gradually become much large and intensive. Limited by the lifting capacity of crane, conventional crane lifting method is difficult to meet the installation needs of mega topside of offshore platforms, especially for 10,000-ton mega topside. To install the mega topside safely and efficiently, floatover installation method has developed rapidly in recent years. In the floatover method, the topside of the offshore platform is carried by barges, and lowered down onto the substructures by the tide level and barge ballast adjustment, finally transferring the topsides loads onto the substructures.

The floatover methods have various configurations and can be classified according to different criteria (Qin et al. 2021). As a floatover installation method emerged in recent years, twin-barge floatover installation method is flexible in form and can use two barges to achieve the installation of topside, which has a broad engineering application prospect. In the twin-barge floatover method, the weight of topside is transferred from the twin-barge onto the jackets under wind, wave and current loads. The complexity of the system involves multi floating bodies hydrodynamic interaction, multi-body elastic connection and external restraint, load transfer, etc.

The floatover installation method has been introduced at the late 1970s and extensively studied by field measurement, numerical and experimental simulations (ONeill et al. 2002, Jung et al., 2009; Wang et al., 2009; Choi et al., 2014; Luo et al., 2015; Chen et al., 2017; Tian et al., 2018; Bai et al., 2020), although most are related to the single barge floatover installation. Chen (2005) developed a heave - pitch coupling model for a single-barge floatover system using the state space method to investigate vertical impact loads on LMU (Leg Mating Unit) and DSU (Deck Supporting Unit) at 0% and 100% stages, where the connection between substructure, barge and superstructure was modeled as a linear spring damping system. Hu et al. (2007) investigated nonlinear shock loads on the connecting units at the beginning of the load transfer phase and developed a state space model in the time domain calculation to replace the time-consuming convolution in the calculation of the delay function. Zhao et al. (2021) performed numerical simulations of the coupled multi-body motion response of a single-barge floatover system, considering time-varying hydrodynamic parameters during the fast load transfer. Bai et al. (2020) investigated the dynamic response characteristics during the floatover installation of mega topside based on the fast load transfer technique using model tests.

However, there are few studies on the motion and loads of the twin-barge floatover process. Tahar et al. (2006) simplified the system into different rigid bodies supported by springs according to the degree of load transfer when studying twin-