Influence of Different Mooring Factors on Characteristics of Docking Mooring System for Large Container Vessel

Ding Zhang, Song Liu, Ying Chen, Hai Tong Yuan
Marine Design & Research Institute of China, Shanghai, China

ABSTRACT

With increasing size of large container vessel, more and more containers are loaded on deck and wind area of the vessel becomes larger and larger. The design of docking mooring system is one of the key points in general layout of large container vessel. Based on time domain calculation method, design procedure of docking mooring system for large container vessel is presented. Wind drag coefficient from CFD simulation and that referring to OCIMF are compared. Also different mooring patterns and different mooring line combinations are analyzed. The research results provide a reference for optimal design of docking mooring system.

KEY WORDS: large container vessel; docking mooring system; wind drag coefficient; mooring characteristics; time domain calculation

INTRODUCTION

With the large-scale development of vessels, more and more attention has been paid to the mooring safety. Once mooring ropes of large vessel are broken under severe environmental conditions, the vessel may crash into the docking and cause serious damage or injury (Wang, Zou and Han, 2012). At present, certain research results have been achieved (Liu, He and Chen, 2021; Luo, He and Yu et al., 2007; Li, Yang and Zong et al., 2018; Zhang, Huang and Yu, 2014): a reasonable pre-tension can balance the mooring rope tension; the length of some mooring ropes should be avoided to be too short as far as possible when mooring, and the rope tension can be reduced by increasing the rope length; for the mooring rope material with good elasticity, the rope tension is relatively small.

The container vessel new building market is very hot during recent years, and the size of container vessel has been larger and larger. The max. tier of containers loaded on deck has been 13 for 24000TEU. As wind area of container vessels is much larger than other type of vessels, the mooring safety condition is more severe. Therefore, wind drag coefficient is the key input in mooring analysis. To data, relevant reference research on environment drag coefficient of container vessel in China is rarely reported. And there is no specific guideline for container vessel to select mooring pattern and mooring rope combination.

In this paper, the characteristics of docking mooring system design are introduced. In order to introduce the verification method of docking mooring system, a 13000TEU container vessel is taken as an example for calculation. Comparative mooring analysis based on the wind drag coefficient of CFD simulation and that of OCIMF MEG4 (2018, hereinafter referred to as OCIMF) are carried out. Different mooring patterns and mooring rope combination are also studied in order to find optimal mooring system design. These findings are promising to provide a basis for issuing a guideline for the design and calculation of docking mooring system of container vessels.

DOCKING MOORING SYSTEM DESIGN

Analysis procedure of docking mooring system

In order to carry out loading and unloading operation of containers effectively, it is necessary to analyze the mooring system design condition of container vessel under external environmental loads (wind, wave and current). The analysis result impacts whether it is necessary to transfer the vessel from docking to anchorage area. Normally frequency domain or time domain calculation methods are adopted for analysis, and the motion program of static or dynamic model under the action of external environmental forces is to be solved. The recommended procedure for design analysis of docking mooring system is as follows:

1) Determine the environmental standard under extreme condition and operation condition according to the hydro-meteorology of the operation area, including basic parameters of wind, wave and current, etc.
2) Determine the material properties of mooring ropes.
3) Determine mooring pattern according to docking layout, including the distribution of head rope, breast rope, spring rope and stern rope.
4) Determine wind and current drag coefficients.
5) Mooring analysis software is used to analyze the mooring system under given environmental conditions by frequency domain or time domain method.
6) Compare the calculated value with design criterion. If criteria is not met, mooring system layout has to be modified and re-analyzed until criteria will be met.