Hydroelastic response of 19,000 TEU class ultra large container ship with novel mobile deckhouse for maximizing cargo capacity

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Abstract

This paper is related to structural design evaluation of 19,000 TEU ultra large container ship, dealing with hydroelastic response, i.e. springing and whipping. It illustrates application of direct calculation tools and methodologies to both fatigue and ultimate strength assessment, simultaneously taking into account ship motions and her elastic deformations. Methodology for springing and whipping assessment within so called WhiSp notation is elaborated in details, and in order to evaluate innovative container ship design with increased loading capacity, a series of independent hydroelastic computations for container ship with mobile deckhouse and conventional one are performed with the same calculation setup. Fully coupled 3D FEM — 3D BEM model is applied, while the ultimate bending capacity of hull girder is determined by means of MARS software. Beside comparative analysis of representative quantities for considered ships, relative influence of hydroelasticity on ship response is addressed.

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Keywords: Structural design; Container ship; Hydroelastic approach; Springing; Whipping

1. Introduction

Structural design of 19,000 TEU Ultra Large Container Ship (ULCS) with open hold under novel mobile deckhouse for maximizing cargo capacity is evaluated in this paper, considering hydroelastic response, i.e. springing and whipping. Springing can be defined as the resonant hull girder vibration at the wave encounter frequency, while whipping is the transient hull girder vibration induced by slamming (other dynamic forces can also produce whipping, but slamming has dominant contribution). Springing is encountered mainly at moderate sea states where the combination of the wave frequencies and the ship speed might cause the closer matching of the excitation and the structural natural frequencies, while whipping, is usually encountered in severe sea states where significant slamming events are likely to occur.

The practical procedure for ship structural design involves the verification of two main structural failure modes:

- Fatigue initiated cracks in the structure.
- Yielding and buckling failure due to extreme event.

These two failure modes are fundamentally different and the methodologies for their assessment differ despite some overlapping steps. The goal of the fatigue analysis is to assess the whole ship life by counting all the combinations of the stress ranges and number of cycles (S-N curves) for particular structural detail, while the final goal of the extreme event analysis is to predict, for each structural member, the single most likely worst event during whole ship life. It is to be noted

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