Analysis on the full scale measurement data of 9400TEU container Carrier with hydroelastic response

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\textbf{ABSTRACT}

Since the advent of hydroelasticity issues in the marine community, a full scale measurement campaign has been considered the most important research to reach a thorough understanding of this complicated physical phenomenon. This study examined the full-scale measurement data of a large container carrier with a 9400TEU capacity. First, modal parameters, such as the mode shapes, natural frequencies, and damping ratios, were examined based upon the measured acceleration data on deck. The evolution of the natural frequencies and damping ratios were also checked and their correlation was explored. In addition, the modal magnitude obtained using the acceleration data was cross-compared with the strain at deck to investigate their temporal relevance. Finally, the fatigue damage was calculated using the measured strain at deck and the expected long-term fatigue damage was estimated based upon the fatigue damage experienced by the vessel during the measurement period.

1. Introduction

Hydroelasticity is recognized as one of the main challenges in the design of modern merchant ships, such as ultra large container carriers and very large ore carriers. Hydroelasticity refers to either the resonant vibratory response of a flexible ship structure under a random ocean wave load, or transient vibratory response induced by an impulsive slamming load that takes place when the ship plunges into the free surface with waves. The former is called springing and the latter is called whipping. The importance of hydroelasticity has become of prime importance since the advent of larger and faster ships, which has increased dramatically the likelihood of resonance between the ship structure and an incoming wave as well as transient vibrations due to the flexibility of the ship.

Considerable research efforts are currently focused on the hydroelasticity problem to establish a robust design methodology, ultimately targeting the safe operation of unprecedentedly large ships. On the other hand, this goal has yet to be achieved owing to the inherent nonlinear nature of the physics behind the hydroelasticity. Some numerical methodologies have been developed under a linear or weakly nonlinear assumption in both the time and frequency domains, the majority of which are based on the combination of potential theory and the finite element method (Price and Temarel, 1982, Jensen and Dogliani, 1996, Wu and Moan, 1996, Malenica et al., 2003, Hirdaris et al., 2003, Kim, 2009, Kim et al., 2013). Computational fluid dynamics coupled with finite element methods is a potentially powerful numerical methodology to solve the problem considering any type of nonlinearity. The model basin