Hydroelasticity in Ship Design

Yongwon Lee(yongwon.lee@lr.org)
Lloyd's Register Global Technology Centre, Southampton, UK

Abstract

Hydroelasticity theory has progressively developed since 1970s. During the last three decades hydroelasticity has evolved from a theoretical concept at the outskirts of naval architecture to a mature science impacting all areas of marine technology. The demand for larger container ships has increased dramatically in the last decade as world trade continues to grow and with the marine industry requirement for more energy efficient ships.

Currently the largest of these ships has a capacity of 21,000 TEU and designs of more are on order. Due to the slender hull form combined with high speed of these ships, hydroelasticity (springing and whipping) phenomena can be critical for the design and operation of these large container ships with large deck openings.

Whipping of a ship is the rapid flexing of the hull girder as a consequence of a wave impact on the hull. This usually results in high frequency cyclic oscillations of the hull girder which may result in increased vertical wave induced bending moments and shear forces compared to linear theory. The oscillations of the whipping responses usually decay rapidly after several wave periods due to damping effects. Whipping is primarily a strength issue. Springing of a ship is the continual hull girder vibration as a consequence of waves exciting resonant hull girder frequencies. The flexing of the hull girder due to springing may continue for a significant period once initiated. This can make springing important with regard to the fatigue life of a structure.

This study presents background and analysis guidance to determine values of wave induced dynamic loads considering the effects due to hydroelasticity which are suitable for ship design application. The analysis procedure includes Ultimate Limit States (ULS) design assessment and springing induced fatigue damage assessment. Examples of the use of these methods are also presented and discussed. The proposed procedure also can be employed for design assessment of other ship types.

Keywords: *Non-linear ship motion, hydroelasticity, whipping, springing, structural vibration, container ship, classification rules*

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Biography

Dr Lee is a senior specialist of Global Technology Centre at Lloyd's Register. He has worked over 20 years for the marine and offshore industry. He has carried out various projects regarding design, research, development, consulting work and technical investigation. He is a member of committees of international professional bodies as well as a peer reviewer of international scientific societies. He is the founder and the president of the Europe-Korea Marine and Ocean Engineers Association.