SPECTRAL FATIGUE ANALYSIS OF LIQUEFIED NATURAL GAS CARRIER STRUCTURAL DETAIL

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1. INTRODUCTION

Natural gas is considered as a cleaner fuel compared to MDO or HFO. In line with increasing environmental care, there is a rising demand for natural gas worldwide and international natural gas markets are continuously growing. One of the most important parts of LNG transportation system are LNG ships, which can be found in service from 1959. A typical LNG carrier is double-hull vessel with four to six tanks located along the centreline, and there are nowadays several containment systems in use, that can be classified into self-supporting ones (also referred to as Moss type) and membrane type ones. Both alternatives are designed, constructed and equipped with sophisticated systems for carrying LNG over long distances at storage temperatures around -162 °C [1]. Recently, the membrane tank system has been adopted widely due maximizing ship load capacity. More details on LNGC cargo containment systems can be found in [1].

IHS Fairplay (IHSF) database [2] includes data on all ships operating worldwide, and here the DWT of ships delivered from 1999 to 2015 (inclusive) is presented in Figure 1, which shows us that largest LNG ships have been built about 10 years ago (several ships with DWT smaller than 60000 t are omitted from the representation). However, it is more interesting to look at the number of delivered ships and number of orders by the end of 2019 (as stated in August 2015), Figure 2. Although there is some slight trend to build larger units, it seems that market of LNG ships is rather unstable, which is a consequence of economic crises.

There are different issues associated with the design (cargo containment system, hydrodynamic aspects, structural aspects, propulsion issues...) and operation (LNG transfer systems, partial filling issues, problem of boil-off...) of LNG ships making them rather complex objects, and this paper is oriented to the structural one, i.e. how to assess fatigue life of a ship structural detail within so-called direct calculation approach.

The applied procedure is elaborated in details, as well as the used general hydro-structure tool HOMER [3,4]. More information on the mentioned software is given within the paper, but it is to be noted that it can be applied to any kind of ships and offshore structures in the analysis of both quasi-static and dynamic structural responses, caused by linear, weakly nonlinear or impulsive nonlinear hydrodynamic loading, respectively. Although hydroelastic effects are not expected to be of