Fatigue Damage Assessment Based on Full Scale Measurement Data for a Large Container Carrier

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ABSTRACT

As modern container vessels become larger and more flexible, the uncertainty of the fatigue assessment has been increased. In the conventional ship rules, the fatigue damage is evaluated based on the linear wave load. For the larger container carriers, however, the wave induced vibration, so called whipping and/or springing, has to be considered, due to their flexible bodies.

In this paper, the fatigue damage due to whipping and/or springing has been evaluated with the full scale measurement data. The measured vessel is an 8000TEU container vessel. The full scale measurement for the vessel started from 2006 with joint project of SHI, ABS and OOCL.

Rainflow counting method and the Palmgren-Miner rule are used to evaluate fatigue damage. At first, the total fatigue damage has been evaluated with raw data and then the fatigue damage from wave component has been evaluated with low pass filtered data. The effect of springing and/or whipping on the fatigue damage is obtained from the difference with the total fatigue damage and the fatigue damage from wave component. From the results, the effect of springing and/or whipping on the fatigue damage is about 30% of the total fatigue damage.

The total fatigue damage, however, is much less than the design fatigue damage. Since the main operation route is from Far East to Europe. The weather condition of this region is known to be much milder than North Atlantic which is generally used for ship design. Nevertheless, the effect of springing and/or whipping on the fatigue damage cannot be neglected for the safe ship design.

KEY WORDS: Fatigue Damage, Springing, Whipping, Frequency Combination Effect, Full Scale Measurement

INTRODUCTION

In recent years, the design and construction of the large container ships have been increased. The large container ship has a long hull relatively and is more flexible than the conventional ship. So the natural frequency of 2-node vibration mode becomes longer. As increasing the possibility of resonance with the waves, the possibility of springing/whipping phenomena is increased.

Whipping is the hull response by the impact load like slamming or underwater explosion and springing is the resonance with the hull and waves. However, it is difficult to distinguish between two phenomena. So, the springing/whipping phenomena are called to the high frequency (HF) components because the frequency due to these is relatively high compared to the wave frequency (WF).

The load and stress due to the high frequency components are smaller than those of the wave frequency. However, the number of occurrences are more than the number of occurrences the wave frequency, it is known to affect the fatigue strength.

As one field of research, the consequences evaluated the fatigue damage due to the high frequency components through the full scale measurement data have been reported.

Tetsuo Okada et al (2006) discovered that the fatigue damage due to springing/whipping is 50% of the total fatigue damage based on the measurement data of Post-Panamax vessel.

Hajime Kawano et al (2009) found out that fatigue damage due to the high frequency components and combination effect of high and wave frequency are 6% and 51% of the total fatigue damage, respectively.

Wengang Mao et al (2010) presented that the fatigue damage due to high frequency components is 24% of the total fatigue damage based on the measurement data of 2800TEU container vessel.

Therefore, the necessity to evaluate reasonably considering the high frequency components unlike the conventional fatigue evaluation