論文の内容の要旨

論文題目　Motion, Structural Responses and Longitudinal Strength Assessment of Larger Container Ships in Freak Waves

「Freak 波に対する大型コンテナ船の運動、構造応答および縦強度評価」

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Freak or rogue waves are abnormal waves surprisingly appearing on the sea surface with exceptional wave height or abnormal shape. The devastating effect of freak waves on offshore structures as well as ships has led to many people's life loss, great economic loss, even environmental pollution from oil leakage. Moreover in the sea around Japan many accidents are also reported to be caused by freak waves. Hence, it is of great importance to understand physical mechanisms of freak waves, wave impact loads on ship hulls and offshore structures subjected to abnormal waves as well as corresponding structural responses. Furthermore, we are also able to explore the possibility of using rogue or freak waves as additional wave load conditions to be considered in the design of ship and offshore structures.

In the University of Tokyo we have recently initiated a joint multi-disciplinary research project on Freak Waves with National Maritime Research Institute, Japan to understand the generation on of the freak wave around Japan Sea and the Pacific Ocean in order to improve its remote sensing and study their influences on the offshore as well as ship structures.

In the present study, the generation mechanisms of the dispersive focusing waves and Benjamin-Feir unstable waves are introduced firstly. Based on them the dispersive focusing wave plus regular waves are generated in laboratory and numerical wave tank, respectively. The comparison in time domain between them shows very good consistency. Next, an elastic

container ship model tests are conducted in regular waves to verify and validate the experimental instrumentation and investigate the dynamic structural responses of the ship in extreme regular waves. Following this, the elastic containership model tests are performed in the dispersive focusing waves and unstable waves with various parameters. The measured motion and structural responses are decomposed through wavelet transform into wave encounter frequency components and high frequency components. Both the components are examined carefully with various freak wave parameters. Additionally the time domain seakeeping code accounting for the nonlinearities such as bottom emergence, hull shape geometry and hydrodynamic impact, etc is adopted to simulate the vertical motion and structural responses of the elastic ship model. The wave frequency components of vertical bending moments are predicted very well, while the maximum responses due to slamming are a little overestimated and the dynamic responses of ship structure seem to be underestimated. In the last part, the safety margin of the longitudinal strength of the real ship under the current freak waves is conducted with the explicit dynamic finite element code incorporating the plastic property and strain rate effects of steel. The results show the structural integrity can be assured under the attack of 28m freak wave in terms of longitudinal strength. The evaluation flowchart is suggested based on the beam element model so as to provide a fast check of longitudinal strength of ship hull in freak waves during the preliminary design. From the viewpoint of energy, an evaluation approach in accidental limit state based on energy absorption capacity is discussed and proposed.