PhD Advert Template

Project title: Predicting whipping induced failure in a cyclic progressive collapse analysis of ship structures

Project ID *(optional)*: *Please leave blank*

Accept all year-round applications

Funding information: Self-funded students only

Project description:

Supporting an ongoing collaboration between Newcastle University (Dr Simon Benson), Osaka University (Prof Akira Tatsumi) and University of Strathclyde (Dr Shen Li), this PhD project will contribute invaluable research in the field of marine structures, specifically investigating the cyclic progressive collapse of ships. The project is ideally suited to candidates with a background in civil-structural engineering, naval architecture, offshore engineering or associated engineering backgrounds. The anticipated research impact is to improve safety in the design and operation of large ships with application to other large-span structures such as bridges.

Ocean going ships are periodically subjected to very large storm waves, which cause complex and nonlinear load-response effects of the ship’s hull including whipping (transient vibration). The long-term structural consequences of these shock events is not fully understood, especially in the occasional but critical event of global failure of the hull structure and the consequential catastrophic loss of the ship. Large waves and whipping cause cyclic bending moments on the hull girder that may cause some regions of the structure to exceed their linear limit. In this event nonlinear damage/defect (e.g. plasticity and buckling deformation) is accumulated in the structure. Further cycles of large load can then cause a global failure characterised by a plastic hinge in the mid-region of the ship along with cracking and sometimes a complete split of the hull.

The aim of this research is to fully characterise this nonlinear response by extending an analytical hydro-elasto-plastic method to predict ship hull girder failure, previously developed by the supervisory team [1, 2, 3], to include large strain plasticity and fracture. The anticipated objectives, to be refined by the PhD, are to 1. Develop a material model of corner fracture from experimental test; 2. Apply the material model within a nonlinear finite element model; 3. Complete numerical analyses at several scales to model local structure buckling and global hull girder failure; 4. Develop an equivalent analytical model of large strain plasticity and fracture; 5. Apply this model within the hydro-elasto-plastic methodology.

The outcome is an important contribution to the field of marine structures with applicability to ship designers, classification societies, operators and academia. The PhD will have access to the extensive laboratory and computing resources in the School of Engineering at Newcastle. The PhD will also benefit from the wider collaboration with Osaka, Strathclyde and other leading marine institutions.

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References (optional):

[1] Benson, S., Downes, J. and Dow, R.S., 2013. Compartment level progressive collapse analysis of lightweight ship structures. Marine Structures, 31, pp.44-62.

[2] Li, S., Hu, Z. and Benson, S., 2020. Progressive collapse analysis of ship hull girders subjected to extreme cyclic bending. Marine Structures, 73, p.102803.

[3] Tatsumi, A., Li, S. and Benson, S. 2023. Collapse response analysis of a ship’s hull girder in cyclic focused waves using a hydro-elasto-plastic beam model. MARSTRUCT 2023. In review.

Application enquires: *Name, email, weblinks*

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