Applications and Analysis of Stiffened Side Shell Panel Failure for Naval Patrol Craft

LT(jg) Matthew K. Mothander, USCG

Prof. Tomasz Wierzbicki	Prof. Trent R. Gooding
Thesis Supervisor	Thesis Reader

Over their lifetime, naval patrol craft are subjected to many different types of loading scenarios, most of which are perfectly safe. In rare instances, through a variety of different reasons, these craft are loaded beyond their means, resulting in structural failure.

This thesis focuses on how side shell stiffened panel failure occurs from a global and local perspective. It incorporates aspects of basic ship structural design theory, detailing static and dynamic shipboard loads, progressive collapse behavior, and global causes of hull strength reduction. Locally, it examines stiffened panel failure modes due to axial loading through a comparison analysis with consideration for sources of panel strength loss. Finally, this thesis discusses methods for avoidance and mitigation of failure in the future at the design, construction, and operational levels.

Globally, this thesis draws from two incidents in the last decade where U.S. Navy and U.S. Coast Guard patrol craft have had class-wide incidents of structural failure. These failures have ranged from buckling, to yield, to fracture. Each ship's background is discussed, and primary stress calculations are presented with design margins based on Classification Societies, along with an engineering analysis of the failures that occurred on each vessel. Internal and external factors for overall hull strength reduction are examined and applied to each case, including considerations for slamming and saltwater corrosion.

Using the failure incident that took place on the U.S. Coast Guard 123', local failure modes are examined across several analysis methods for axially loaded stiffened panels. Buckling and ultimate load values are calculated through a parametric design space, while boundary conditions and geometric properties are varied. Finite element analysis and proven analytical methods are used, including those developed by Von Karman. A comparison analysis is completed using experimental data, where local causes for strength reduction in panels are considered, including construction imperfections, shearing, residual stresses, cracking, and initial deflection.

Master of Science in Naval Architecture and Marine Engineering and Master of Science in Mechanical Engineering