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Discussion art. de PAIK

Paper D2(D04): *Ultimate Limit State Design Technology for Aluminum Multi-Hull Ship Structures*, Jeom K. PAIK et al.

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Reader: The discussers cannot attend the meeting.

First we would like to congratulate the authors for the quality of their paper. This one is very useful for ULS based design and strength assessment of aluminum multi-hull ship structures. We read it with great interest and we would like to make some comments, particularly in regard to the closed-form ULS formula (Eq.(3) in the discussed paper).

In the paper entitled *Effect of Welding on Ultimate Compressive Strength of Aluminum Stiffened Panels* presented at HIPER'04, Richir et al. investigate the ultimate compressive strength characteristics of a welded aluminum stiffened panel with varying welding related parameters such as weld type, width of HAZ (heat-affected zone) and reduction of yield stress due to HAZ softening. Non linear finite element analyses and the ULS formula were used for the sensitivity analyses on the parameters.

The sensitivity on weld type was analyzed by considering the following weld zones in the mesh modeling (Figure 1):
- five longitudinal welds at the junction between the transverse plate and the five stiffeners,
- four longitudinal welds at the intersection between the five extruded elements,
- two transverse welds between plates.

The ultimate strength obtained through the ULS formula for welds A (stiffeners welded on the plate) was quite similar to that for welds B (extruded elements) while the ultimate strength calculated by finite element analyses was higher for welds B than for welds A. Indeed welds B are only taken into account in the ULS formula through the P_s expression (Equation 1) which becomes:

$$P_s = (b-2b_p')\, t\, \sigma_{Yp} + 2\, b_p'\, t\, \sigma_{Yp}' + h_w\, t_w\, \sigma_{Ys} + b_f\, t_f\, \sigma_{Ys} \qquad [1]$$

Is it right or the ULS formula is only valid for welds A?
Moreover the ULS formula can not consider the effect of welding along transverse frames (Welds C).

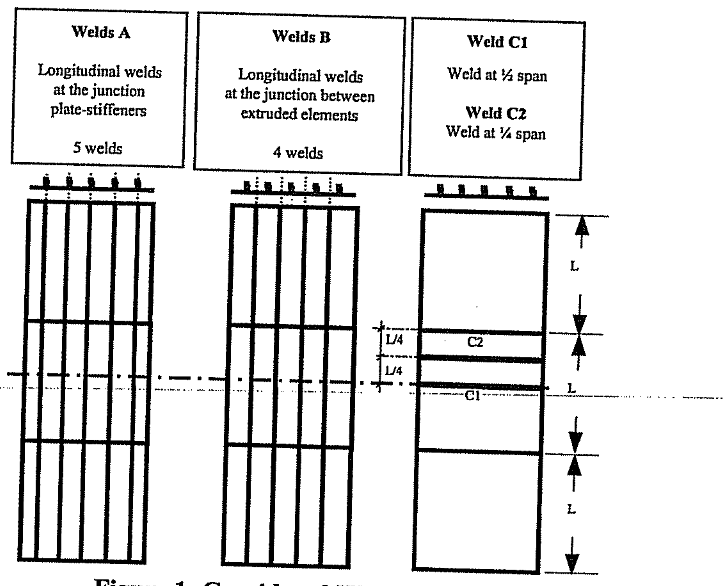

Figure 1: Considered Weld Locations

Figure 2 shows the effect of yield stress in HAZ on the panel ultimate compressive strength. The ULS formula gives a very small sensitivity of the panel ultimate strength on the yield stress in the HAZ, while a reduction of 10% yield stress in the HAZ results in an ultimate strength reduction varying from 2% to 5% in the finite element analyses.

Do you have an explanation?

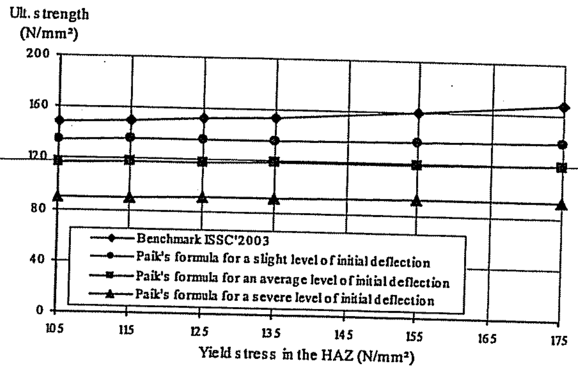

Figure 2: Sensitivity on Yield Stress of the HAZ

We would like to thank again the authors for their remarkable paper.

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Ultimate Limit State Design Technology for Aluminum Multi-Hull Ship Structures*

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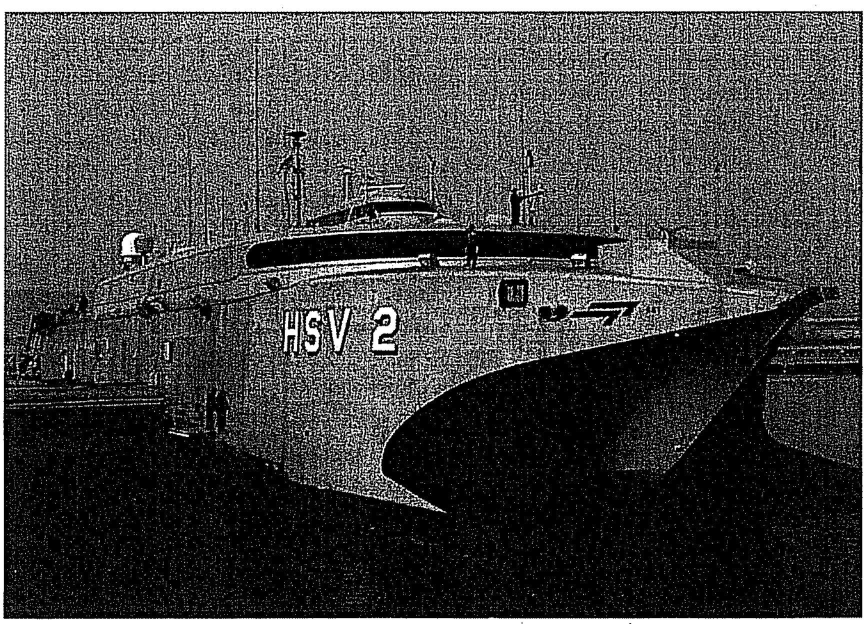
* Disclaimer: The opinions expressed herein are the views of the authors and are not necessarily those of the Naval Surface Warfare Center or the Department of the U.S. Navy.



- A photo of an aluminum fast catamaran ship -

The present paper is a summary of recent research and developments related to some core ultimate limit state (ULS) technologies for design and strength assessment of aluminum multi-hull ship structures, jointly undertaken by Pusan National University, Virginia Tech, U.S. Naval Surface Warfare Center and Alcan Marine. An extensive study on the subject has been undertaken by the authors theoretically, numerically and experimentally. Methods to analyze hull girder loads / load effects, stiffened panel ultimate strength and hull girder ultimate strength of aluminum multi-hull ship structures are developed in the present study. Application examples of the methodologies for the ULS structural design and strength assessment of a hypothetical 120m long all aluminum catamaran fast ship structure are presented. Important insights and conclusions developed from the present study are summarized. Some of the comparisons have shown that 5383 called Sealium (a patented Alcan Marine alloy) is superior to the standard aluminum alloy 5083 in terms of material properties, ULS characteristics and welding performance. It is our hope that the methods developed from the present study will be useful for ULS design and strength assessment of aluminum multi-hull ship structures.