FLEXURAL BEHAVIOR AND ASSESSMENT OF ALUMINUM STIFFENERS USED ON UNITED STATES NAVY LITTORAL COMBAT SHIP (LCS).

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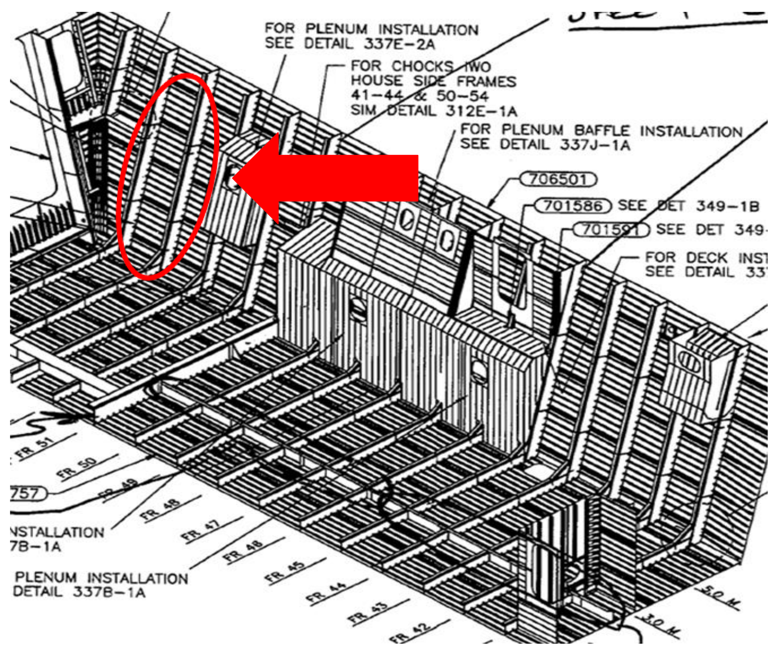
Research Experience for Undergraduates – Summer 2013

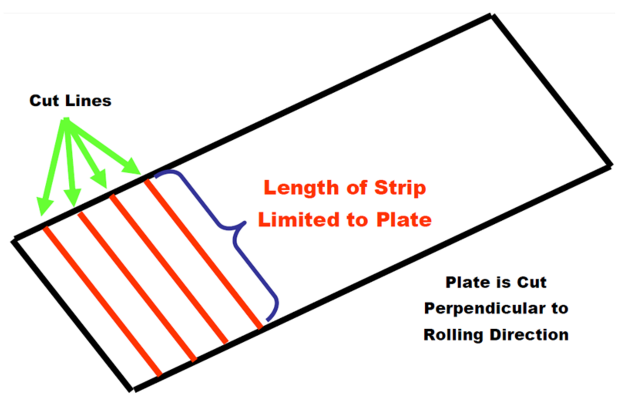
Background



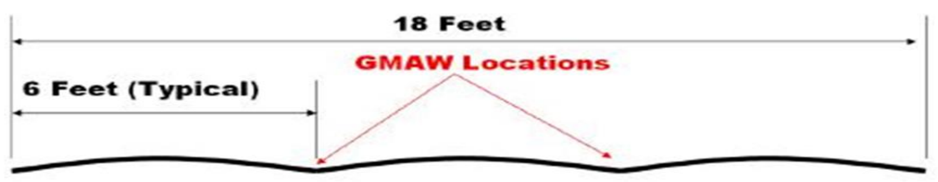
Longitudinal stiffener identified by arrow

- Aluminum Alloy 5083 stiffeners are currently used on the LCS hulls and superstructure.
- The traditional method of production is to cold form the angle to 90 degree.
- Typically member length produced is limited to six feet
- Resulting in multiple splices to achieve a usable length and frequent distortion due to the imperfect nature of Gas Metal Arc Weld(GMAW)

Introduction

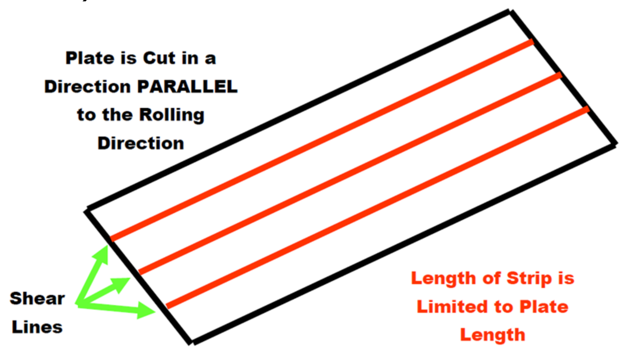


Model of perpendicular cut locations required for cold-forming (Smith, et al. 2009)



Traditional Method Production

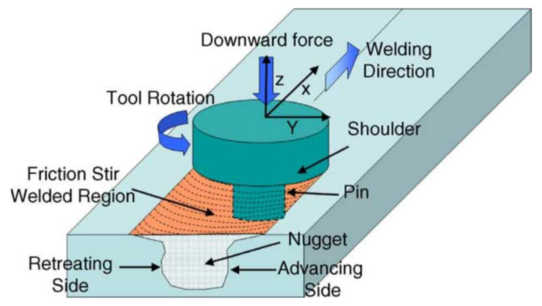
- Cut Perpendicular to rolling action
- Multiple splicing
- HAZ cause warping



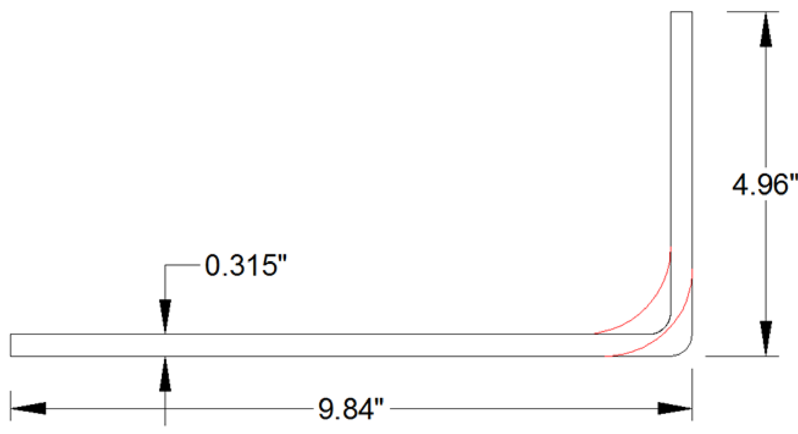
Model of parallel cut locations allowed for FSP (Smith, et al. 2009)

Future Method Production

- Cut Parallel to rolling action
- Angle Bent parallel to rolling action
- Longer stiffener members are produced
- Production Increases and Cost Falls



Schematic of FSW Process (Mishra and Ma 2005)



Cross-section of LCS stiffener

LCS Panel with Stiffener attached

Broader Impact

In the future the United States Navy expects to produce a total of 60 to 70 of the LCS platform ships. With the new method in using the FSP to create the longer members of the aluminum alloy 5083 stiffener, the pace of production will speed up and cost of building the ships could be reduced. Thus having a significant impact on future engineering of ship building.

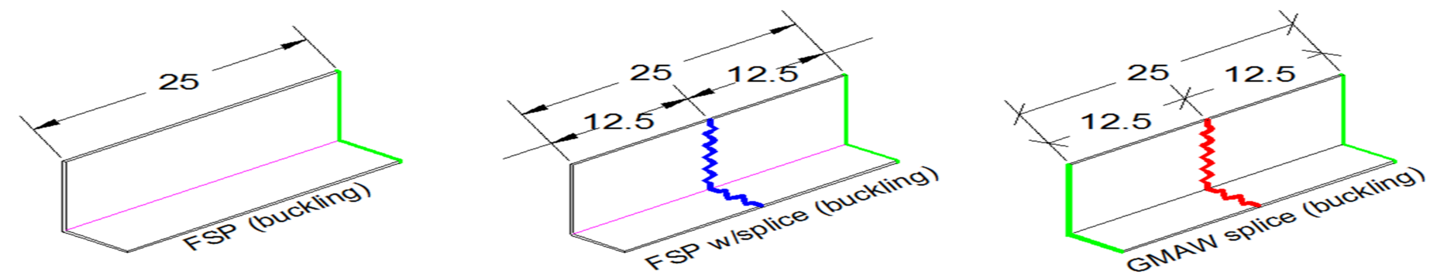
Objective

- Develop a four-point test for flexure and instrumentation strategy
- Compare the response of the FSP angle to the traditional method of production
- Evaluate the performance of a gas metal arc weld splice and a friction stir weld splice
- Identify any correlations with tests done previously involving tensile coupon test and compression buckling test.

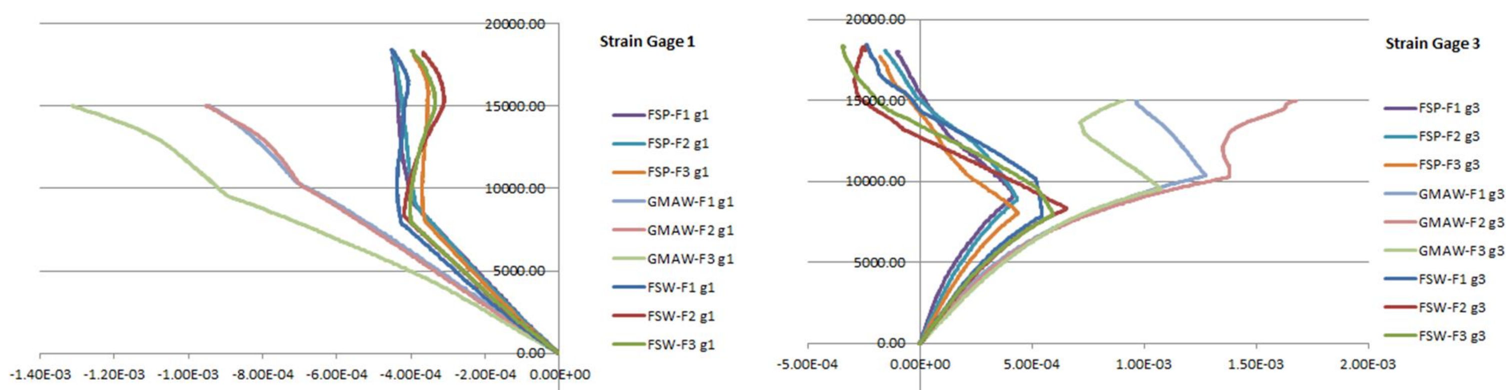
Procedures

- Instrumentation Design & Installation
- Tinus Olsen 300 kip load frame measurements. Data Acquisition/Programming using National Instruments Lab Signal Express Software
- Four-point flexure testing to evaluate specimen strains and displacement response.

Single Angle Members Tested



Results



Specimen tested	Contact Load (KIPS)		Contact Strain	
	Strain Gage 1	Strain Gage 3	Strain Gage 1	Strain Gage 3
FSP-F1	9.0	9.0	-3.88E -04	4.09E -04
FSP-F2	9.0	8.8	-3.86E -04	4.27E -04
FSP-F3	7.9	7.9	-3.57E -04	4.28E -04
GMAW-F1	10.2	10.2	-6.98E -04	1.26E -03
GMAW-F2	10.2	10.2	-6.98E -04	1.37E -03
GMAW-F3	9.4	9.5	-8.80E -04	1.06E -03
FSW-F1	7.7	7.7	-4.18E -04	5.30E -04
FSW-F2	8.2	8.3	-4.15E -04	6.46E -04
FSW-F3	7.8	7.9	3.95E -04	5.87E -04

Conclusions

- Strain Gage 1 and 3 show the stiffness of the new fabrication method as the trends of the Strain vs Load Data indicates a steeper slope for the New Method of Production
- Short leg of GMAW specimens was approximately “27%” less stiff than the FSP and FSW specimens measured by the slope of the load-strain curves
- Long leg of GMAW specimens made contact with steel platen at approximately 2500 lbs higher than FSP and FSW specimens

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