Laser Hybrid Tack Welding of Structural Steel Fillet Weld Joints

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Topics

Problem to Solve

Current Application of Hybrid Laser in Shipbuilding

Equipment and Safety

Preliminary Welding Trials and Results

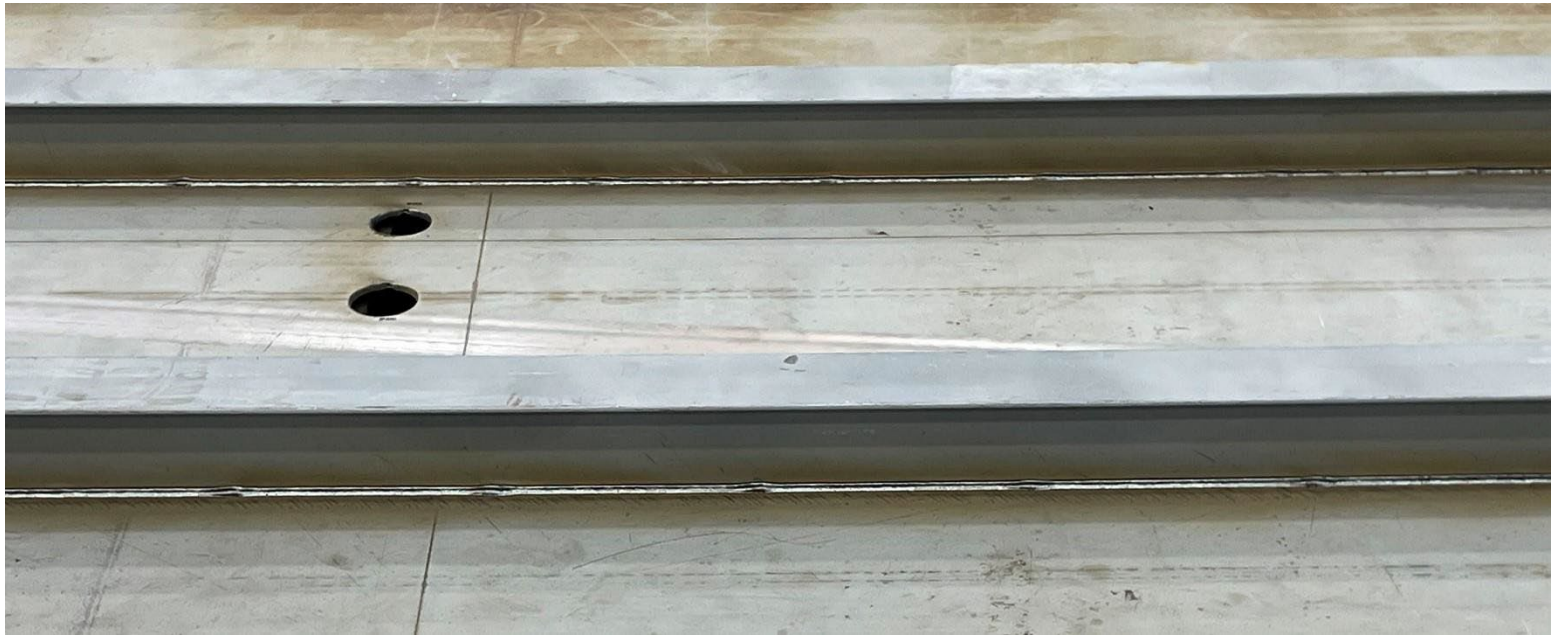
Future Efforts

Problem to Solve

Tack welds made using manual or semi-automatic welding processes

Tack size equal to or greater than required weld size

Mechanized welding over tacks



Current Application of Hybrid Laser in Shipbuilding

Seaming of S-1 materials for ship structure using hybrid laser

Fillet welding of stiffener to deck connections

Handheld laser hybrid for sheetmetal applications

Equipment and Safety

IPG LightWELD 1500 XR

Equipment and Safety

IPG LightWELD 1500 XR

Equipment and Safety

IPG LightWELD 1500 XR

Equipment and Safety

External Interlocks

Fiber Interlock

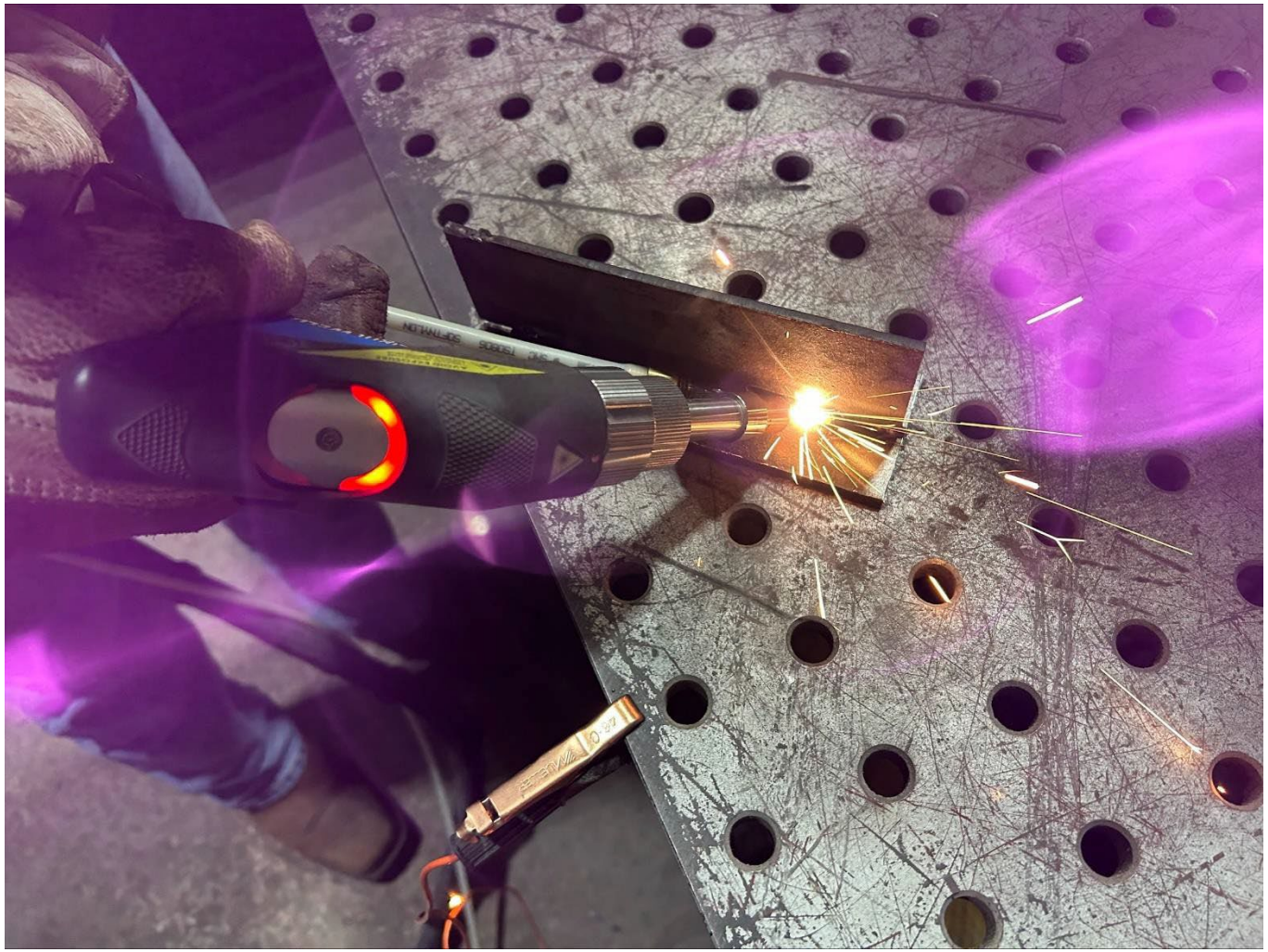
Nozzle to Workpiece and Trigger Control

Equipment and Safety

IPG LightWELD 1500 XR

Equipment and Safety

IPG LightWELD 1500 XR



Preliminary Welding Trials and Results

Thick and thin materials
- 3/16" and 1/2" material

Extremes of welding parameters
- Power from 950 to 1500 watts
- Wire feed speed from 10 to 25 ipm
- Travel speed from 10 to 25 ipm
- Wobble and frequency

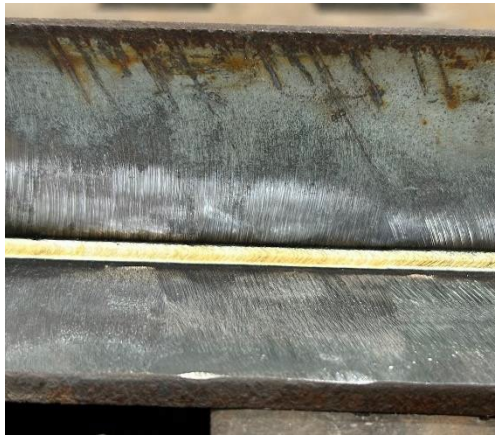
Wide range of heat inputs
- 2500 J/in for low wattage, high travel
- 9500 J/in for high wattage, slow travel

Preliminary Welding Trials and Results

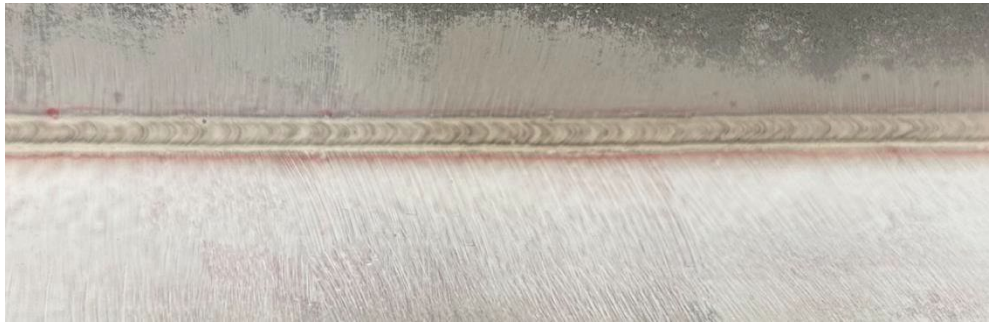
Plate Thickness	Wattage	Wire Feed Speed	Wobble Width	Wobble Frequency
3/16"	950	10	0	0
			9	50
		25	0	0
			9	50
	1250	10	0	0
			9	50
		25	0	0
			9	50
	1500	10	0	0
			9	50
		25	0	0
			9	50
1/2"	950	10	0	0
			9	50
		25	0	0
			9	50
	1250	10	0	0
			9	50
		25	0	0
			9	50
	1500	10	0	0
			9	50
		25	0	0
			9	50

Preliminary Welding Trials and Results

Visual Inspections



Dye Penetrant



Macro Etch

Preliminary Welding Trials and Results

Visual Inspection Results

Low travel speeds and high wobble conditions showed rejectable visual indications

Dye Penetrant Results

All samples passing VT were subject to PT, with all results acceptable

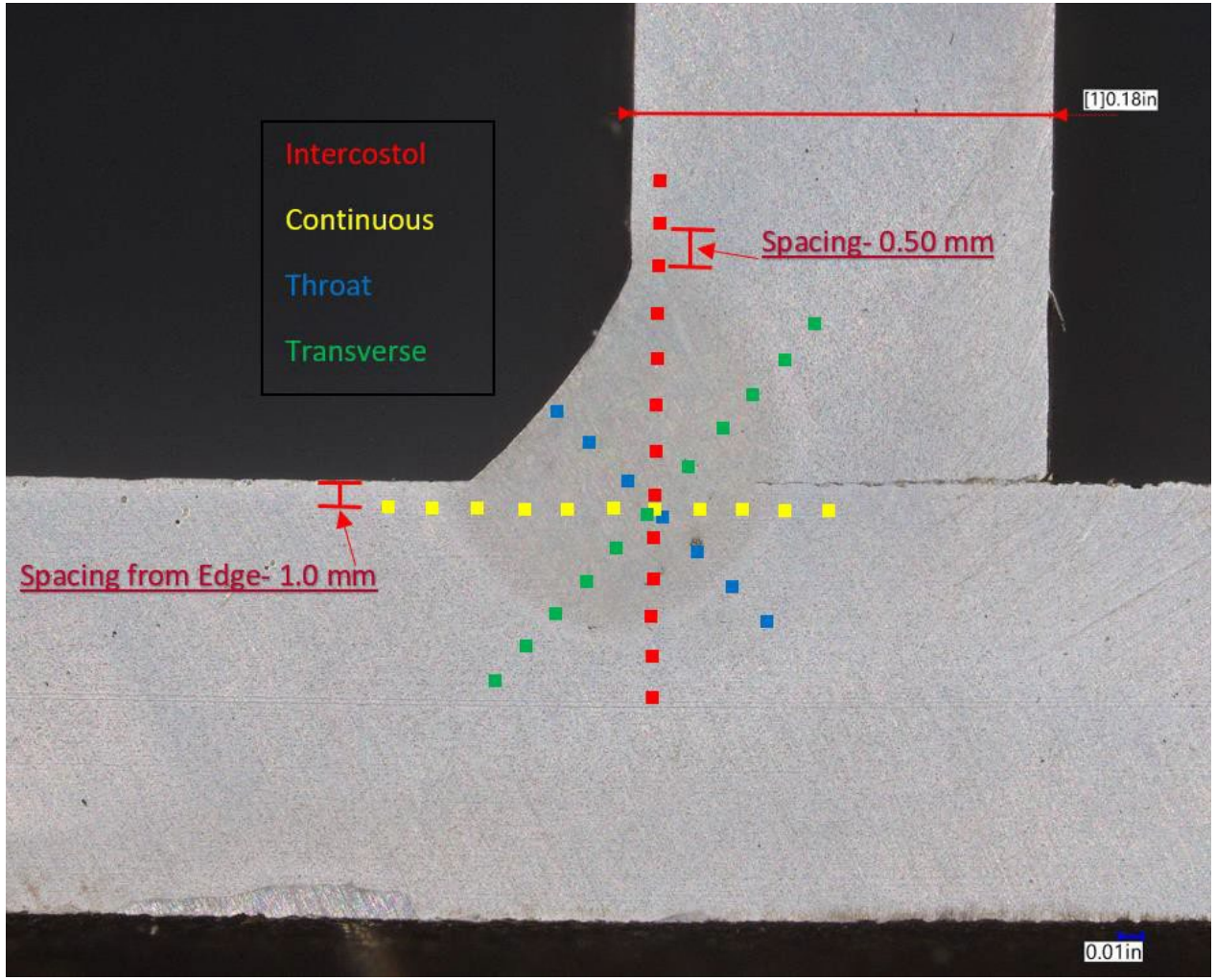
Macro Etch

High travel speeds and high wobble conditions showed lack of fusion in the root

Decreased travel speeds and increased power created larger HAZ and weld cross sections

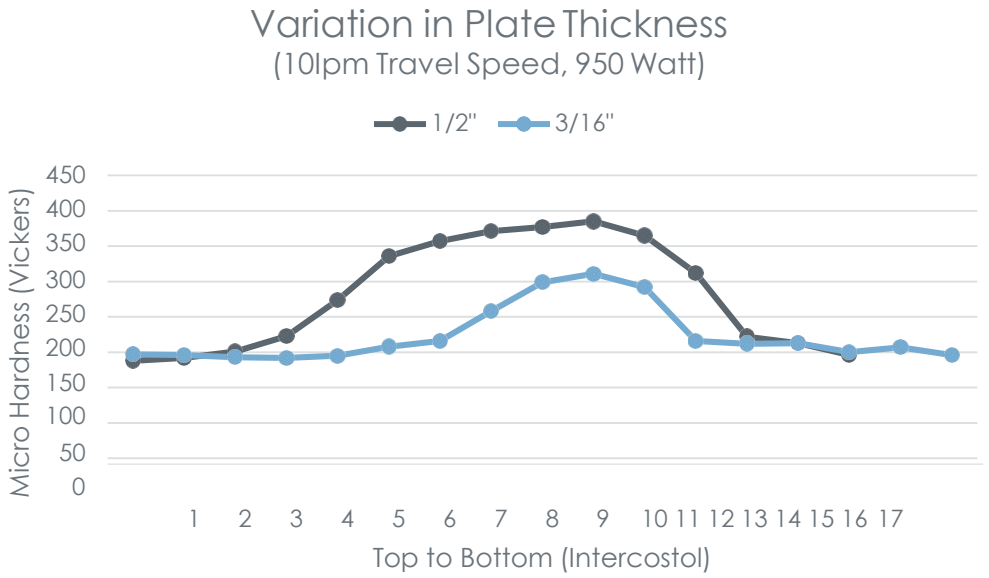
Preliminary Welding Trials and Results

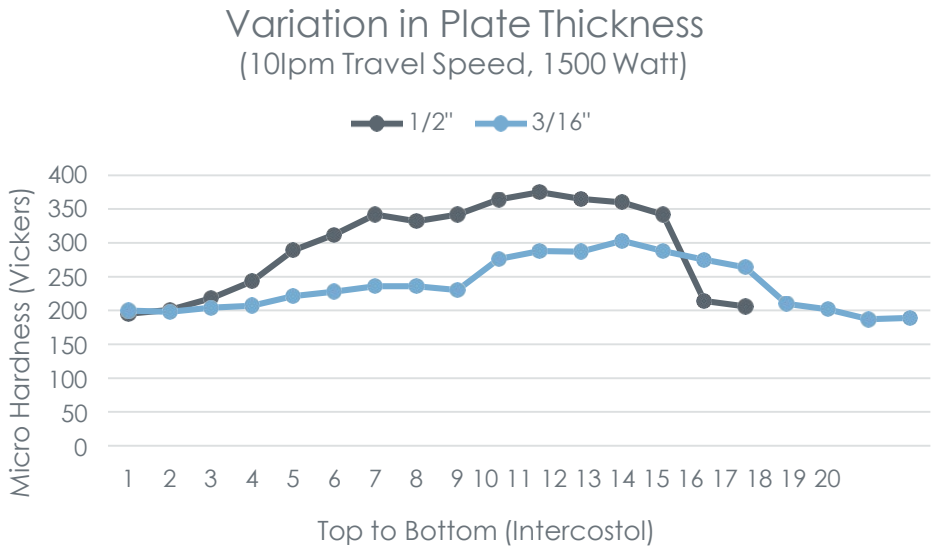
Hardness Mapping



Preliminary Welding Trials and Results

Hardness Mapping





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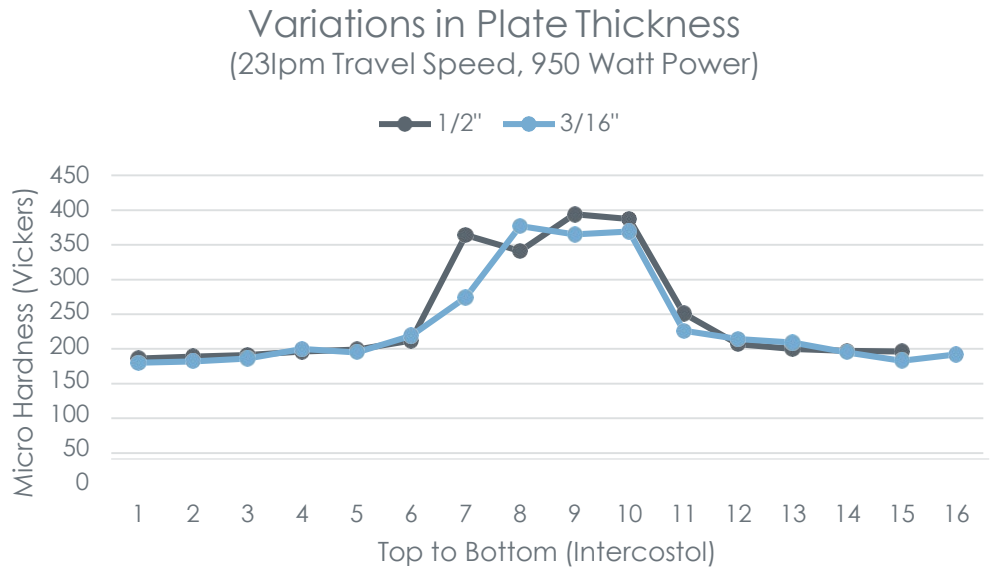

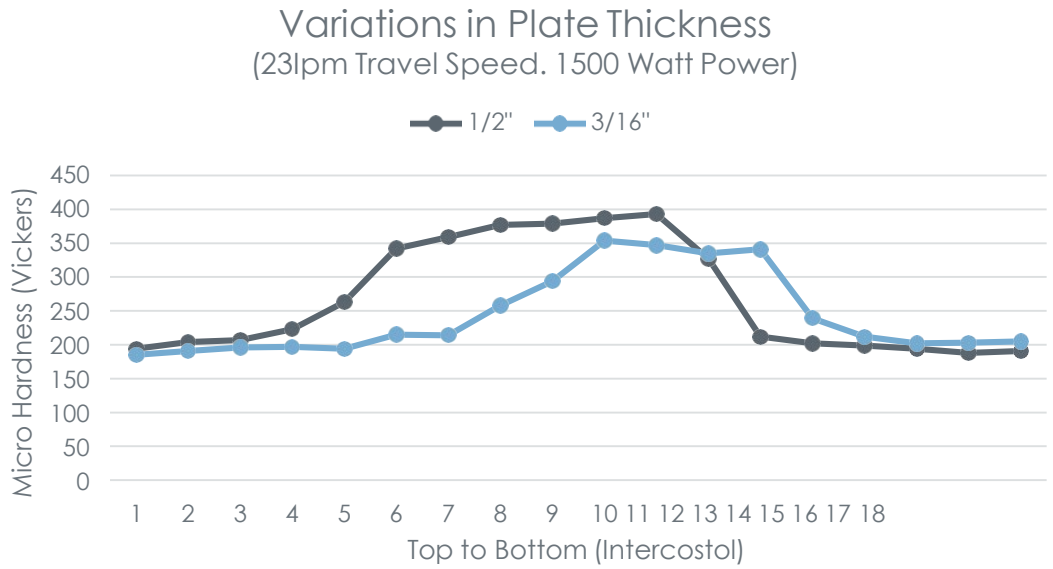

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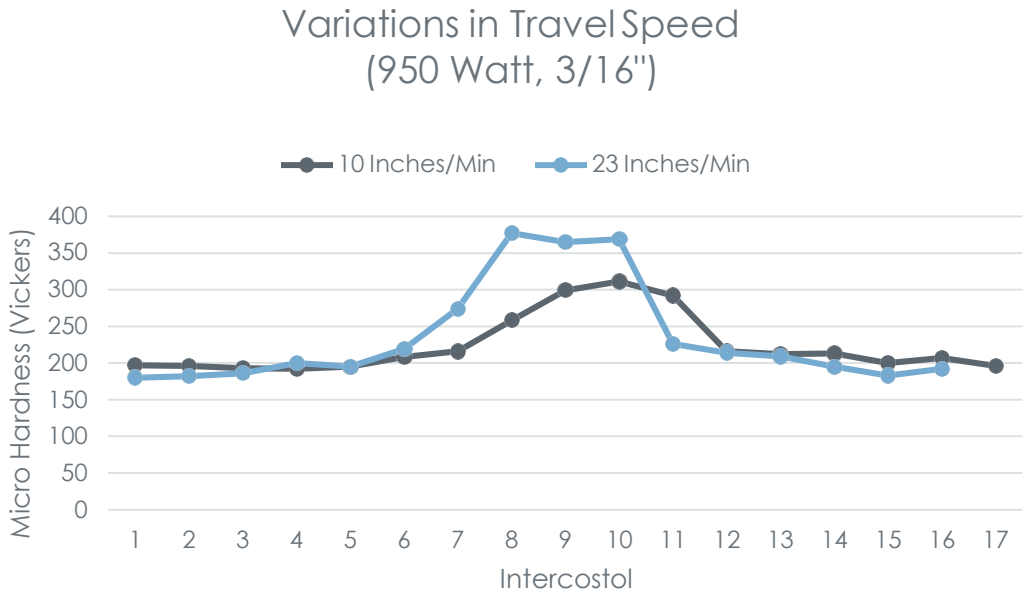
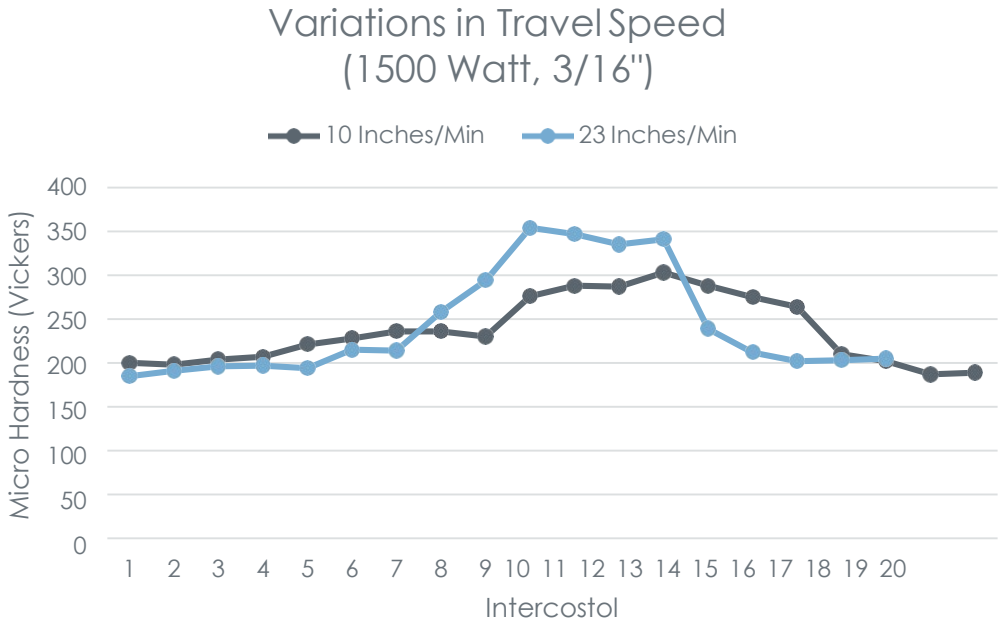




Preliminary Welding Trials and Results

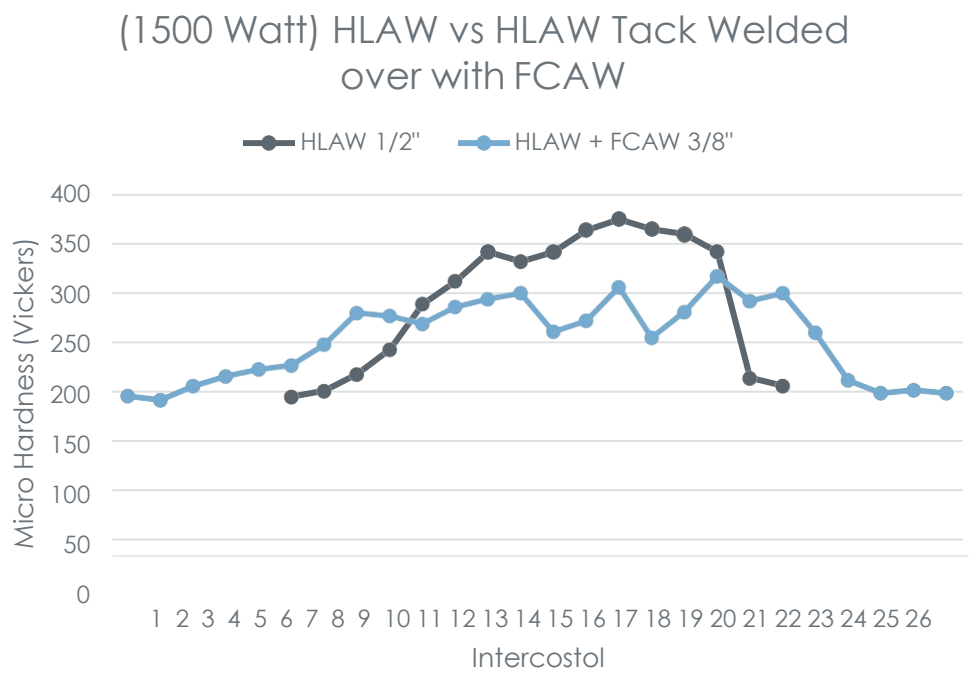
Laser Hybrid Tacks Welded over with FCAW

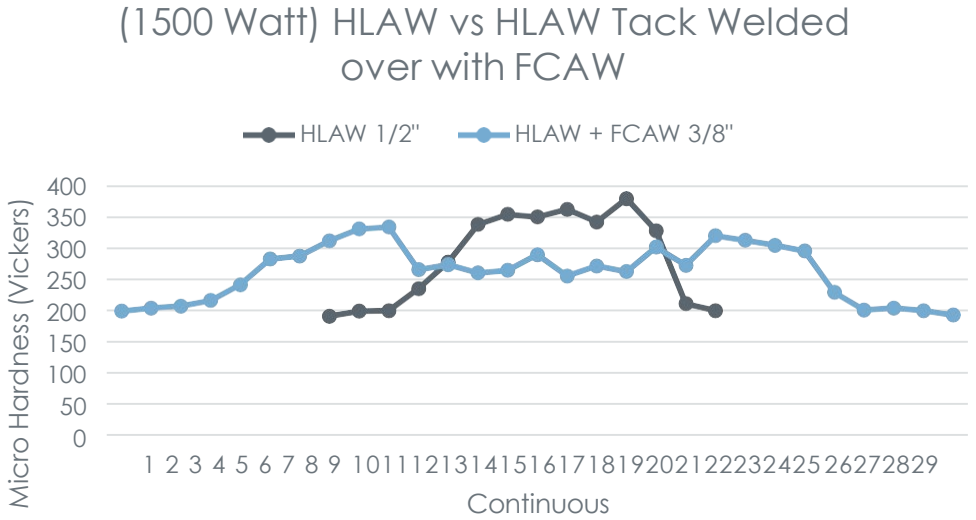
Preliminary Welding Trials and Results

Laser Hybrid Tacks Welded over with FCAW

Preliminary Welding Trials and Results

Hardness Mapping





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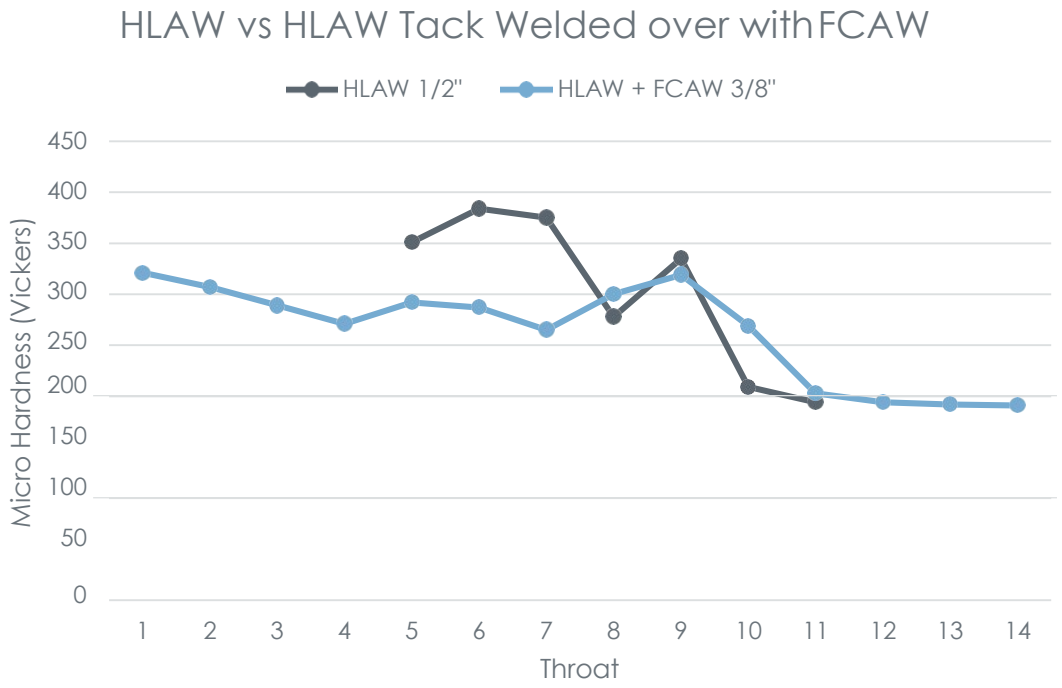

Preliminary Welding Trials and Results

When travel speed and power were held constant, hardness increased as plate thickness increased

As travel speed increased, with other variables constant, hardness delta decreased between plate thicknesses

Wobble width and frequency had no noticeable influence on hardness

Welding over laser hybrid tacks with conventional welding processes reduced hardness but did not completely consume the tack

Future Efforts

Ingalls traveled to Colorado School of Mines to share test results and supply welded samples for additional preliminary testing

Welding parameter sets that bracket the highest and lowest heat inputs will be selected for additional testing

Multiple samples of each parameter set will be provided to Colorado School of Mines for statistical analysis

Colorado School of Mines will evaluate microconstituents using SEM and characterize the microstructure of the HAZ

Samples of conventional welding processes will be used as baseline comparison

Samples of conventional welding processes where tacks are welded over will be provided

Questions and Comments