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Automation International, Inc.

SCHOOL OF MINES 1874 COLORADO

Flash Butt Welding

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Topics

Problem to Solve

Flash Butt Welding Overview

Preliminary Evaluation

Project Plan

Problem to Solve

Compensation rings fabricated from one or two pieces of plate or flat bar

Various shapes, sizes, and thicknesses

Standard semi-automatic welding processes

Full penetration weld required

Large quantities

DDG – 3400 rings, LPD – 4200 rings, LHA – 10500 rings

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Flash Butt Welding Overview

What is Flash Butt Welding?

AWS A3.0 Definitions

Fash Butt Welding or Flash Welding

A resistance welding process producing a weld at the faying surfaces of butting work pieces by the rapid upsetting of the workpieces after a controlled period of flashing action.

Upset

Bulk deformation of a workpiece(s) resulting from the application of pressure

Flash

Molten metal displaced from the joint by expulsion or extrusion

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Flash Butt Welding Overview

Flash butt welding provides a full penetration weld in a short, single cycle

Used to weld materials of like dimensions and cross sections

Can be used for two individual pieces or rolled parts to form rings

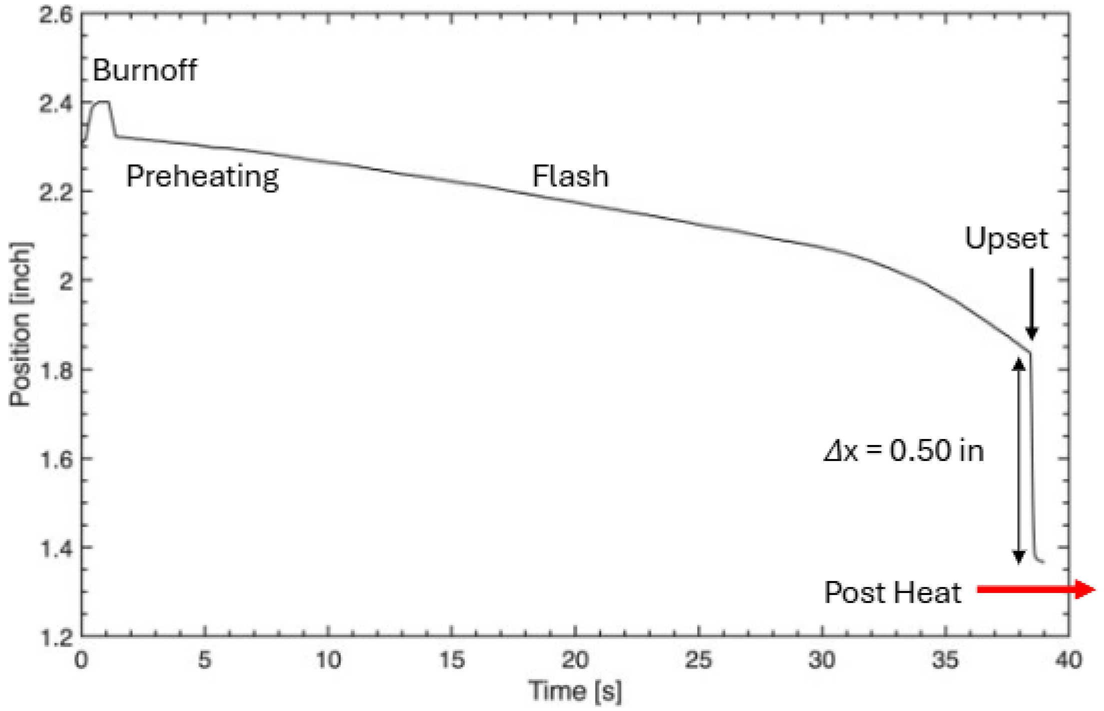
Meets the need for welding of compensation rings

- Full penetration
- Identical cross sections
- Single or multiple welds

Flash Butt Welding Overview

Process Steps

- Burnoff
- Preheat
- Flash
- Upset
- Post Heat



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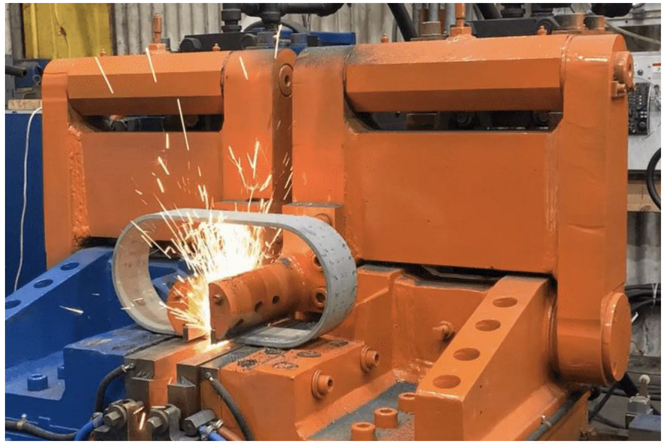
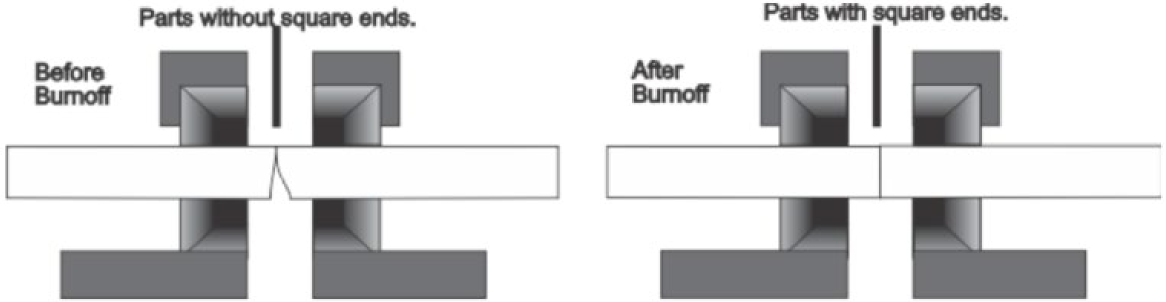
Flash Butt Welding Process Steps

Burnoff

Ensure part ends are square and flush

Compensates for misalignment, cutt kerf, and cut roughness





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Flash Butt Welding Overview

Preheat

Not preheat in the typical sense of welding

Used to build heat in the part for easier flashing and upsetting in large width or cross section of parts

No expulsion of material, rapid touching and pulling apart of multiple cycles

Not needed for joining material widths or thicknesses intended for compensation rings

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Flash Butt Welding Overview

Flash

Heat part ends in preparation for forging, to a semi-solid or plastic state

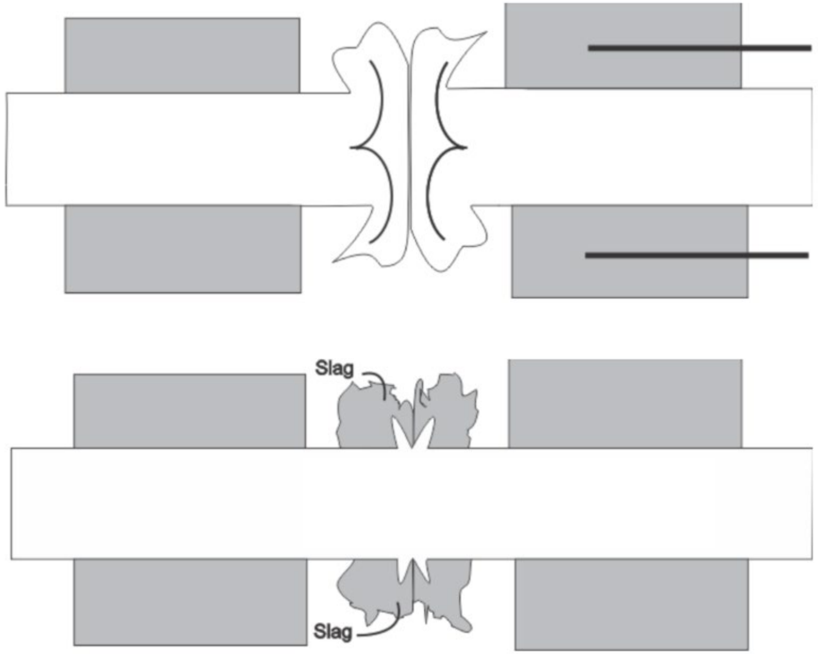
Small particles expelled during cycle

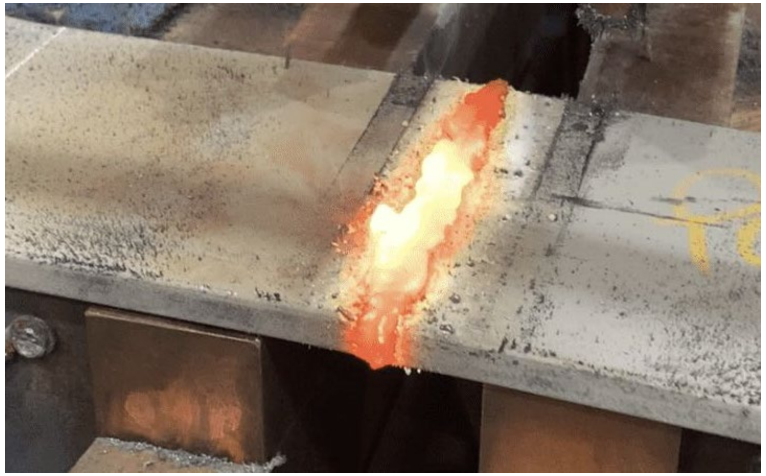
Flash Butt Welding Overview

Upsetting

Pushing parts together at high speeds to create weldment

Additional current applied during process



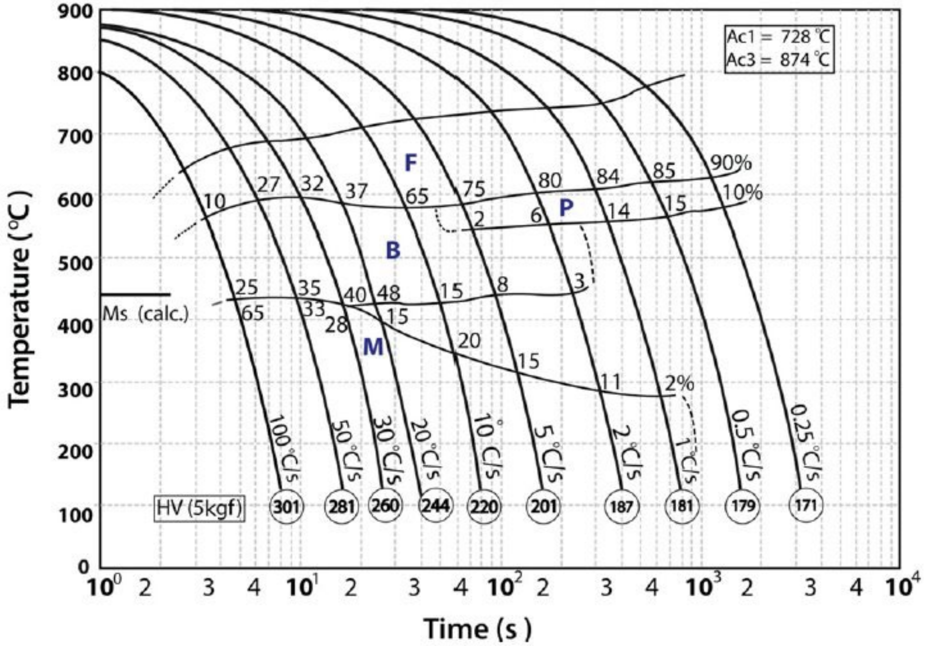


Flash Butt Welding Overview

Postheating

Pulsing of current to slow cooling process

Jaws are water cooled, flow rate can be adjusted to influence cooling rate



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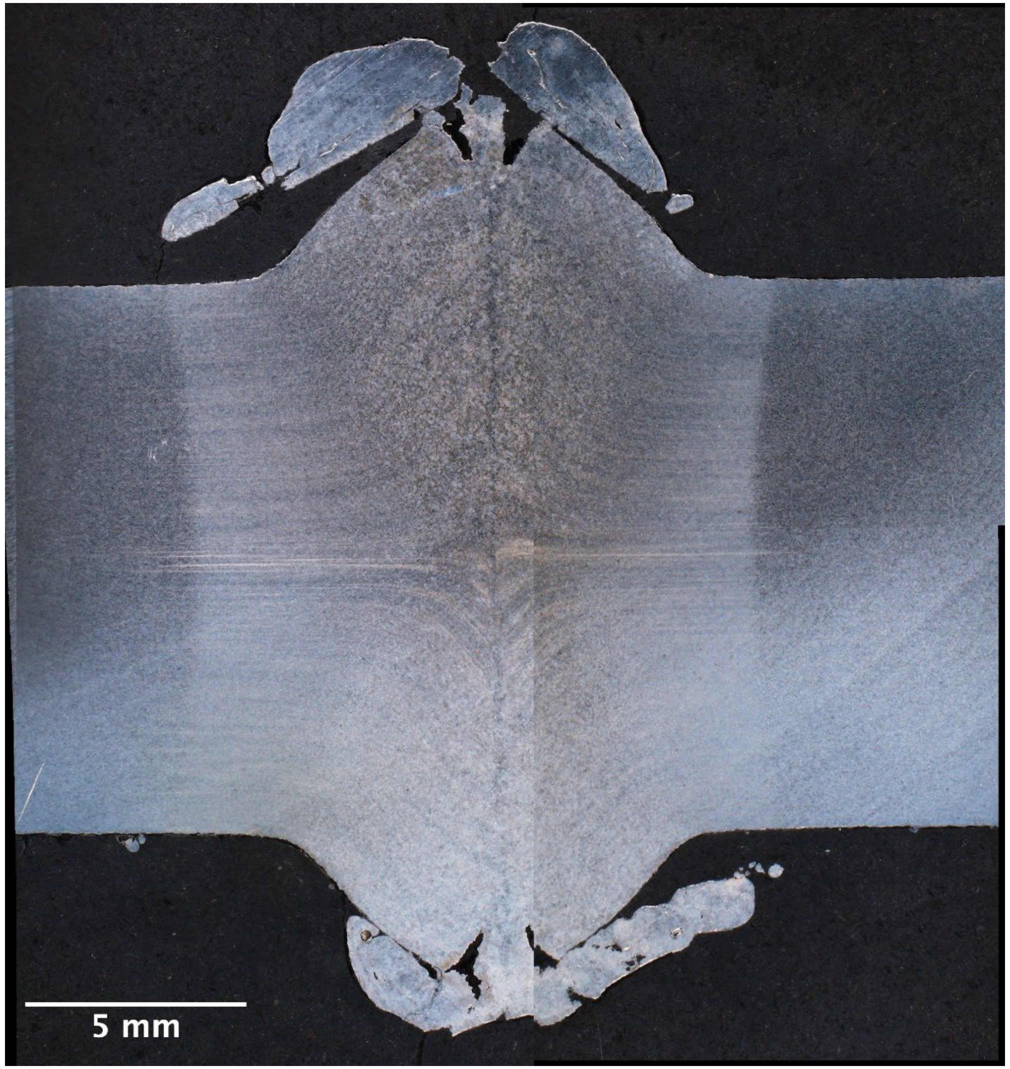
Initial Welding Trials

HSLA 65 plate, 1/2in thick flash butt welded at Automation International

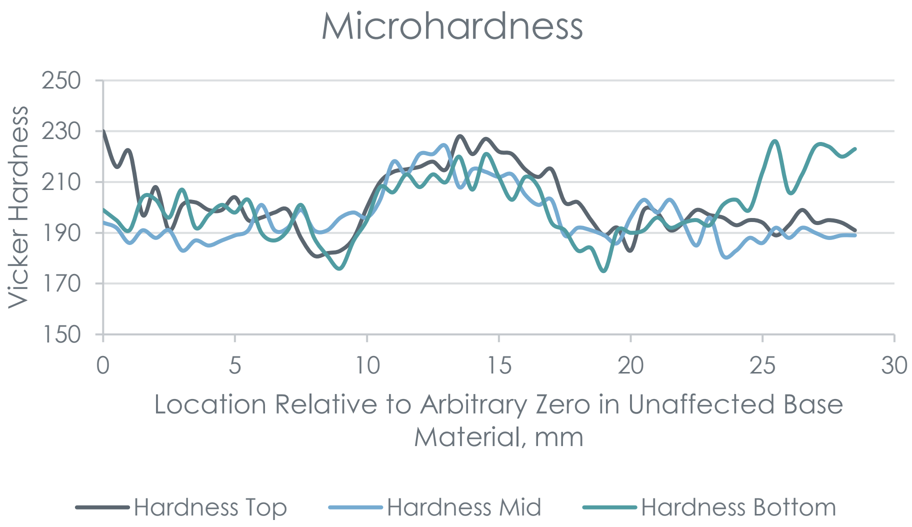
Evaluated by Ingalls for soundness and properties, particularly microhardness and CVN

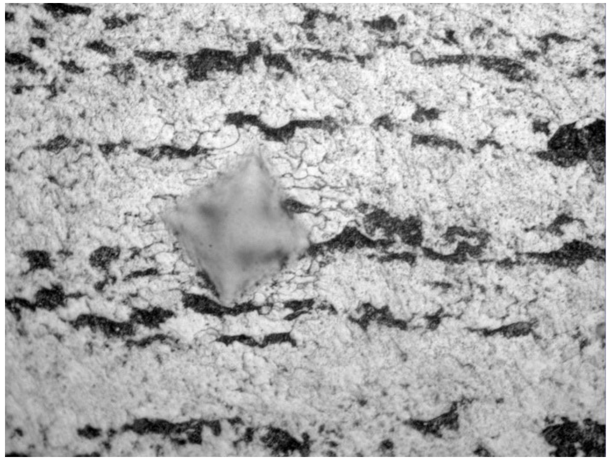
- Microhardness did not show any indication of increased hardness, maximum hardness of 230 Hv
- Microstructure shows undesirable constituents
- Impact testing showed very low results, with average of 9 ft-lbs at -20°F

Microhardness and Microstructure

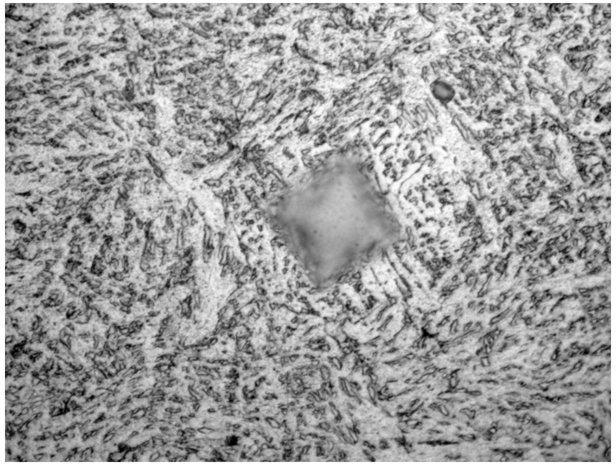


Microhardness and Microstructure





Unaffected Base Material



Weld Metal

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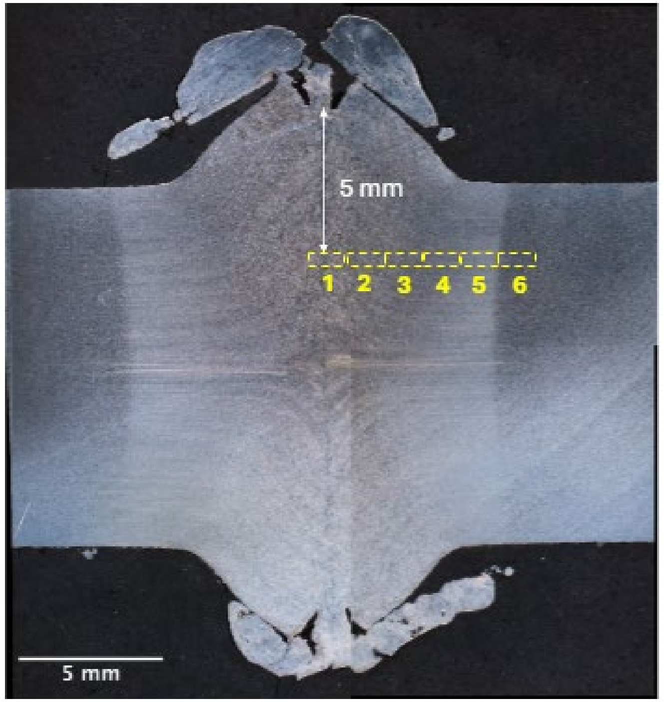
Impact Properties

4 ft-lbs at -20°F

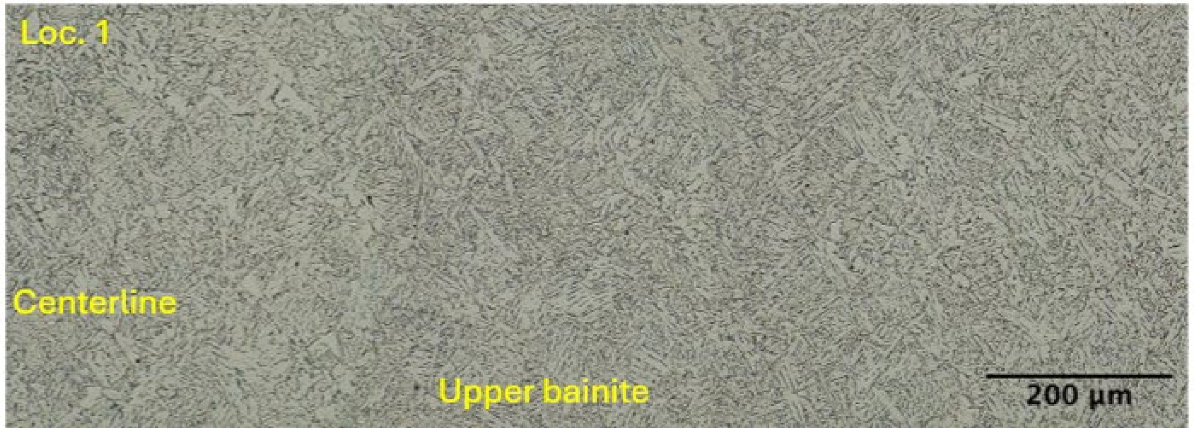
15 ft-lbs at -20°F

Charpy impact specimens showed brittle fracture, with no shear lip or lateral expansion

Plan for Improved Impact Properties



Carefully designed post weld heat treatment will allow for transformation of upper bainite to a more desirable microstructure with improved impact toughness.



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Project Weldments

- Welds were produced for Colorado School of Mines and Ingalls Shipbuilding for metallurgical, nondestructive, and destructive testing

- ½" HSLA-65 material

- Welds were subject to visual inspection, radiographic inspection, ultrasonic inspection, and magnetic particle inspection in the ground flush condition

- All weldments passed Class 1 inspection requirements in accordance with MIL-STD-2035A

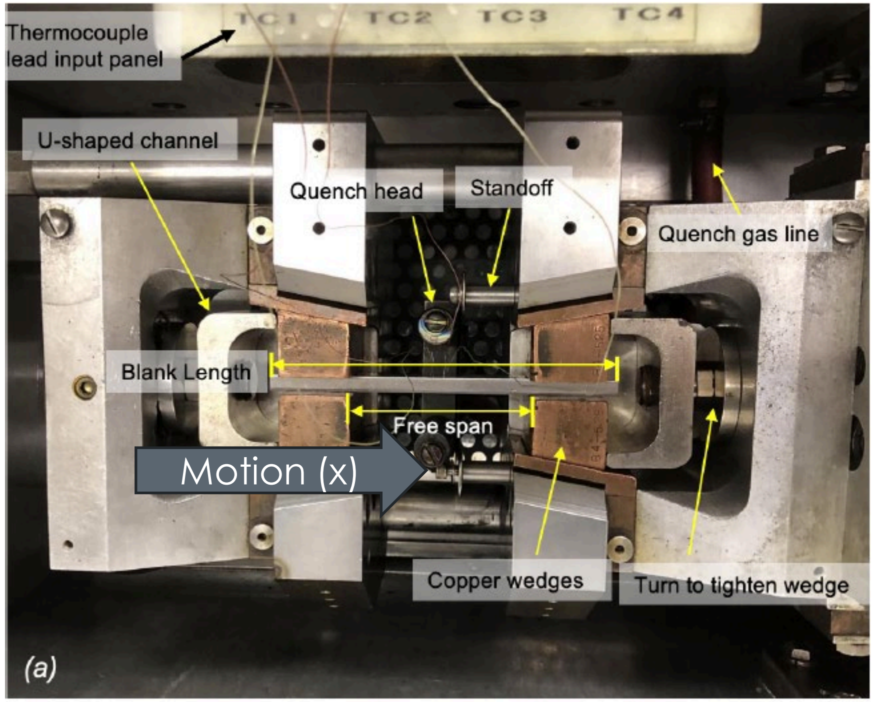
- Gleeble blanks machined for Colorado School of Mines

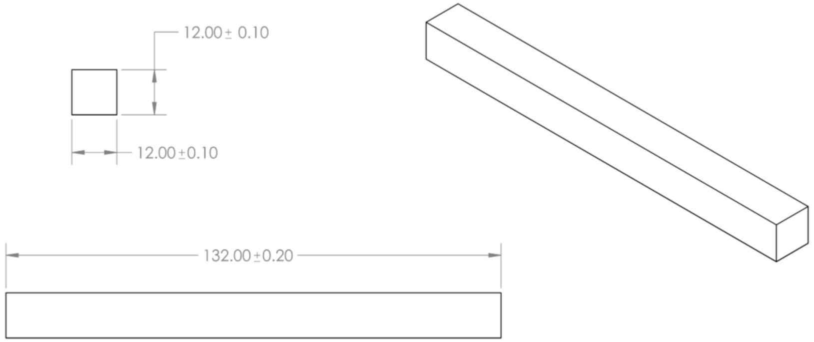
- Charpy specimens machine for impact testing at Ingalls

Plan for Improved Impact Properties

Gleeble Testing and Simulation

As welded samples from Automation International will be machined in Gleeble blanks for testing at Colorado School of Mines





Dimensions in mm
All surface finishes 3.2 micrometers (125 microinches).

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Impact Properties

186 ft-lbs

122 ft-lbs

36 ft-lbs

Impact properties at room temperature

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Project Plan

Metallurgical analysis at Colorado School of Mines

Gleeble Testing at Colorado School of Mines to optimize system parameters

Additional weldments at Automation International with optimized parameters

Mechanical testing, with focus on Charpy impacts, from weldments with optimized parameters

Questions and Comments

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