Qualification of VBAC Submerged Arc Welding Procedures and Metal Cored Electrodes to ABS Rules for Panel Welding

Project Lead

BMT Fleet Technology Limited

Project Team

NASSCO

Hobart Brothers

Miller Electric

SP7 Welding Technology Panel Meeting

Fort Collins, Colorado

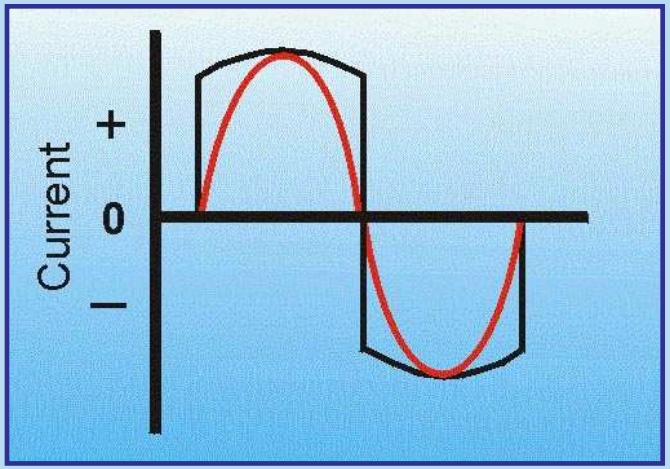
March 28, 2007

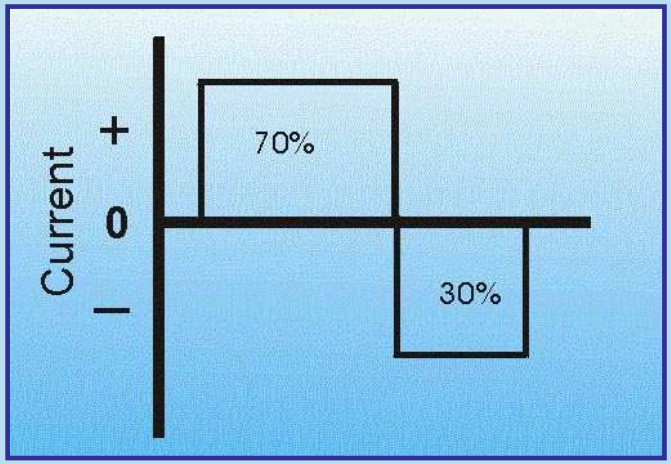
- OUTLINE
  - Background
  - Task 1 – ABS Qualification of Metal Cored Electrodes for HSLA-65 and EH36 Steels
  - Task 2 – ABS Qualification of VBAC SAW Procedures for HSLA-65 and EH36 Steels
  - Project Status
  - Questions?

BACKGROUND

- In a recent NSRP project (ref TIA 2005-386) highly productive tandem SAW procedures were developed for ½" and 1" thick DH36, HSLA-65, and HSLA-100 steels, using Miller,s VBAC technology with specifically formulated metal cored electrodes
  - Single pass one sided welding (OSW) onto a modified FCB for ½" and 1" thick DH36 and HSLA-65 steels
    - ½" plate at 30 inches per minute (ipm) travel speed, deposition rate of 75 lbs/hr
    - 1" plate welded at 20.5 ipm, deposition rate of 112 lbs/hr
  - Two sided welding (one pass per side) with no back gouging of ½" (deposition rate of 85 lbs/hr) and 1" thick HSLA-100 steel, each pass at 45 ipm (deposition rate of 112 lbs/hr)
- Project Recommended by NASSCO to Qualify Welding Consumables and Procedures to ABS Rules

- **VBAC SAW**
  - Heat generated at the cathode (-)
  - DCEP greater portion of heat at work piece
    - Deep penetration
  - DCEN greater portion of heat at electrode
    - Enhanced weld deposition rates
  - Balanced AC provides characteristics between EP and EN polarity
  - Variable Balance AC
    - Control over EP / EN duration





OBJECTIVES

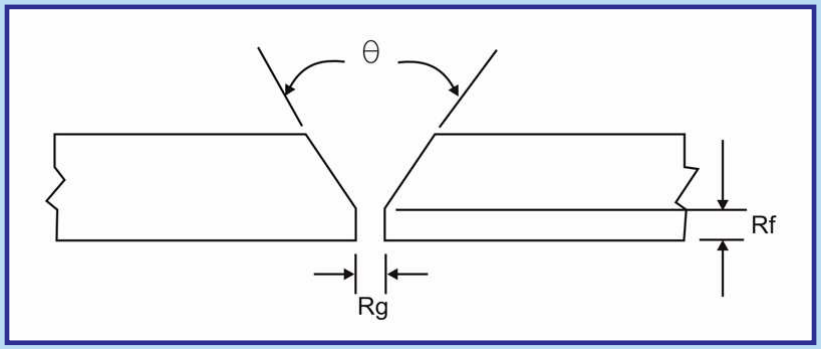
- **Task 1 - Qualify Metal Cored Electrodes to ABS Rules designed for EH36 and HSLA-65 Steels, Manufactured by Hobart**
  - **EH36 Weld Metal Targets**
    - **Min. 58ksi YS, 71 to 95ksi UTS, and 20% Elongation**
    - **Impacts of 20ft-lbs @ -20F**
  - **HSLA-65 Weld Metal Targets**
    - **Min. 65ksi YS, 20% Elongation**
    - **Impacts of 30 ft-lbs @ -20F**

Compositions (%)																	
C	Mn	Si	S	P	Ni	Cr	Mo	Al	B	Cu	Zr	Nb	Ti	V	N	O	Pcm
0.060	1.400	0.550	0.002	0.002	0.500	0.015	0.150	0.004	0.004	0.060	0.008	0.002	0.015	0.001			0.191

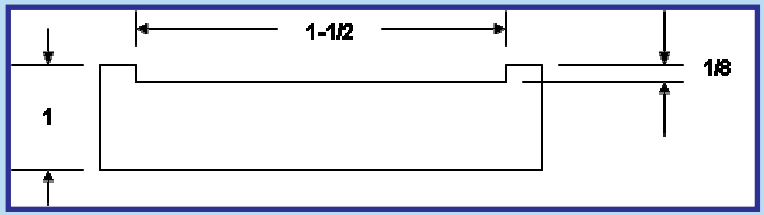
- **Single Chemistry with Lincoln MIL800-H flux to satisfy both steel requirements**
- **Estimate 78-85ksi Weld Metal YS, 88-95ksi UTS, 24% Elongation, and 100ft-lb impacts @ -20F, at heat inputs up to 215kJ/in (combined in tandem)**

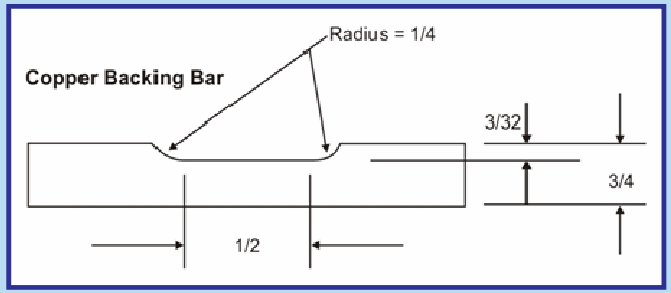
OBJECTIVES, Cont.

- **Task 2 - Qualify VBAC Tandem SAW Procedures with Metal Cored Electrodes to ABS Rules (Millers Summit 1000 Power Sources), Lincoln MIL800-H Flux**
  - **Single pass OSW onto modified FCB**
    - **½" and 1" thick EH36 and HSLA-65**

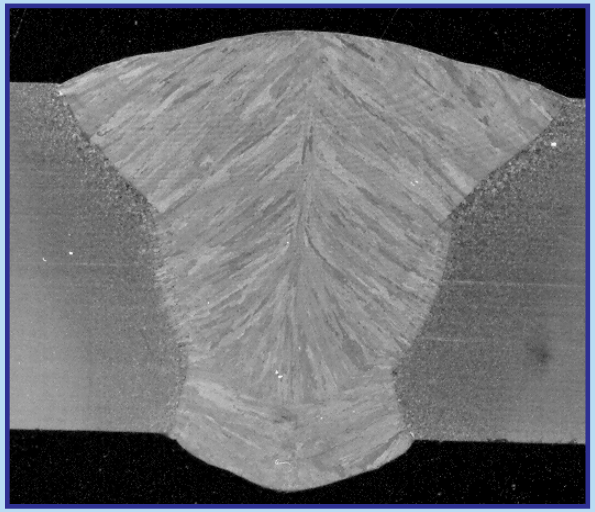


Modified Design



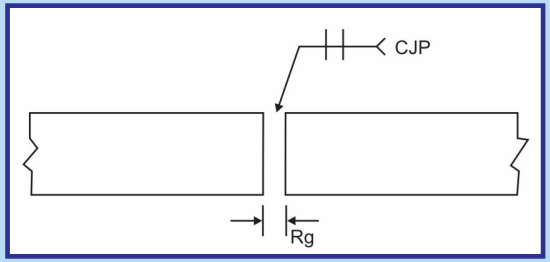


  - **½" - Θ = 30°, Rg = 3/32", Rf = 1/8" – 66/34 (EP/EN)**
  - **1" - Θ = 30°, Rg = 3/32", Rf = 3/16" – 66/34 (EP/EN)**
  - **5/32 Electrodes, ¾" Spacing for ½" T, and 5" Spacing for 1" T**

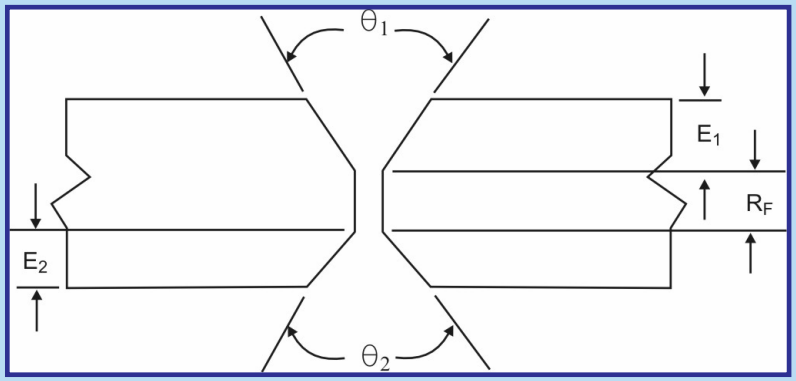


OBJECTIVES, Cont.

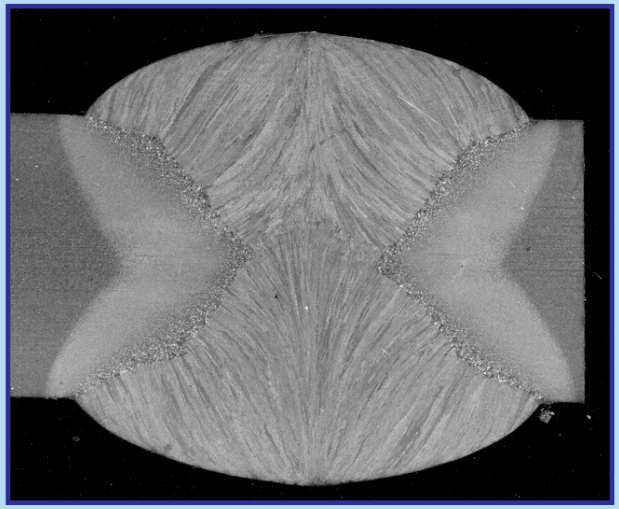
- **Task 2 - Qualify VBAC Tandem SAW Procedures with Metal Cored Electrodes to ABS Rules (Miller Summit 1000 Power Sources), Lincoln MIL800-H Flux**
  - **Two sided (one pass per side with no back gouging) SAW, 5/32 Electrodes, ¾" Electrode Spacing**
    - **½" and 1" thick EH36 and HSLA-65**

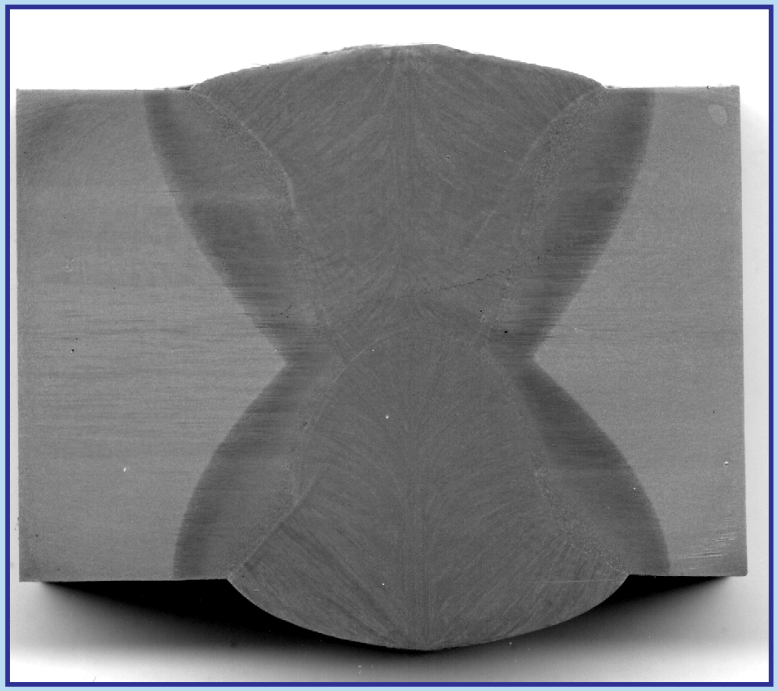


    - **Rg = 0**



    - **Θ_1 = 70° Θ_2 = 90°, Rg = 0, Rf = 5/16", E_1 = 7/16", E_2 = ¼"**





PROCEDURE QUALIFICATION TEST MATRIX

- **All plates to be radiographed**
- **½" Plates**
  - 2 Cross Weld Tensiles
  - 1 Macro / Micro / Hardness
  - 2 Root Bends and 2 Face Bends for OS Welds
  - 4 Side Bends for Two Sided Welds
  - Charpy V-notch Impact @ T/2
    - 5 Weld Centerline, 5 Fusion Line, 5 Fusion Line + 1mm, and 5 Fusion Line + 3mm
- **1" Plates**
  - 2 Cross Weld Tensiles
  - 1 All Weld Metal Tensile (centered at ¼" below Side #1 surface)
  - 1 Macro / Micro / Hardness
  - 4 Side Bends
  - Charpy V-notch Impact @ 1/16" from Side #1 surface
    - 5 Weld Centerline, 5 Fusion Line, 5 Fusion Line + 1mm, and 5 Fusion Line + 3mm

PROJECT STATUS

- Metal Cored Electrodes Have Been Manufactured by Hobart and Delivered to BMT's Lab
  - Need to Make Arrangements with ABS Rep to Witness Consumable Certification Testing
- ½" and 1" HSLA-65 Plate will be Ordered Next Week
- Awaiting EH36 Plate from NASSCO
  - Also perform trials with resin backing flux
- Making Arrangements to Visit NASSCO to Have Formal Kick-off Meeting and View Current Panel Line Configuration in April 07

QUESTIONS?