Fall 2018 FD & E Conference

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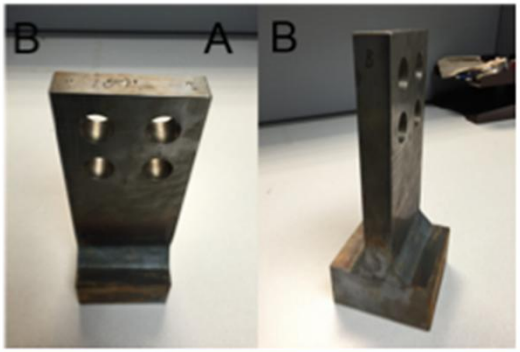
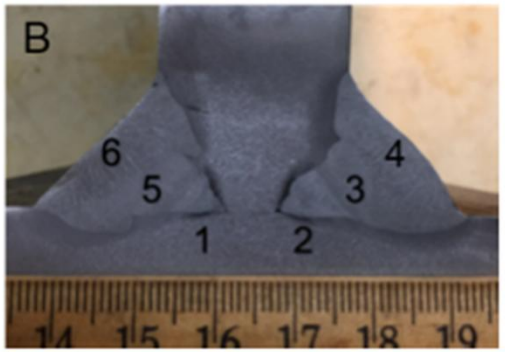
Background (Process Parameters)

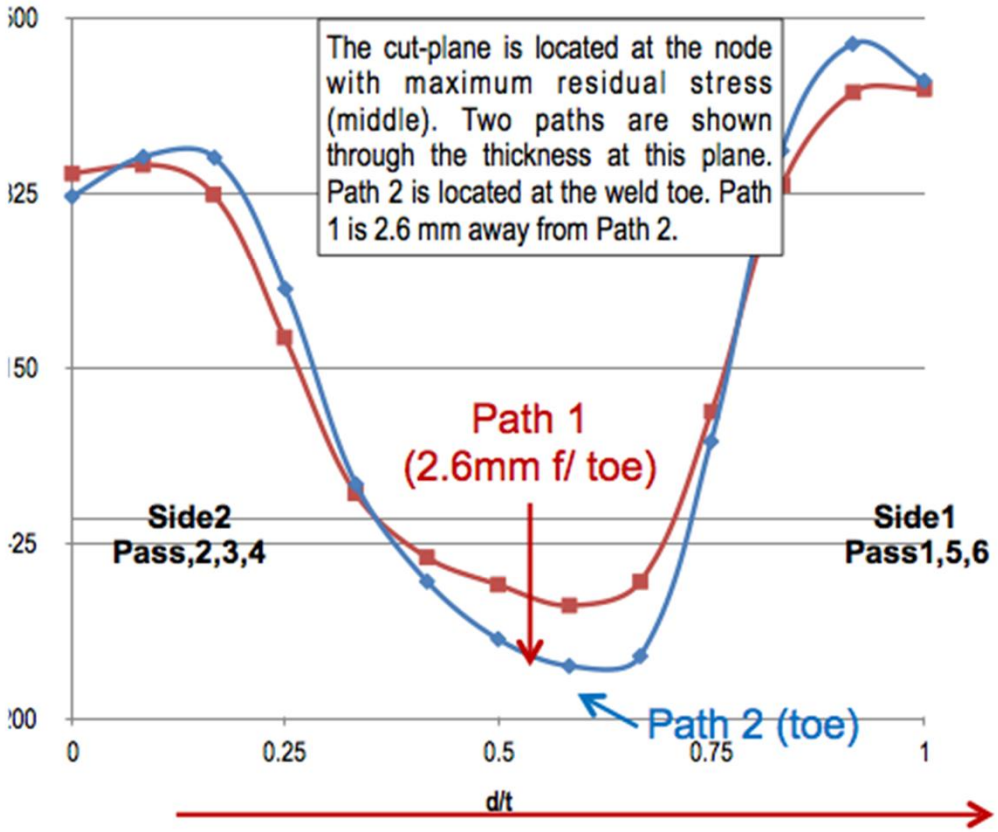
Weld	Side	Starting End	Voltage	Current	Wire Speed	Travel Speed	Work Angle	Cooling Time*
1	1	A	38.5 V	235 A	7 m/min	40 cm/min	45	NA
2	2	B	38.5 V	235 A	7 m/min	40 cm/min	45	45 s
3	2	B	39.0 V	300 A	8 m/min	35 cm/min	45	3 s
4	2	B	39.5 V	225 A	8.5 m/min	60 cm/min	45	3 s
5	1	A	39.0 V	300 A	8 m/min	35 cm/min	45	1 m 30 s
6	1	A	39.5 V	225 A	8.5 m/min	60 cm/min	45	2 m 30 s

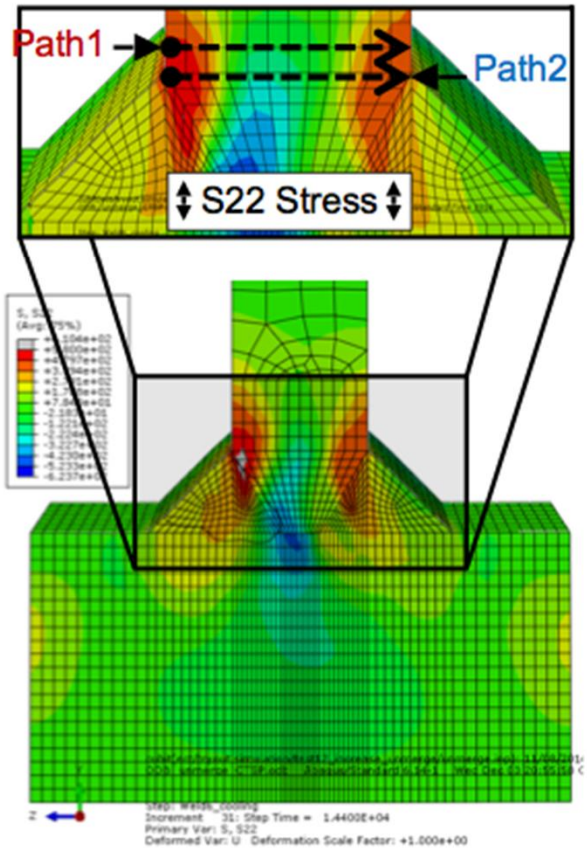
Parameter/Characteristic	Value
Welding Process	(GMAW)
Wire Type	(Solid)
Wire Diameter	0.062 inches
Shielding Gas	90% CO2/ 10% Ar
Base Material	A36
Filler Metal	ER70S-6
Welding Position	45 deg for all weld passes





2014 Simulation Results

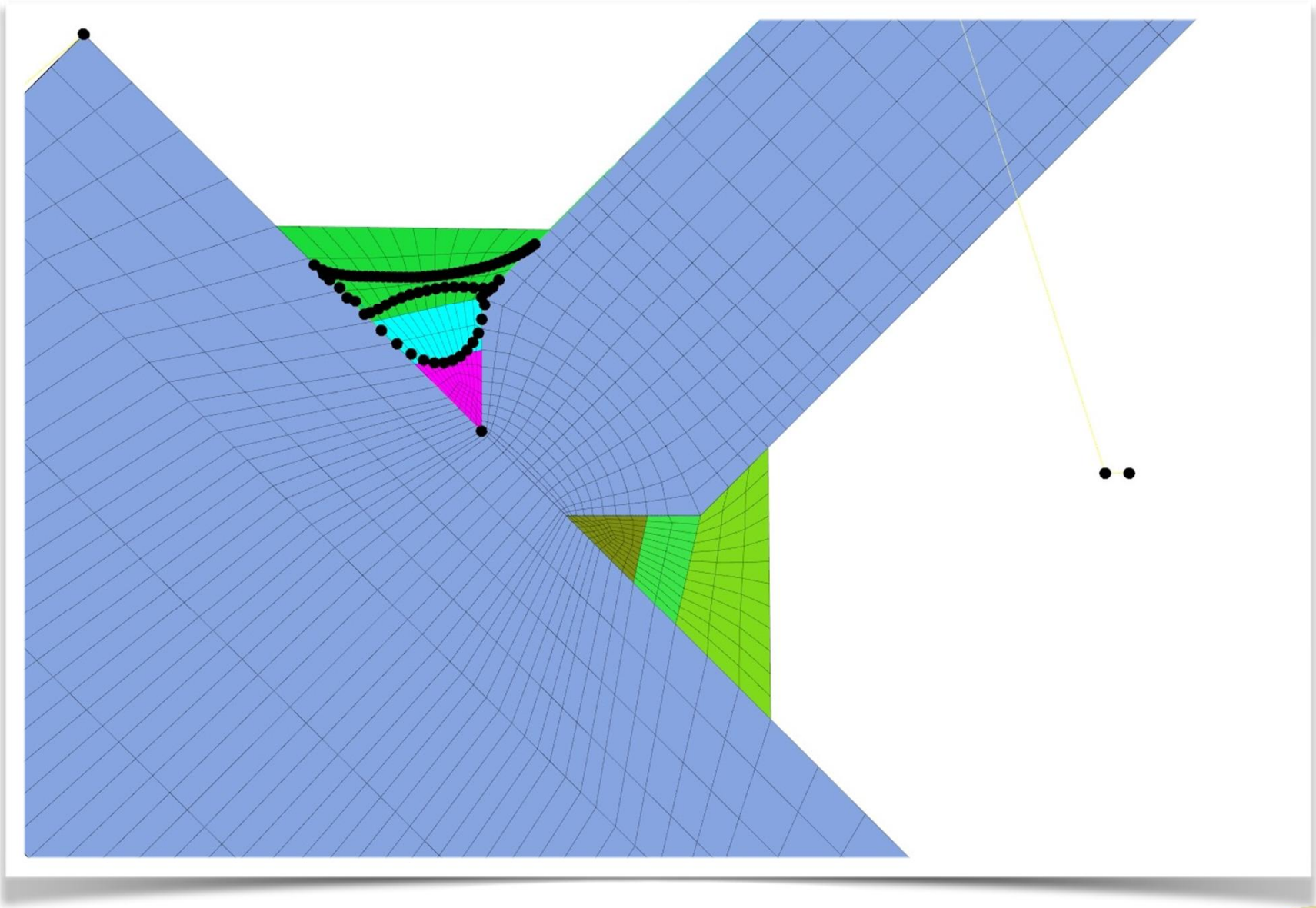




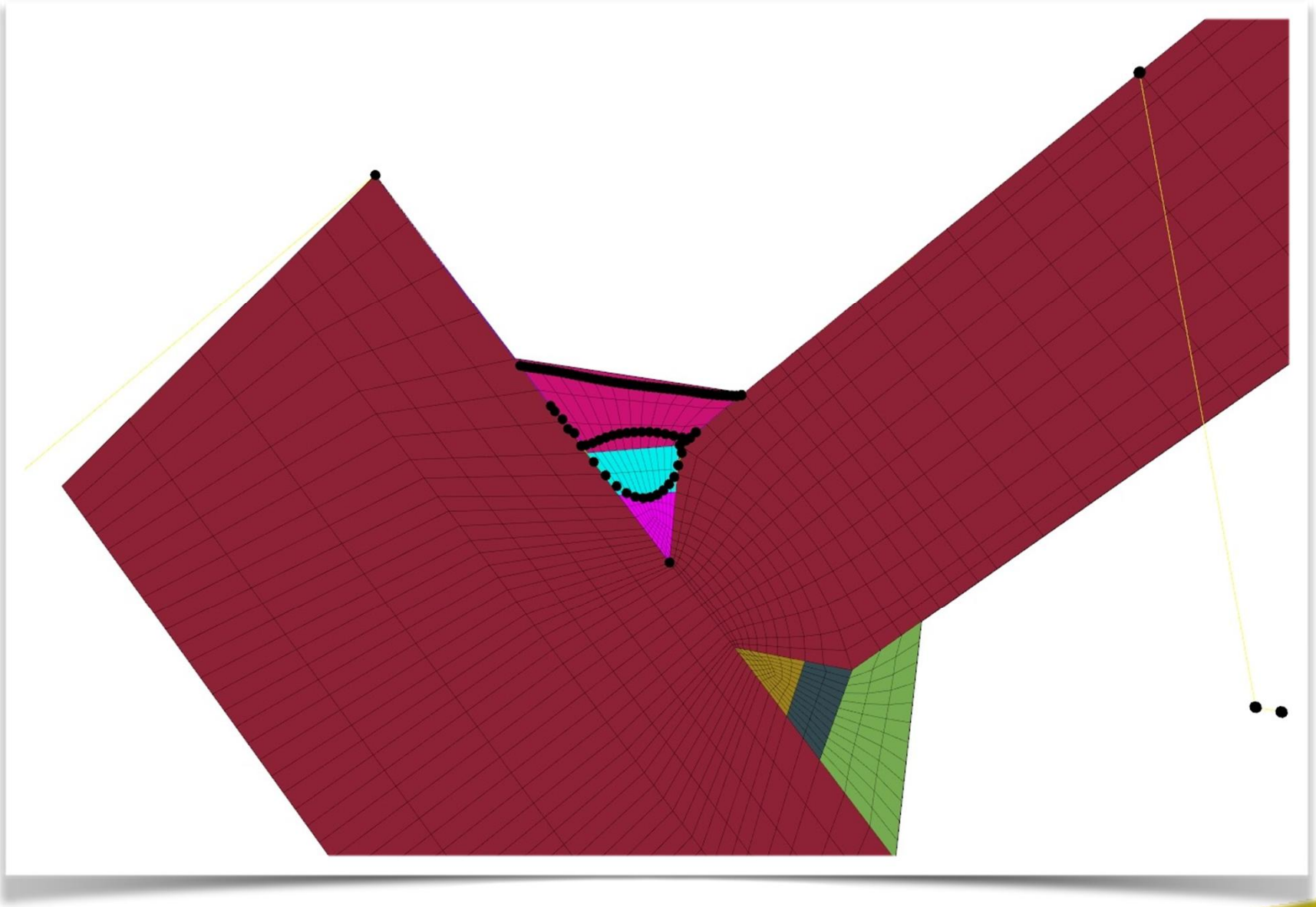
Weld Weave Parameters

Pass	Amplitude (mm)	Wavelength (Hz)	Dwell time
1 & 2	1.5	2.38	
3 & 5	4.5	1.67	
4 & 6	8	0.74	yes

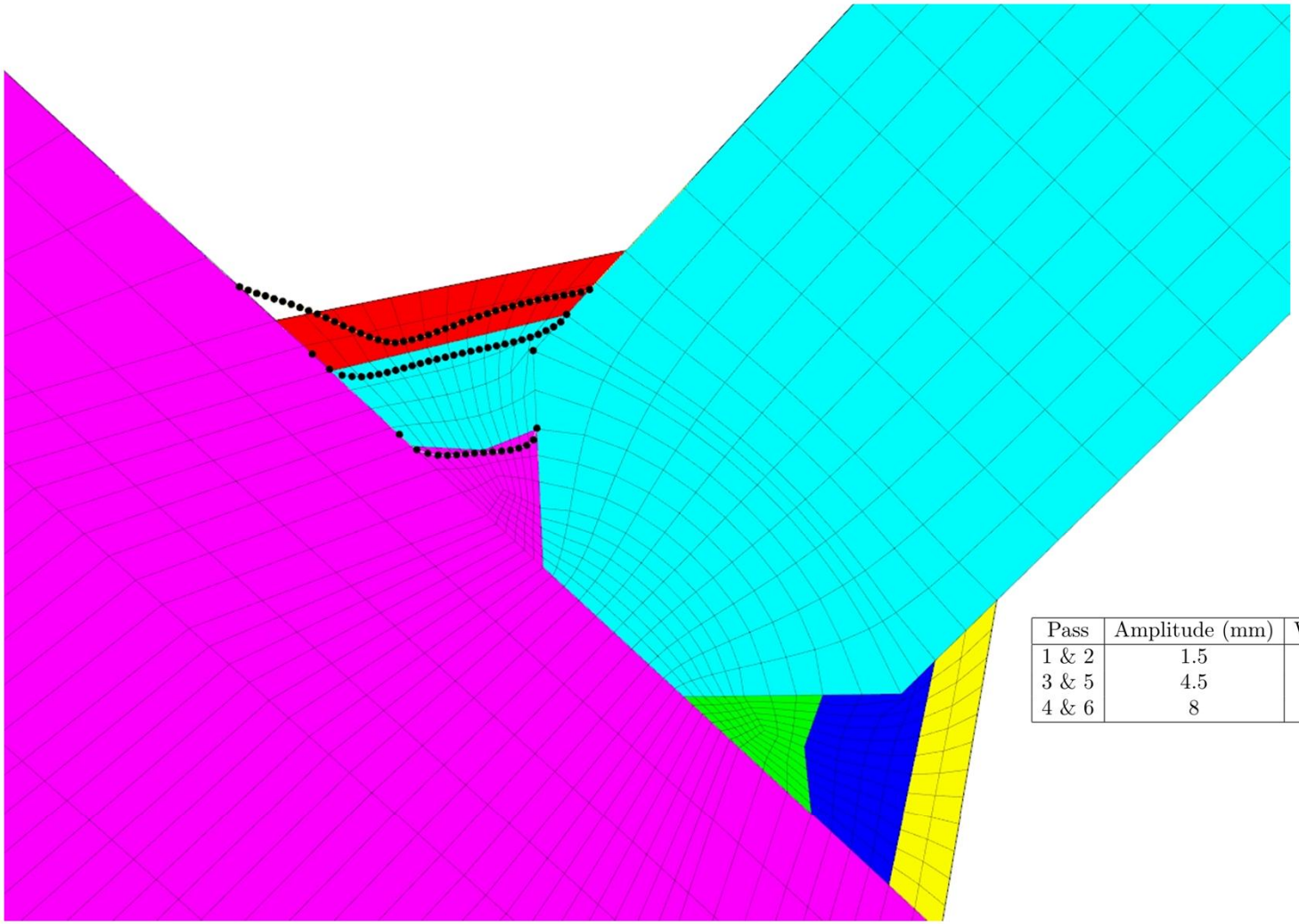
Passes 2, 3 & 4 Guessed Weave Data



Weld Weave Parameters for Passes 2, 3 and 4 Adjusted to Fit Filler Metal Geometry



Passes 2, 3 & 4 with Weave Data



Pass	Amplitude (mm)	Wavelength (Hz)	Dwell time
1 & 2	1.5	2.38	
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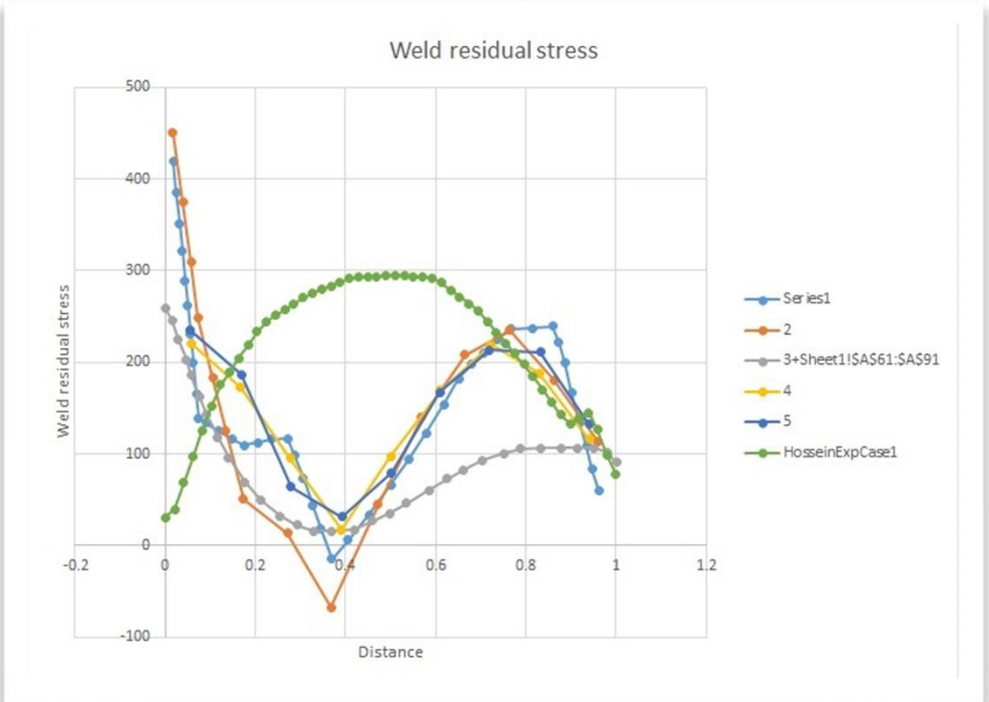
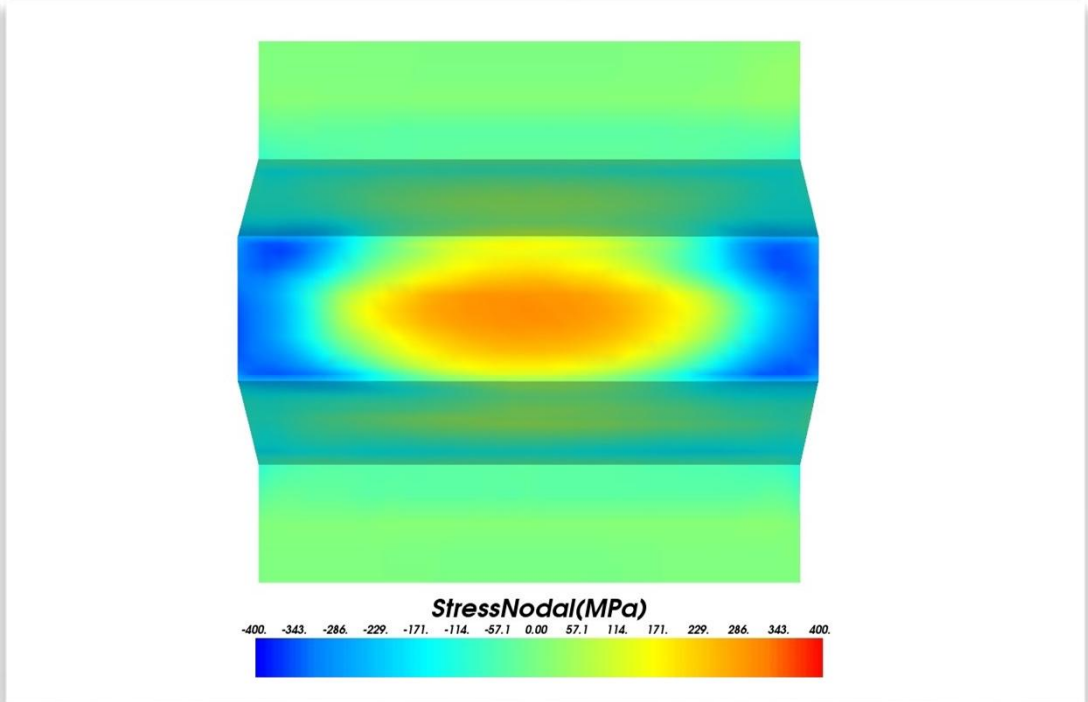
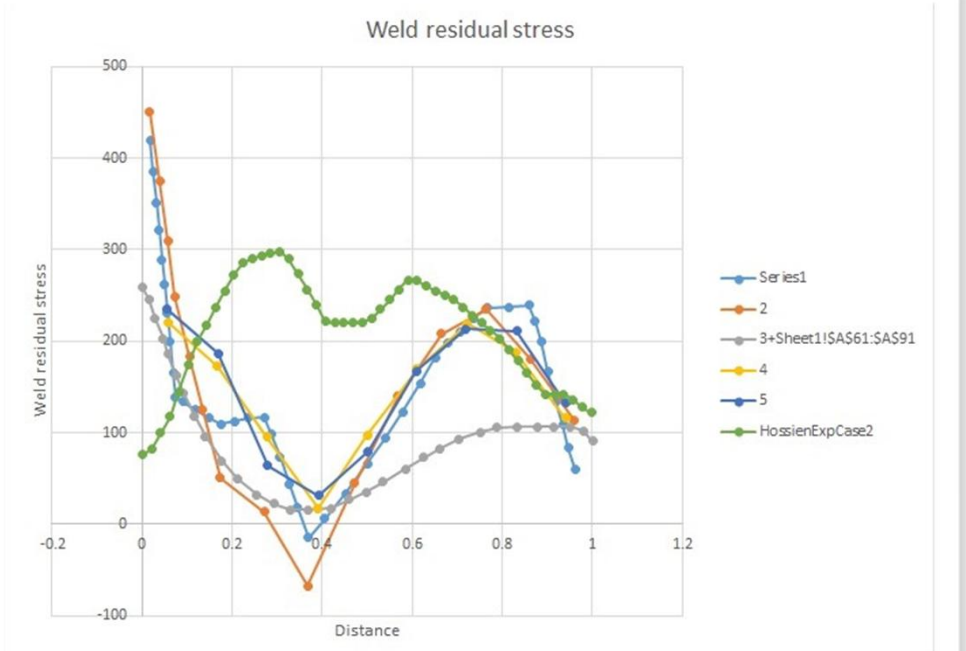
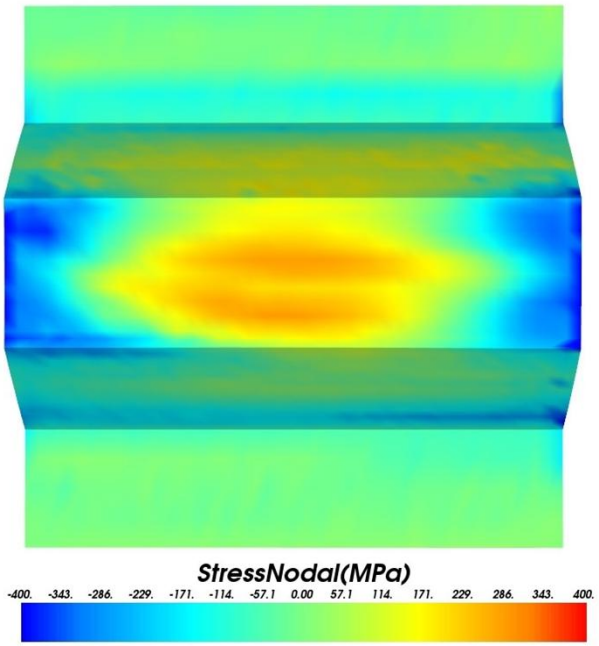
Case 1: Residual Stress with Convection Cooling all Surfaces and Free Expansion. (A13C, A13C) Double ellipsoid.



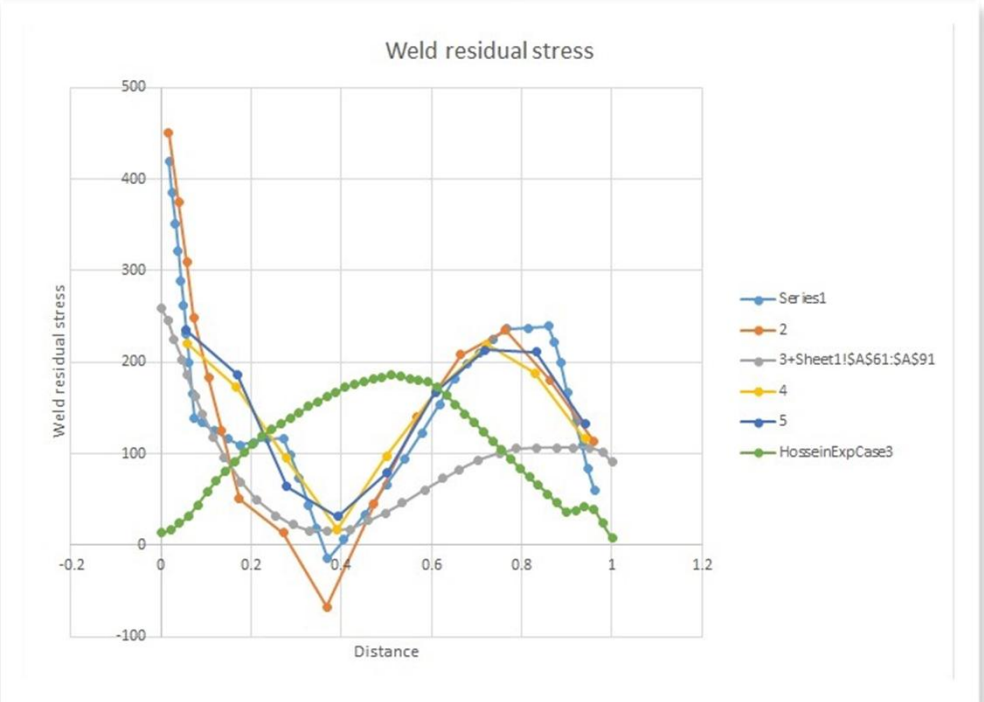


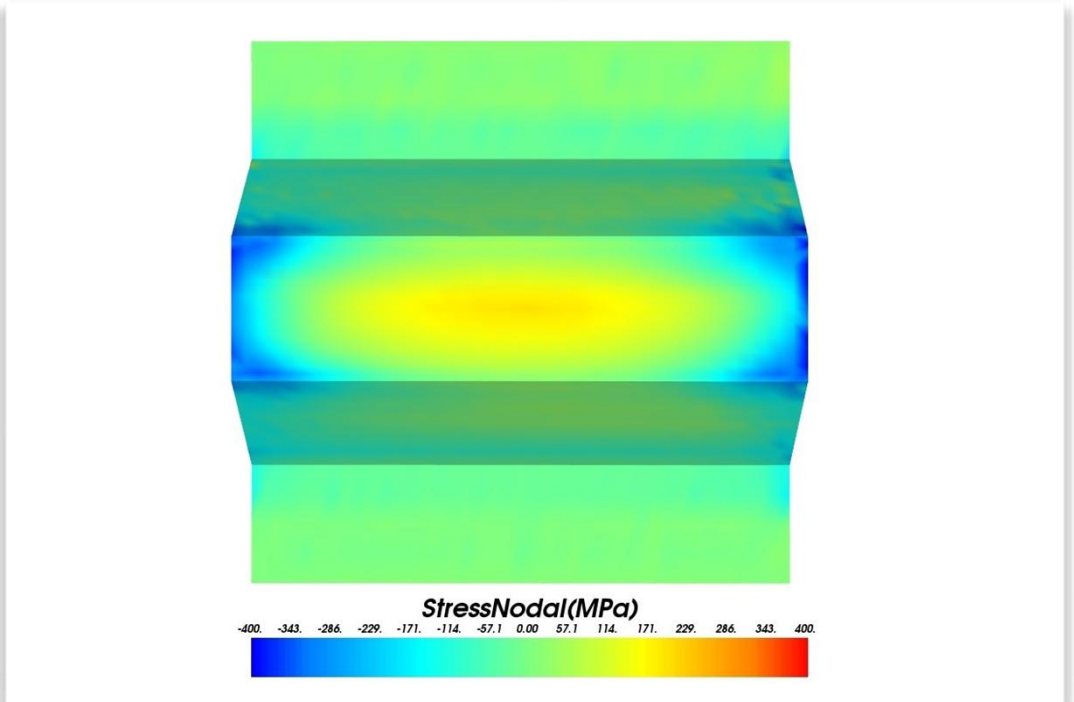
Case 2: Residual Stress with Insulated Surface Between Parts and Zero Length Expansion. (A13C, A13C) Double ellipsoid.



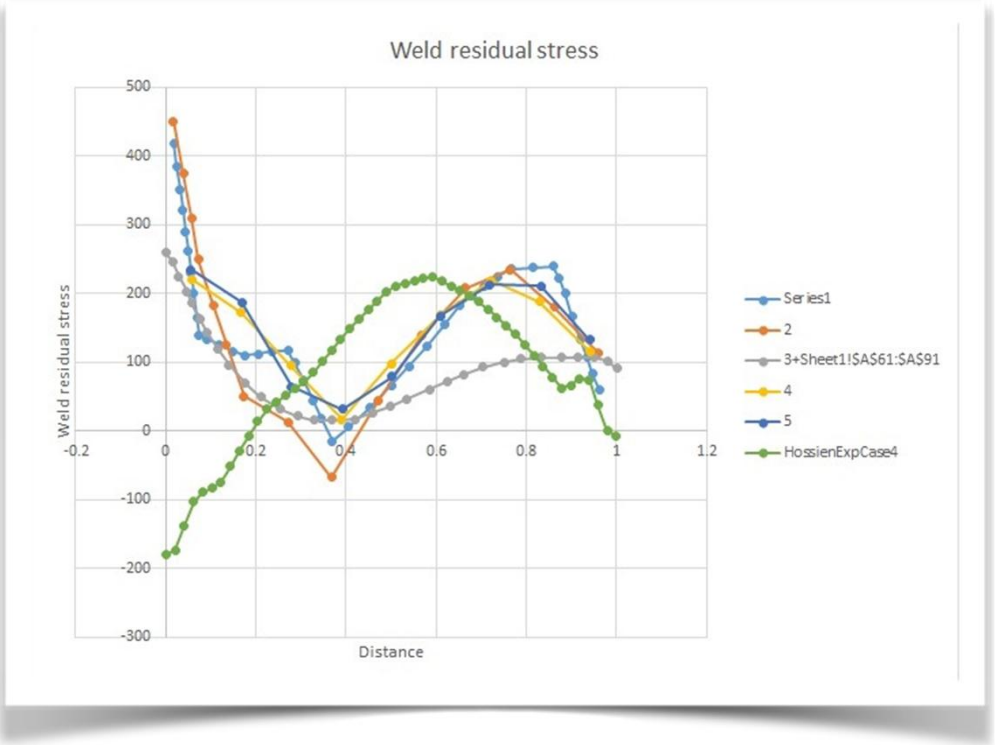


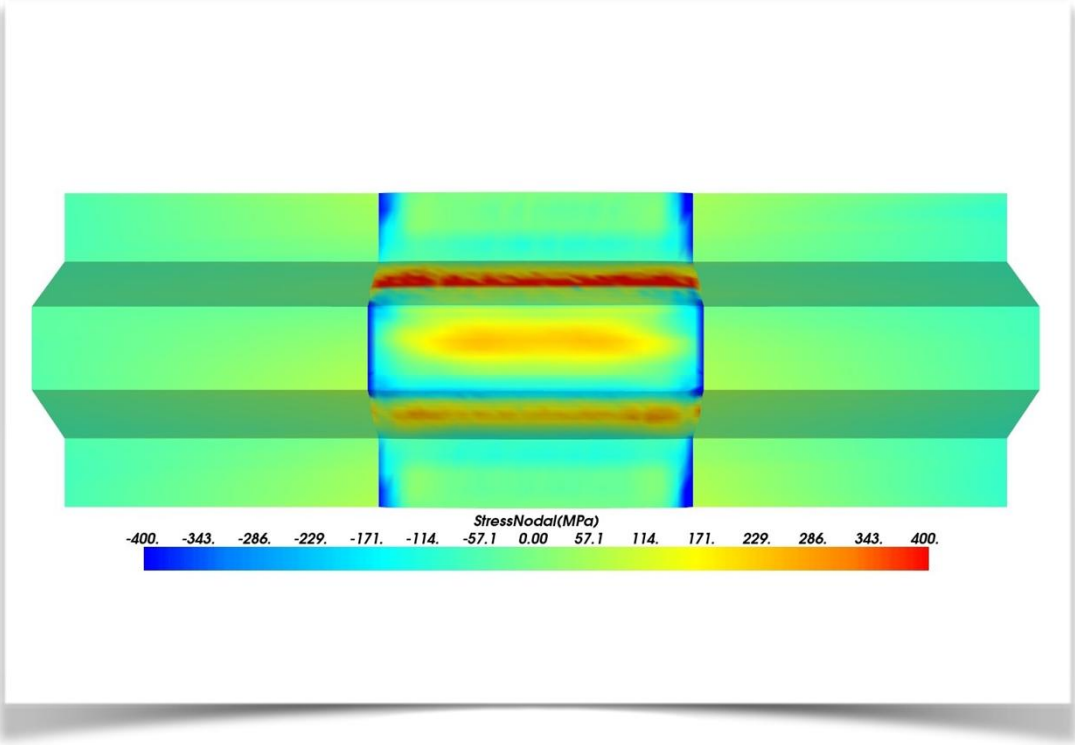
Case 3: Residual Stress with Insulated Surface Between Parts. Zero Length Expansion During Welding and Cool Down. Then released. (A13C, A13C)



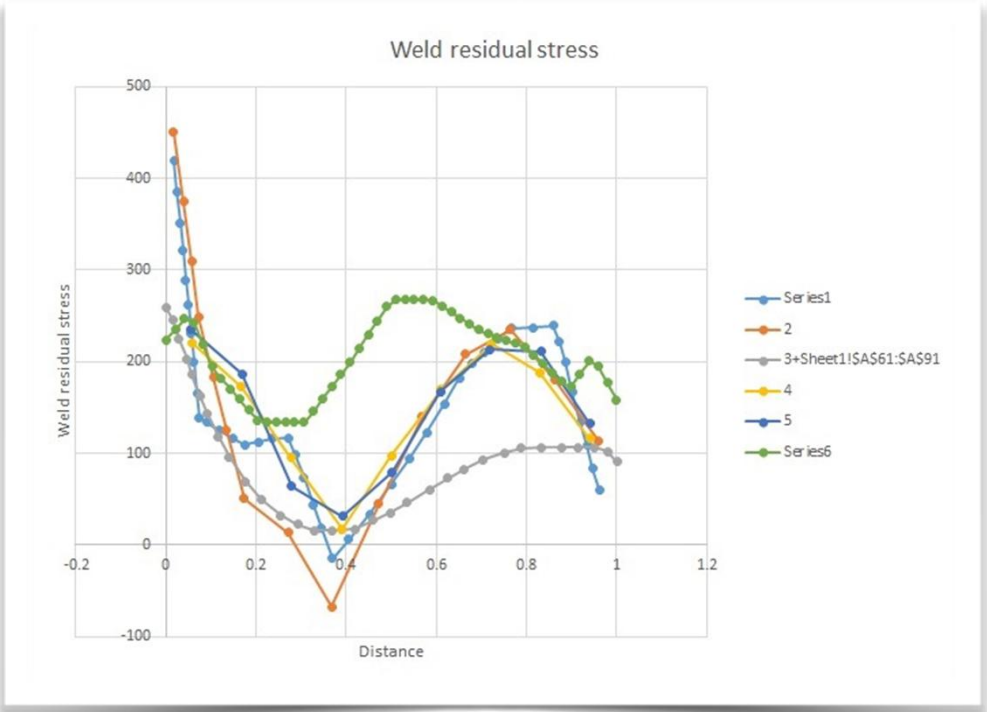


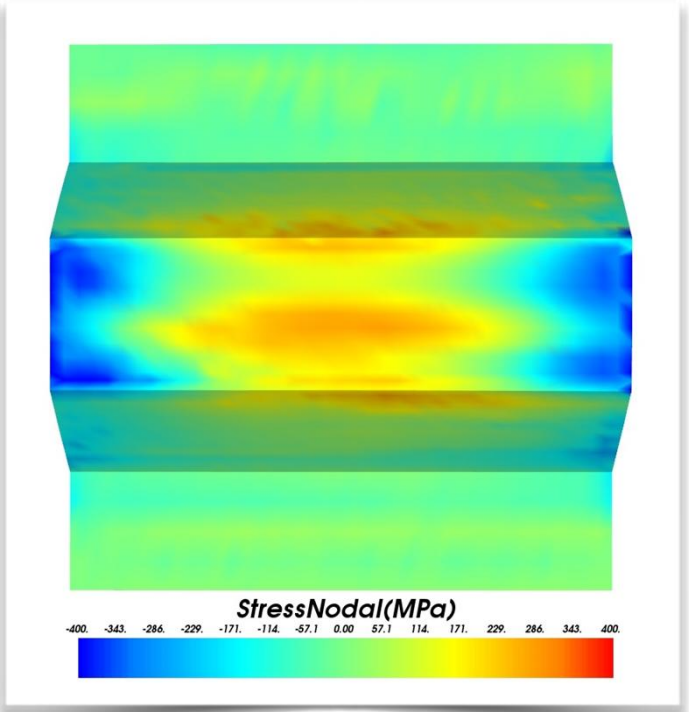
Case 4: Residual Stress with Insulated Surface Between Parts. Contact Stress Stiffness 1e14 n/m^2 in 3D During Welding and Cool Down. Then Released. Double ellipsoid. Microstructure Included. (A13C, A13C)



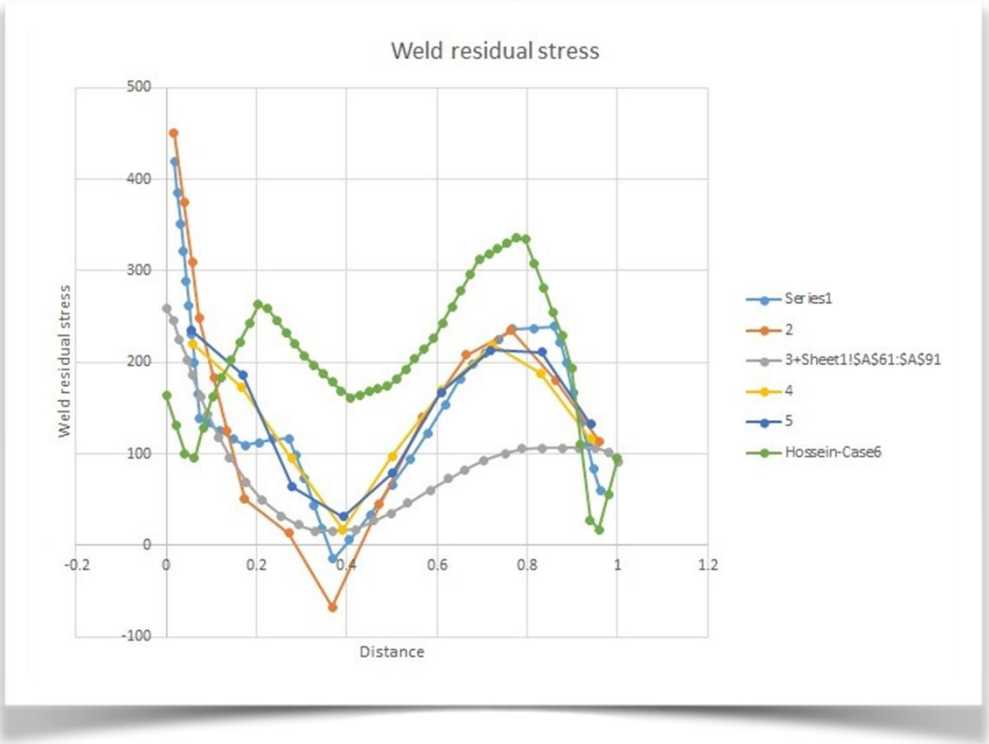


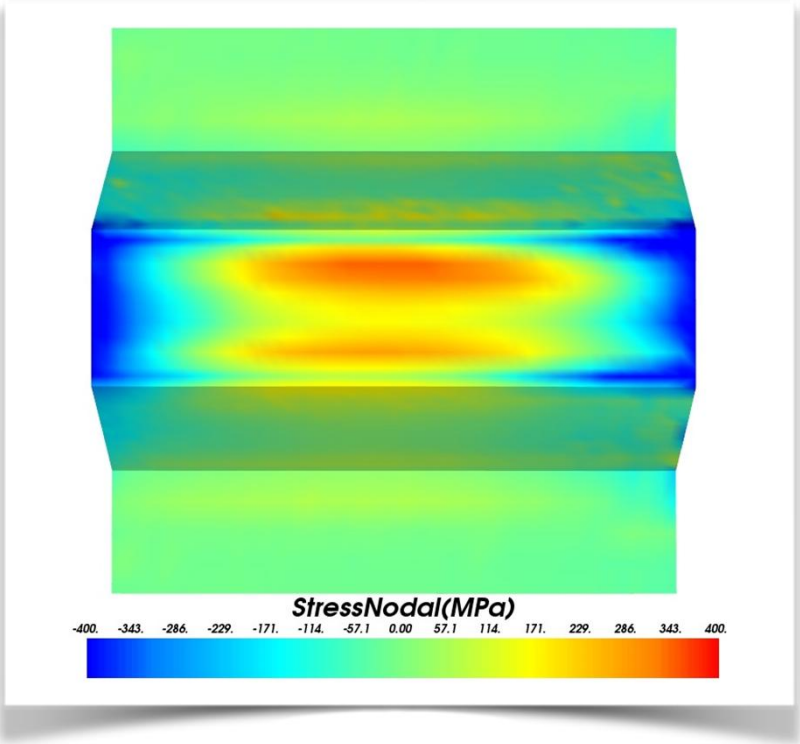
Case 5: Residual Stress with Insulated Surface Between Parts. Contact Stress Stiffness 1e14 n/m^2 in 1D During Welding and Cool Down. Then Released. Double ellipsoid. Microstructure Included. (A36, ER70-6)



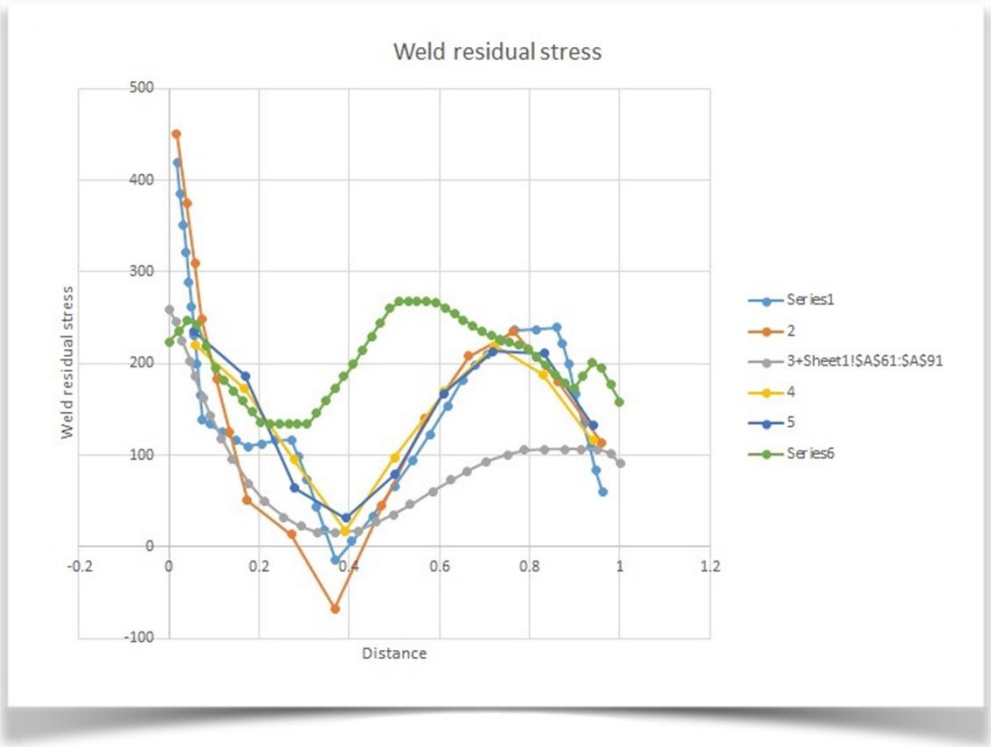


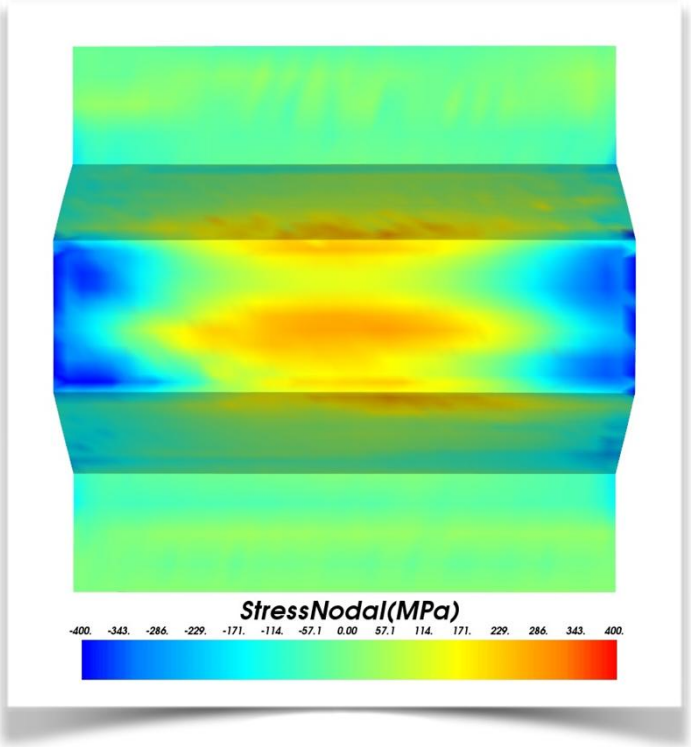
Case 6: Residual Stress with Insulated Surface Between Parts. Only Weld Passes 4 and 6 Analyzed. Contact Stress Stiffness 1e14 n/m^2 in1D During Welding and Cool Down. Then Released. Microstructure. (A36, ER70-6) Double Ellipsoid.



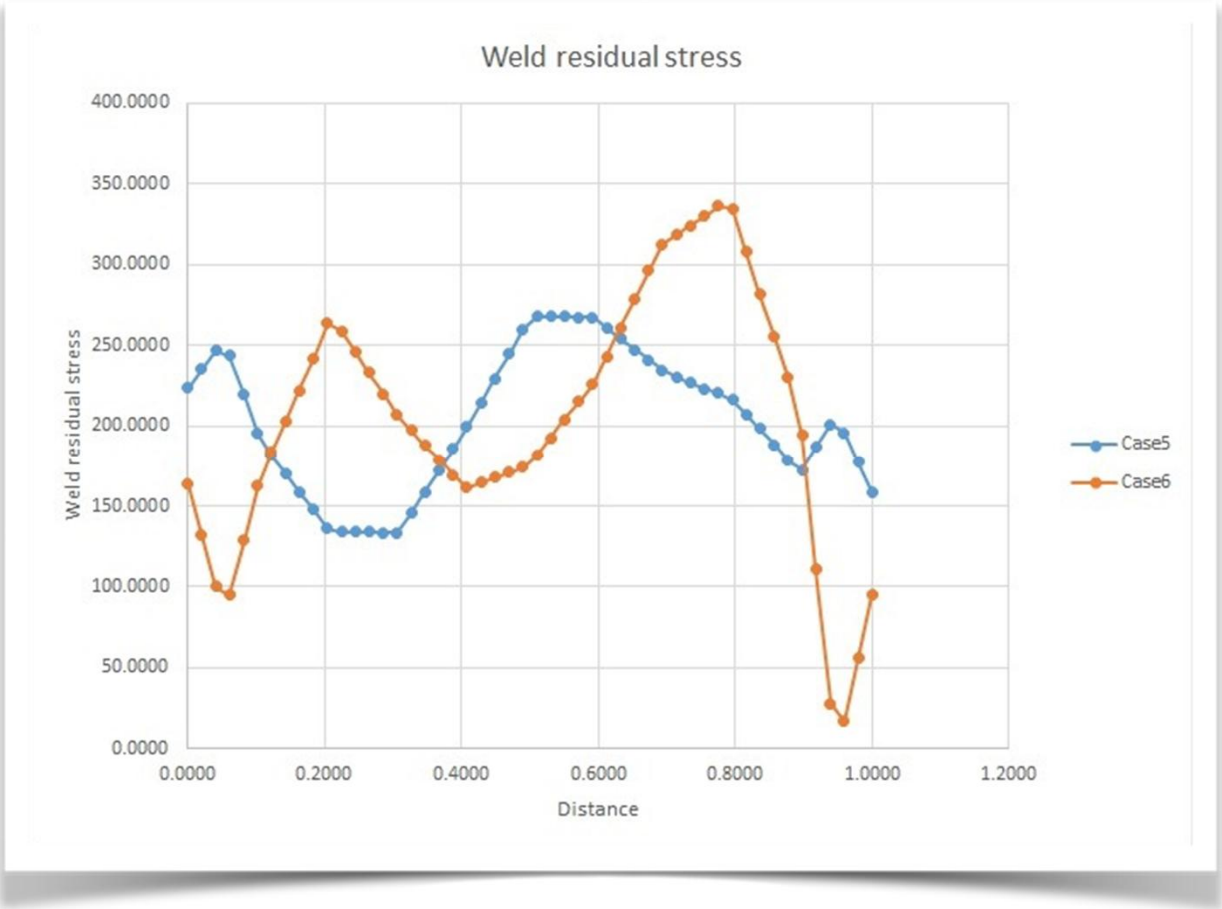


Case 7: Residual Stress with Thermal Contact Between Parts. Contact Stress Stiffness -1e14 & +1e9 n/m^2 in 1D During Welding and Cool Down. Then Released. WeldPool. Microstructure. (A36, SR70-R)

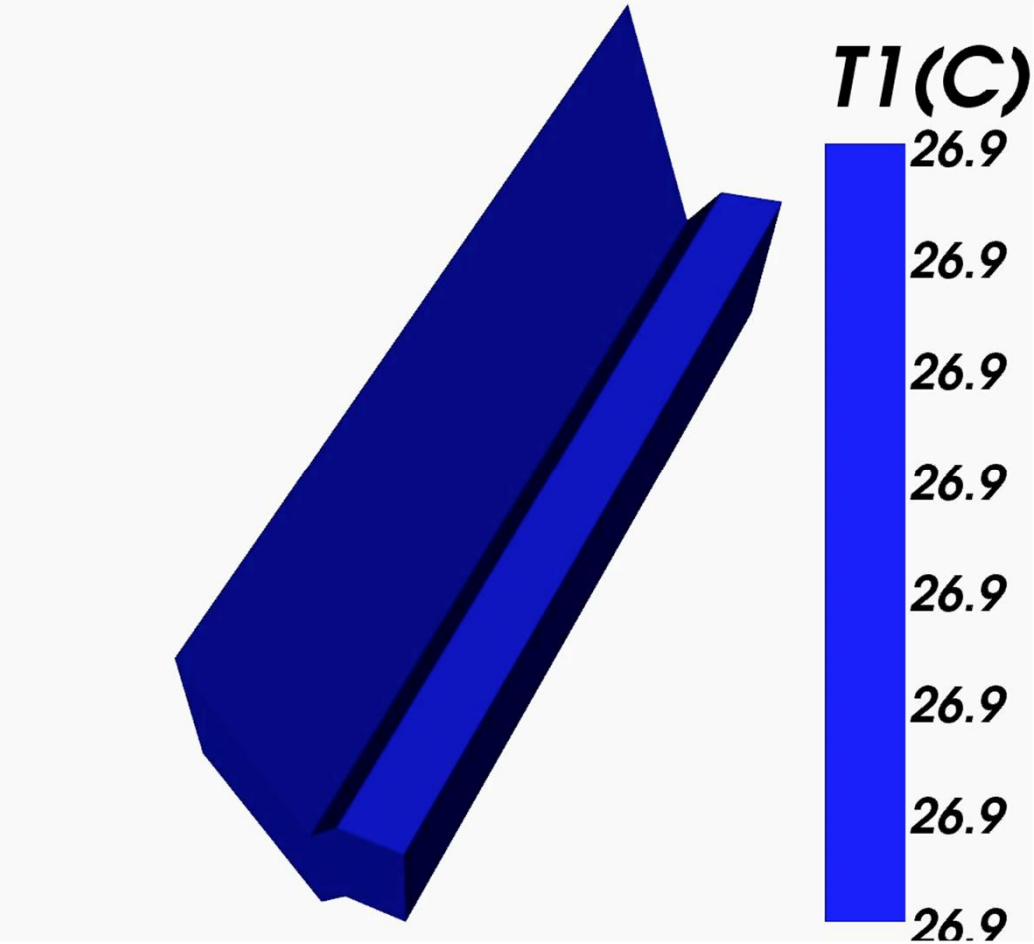




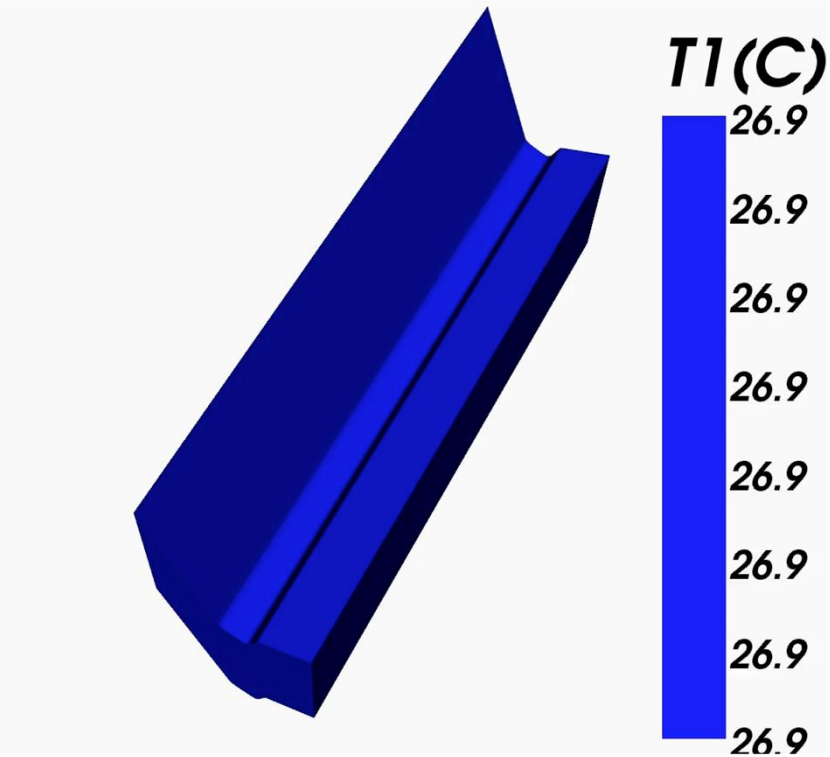
Merged Case 5 & 6: Residual Stress Contact Stress Stiffness - 1e14 & +1e9 n/m^2 in 1D During Welding and Cool Down. Then Released. WeldPool. Microstructure. (A36, ER70-6)



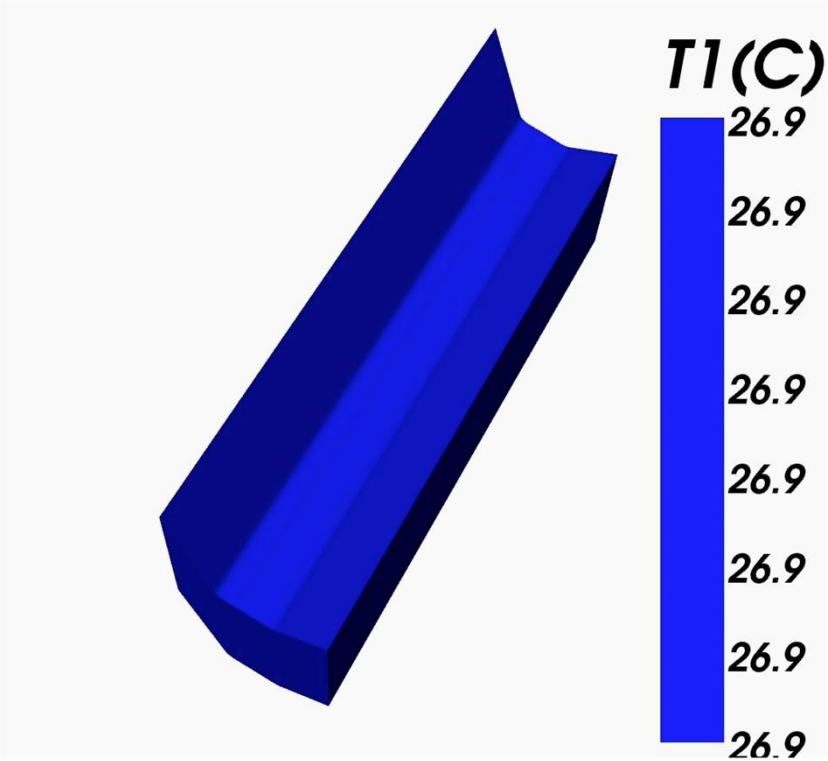
Welding passes 1 & 2



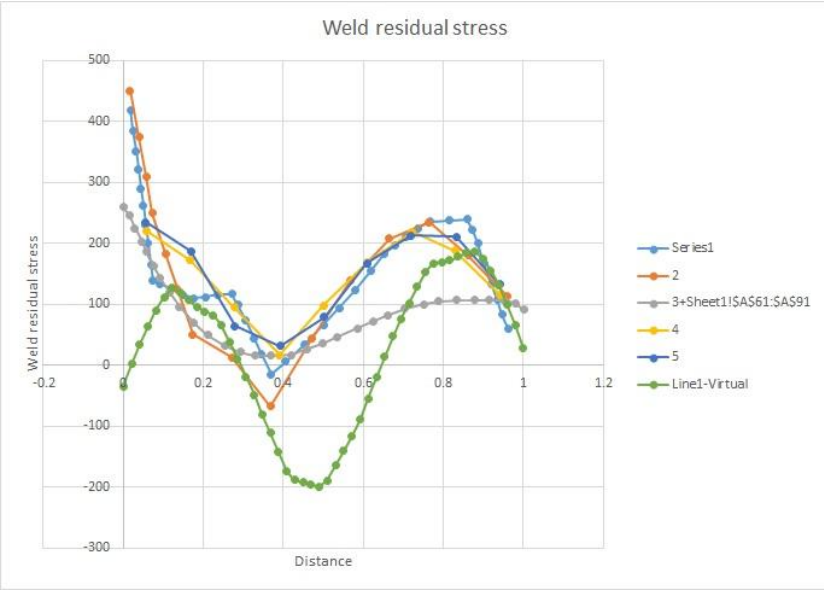
Welding passes 3 & 5

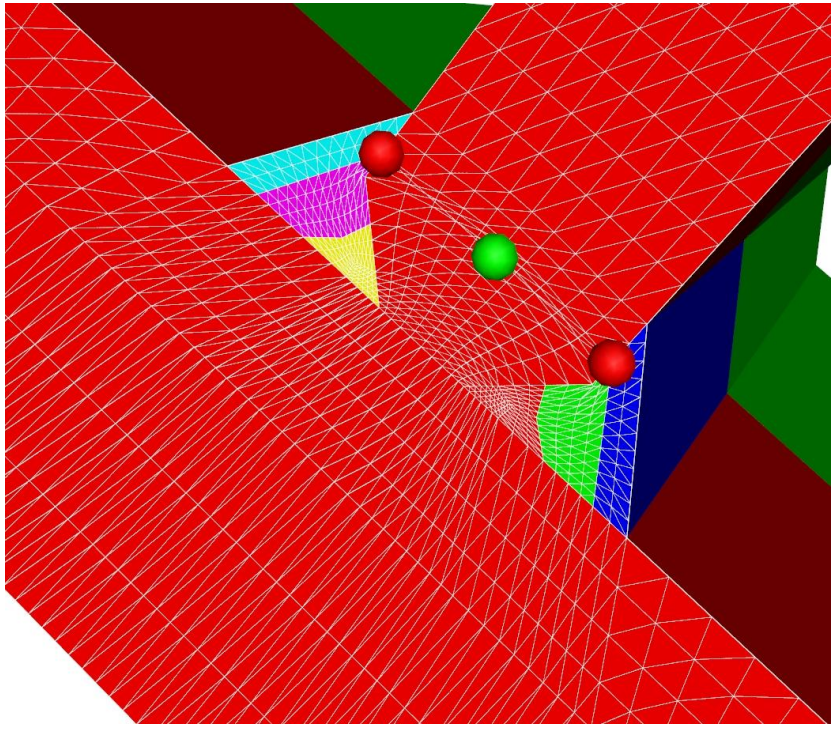


Welding passes 4 & 6

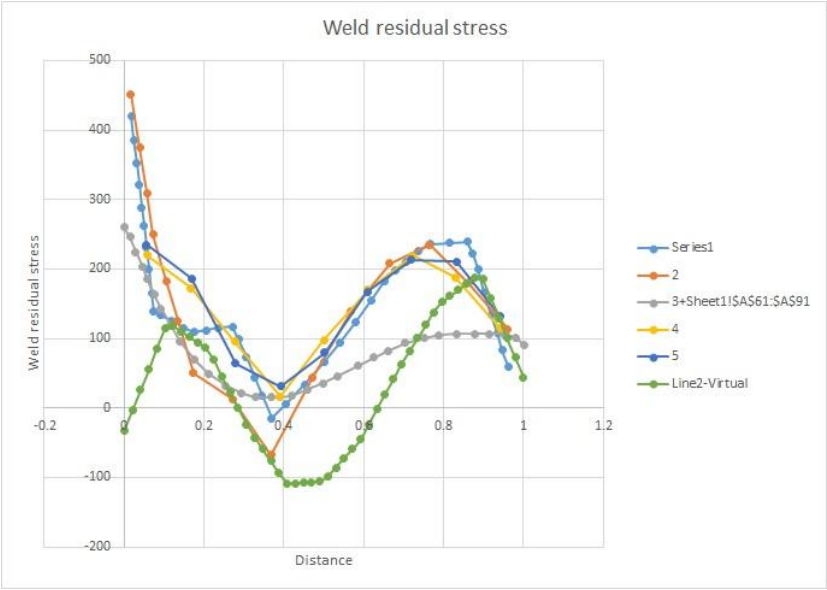


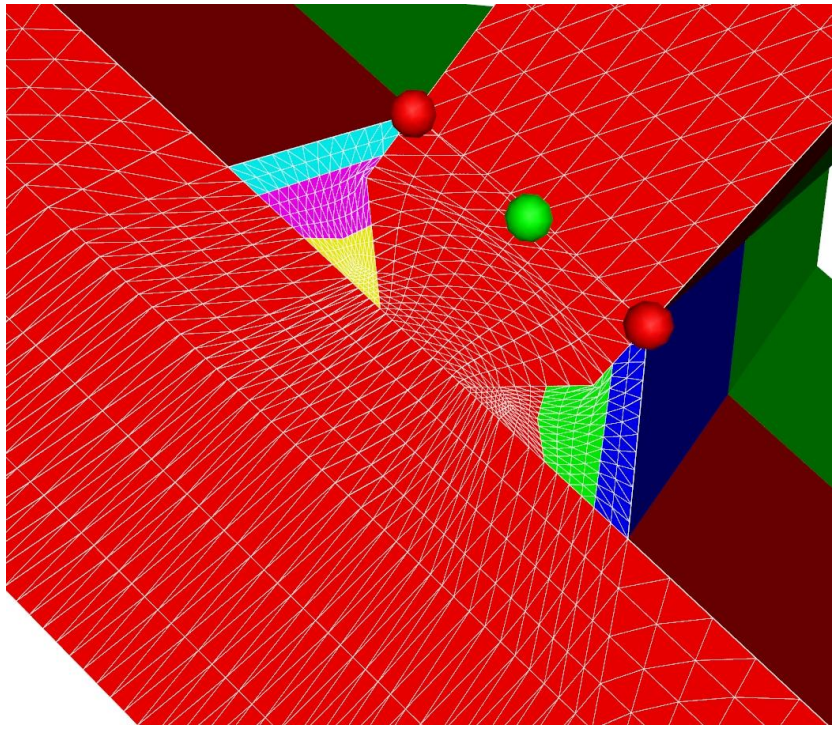
Vertical Residual Stress on a line





Vertical Residual Stress on a line

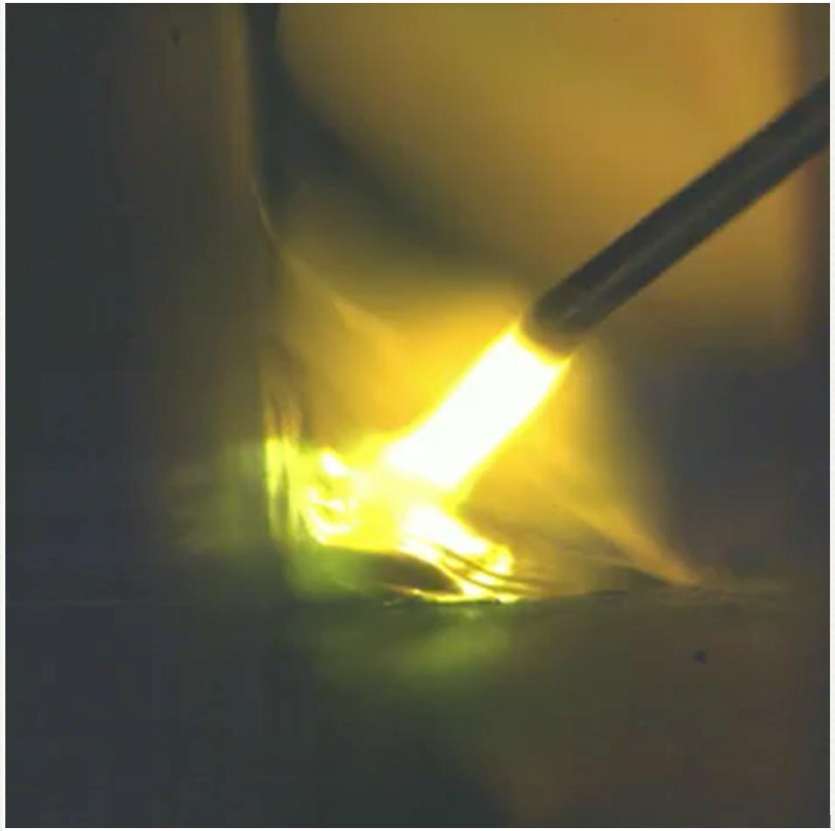


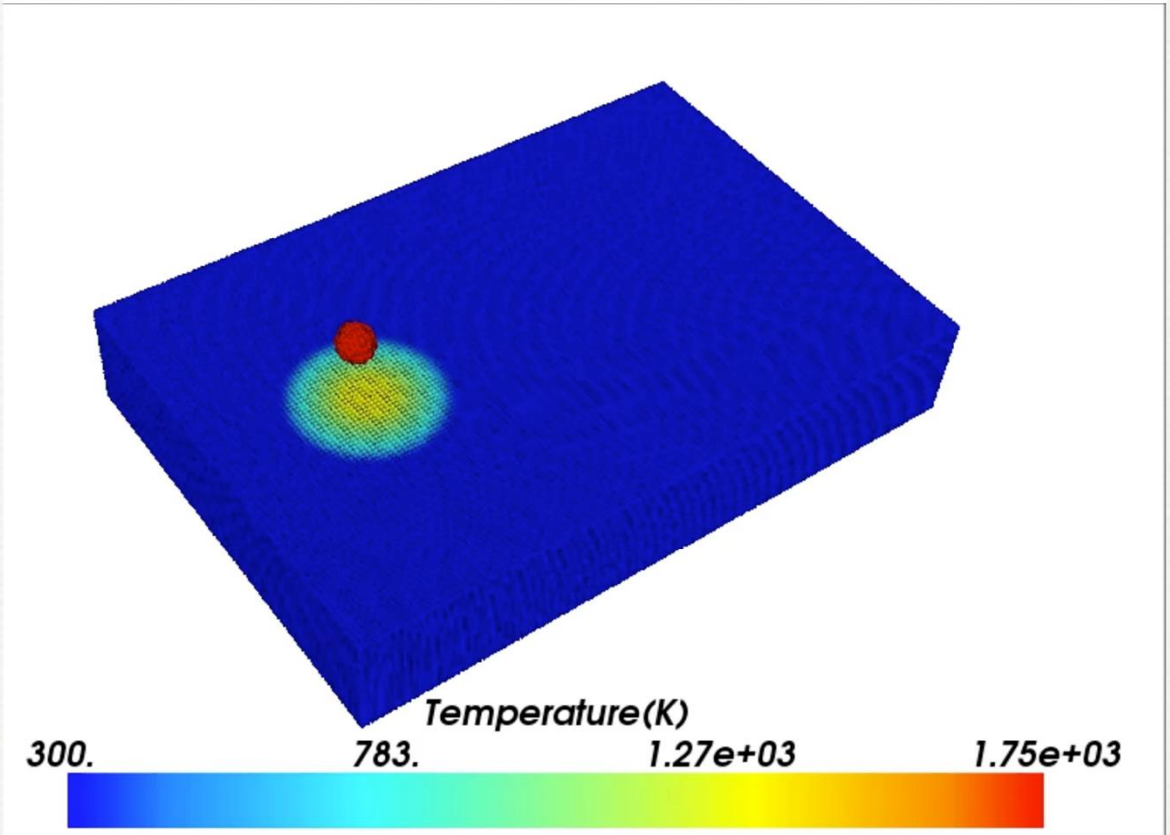


Are Traditional Weld Procedures Obsolete?

- John Norrish suggested at IIW 2015
- Computer control systems on modern power supplies do not allow users to specify control of the arc.
- Are weld procedures developed for a particular power supply? Is it like programming robots?
- Should companies use computer vision to develop their weld procedures?

3D SPH Model of Electrode, Arc, Weld Pool





Computer Simulate Your Test Coupons

- Computer simulate your test coupons.
- Gather data from computer vision, e.g., Visible Welder
- Use the data acquired from developing the weld procedure to do computer analysis of real welded structures

Optimal Experimental Design with R: D. Rasch, J. Pilz, R Verdooren, A. Gebhardt, 2011

Optimal research design implies that the objective of the investigation is determined in detail before the experiment or survey is carried out and that the precision requirements for the type of analysis planned for the data using the chosen statistical model are formulated and that all possible things which would have a negative influence on the research work or could bias or disturb the results are considered.

This all makes work, takes time, and is much more difficult than simply starting with the practical investigation and formulating the objective of the study after the data have been collected and then seeing the reliability the results have.

Analyze Welded Structures in the Early Stages of Design

- As soon as the geometry of the structure specified,
- Materials chosen
- Weld joints can be designed
- Residual stress analysis
- Do stress analysis with in-service loads.

Thank-you