FACULTY OF ENGINEERING AND ARCHITECTURE

SOETE LABORATORY – EMSME (EA08)

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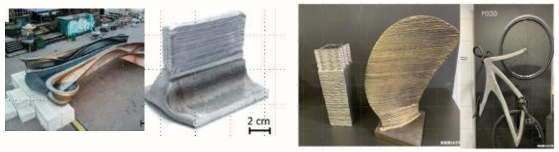
The FE Modelling and with ANN Tool to Predict Microstructure and Hardness for Low Carbon Steel WAAM Components

CONTEXT:

Various Components made by WAAM

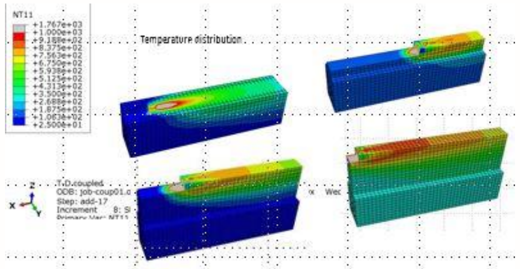
WAAM- one of 3D printing processes, Wire arc additive manufacturing.

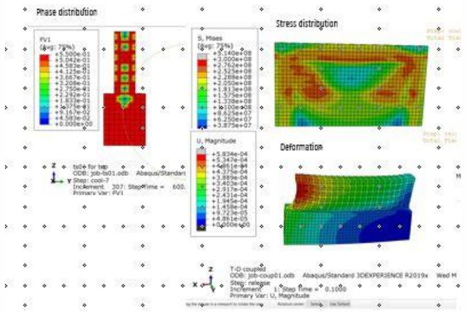
Define the printing strategy for quality of the components are underway.



RESULTS:

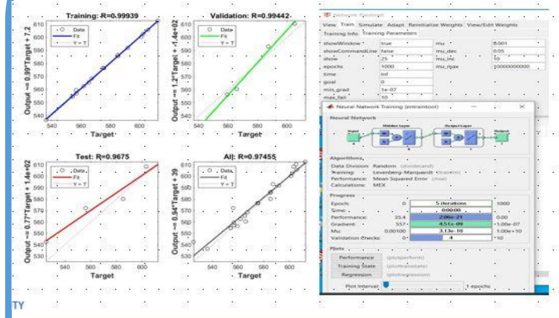
Thermo-Metallo-Stress Coupled Analysis (Virtual Experiments) with Abaqus CAE and User Subroutines to Collect Data For ANN





RESULTS:

Inverse Modelling Based ANN (Matlab Tool) and Tauguchi Method



25 x 4 Inputs 25 x 2 Targets

Current (A)	Voltage(V)	Cooling	Speed (cm)	UTS	HV VPN
150	14	50	50	535	160
150	15	75	60	558	171
150	16	100	70	587	184
150	17	125	80	608	198
150	18	150	90	635	205
160	14	75	70	585	183
160	15	100	80	594	189
160	16	125	90	651	215
160	17	150	50	635	209
160	18	50	60	554	170
170	14	100	90	578	180
170	15	125	50	590	191
170	16	150	60	605	195
170	17	50	70	585	185
170	18	75	80	587	184
180	14	125	60	594	189
180	15	150	70	610	195
180	16	50	80	587	183
180	17	75	90	588	184
180	18	100	50	585	182
190	14	150	80	535	165
190	15	50	90	545	169
190	16	75	50	565	171
190	17	100	60	590	191
190	18	125	70	605	195

optimal parameters obtained from ANN Tool

I	V	Fc	S (cm/min)	UTS (Mpa)	HV10
160	16	125	90	650	210
180	15	150	70	610	195

METHODS:

Implement multi-physical models

* Heat source input model:

$$\dot{Q}_w = \dot{Q}_b = \frac{\eta I V}{2}$$

$\dot{Q}_b$- power to base material

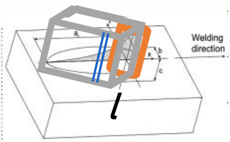
$\dot{Q}_w$- power to filler material

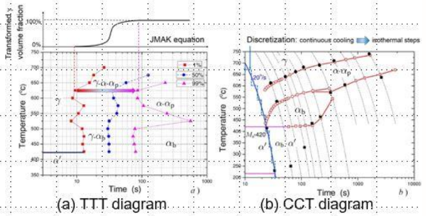
$$\dot{q}_b = \frac{6\sqrt{3}\dot{Q}_b f_{f,r}}{\pi\sqrt{\pi}a_{f,r}bc}\exp\left[-3\left(\frac{x^2}{a_{f,r}^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}\right)\right]$$

$$\dot{q}_w = \frac{\dot{Q}_w}{V_{el}} \qquad q_w = \frac{\dot{Q}_w}{V_{el}}\tau = \frac{\dot{Q}_w}{w_f h_f d_{el}}\frac{l}{v_f}$$

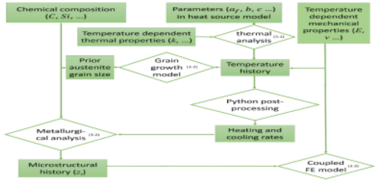
$\dot{q}_b$-Base material power density function

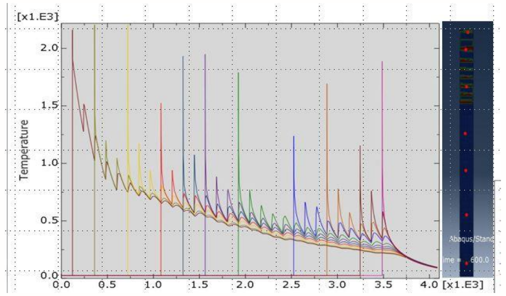
$\dot{q}_w$-Filler material power density function





** The Flowchart of Thermo-Metallo-Mechanical:





CONCLUSION:

- A numerical tool has been developed which can be used for virtual experiments of WAAM process.
- Conduct series of numerical simulations on the scaled model of WAAM plate to collect data for ANN training.
- Add JMAK model in AMBMAIN to obtain data (UTS and HV distribution) for low alloy steel.
- Design an inverse model for low carbon alloy steel with ANN Tool to realize "Properties –> fractions of phase volume-> WAAM processing parameters". → The simple WAAM strategy tool.

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