THERMAL ANALYSIS OF TIG-WAAM BASED METAL DEPOSITION PROCESS USING FEM

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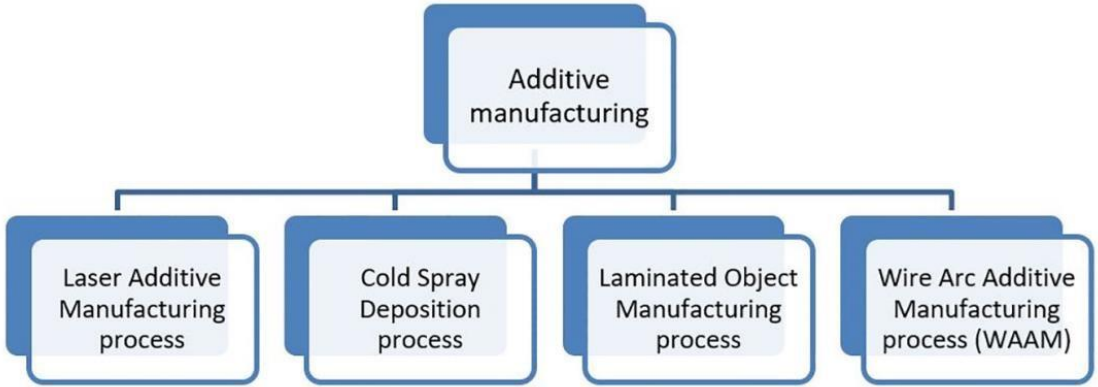
INTRODUCTION

Additive Manufacturing:

Additive manufacturing, also known as 3D printing, is a manufacturing process that builds objects layer by layer based on a digital model. It involves the sequential addition of material, usually in a powder, liquid, or filament form, to create three-dimensional objects. This is in contrast to traditional subtractive manufacturing methods, where material is removed from a solid block. Additive manufacturing allows for complex and customized designs, rapid prototyping, and the production of intricate structures with greater efficiency and precision.



WAAM

- Wire Arc Additive Manufacturing (WAAM) is a production process used to 3D print or repair metal parts. WAAM is similar to welding, as it includes layer by layer deposition for large parts with fewer complexities. WAAM is automated and controlled by a computer program and performed by a robot arm to build complex geometries. This manufacturing technology uses an electric arc to melt a metal wire, which is then deposited layer by layer to create a 3D object.
- Wire arc additive manufacturing (WAAM) has acquired more recognition on account of peerless efficiency and benefits that mainly comprises high deposition rates, increased material efficiency, lesser lead time, better component performance and reduced inventory costs.
- In future, WAAM adoption will accelerate, as it opens the possibilities to produce heavy metal parts, providing industries the alternative which is fast and cost-effective

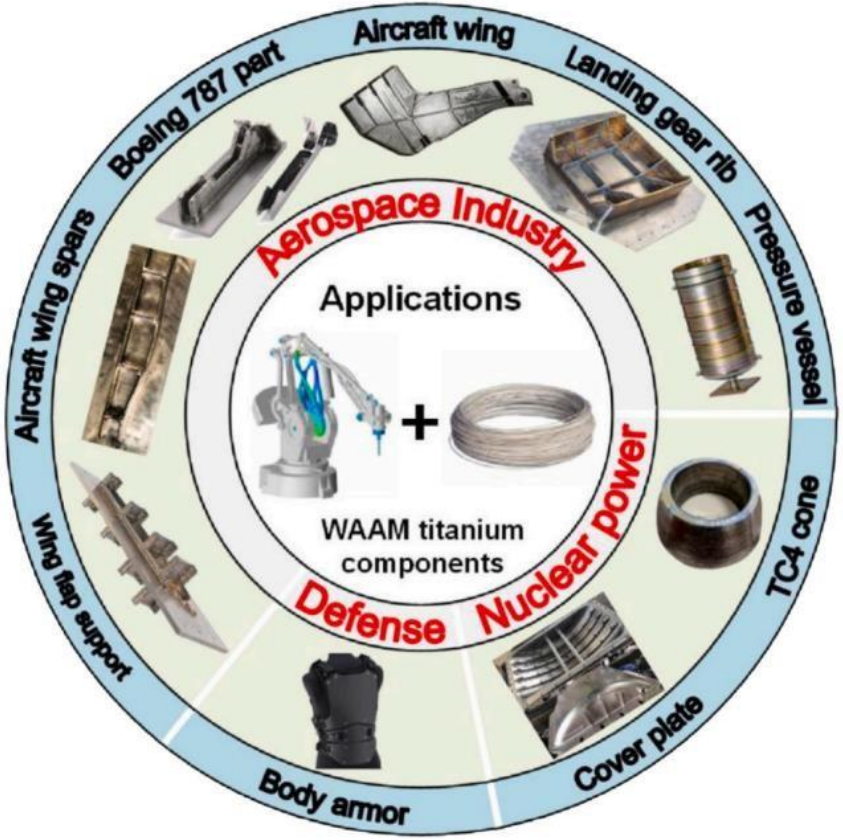
OBJECTIVE

- Development of a thermal model for single layer deposition using TIG-WAAM.
- To analyze Temperature variation with the time during deposition of the material.
- To investigate the Effect of temperature on the microstructures of the material .
- Exploring techniques to reduce the distortion of the component due to the concentrated temperatures.
- To do Thermal simulation and validation of the data on the single layer of TIG-WAAM using FEM(Finite element method)

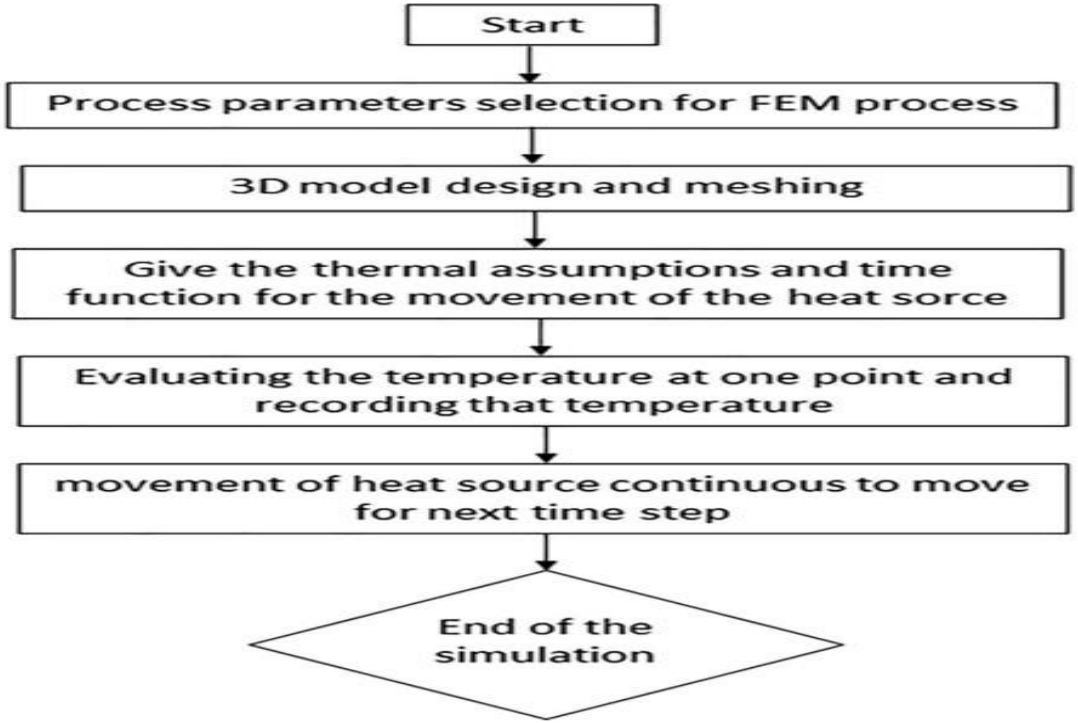
Experimental Setup

- 6-axis robot
- Wire feeder
- TIG welding
- CNC control system
- Power Supply
- Cooling system
- Fume extraction down draft table
- Monitoring and control system

Applications of WAAM

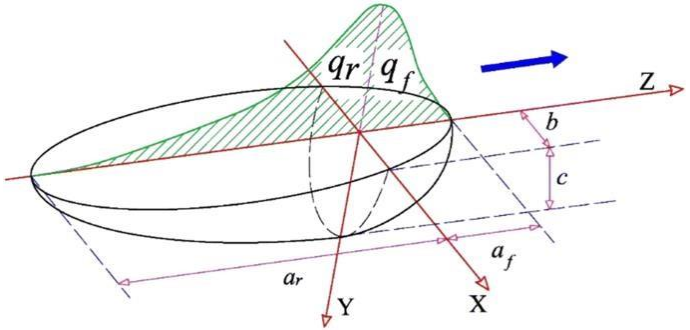


METHODOLOGY



Goldak heat source parameters	Values
Material	Stainless steel
Deposition rate	5 mm/s
Current	300 A
Voltage	40 V
a_f	1.96 mm
a_r	7.20 mm
b	2.77 mm
c	3.77 mm
Gaussian parameter H	3.0

Goldak heat source



a_f = Front length

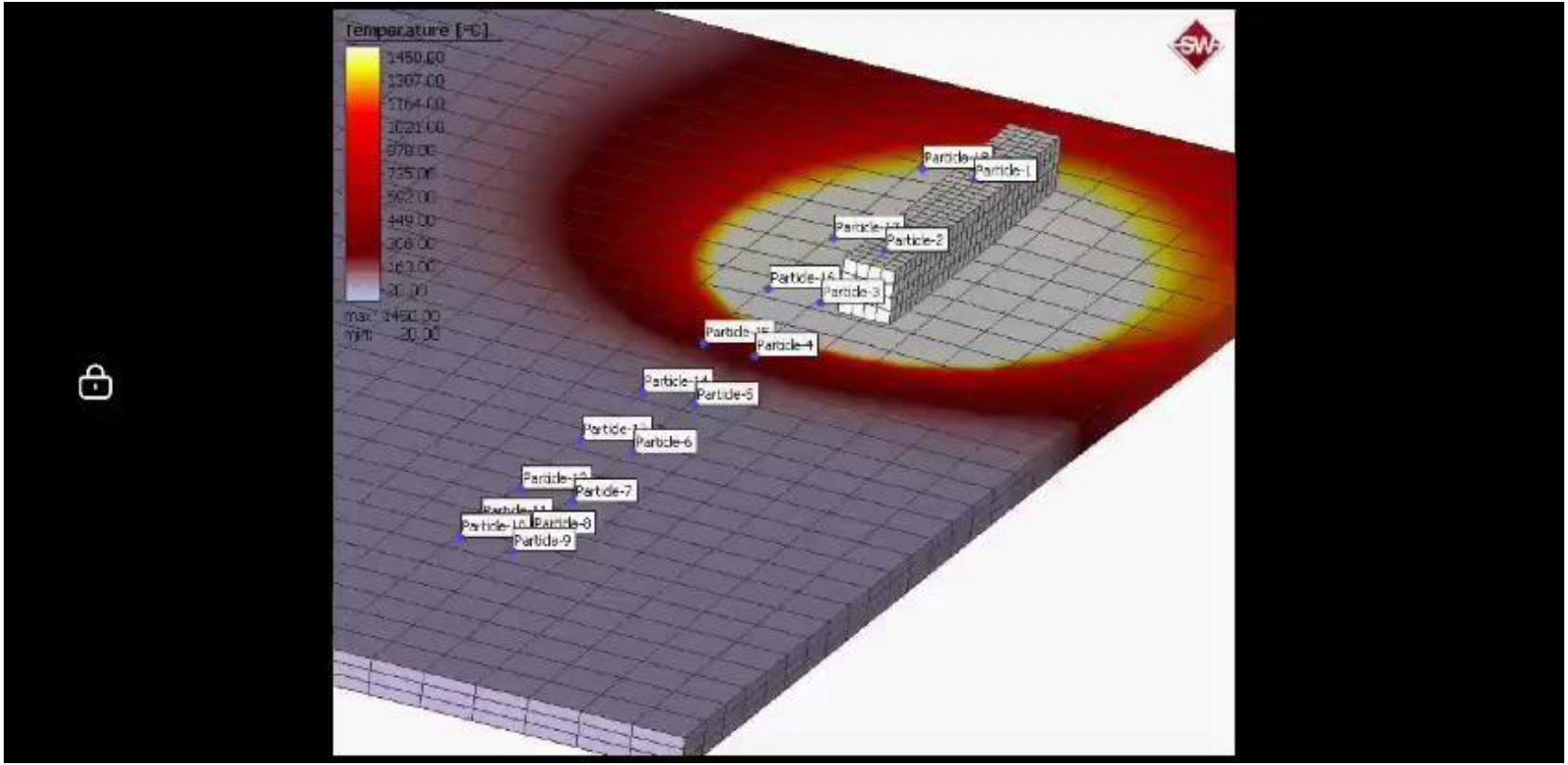
Weld bead details

a_r= Rear length

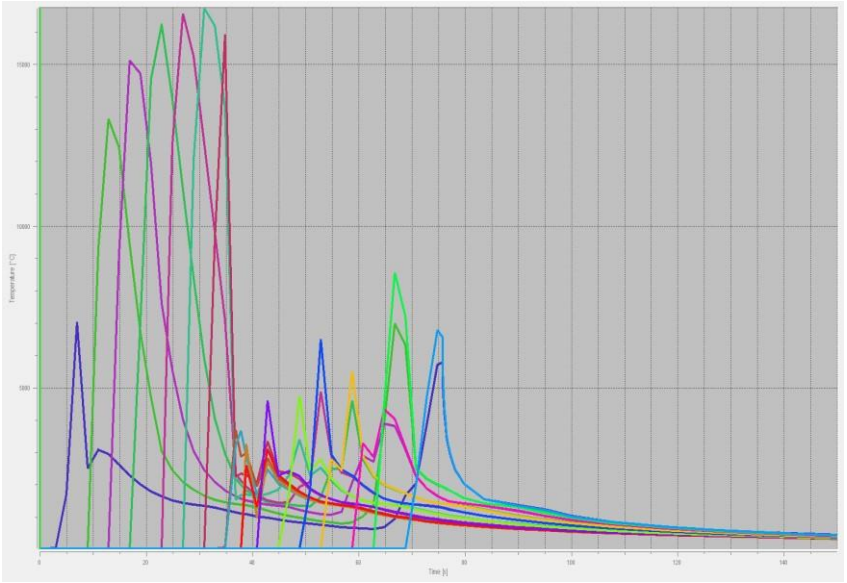
b = Width Shape : Quadrangle c = depth

Dimensions:4x4x4 (mm)

Simulation using Simufact software



Results



Weld bead temperature vs time

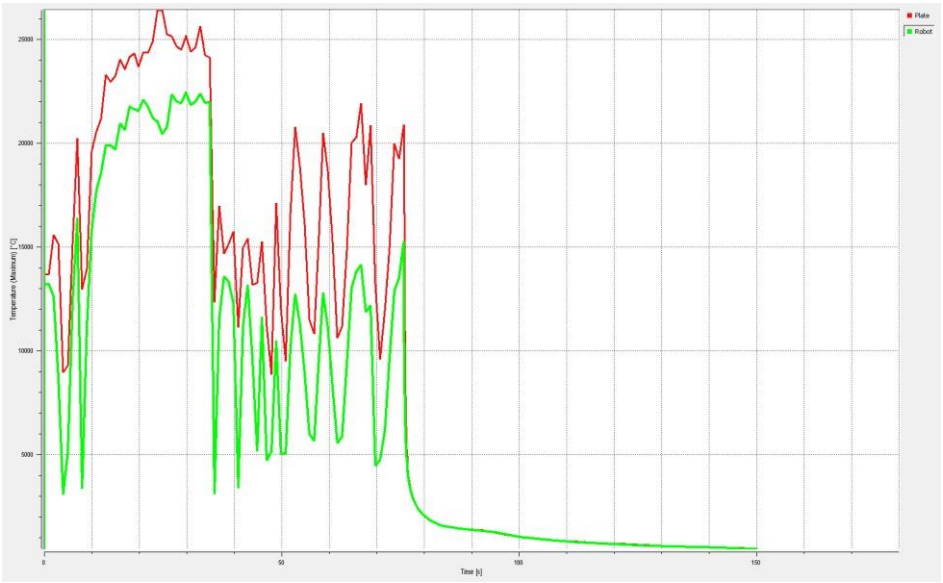


Plate and robot temperature vs time

CONCLUSION

- The concentration of temperature and heat was observed at different points on the weld. The highest temperature was recorded at the turning points in the deposition path whereas at all intermediate points the temperature levels remain within the range of melting point of the material.
- The drastic increase in temperature may cause a change in the shape of a molten pool. The change in the shape of a molten pool may lead to the deterioration of the geometric shape of the deposited layer.
- Hence, the developed model will be useful for the development of a feedback control system for temperature management of WAAM process in future.

FUTURE WORKS

- Carrying out the experiment practically and comparing the results with our simulation (FEM model).
- Effects of the different deposition rates, power supplies on the mechanical properties of the component and finding the optimum conditions.
- Exploring techniques like preheating or adding cooling systems to reduce the distortion of the component due to the concentrated temperatures.
- Analysis of stress on the weld bead.

REFERENCES

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- Wire Arc Additive Manufacturing (WAAM) Explained (makerverse.ai)
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