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Thermal simulation of WAAM process to support production

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Wire Arc Additive Manufacturing (WAAM) is an additive manufacturing (AM) production process used to 3D print large metallic parts. This new process combines Gas Metal Arc Welding (GMAW) equipment with a robotic arm integrated with a welding power source. The part is printed with WAAM layer after layer each composed of successive weld beads. Benefits of WAAM compared to more standard processes includes the versatility of the process to design product families, reduction of lead-time to deliver final parts, reduction of weight, costs and carbon footprint of the manufactured products.
Nevertheless, production with WAAM requires to define accurately all process and production parameters to deliver product of high quality. Hence, simulation of WAAM process can play an important role to shorten and ease the process of qualification. Moreover, simulation can also be an important tool to support production of parts made with WAAM.

Many numerical models have been presented in the literature in order to describe Additive Manufacturing at the scale of the molten pool, to understand how defects can be generated, how process parameters impact material properties···Yet, only a few numerical models allow to describe the process at the scale of the whole part. The proposed work consists in developing a simplified thermal model of the WAAM process, able to evaluate inter-layer cooling time and the thermal history at any point of the manufactured component. The simulation has been implemented using the finite element software Code_Aster. It has been calibrated and validated thanks to experimental data.
The numerical tool developed helps the industrialization of WAAM at 3 different levels:
• Extrapolation of process parameters to new dimensions of a product family
• Determination of cooling time and production of a part in a given material
• Optimization of the batch sizes to maximize the productivity of the robot.

Primary author: FERNANDES, Mériane

Presenter: FERNANDES, Mériane

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