Manufacturing of a demonstrator using WAAM technology on the Addilan V0.1 machine

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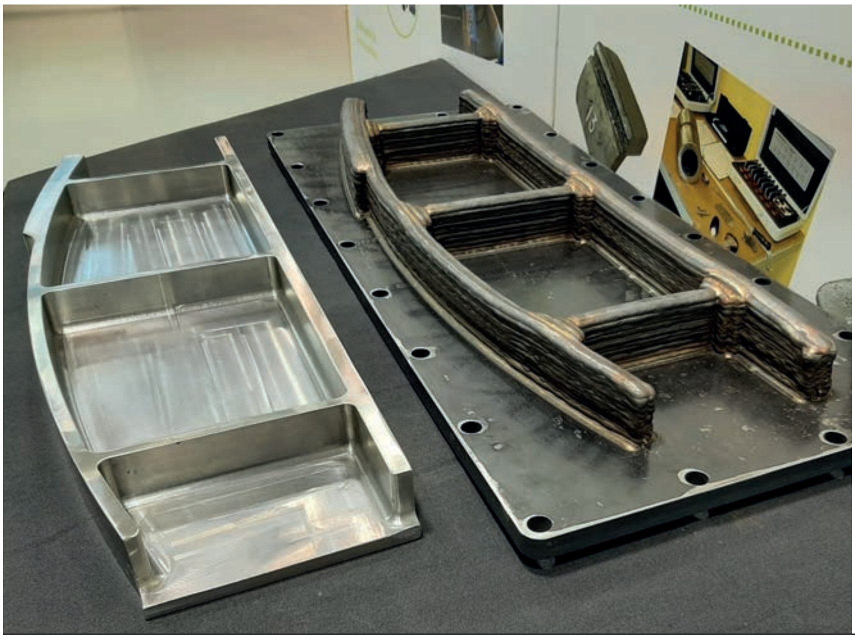

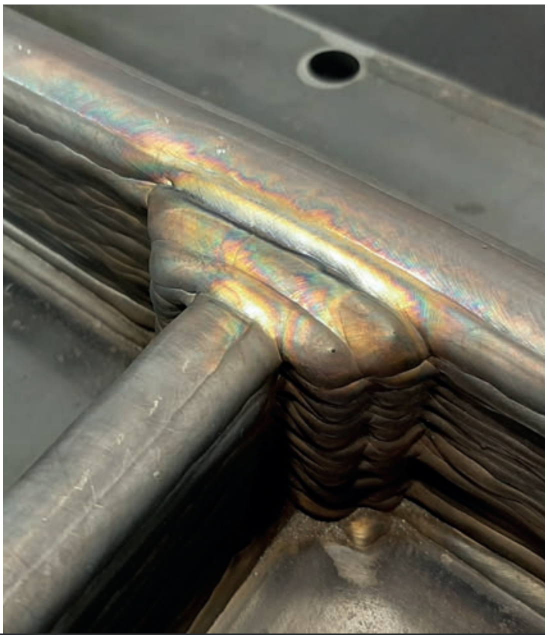

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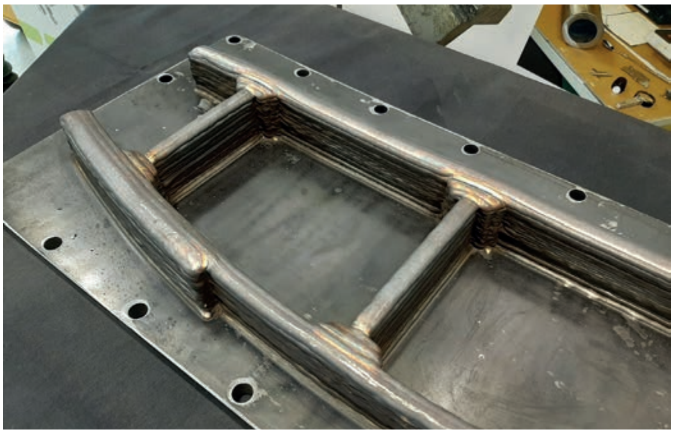
Sector: Aeronautics
Challenge: Manufacture of a medium-sized demonstrator using WAAM, identifying the key aspects to be taken into account in the manufacture of this type of parts.

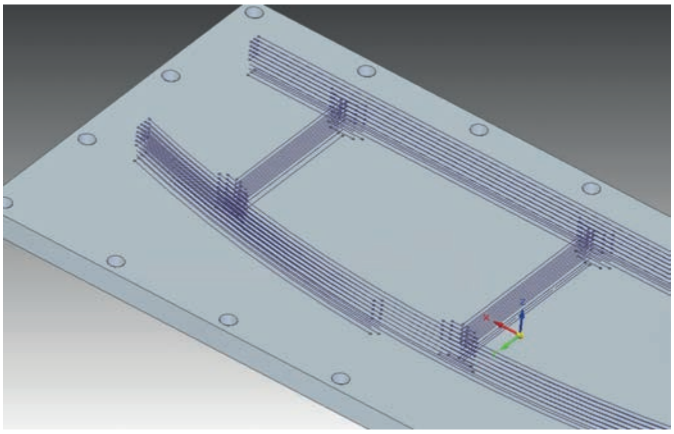
Solution: The solution has consisted of manufacturing a three-piece series based on previous experience and following the phases of design, manufacture and improvement.

CHALLENGE

One of the project lines of TKNIKA's area of specialisation in Additive Metal Manufacturing is related to the WAAM ("Wire and Arc Additive Manufacturing") technology, and one of the main objectives is the generation of knowledge through practice and experimentation. The development of the following piece is circumscribed within this field and this objective.

A medium-sized part has been selected, with a simple geometry, which would normally be manufactured from a metal block or a forged preform. In this case, an arc-wire manufacturing process can be a very interesting alternative. The main objective of this practice is to produce a quality preform, identifying the key aspects that allow it to be manufactured, in a controlled manner, on the Addilan WAAM V0.1 manufacturing machine.





SOLUTION

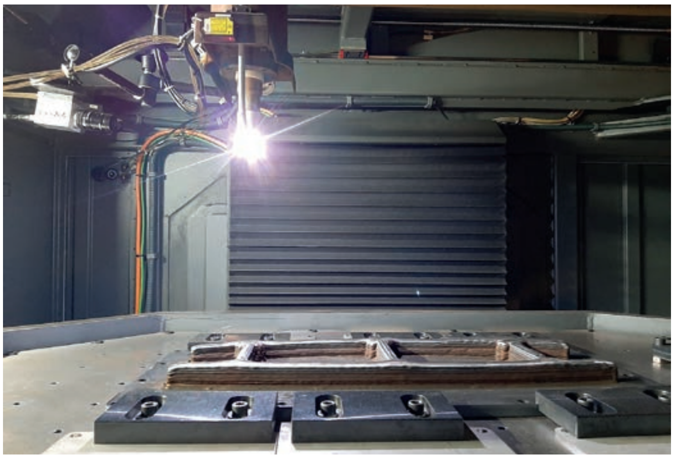
The solution is structured in three phases: design, manufacturing and analysis of results, adjustments and improvements.

In the process design phase, the following are considered:

- Selection of the feed rate and main parameters. From this information we will obtain the weld bead geometry, which will be used as a reference to define the overlapping values between beads and the step value between layers. The feed rate will be 4 m/min, which is equivalent to a total feed rate of 2.18 kg/hour.
- Programming of the paths. Taking the initial trials as a reference, the paths are defined which, in the case of plasma additive processes, are mainly based on longitudinal beads that overlap, depending on the widths of both the long sections and the knots that make up the part. When programming these paths, it is necessary to take into account the necessary excess thickness to be able to finish the part with machining processes.

In the manufacturing phase, it is essential to consider how the conditions of the part change as it is being formed: on the one hand, the part is acquiring heat and, on the other, the geometry of the part is changing. This makes heat conduction more and more difficult. It is essential to control heat input during the manufacturing process, in the case of this part, it has changed from 12kJ/cm in the first layers to 8,61 kJ/cm in the last part of manufacturing.

In the different tests carried out, the main aspects to be improved have been related to adjustments in the overlapping values between beads, with the programming of the start and the end of the bead, and with aspects related to the protection of the molten pool.



ADVANTAGES

The benefits of manufacturing a part of this type using WAAM are those inherent to FA processes, especially the use of both the raw material and the overall energy used in the entire process.

The 620 x 200 part weighs 12.35 kg and its 30 layers are 50 mm high. The cycle time is 25 minutes per layer, of which 17 are feeding time. The effective rate is 68%, i.e for a total of 1.48 kg/hour.

The material used is AISI 316L stainless steel wire, because the main objective of this production was to learn how to do it, identifying the key aspects of the process. This type of parts, especially those aimed at the aeronautical sector, depending on their use, can be manufactured with aluminium or titanium alloys. The technology developed by Addilan is especially suited to this type of application and provides both process control and monitoring solutions in real time, as well as optimum protection conditions in an inert chamber.

The next challenge is to fabricate one of these medium or large format parts in one of these materials, applying the methodology and results obtained in the current practice, and adapting them to the new conditions and requirements of these materials.

Another aspect to be worked on is related to the quality of the pieces obtained, both in terms of their metallurgical characteristics and their mechanical properties.