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EVALUATION OF ADDITIVE MANUFACTURING PARTS MACHINABILITY USING AUTOMATED GMAW ER70S-6 WITH NODULAR CAST IRON

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INTRODUCTION

Through additive manufacturing is possible to obtain products with few material waste, low production time and great flexibility in geometry. In recent years, the application of arc welding processes has been studied as additive manufacturing techniques for metals. When compared to laser welding processes, they have low equipment cost, high deposition rate, however a low surface quality.

With the welding process it was possible to obtain prismatic geometries, defects free with low lateral waviness deposited on nodular cast. This paper proposes to study the machinability of additive manufacturing parts using automated GMAW.

EXPERIMENTAL PROCEDURE

The deposition was carried out using a robotic arm and ER70S-6' wire with a substrate of Nodular Cast Iron. Two deposition strategies were carried out, one alternating the passes directions and the other one depositing in the same direction, Figure 1. The welding parameters were defined in pre-tests, Table 1 and Table 2.

Welding Parameters Envelop	
Welding current [A]	170
Welding voltage [V]	20
DBCP [mm]	16
Feed speed [(m/min]	3,5
Welding speed [cm/min]	40
Shielding gas	Ar-25%CO2
Shieldgin gas flow [l/min]	15
Interpass Temperature [ºC]	80 - 100

Table 1 – Welding parameters

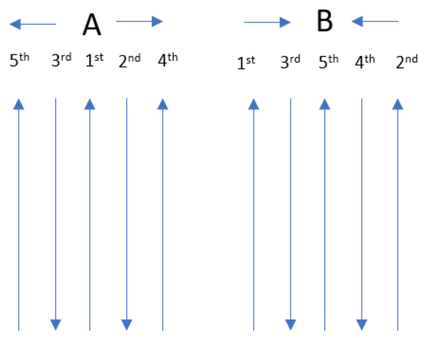


Figure 1 – Deposition strategies for on prismatic geometry

Layer	Overlap (%)	Offset from centerline (mm)
ER 70S-6 / Buttering layer	37,5	5
ER 70S-6	36	4,5

Table 2 – Welding parameters

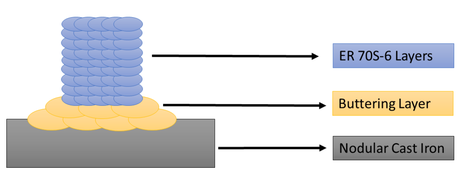
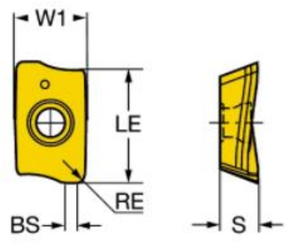


Figure 2 – Deposition structure

The machining parameters were defined in pre-tests, Figure 1. The machining process used was milling in ROMI DCM 620-5x and the insert was Sandvick R390-11 T3 10M-KH 3040, Figure 3.



W1 = 6.8 mm
LE = 10 mm
S = 3.59 mm
BS = 1.02 mm
RE = 1 mm

f_z=0.12 mm
Vc^1= 175 m/min
Vc^2= 200 m/min
Vc^3= 250 m/min

Figure 3 – The sample form of cutting tool

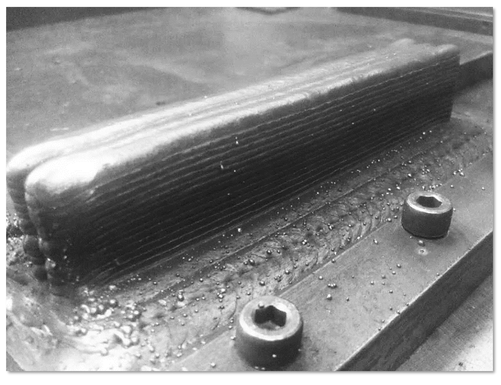


Figure 4 – Specimen

The machined surface was analyzed with the Cyber CT 100.

RESULTS AND DISCUSSION

With strategy B, the profile of the final structure showed an elevation in the central part when compared to A, Figure 5 a-b.

Pores were found in the internal structure of the deposited wall, Figure 5-c.

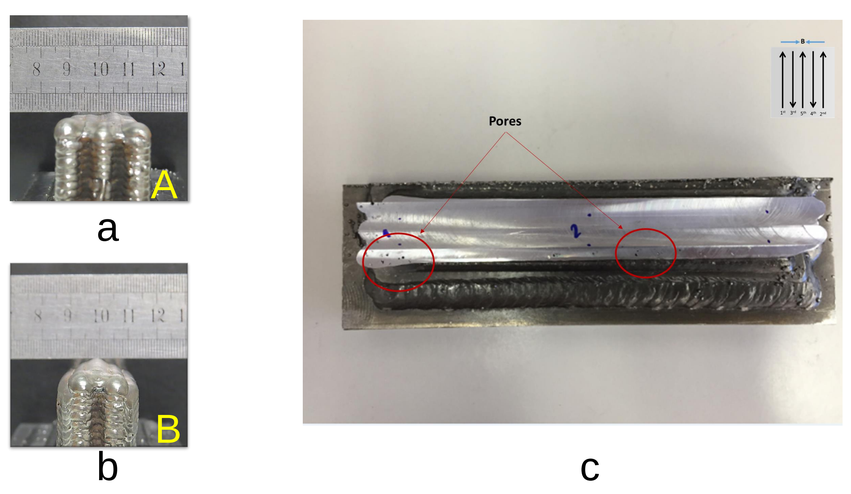


Figure 5 - a) profile obtained with strategy A; b) profile obtained with strategy B; c) internal structure of the deposited wall.

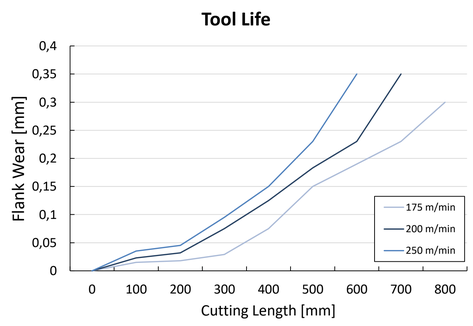


Figure 6 Flank wear for the three cutting speeds analyzed

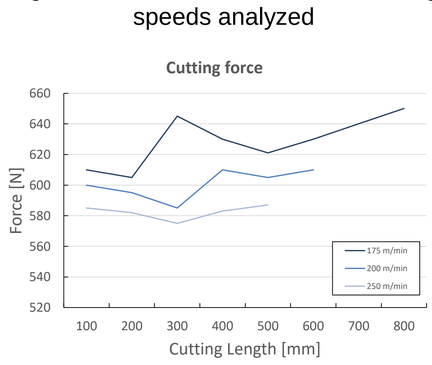
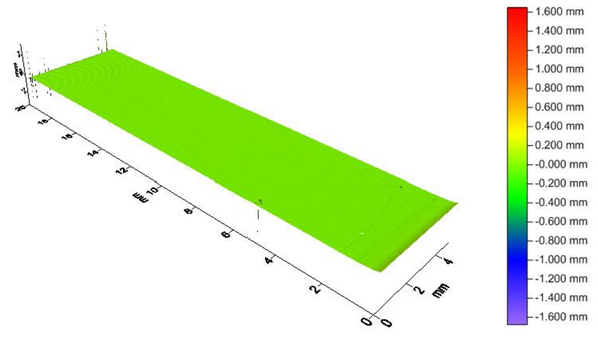


Figure 7 - Cutting force for the three cutting speeds analyzed



Name	All cursors (mm)	P1 (mm)	P2 (mm)
Ra - Average Roughness	0.00058	0.000701653	0.000463691

Figure 7 - Surface finish with strategy A

CONCLUSION

Deposition

- Welding parameter envelop was established. The robustness of this envelope was proved by the deposition of ten prismatic geometries pieces and no visual defects were found;
- The most important parameter to deposit a prismatic geometry is the lateral overlap.

Machining

- Greater number of pores in the deposited wall were found with strategy B deposition;
- The cutting force decreased with increasing cutting speed;
- The speed of flank wear increased with increasing speed.
- Both deposition strategies showed a good surface finish, but strategy A showed a higher quality.

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