Finite Element Simulation of Hardness Profile on Additive Manufactured SS347

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Abstract- *Metal additive manufactured using involves manufacturing technique that add material to produce metallic components, typically layer by layer. Metal additive manufacturing (AM),also known as 3D printing, is a disruptive manufacturing technology in which complex engineering parts are produced in a layer-by- layer manner, using a high-energy heating source and powder, wire or sheet as feeding material. Many of the early applications of AM technologies have been in the aerospace, automotive, and healthcare industries. building on the advances in AM in these industries, there are several experimental applications of AM in the construction sector. In this project i shows the hardness of the additive manufacturing.*

In that, Finite element analysis is a computational technique to predict how different materials will react when range of forces are applied. It is very important to understand the microstructure of single track. The process of this project to find out the hardness in the vicker`s hardness.

Keywords- Wire arc additive manufacturing, finite element, microhardness.

I. INTRODUCTION

Wire and arc additive manufacturing (WAAM) has proven that it can produce medium to large components because of its high-rate deposition and potentially unlimited build size. Like all additive manufacturing (AM) technologies, however, an optimized process planning that provides uniform, defect-free deposition is key for the production of parts. Moreover, AM, particularly WAAM, is no longer just a prototyping technology, and most of today's attention is on its transformation to a viable and cost-effective production. With this transformation, a number of issues need to be addressed, including the accuracy and effectiveness of the manufactured components. Therefore, the emphasis should be on dimensional precision and surface finish in WAAM.The potential range of WAAM systems is vast, but most fall into one of two types: robotic or machine tool-based.

The emerging range of low-heat-input MIG/MAG systems are proving particularly suitable for WAAM.one of the systems used for WAAM ; this is an industry standard robotic welding setup which is also used for AM projects. The adaptions for AM on this system include modification of the turntable for endless rotation, modified control software, increased thermal management and robust wear parts in the power source to cope with long arc-on durations.

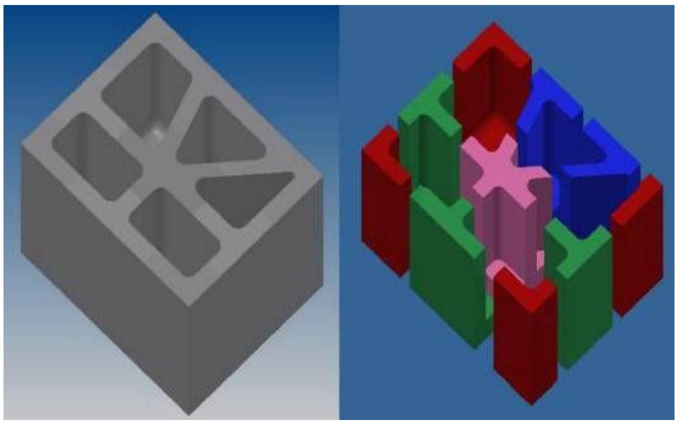
II. ADDTIVE MANUFACTURING

Machine tool-based systems into which the deposition equipment has been integrated have additional potential to allow the combination of AM and subtractive/cutting (SM) processes in a layer-by- layer manner, allowing features to be created and finish machined that would not otherwise be possible. There are laser/powder-based hybrid AM/SM machines available; development of hybrid WAAM/SM systems is underway and it is only a matter of time before a system is brought to market.

WAAM-BASED PROCESS VARIABLES AND CONTROL

Although described above as 'outwardly simple', WAAM is not a simple process to use. the main controllable variables are the same as robotic welding, AM is a different process. process variables combine to produce deposit bead geometry, and it is manipulation of this bead that results in the desired component shape. Unfortunately and unlike welding, bead geometry is affected by more than just the deposition parameters; the residual heat as the part is built results in a continuously changing thermal field that must be accounted for if a deposited layer is to be accurate and free from defects.

As parts become more complex, the programmed path of each layer becomes significantly more so. It is rarely possible to strike an electric arc at the beginning of a layer and extinguish it at the end. Most layers consist of several 'sub-shapes' which are programmed and deposited separately but joined together. Figure 2 shows an example of a relatively simple part, which is made up from ten sub-shapes in four different configurations (i.e. L, T, angled T and five-legged X).



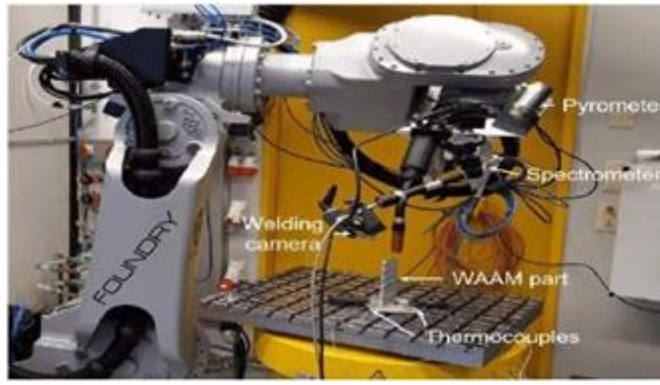
Relatively simple AM part made from ten separate sub-shapes

Although offline programming software for Whilst WAAM is becoming available, the success of the process can be reliant upon the skill of the operator. Although the degree of software capability is developing rapidly, until the ability to break a component down into sub-shapes, decide the order in which they are to be built, consider thermal field, residual stress and distortion, assign appropriate deposition parameters and compile a part programme is completely automated, A highly skilled programmer / operator is required. Despite the difficulties, examples of some very complex parts have been presented in the public domain.

III. ROBOTIC ARC WELDING

The technology of robotic wire arc additive manufacturing (WAAM) is essentially a welded robot programmed such that it deposits metal material layer- by-layer repeatedly to create specific metal applications. Robotic waam builds parts layer by layer by melting and dispositioning net-shape precisely.Open articuled robot systems are the most flexible and can be modified to fit each application specific needs. Enclosed cartesian systems offer the highest positional accuracy and process control. Tool attactments can transform existing equipment into a hybrid ,additive and subtraction system.

Robowaam our wire arc additive manufacturing machine, was first commissioned in 2020.this method of 3D printing has actually been employed in heavy industry and aerospace for years.in the 1970`s,its was called shape welding, but it`s come a long way since then.



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ROBOTIC ARC WELDING

IV. WIRE CUTTING

A WIRE CUTTING is based off the same principal as a traditional EDM. It uses an electrode, which is electrically charged ,so that when it comes close to a conductive material, the electricity wants to jump across to it. This causes a spark, which lands on the conductive material and erodes it. Wire cutting speed is 3 AMPS current and it takes 55 volt. It has the drum speed of 100 rpm. It pulse ON at 10,it pulse off at 12. Additive manufacturing (AM) in industrial applications benefits from increasing interest due to its automation potential and its flexibility in manufacturing complex structures. The construction and architecture sector sees the potential of AM especially in the free form design of steel components, such as force flow optimized nodes or bionic-inspired spaceframes. Robot-guided wire and arc additive manufacturing (WAAM) is capable of combining a high degree of automation and geometric freedom with high process efficiency. build-up strategy (layer by layer) and the corresponding heat input influence the mechanical properties of the WAAM products. This study investigates the WAAM process by welding a bar regarding the build-up geometry, surface topography, and material properties. For tensile testing, an advanced testing procedure is applied to determine the strain fields and mechanical properties of the bars on the component and material scale.

WIRE CUTTING EDM

V. MOUNTING

In the mounting machine I place the work piece into the machine and I add 5gms of black phenolic powder and then I closed the lid tightly. Set the recycling process it takes 10 mints of hot process and 10 mints of cooled process by adding pressure upto 1000-1500. The purpose of mounting is to protect fragile or coated materials during preparation and to obtain perfect edge retention. Mounting is used when the protection of layers is imperative, and also it enables a safer and more convenient handling of small, sharp, or irregularly The shaped specimens

MOUNTING MACHINE

VI. POLISHING

The polishing machines also called buffing machine are machines that work with brushes and are designed to perform operations of brushing, buffing, polishing and for the finishing of any metal material. The polishing machine is then used to gently rub the surface of the paint, applying light pressure and moving in a circular or back-and-forth motion. The machine polisher spins the pad at a high speed, creating friction with the paint surface that effectively removes imperfections from the surface of the paint. Polishing is the process of creating a smooth and shiny surface by rubbing it or by applying a chemical treatment, leaving a clean surface with a significant specular reflection (still limited by the index of refraction of the material according to the Fresnel equations). There are ten emirates sheets:

- 80p
- 120p
- 320p
- 400p
- 600p
- 800p
- 1000p
- 1200p
- 1500p
- 2000p

Disc finishers, buffers, and centerless finishers are common types of polishers and buffing machines. Disc finishing polishing machines and buffing machines are abrasive grinders or grinding wheel face-grinders. Buffers and buffing machines are used to improve a surface's brightness or finish.

POLISHING

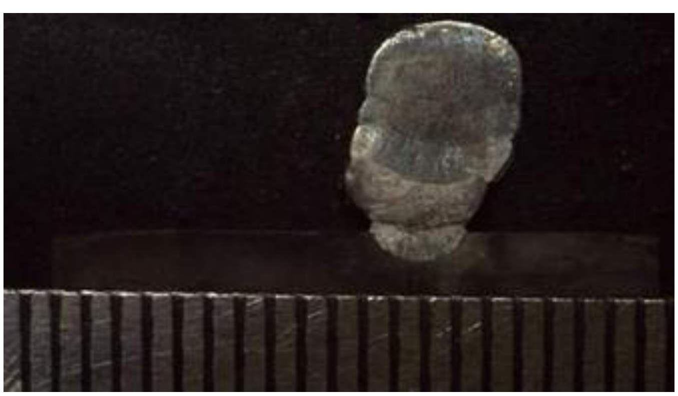
VII. ETCHING

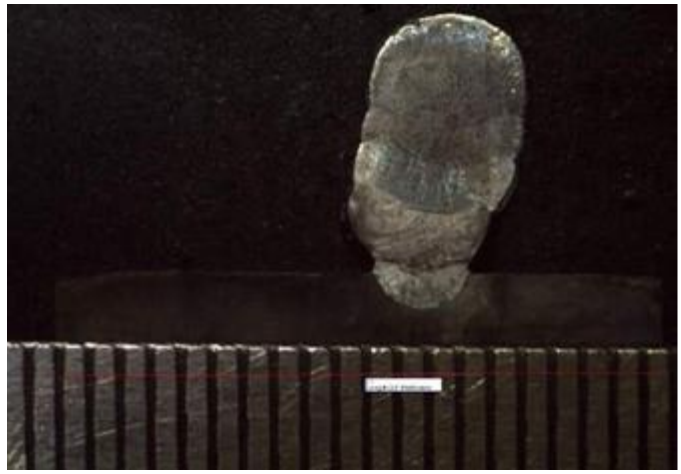
Etchers and etching machines remove material from the surface of a part using an acid alkaline chemical solution. Etchers and etching machines, also known as chemical milling machines, use masking substances to protect some surface areas of the part, providing selective material removal or patterning.In the beaker I add 95ml of distilled water and add 5 gms of oxlic acid (powder format).giving a electrode light touching of 1AMPS and 12 VOLT. Red wire consist as an positive and the black wire consist of an negative.

ETCHING

VIII. MACRO VIEW

A stereo microscope is a type of optical microscope that allows the user to see a three-dimensional view of a specimen. Otherwise known as a dissecting microscope or stereo zoom microscope, the stereo microscope differs from the compound light microscope by having separate objective lenses and eyepieces. This results in two separate optical paths for each eye. Three- dimensional visuals are produced by the different angling views for the left and right eye.



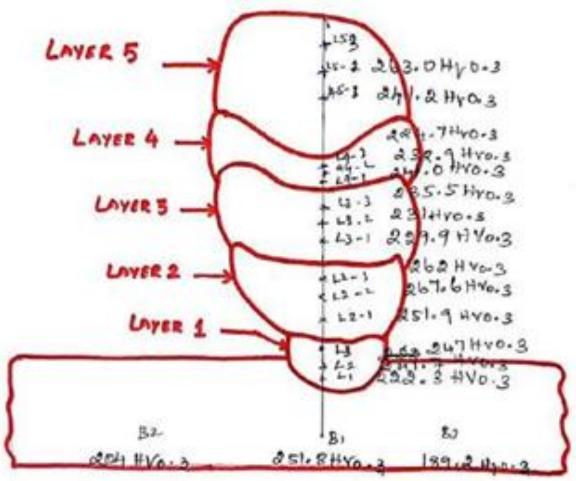


IX. HARDNESS

I done my hardness test in the vicker`s hardness Vickers hardness is a measure of the hardness of a material, calculated from the size of an impression produced under load by a pyramid-shaped diamond indenter. It is reliable for measuring the hardness of metals, and is also used on ceramic materials. In this test the force used is much lighter than the force used in the Rockwell hardness test.

THE VICKERS HARDNESS CALCULATION

The Vickers Hardness (HV) is calculated by optically measuring the diagonal lengths of the impression left by the indenter. The measurements are converted to HV using a table or formula.



READING :- LOAD : 300g
DURATION TIME:-10 SEC

LAYER 1
1)222.3 HV0.3
2)241.7 HV0.3
3)247 HV0.3

LAYER 2
1)251.9 HV0.3
2)267.6HV0.3
3)262 HV 0.3

LAYER 3
1)229.9 HV0.3
2)231 HV0.3
3)235 HV0.3

LAYER 4
1)241 HV0.3
2)232.9 HV0.3
3)224.7 HV0.3

LAYER5 1)241.2 HV0.3
2)263 HV0.3
3)268.7 HV0.3

BASE
B1)251.8 HV0.3
B2)204 HV0.3
B3)189.2 HV0.3

X. CONCLUSION

- Stainless steel 347 is a choose material
- Wire and arc additive manufacturing of component
- Testing the performance of a material characterization

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