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A New Approach to the Fabrication of Thin-Walled Plate Component through Typical Wire Arc Additive Manufacturing

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Abstract

Wire Arc Additive Manufacturing (WAAM) is a trendy practice evolving nowadays for the development of metal parts employing a suitable welding process with the help of automation and additive manufacturing concept. In this work, a new way of fabrication for the metallic components based the geometry a shape of final component is introduced as a typical wire arc additive manufacturing. A thin-walled plate is attempted with AISI 316L grade of austenitic stainless steel using flux cored arc welding process with linear manipulator automation to control the welding torch. The fabricated thin-walled component is found be a successful component but still a lot of quality analysis to be done for making the plate to meet the ensured quality. This Typical WAAM is believed to be a successful approach for the fabrication of metallic plate like components with cost and quality effectiveness.

Keywords: *Welding, stainless steel, thin-walled component, plate components, WAAM, additive manufacturing.*

1. INTRODUCTION

Wire Arc Additive Manufacturing (WAAM) is one of the popularly adopted additive manufacturing method for the preparation of metal parts [1]. Many more factors to be verified to the peoples both in academia as well as industry especially the quality of the component being made-up [2]. Many of the research organizations have now started working for the development of WAAM process. Cranfield University, University of Nottingham, UK and University of Wollongong, Australia and various institutes in India including Indian Institute of Technology Kanpur, Indian Institute of Technology Madras, National Institute of Technology Trichy, Coimbatore Institute of Engineering and Technology, Coimbatore etc. have been certain known leading institutes operational under this WAAM process [3].

In fact, Additive Manufacturing (AM) is of transformational technological advancement from other fabrication methods and this is being a novel application and the ever-broader contribution of the available technology to the productivity and economic benefits. It is often found composed with robotics, digitalization and the Industry 4.0. Industry 4.0 is well known as fourth industrial revolution and treated as vision of the factory of the future [4]. This is the power of the 3D printed future through AM but is not a new. Additive manufacturing actually first emerged in 1987 itself. Comparing the most common powder AM processes, WAAM works are strongly believed to be good in terms of quality as well as cost benefits [5,6].

Usually in arc-welding based WAAM, the metal product is fabricated by depositing weld beads as layers over other layers up to the necessary dimension whereas another typical technique of manufacture might be followed when particularly the height of the metal component being fabricated will be within the weld thickness of a single weld bead height [7,8]. This kind of a new approach is introduced here to fabricate a thin-walled metal plate component.

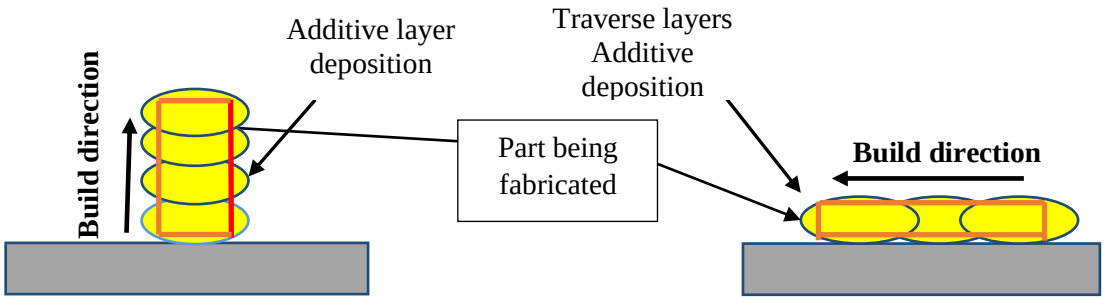
This paper deals with a typical WAAM for the fabrication of thin-walled plate components. Austenitic stainless steel of grade 316L is employed for fabricating thin plate component using welding as a trial to real time fabrication. A typical GMAW welding process is used in this study for the fabrication of thin plate sample. Usually in WAAM the weld beads are deposited layer over the layer but the deposition of weld bead with overlapping is exercised in the present study especially for producing thin-walled component samples with laying beads in traverse direction. Actually, this method would ensure the repeatable ability of the WAAM process with essential qualities. The fabricated sample was then employed.

2. MATERIALS AND METHODS

The material used in the present study and the details of thin plate fabrication using GMAW welding are furnished in this section as discussed in the further sections.

2.1. Materials used

Low carbon high tensile structural steel (ASTM A 105 / IS: 2062) was used as the base material for welding. Austenitic stainless steel (AISI 316L grade) was nominated as filler material in the present study to fabricate thin-walled plate samples on structural steel plates. In the market different sizes of filler wires available, in this study 1.2 mm dia wire was used.



(a) Additive Layers (b) Typical Additive Layers

Figure 1. Understanding Typical WAAM process

2.2. GMAW based thin-walled component fabrication

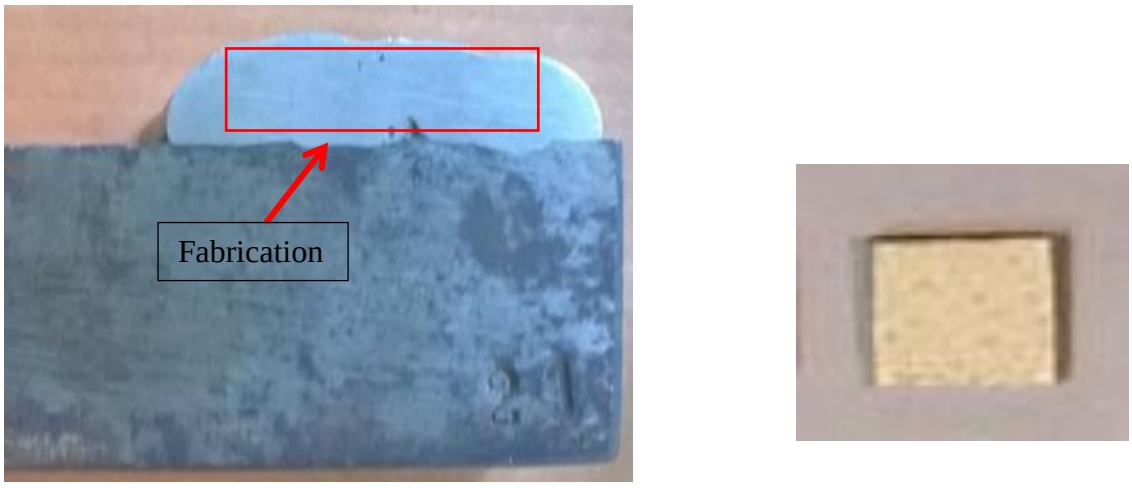
The work for fabricating a thin-walled plate sample was performed using Adore make GMAW machine available at Welding Research Laboratory, Coimbatore Institute of Engineering Technology, Coimbatore, India. The experimental setup contains a welding manipulator for the linear movements that could control the welding layers as well [9]. The fabrication setup of gas metal arc welding with 400 amps capacity used for the present work is shown in Figure 2.

Figure 2. GMAW welding setup

The thin-walled plate components shall be fabricated with single weld bead deposition itself however many depositions are required to get the required length and breadth of thin plates. Thus, this type of typical WAAM is charted in this work to establish and prove a standard method for the fabrication of thin-walled metal components. The prepared structural steel low carbon base plate was prepared using grinding and cleaning processes to achieve good quality joint.

3. RESULTS AND DISCUSSION

There were only three numbers of weld beads were deposited as additive layer depositions in traverse direction since the size of the fabricating plate is designed so for making thin-walled plate component. The produced weld has 40 % effective bead overlap [17]. The fabricated sample was permitted to cool logically among every pass to diminish heat affected zone (HAZ) and the inter-pass temperature is maintained within the appropriate level to avoid warping [10]. The thin-walled plate sample fabricated details are given in Figure 3 (a). Then, the fabrication was taking into the milling machine to shape the component. Finally, a plate of 35x35x8 mm 316L stainless steel plate was successfully fabricated based the typical WAAM concept. The dimensions of the fabricated plate sample was measured for the verification using Vernier calliper and the sample produced from this new approach of WAAM is presented in Figure 3 (b) [7,11].



(a) Plate structure fabricated (b) Final plate component

Figure 3. Stainless Steel Plate Component fabricated

This plate sample is found to be well enough for meeting the requirements. The austenitic stainless steel thin-walled component fabricated during this work is shown in Figure 3 (a) and (b). The same sample is involved for the visual examinations. During the visual examination, it is observed that the component is good enough in meeting the plates requirement, only small amount of machining is required to shape the component, corrosion free plate surfaces, welding defect free surfaces in the entire plate component with highest smoothness. Hope this kind of typical WAAM having the enough potential to fabricate such kind of metallic components in future.

4. CONCLUSION

The following key conclusions have been observed from the study carried out for thin walled 316L plate component.

- The Typical WAAM process has been successfully adopted for the fabrication of thin-walled plate
- Component fabricated is satisfactorily enough comparing to the conventionally manufactured plates
- Plate component manufactured is not included any visible weld defects
- The machining undertaken with conventional milling machine to shape the plate is found to be a well suited one
- Typical WAAM could be extended for the real time fabrication of thin walled plate structures without compromising the superiority.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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