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Inside the Issue

Recent Publication

Book Chapters;
1. Chapter 1
2. Chapter 2
3. Chapter 3
4. Chapter 8
5. Chapter 9
6. Chapter 11
7. Chapter 13
8. Chapter 15

All are in A.B. Abdullah and S.M. Sapuan (Eds.): *Hole-Making Technologies for Composites: Advantages, Limitations and Potential*, Woodhead Publishing Series in Composites Science and Engineering, 2019, ISBN: 978-0-08-102397-6

Active Grants

RUI Grant
Title: Formability Analysis of Tailor Welded Blank of Steel and Aluminum Alloys., 2018-2021.

Preface

In general, a 3D printing or Additive Manufacturing (AM) is a technology that enables the fabrication of 3D part from 3D data by depositing a thin layer of material layer-by-layer until a semi-finish part is produced. Most of the available 3D printing machine available in the market is polymer-based material. Recently there are few, which is using powder form metal-based 3D printing machine. Since it's powder, strength of the produced parts will an issue. This may limit application of the technology, especially whenstrength is critically needed. Furthermore, there are hybrid machines, where combine 3D welding operation and machining operations such as milling to get the finish parts. Again, here strength and time become main issue, which may cause extension of the total fabrication time. Forging, known as metal forming process, that involve large deformation and can improve parts strength. In addition, time taken is shorter compared to machining. Through 3D welding, pre-form shape can be prepared, and this will reduce waste and can shorten the process steps. But, the critical issue is on part complexity, where it become the main problem with forging, as harder materials may have difficulty to filla complex cavity.

New Staff

The Metal Forming Research Lab. would like to welcome Puan Zarrirah Wani Karrim, a Research Officer at the School of Mechanical Engineering, who has been newly attached to the group to help on technical matters and improving KPI of the Lab. Currently she is involving with 3D welding research, focusing on the machine design. This is one of new research areas explore by the Lab, that is emphasis mainly on improving low and medium part production that requires strength as one of the crucial properties.

Showcase and Open Day Carnival School of Mechanical Engineering 2019

In conjunction to 30th anniversary of the School of Mechanical Engineering, a showcase and open carnival was organized on 24th of July 2019. The showcase mainly to exhibit final year projects and design projects to public. Metal Forming Research Lab (MFRL) also takes part at the Showcase and Open Day Carnival School of Mechanical Engineering USM. It is part of promotion about the lab research works and sales lab merchandise to the public. There are also visitors from nearby secondary and primary schools such as Sekolah Menengah Kebangsaan Methodist Nibong Tebal and MRSM Transkrian. Thank you to few members who help at the booth.

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3D WELDING MACHINE DESIGN CONSIDERATION: A BRIEF REVIEW

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Introduction

Demand for low and medium production of metal-based part via Additive Manufacturing (AM) is increasing. Various companies from medical and aerospace industries keep requesting for this technology advancement in fulfilling their needs (2018; Winnick, 2017). There are many advantages of AM, especially shorter time to market and more importantly can lower down the overall production cost. Research on 3D welding machine is not new and various successful stories were reported from all over the world and had been reviewed by Korzhik et al., (2016). In terms of welding technique, there are various techniques employed e.g. arc-weld (Pan et al., 2018), laser (Brandl et al., 2011), MIG (Rosli et al., 2018), TIG (Wang et al., 2011; Ding et al., 2016), plasma-arc (Aiyiti et al., 2006) and electron beam (Murr et al. 2012). Note that, the profile or part produced via 3D welding are not finish part and they required additional processes to produce net shape. Most of current machine available is a hybrid machine, where two or more processes were integrated on the same machine for example 3D welding and milling, which result in relatively more complex system. In this article that may be published in few series attempt to briefly review the state of art of welding machine design and outstanding issues in performing welding operation in the production of a 3D metal-based part.

Main Components

A typical machine must at least consist main body/frame, mechanism involve in performing the task (for this case welding), control system and accessories. In the next section, these compartments will be further discussed in brief.

Main body/frame

Frame plays a significant role for a machine in general. Strength and stiffness of the machine depends on the configuration of the frame or main body of the machine. Frame can be like typical solid casted iron body (Fig. 1(a)), structure wireframe (Fig. 1(b) by Rosli et al., 2018) or without frame as robotic arm is utilized by Colgrove and William (2013) as shown in (Fig.1 (c)). The shape and size of the frame also important and may influence the mechanism and arrangement of machine parts. Too complex configuration of the machine will cause process difficulty and should be avoided. The movement of the platform also play an important role, for example Cartesian movement such as in Fig.1(b) and hexapod movement as developed by Nilsiam et al., (2018) in Fig.1(d) are among the typical mechanism of platform movements.

Fig. 1(a)

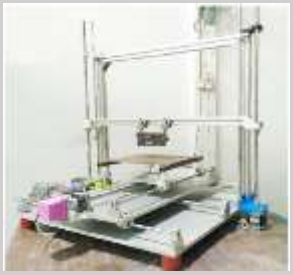

Fig.1(b)

Fig. 1 (c)

Fig. 1 (d)

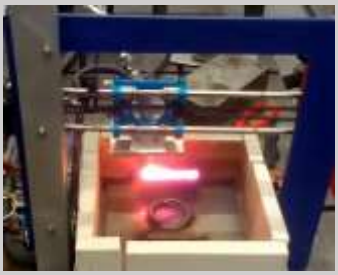

Fig.1 (e)

Welding Mechanism

Typically in performing the welding operation, at least two main components are needed, a welding nozzle and a platform. The nozzle uses to perform welding need to mount or clamp on a bracket or holder, while the platform is needed to prepare a space where weld bead is produced. There two options for the welding mechanism, either fixed nozzle and moving platform or vice versa, where nozzle moves, and platform fixed. Both mechanisms have their own advantages and disadvantages. Fig. 1(b) shows one of the machines available in the market, where moving platform and fixed nozzle can be seen. This mechanism allow for more efficient welding operation compare to the other mechanism. A stationed nozzle could reduce machine complexity, as the cable and bulky size will limit the movement of the nozzle. In addition, moving platform is much easier to control. There is also s 3D welding machine, where nozzle moves as shown in Fig. 1(e) as published at www.3ders.org.

Control System

Control system will ensure all parts perform the task accordingly. Complexity of the control depends on how complex the machine configuration, number of components involve and profile to be produced. Most likely numerical control is preferred such as CNC or any micro-controller.

Accessories

Additional parts, which are not compulsory to be in the machine, but still important. There are many and depends on application of the machine. One of the examples is the monitoring system to inspect quality of the weld and to accommodate variations during welding.

Challenges

Significant research and further understanding are required in aspects of machine design and process integration, optimization and level of automation including for process planning to meet future demands. Shape complexity is one the main challenges for 3D welding as to compared powder-based metal additive manufacturing. Therefore, it is important to admit that 3D welding should not be expected to replace current subtractive manufacturing processes. But more to complement each other where possible to reduce material usage, to shorten time to market and cut overall cost.

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