

Vibration and Temperature of AA1100 During Joining Thin Material Using Bobbin Friction Stir Welding Process

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ABSTRACT – Vibration during welding process is one of the important variables to ensure the weld quality is in good condition. This study using an AA1100 with a 3mm thickness as the material. With a range of 1500 – 1600 rpm for rotational speed and 150 – 210 mm/min for welding speed, the study is conducted. Two main response is collected which are vibration and temperature during a process. it was found that with parameters of 1550 rpm and 180 mm/min producing higher average of vibration with spread of heat along the process. Higher result of vibration producing defects to the weld quality.

1. INTRODUCTION

There are two types of Friction Stir Welding (FSW) which are Conventional Friction Stir Welding (CFSW) and Bobbin friction stir welding (BFSW). In BFSW, bobbin tool is composed of a pin and two shoulders that generate sufficient heat at both top and bottom of the welded material. Previous study has stated that BFSW process are produced better weld product in term of microstructures and mechanical strength compared to the CFSW technique [1].

Nowadays, there is a higher demand of application for thin material especially in aerospace industry [2]. Moreover, the advanced of technology are requiring the reduction of weight for the structures, machines and mechanical components. With the additional of thin material usage, the end product can be maintained as lighter product [3]. However, the difficulties in joining thin material produced a barrier in this improvement of technologies. Joining thin material is difficult because of the flexibility in thin materials, easily to be distorted and having good heat transfer during process make the material are easily to be deformed [4]. Moreover, it is believed that insufficient heat during the process are causing the difficulties in joining thin materials [5]. The study of vibration during the BFSW process is to provide an information regarding the smoothness of the process with the help of temperature data in joining thin material that focused more on aluminium alloy material.

2. METHODOLOGY

This study used AA1100 as the workpiece material with 3mm thickness. The selected of this thickness is because the material below 6mm was classified as thin material [5]. Figure 1 shows the dimension of bobbin

tool used in this study. Rotational speed and welding speed were chosen as the main parameters. Range of rotational speed from 1500 rpm until 1600 rpm with the welding speed was 150 mm/min until 210 mm/min were selected based on pilot run that been conducted. Then, central composite design under response surface method (RSM) is apply for the list of experimental during this study. The tool started the process from the entry side and stop for dwell time for 15 seconds before continuing the process until the exit side. Table 1 shows the list of experiments in this study. During the process, the vibration meter has been affixed to the material near the welding path to record the vibration data along the process from the beginning to the end of process.. While, 8 channels of thermocouple had been setup along the welding path to recorded the temperature data.

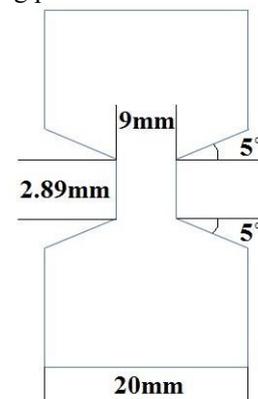


Figure 1 Bobbin tool used with two angles of convex shoulder

Table 1 List of experimental parameters and variables

Run	Rot. Speed, rpm	Weld Speed, mm/min
1	1500	180
2	1500	150
3	1500	210
4	1550	180
5	1550	180
6	1550	210
7	1550	180
8	1550	180
9	1550	150
10	1550	180
11	1600	150
12	1600	210
13	1600	180

3. RESULT AND DISCUSSION

Table 2 shows the average of all vibration frequency result for this study. It shows that run 10 has the highest average of vibration data recorded as compared to other runs. Figure 2 represents the graph of vibration for run 10. It shows that the higher vibration data recorded; 12.81 Hz at the entry of the welding process. During the entry, the material was in normal condition without any increment of heat. Therefore, higher vibration data had been recorded to soften the material. Trend of the graph shows that the beginning of the process having higher vibration compared towards the end of the process.

Table 2 Average of vibration frequency data recorded

Run	Avg. Vibration Data, Hz
1	0.270331
2	0.208581
3	0.258742
4	0.270181
5	0.464310
6	0.239502
7	0.398435
8	0.425420
9	0.252266
10	0.647187
11	0.208454
12	0.185812
13	0.321530

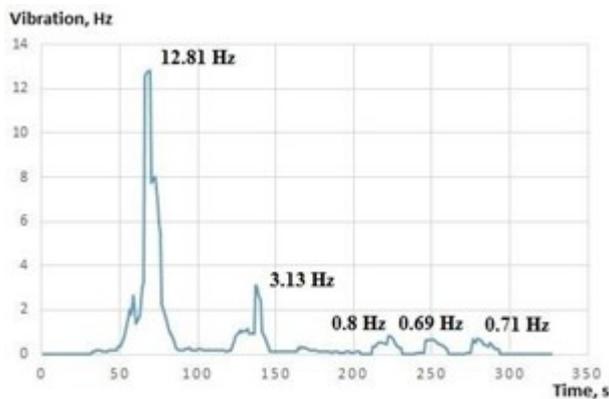


Figure 2 Graph of vibration data recorded for run 10

Figure 3 represents the temperature recorded for run 10. It shows that the entry of the process does not achieve the required temperature to soften the material. The beginning of the process should experience higher temperature because of the 15s dwell time. However, it cannot be achieved is believed because of the unparallel plate during the setup process. As mentioned by [6] the location of the tool and the contact between the tool and material is crucial. The workpiece material plate was cut using the shear machine that possibly make the edge of the plate distorted. The unparallel plate make the meeting point of the tool and material are not consistent. Fig. 4 shows the entry side of the welding path is clearly torn. It clearly shows that the temperature during the entry side are lower than the needed temperature which are 50 – 60% of melting point of the material.

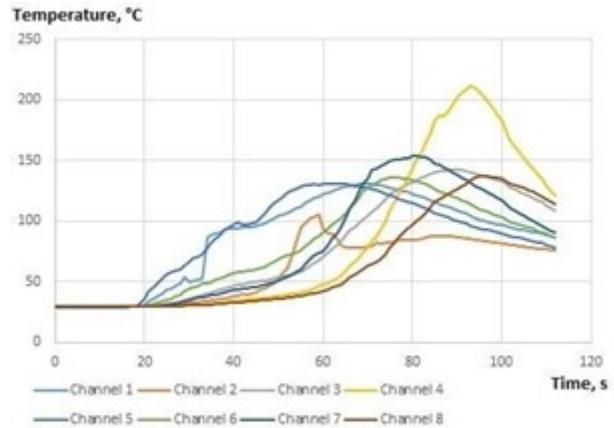


Figure 3 Graph of temperature data for run 10

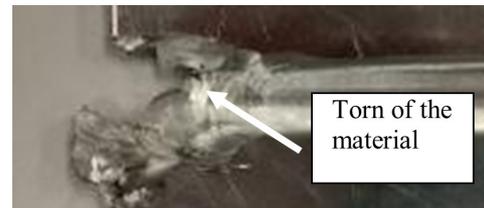


Figure 4 Torn like defect at the entry side of run 10

4. CONCLUSIONS

The higher vibration during entry is believed because of the unparallel condition of the material with lower heat provide by the friction of the tool. It is clearly shown at run 10 that with the lower heat during entry, producing higher vibration that resulting a defect at the initial of welding path

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