Editorial Board

VOL. 12, NO. 15, AUGUST 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

MECHANICAL PROPERTIES ON FRICTION STIR WELDING OF ALUMINUM ALLOY 5052

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ABSTRACT

Aluminum alloy was a material widely used in the fields of engineering but not easily connected by welding process. In this research experiments conducted using friction stir welding (FSW). This study aims to analyze the resulting mechanical properties as well as studying the effect of welding parameters i.e. shoulder diameter, round tool, and speed in welding (feeding) in the friction stir welding on aluminum material AA 5052. The mechanical properties was analyzed include tensile strength and bending strength of results welding. Best mechanical properties are on the tool with a shoulder diameter of 17.8 mm the highest tensile strength at 1300 rpm with a feeding rounds of 50 mm/min at 222.1 MPa and the highest of bending strength at 1300 rpm with a feeding round 208 mm/min at 422.6 MPa, With a smaller shoulder diameter, round and proper feeding friction and forging processes that occur while welding gives smaller influence on the decline in good mechanical properties in the material to be joined.

Keywords: friction stir welding, mechanical properties, aluminum alloy.

INTRODUCTION

The joining method of welding has been widely used in the connecting rods, general construction and construction machinery. In 1991 held at The Welding Institute (TWI) United States, have found a method of grafting a solid metal with a welding method of friction, called the method of Friction Stir Welding (FSW), which in welding the two metals joined by heat generated by a tool rubbing with the workpiece to be joined [1]. Aluminum is a material that is widely used in the construction field. There is one kind is the type of alloy AA 5052. The mechanical properties of aluminum were strong and resistant to corrosion. The aluminum was the most widely used in the construction sector. In general, this is done by connecting aluminum TIG and MIG welding process. However, both of these processes allow the formation of defects such as porosity and deformation. This was due to welding temperature occurring very high levels can exceed the melting point of the material. To minimize this is a way that can be used to connect weld aluminum with a temperature below the melting point of aluminum.

The process of friction stir welding is a welding process that can connect welding metal with a low temperature below the melting point of the material so that it can be used for connecting aluminum. However, it was found that when compared to welding methods such as gas welding, TIG and MIG, FSW have differences in terms of the mechanical properties of the weld. Variations on the rotation tool, feeding and shoulder diameter or friction welding field where the heating takes place can lead to changes in the value of the weld strength and hardness. Therefore, it is necessary to obtain the value of rounds, feeding and shoulder diameter to produce good mechanical properties in the weld.

FRICTION STIR WELDING

Friction Stir Welding is a welding method including friction welding, wherein the process requires no filler or certain additives and fillers of heat generated to melt the metal work by the friction of the rotating object (pin) with a stationary workpiece [2]. Pin rotating at a constant rotational speed is touched to the work material that has been seized, the friction between the two objects produce heat up to 80% of the melting point of the material and further work is emphasized and the pin is pulled in the direction of the area to be welded [3]. The rotation of the pin can be unidirectional or reverse clockwise. The Pin used must have the hardness and high melting point compared to the material to be welded, in order to weld pin is not damaged and participate melt material when welding work so that the weld was better [4]. Welding by FSW method can be used to connect the same or dissimilar material such as steel, stainless steel, brass and aluminum with allowing other weld material combinations which cannot be welded with other welding methods. Parameters used must be adjusted such that a reduction in the volume of the pin when it comes to friction with work material can be minimized. It aims to maintain a constant heat input welding along [5]. Advantages in this welding process is not require filler material and energy inputs are low so that more economic. The shortage of this process is the tool being used vulnerable to damage because it operates at a high enough temperature and therefore required to use the tool of the material is strong and heat resistant.

Technically, the working principle of FSW welding is like in Figure-1. The friction tool, which is equipped with two objects pin, will continually generate heat, resulting in the local heat that is able to soften and connect two such objects [6]. It became a fundamental principle of the creation of a friction welding process in the friction stir welding process. Tool moves at a constant speed and moves transversely along the line of welding.

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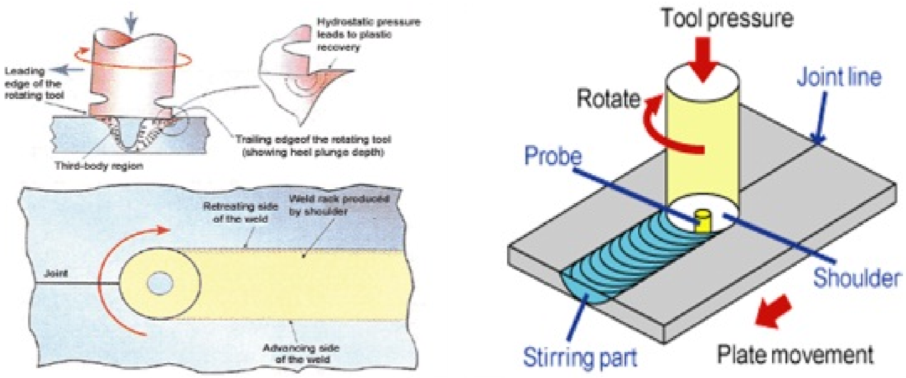

Figure-1. Process of friction stir welding [6].

EXPERIMENTAL METHOD

Welding process is done by using a milling machine. The tool used was a tool formed with a lathe as in Figure-2. The material to be joined is aluminum alloy AA 5052 with 4x85x200 size. The workpiece is clamped using a clamp vice. The tool was rotated and penetrating into the workpiece. Experiments carried out by doing some initial experiments in order to obtain study variables such as the value of the round and feeding tool that can be used to connect the material and further testing the mechanical properties of the weld which includes tensile testing, bending, hardness and SEM. There are two sizes of shoulder diameter that is used is 17.8 mm and 25 mm with a round that can be used is 855 rpm, 1300 rpm and 1950 rpm while feeding large 50 mm/min, 135 mm/min, 208 mm/min.

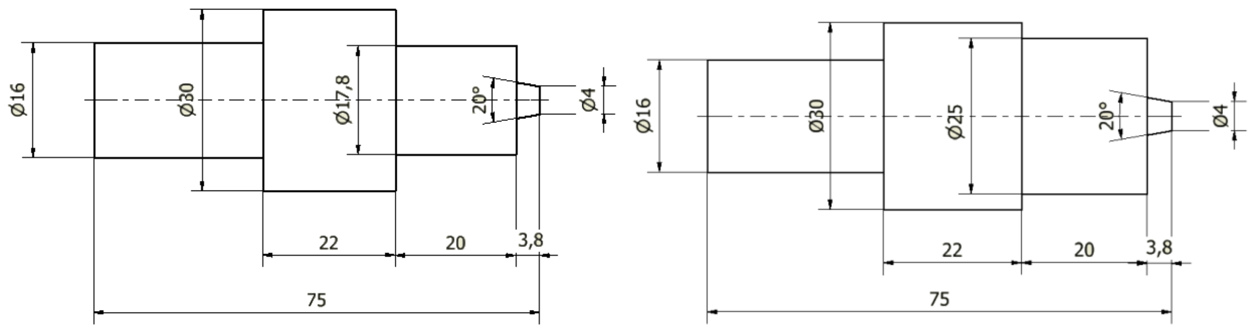

Figure-2. Dimension of tool.

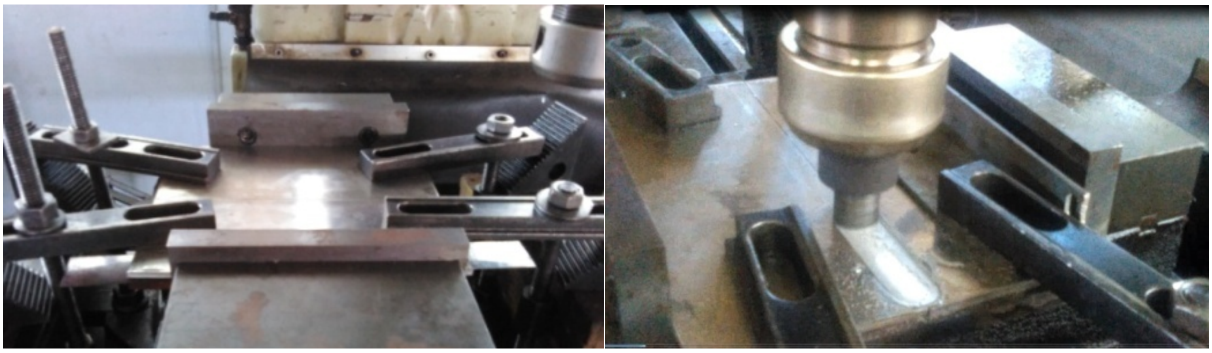

Figure-3. Dimension of tool.

After the welding process, further cutting the workpiece and moulded to make test specimens tensile and bending test. The shape and size of the specimens are shown in Figure-4.

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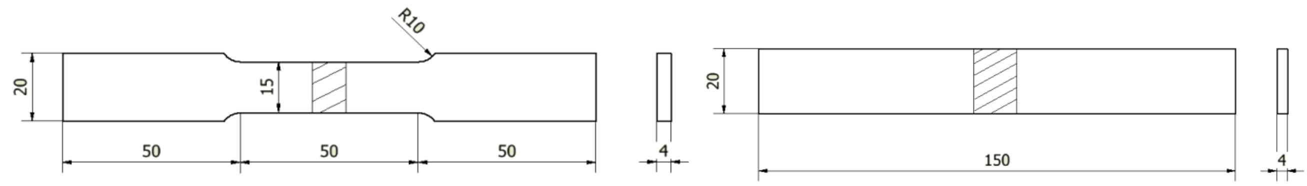


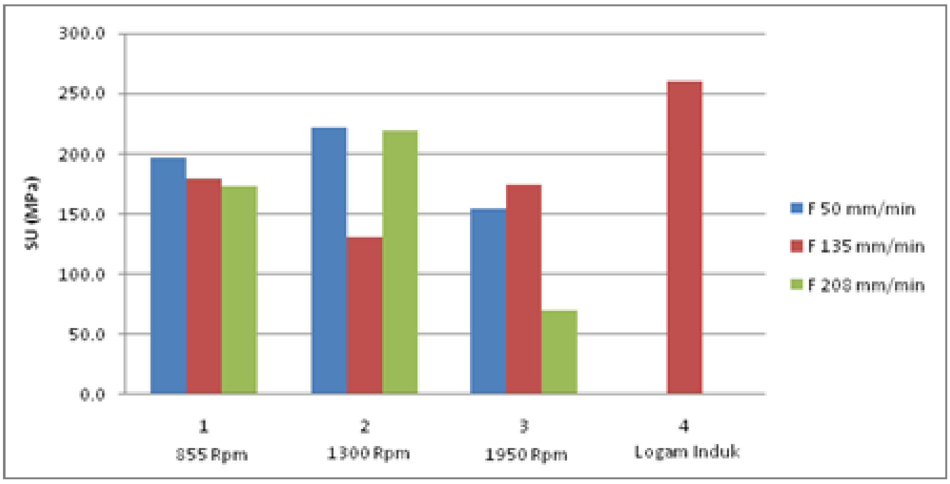
Figure-4. Specimen for tensile test and bending test.

RESULTS AND DISCUSSIONS

The mechanical properties of the weld were an important factor that determines the quality of the welding connection. The mechanical properties of FSW welds on aluminum alloys (AA 5052) such as tensile and bending strength of the material weld results can be explained as follows.

Tensile Strength

Results of research shows the tensile strength of FSW results on Aluminum AA 5052 for the variation of rotation, feeding and two shoulder diameter of the tool, which can be seen in Figure-5.



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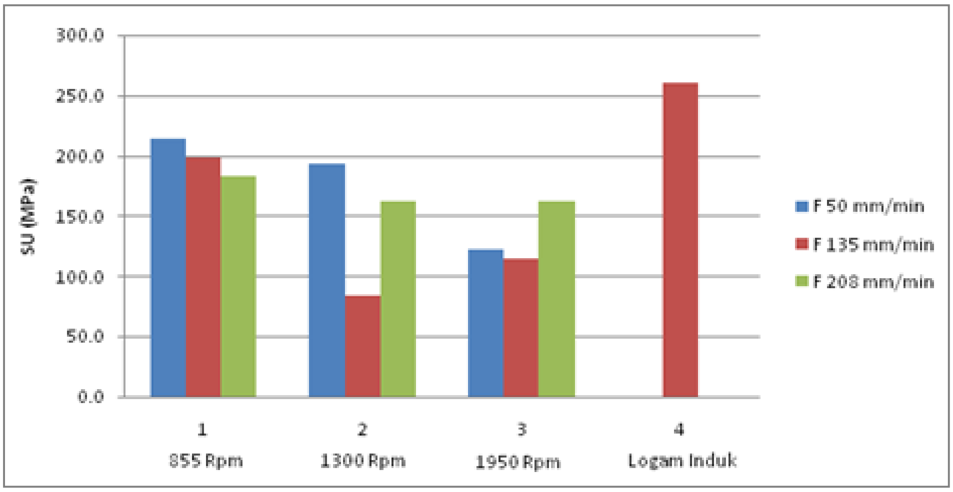


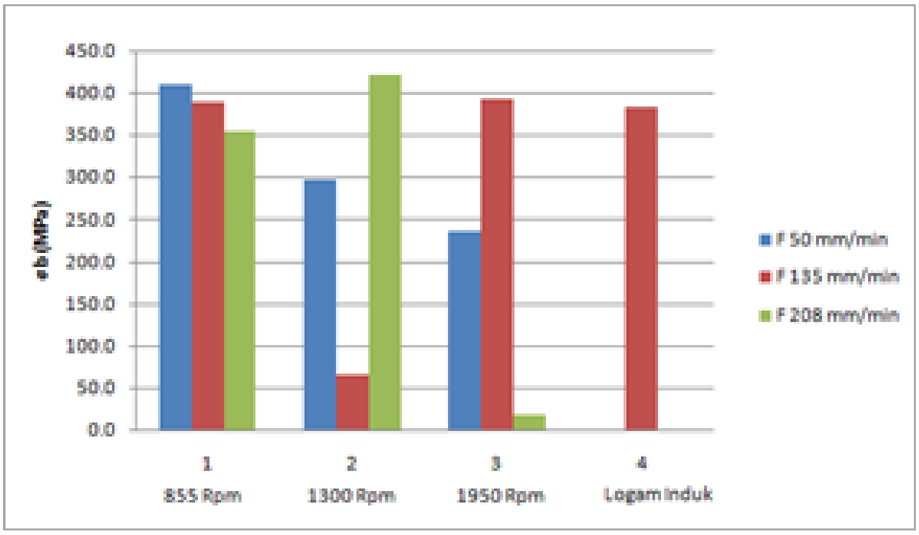
(b)

Figure-5. FSW result of tensile strength for shoulder diameter of a) 17.8 mm and b) 25 mm.

From Figure-5, the tensile strength of welding results showed a tensile strength in contrast to the variation of rotation and feeding as well as the diameter of the tool shoulder. The highest tensile strength for shoulder diameter of 17.8 mm by 222.1 MPa was obtained at 1300 rpm with a feeding rounds of 50 mm/min with the achievements of the percentage of the tensile strength for base metal by 85% while the lowest tensile strength of 70 MPa was obtained at 1950 rpm rotation with feeding 208 mm/min with the achievements of the percentage of the tensile strength for base metal by 26%. Diameter 25 mm to shoulder the highest tensile strength of 213.4 MPa was obtained at 855 rpm with a feeding rounds of 50 mm/min with the achievements of the percentage of tensile strength for the base metal by 82% while the lowest tensile strength of 83.4 MPa was obtained at 1300 rpm rotation with feeding 135 mm/min with the achievements of the percentage of the tensile strength for base metal by 32%. Decrease in strength occurs with the addition of welding speed or feeding because the feeding of high agitation and material connected unification not occur optimally, resulting in the two metals cannot be used to perfection. In addition to the high welding speeds produce welding defects in the weld metal surface such as cracks and small holes, causing the tensile strength decreased.

Bending strength

The results show that the bending strength gained from FSW aluminum AA 5052 with a variation of the round, feeding and two shoulder diameter tool can be seen in Figures 6 and 7.



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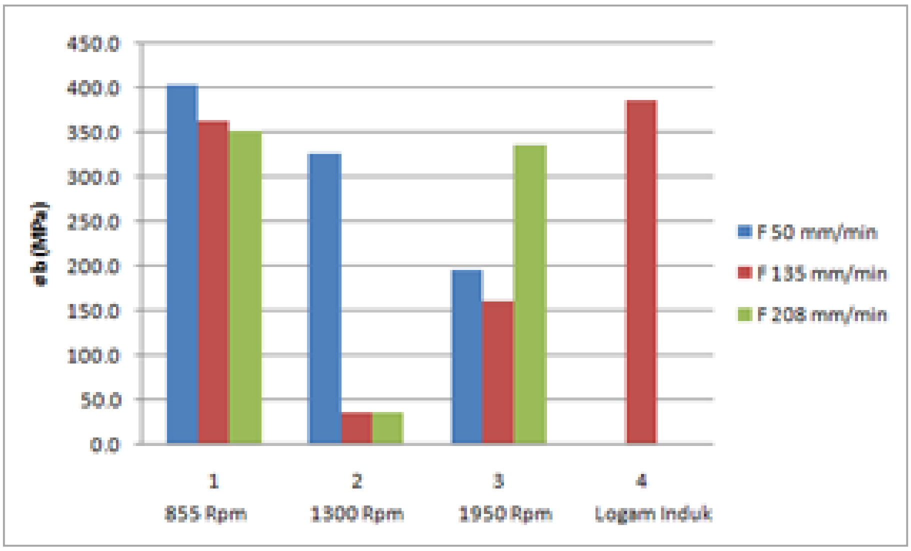
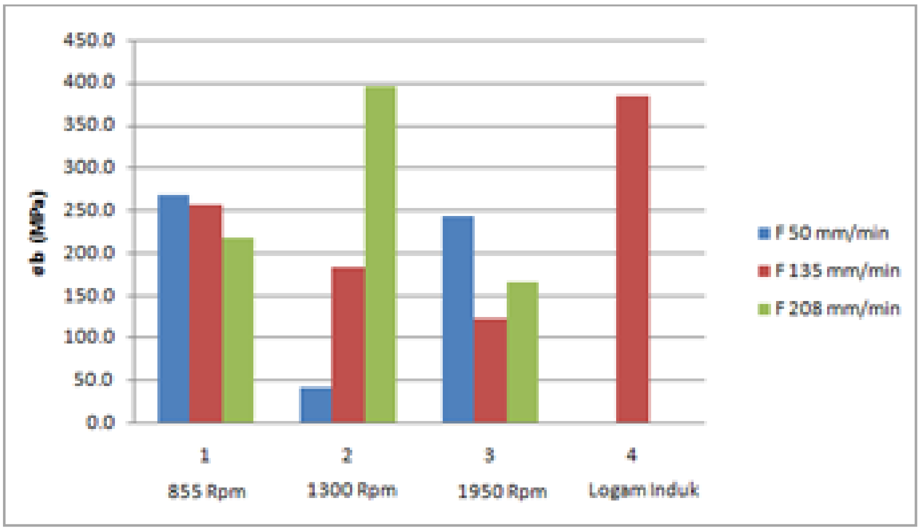


(b)

Figure-6. FSW result of face bend for shoulder diameter of a) 17,8 mm and b) 25 mm.



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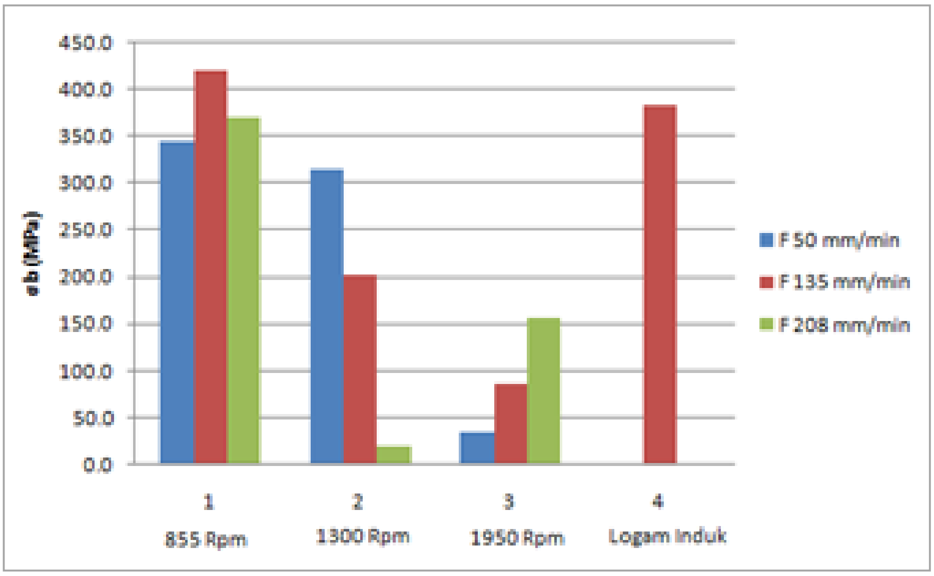

(b)

Figure-7. FSW result of root bend for shoulder diameter of a) 17, 8 mm and b) 25 mm.

From Figures 6 and 7, bending strength of face bend show with three variations of rotation and feeding were provided as well as two diameters of shoulder, bending strength high of 422.6 MPa are round 1300 rpm with the feeding 208 mm/min and a diameter of shoulder 17.8 mm. The bending strength lowest was 1950 rpm rotation with feeding 208 mm/min and a diameter of 17.8 mm shoulder is equal to 18.3 MPa. The highest percentage of bending strength against bending strength the base metal is 106.98% while the lowest was 4.76%. While the root bend bending strength showed the highest bending strength 420.9 MPa contained on rotation 855 rpm with the feeding of 135 mm/min and shoulder diameter of 25 mm. The bending strength lowest was 1300 rpm rotation with feeding 208 mm/min and a diameter of 17.8 mm shoulder is equal to 20.2 MPa. The highest percentage of bending strength against bending strength the base metal is 109.56% while the lowest was 5.26%. Low bending strength due to the high rotation experiencing greater heat input so it can reduce bending strength welding results. The value of bending strength specimens welding results was greater than the base metal due to the formation of the optimal tacking while welding.

This experiment can also be performed to calculate the power consumption for the welding process as well as was done by Nur et al [8]. They were analyzed the use of power consumption in the turning process of aluminum alloys.

CONCLUSIONS

Research has been performed on welding friction stir welding (FSW) aluminum AA 5052 using the round (855, 1300 and 1950 rpm) and feeding (50, 135, 208 mm /min), as well as the size of the tool shoulder diameter (17.8 and 25 mm), it can be concluded:

- Related to the Mechanical properties of the weld, better results was obtained in the testing of tool 1 with a shoulder diameter of 17.8 mm
- The highest tensile strength of 222.1 MPa and 213.4 MPa was obtained at feeding rounds of50 mm/min for different speed of 1300 rpm and 855 rpm.
- The highest bending strength of to 422.6 MPa and 410.2 MPa was obtained at different speed (1300 and 855 rpm) and feeding (208 and 50 mm/min).

ACKNOWLEDGEMENTS

In this paper, the research was sponsored by the DIPA-PNUP (Project No. 015a/PL10.10/PM/2016) and we are also thankful to Mechanical Engineering Department of PoliteknikNegeri Ujung Pandang.

REFERENCES

[1] Meran C. and Canyurt O.E. 2010. Friction Stir Welding of Austenite Stainless Steels. Journal of Achievements in Materials and Manufacturing Engineering. 43(1).

[2] Doss, M. 2012. Experimental Study of Friction Stir Welding of 6061-T1 Aluminum Pipe. International Journal of Mechanical Engineering and Robotics Research. 1(3).

[3] Anaelis. 2010. Pengaruh Feed Rate terhadap Sifat Mekanik Pengelasan FSW Aluminum 6110. Yogyakarta: IST AKPRIND.

[4] Pradeep A. and Muthukumaran. 2013. An Analysis to Optimize the Process Parameters of Friction Stir Welded Low Alloy steel Plates. International Journal of Engineering, Science and Technology. 5(3).

[5] Palanivel. 2014. Mechanical and Metallurgical Properties of Dissimilar Friction Stir Welded AA 5083-H111 and AA 6351-T6 Aluminum Alloys. Transactions of Nonferrous Metals Society of China. 24(58).

[6] Leon J. 2014. Investigation of Mechanical Properties of Aluminum 6061 Alloy Friction Stir Welding. International Journal of Students Research Technology and Management. 2(04).

[7] Danial Ahmad. 2012. Mechanical Properties of Dissimilar Aluminum-Based Alloy Joints by MIG Welding. Thesis. Universiti Malaysia Pahang. Malaysia.

[8] Nur Rusdi, M.Y. Noordin I. Sudin and D. Kurniawan. 2014. Power Demand Calculations in Turning of Aluminum Alloy. Advanced Materials Research. 845: 786-789.