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Influence of Axle Speed and Transverse Speed in Alloys Distribution of Friction Stir Welded Aluminum Alloy 6082

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Abstract*: In numerous auxiliary applications, steels are predominantly supplanted by aluminium alloys on account of its great quality weight proportion. One noteworthy issue emerges in this material is a reduction of mechanical properties during the joining process. To wipe out shortages of mechanical properties, it is essential to discover a superior method of metal exchange. In this analysis, a comparative joint of grating friction stir welds 6082-T6 was created by changing the axle speeds between 800 rpm to 1800 rpm and the welding speeds between 30 mm/min to 120mm/min. An imperfection free welding was acquired at 1400 rpm axle speed and 65 mm/min welding speed with the most extreme tensile strength of 158.61 MPa. Examining electron microscopy (SEM) and Electron dispersive spectroscopy (EDS) test were directed to explore the molecule dissemination of the weld tests for optimum weld. From the results, presents of porosity are higher in optimum weld. In order to reduce the porosities, major elements were added and repeated the tests again.

***Key words*: Friction stirs welding, axle and transverse speed, alloy distribution, EDS.**

I. INTRODUCTION

Aluminium combinations have been utilized in the manufacture business and auxiliary application for their phenomenal mechanical properties with the lightweight proportion. There is an expanding interest for low twisting during joining of aluminium combinations in ship boards and transportation applications [1]. Al-Mg-Si alloys are generally utilized in basic application because of its simplicity of weld ability. Mechanical properties of Al-Mg-Si combinations are relying upon encourage structure and dissemination of compounds [2]. Be that as it may, it's very unpredictable to utilize combination welding without filler material for joining. Friction stir welding is one sort of solid state welding process which assumes a gigantic job in green welding process throughout the previous couple of decades. Points of interest over the traditional welding procedures are a disposal of splits and evaporative misfortunes of alloying components [3].A noteworthy contrast between regular welding and erosion friction stir welding is the heat generation. Welding and heat generation produced by friction (rubbing) is Called FSW. Frictional heat generation is created between the welding tool and the work pieces because of pivot of axle speed and entrance of hardware pin. FSW procedure includes warm and material stream elements because of varieties of procedure parameters. Low shrinkage and phenomenal mechanical properties acquired at beneath softening point temperature [4, 5]. Most FSW procedures are completed on just one side of the joint by a solitary pass. It makes a root deformity, which is characterized as a zone at the base of the joint that isn't welded properly. It can be killed by picking legitimate procedure parameters with incredible tool plan [6]. In a customary processing machine, the axle power is accomplished by changing shoulder penetration. [7] FSW produces unbalanced microstructure on the progressing and withdrawing side because of the variety of warm cycles. By and large, a microstructure of the contact mix weld is grouped into the accompanying area, weld nugget zone (WN), thermo mechanically affected zone (TMAZ), heat affected zone (HAZ) [8, 9]. The goal of the present work is to examine the impact of axle speed and transverse speed on appropriation of combinations on the metallurgical and mechanical properties of grating mix welded aluminium alloy 6082 T6 comparable joints [10].

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II. EXPERIMENTATION

This Experiment was done on the customary (Kirloskar) HMT FN2V vertical processing machine with a limit of 7.5 HP and 1900rpm. The material utilized in this examination was 6 mm thick plate aluminium alloy 6082. Butt joint 200mm x 75 mm was set up to create FSW joints. The single pass technique was pursued all through the investigation. Substance creation and mechanical properties of aluminium compound 6082-T6 are referenced in table 1.

Table1 – Chemical composition and mechanical properties

Chemical composition (weight %)

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Al
0.86	0.39	0.06	0.73	1.18	0.07	0.06	0.04	Remaining

Mechanical properties

Yield strength (MPa)	Ultimate tensile strength (MPa)	Elongation (%)	Hardness (VH)
218	275	8.7	96

The tool utilized in this procedure was made of high carbon, high chromium steel which has hexagonal stick profile with a distance across of 6 mm, shoulder measurement 16mm, stick length 5.7 mm, with steady shoulder infiltration of 0.15mm [11].The apparatus has an essential capacity to control confined warming and material stream in the underlying phase of hardware infiltration. Following figure 1and 2 explains tool geometry. After the welding, tensile test examples were set up as per ASTM-E8M-04 guidelines. The welded joints are cut utilizing CNC milling machine. [12] These examples are taken in the ordinary heading of the weld. The tensile test on butt joint was directed by utilizing PC controlled 100 tones limit widespread testing machine (UTM). Hardness test was led by Vickers micro hardness with a limit of 5 kg [13].

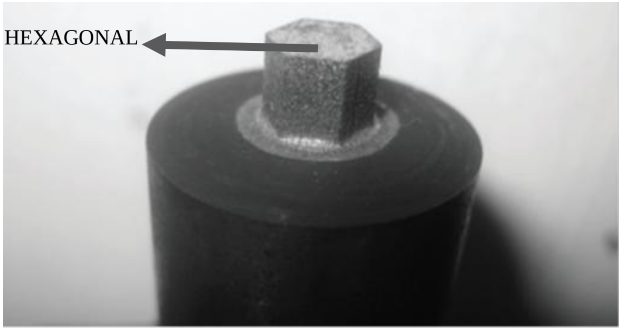

Fig 1 Tool with hexagonal structure

Fig 2 Tool with collar setup

A. *Selection of process parameters*

Welding parameters and the vitality contribution of the weld is assumed.

Weld Quality (Q) = f (axle speed / weld speed)

Nature of the welds relies upon the variety of axle speed and welding speed. The accompanying mix of material axle speed and welding pace were performed. Low axle speed with high welding (transverse) speed, high axle speed with low welding (transverse) speed. In this analysis directed with the steady tool penetration of 0.15 mm

III. RESULT AND DISCUSSION

A. *Visual inspection*

Visual investigation was performed on welded tests so as to recognize the nearness of outer deformities. For the most part Inordinate blaze and void imperfections were happened because of deficient progression of material.

Fig 3 Visual inspection of Low axle speed with high welding speed Weldment

Fig 4 Visual inspection of high axle speed with low welding speed Weldment

At low axle speed with high welding speed produces inappropriate heat generation, it causes friction stirring surrenders in the welded joint. Over the top heat generation creates a more extensive weld zone because of extreme blaze abandons.

B. *Tensile strength.*

Tensile strength of the weld joints was assessed by directing tests in a general testing machine. Three tractable test examples were set up from the each weld understanding with ASTM – E08-651 guidelines, to locate the tensile strength. Figure 5 demonstrates the malleable example after break.

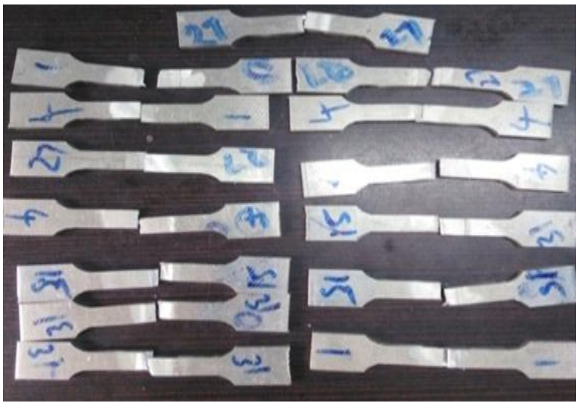

Fig 5 Sample tensile specimens after fracture

The crack happened generally in the retreading side of the weld due to inadequate stream during welding process. Table 2 speaks to the testing parameters and test estimation of tensile strength.

Table 2Testing Parameters and experimental value of tensile strength

Sample No	Axle speed (rpm)	Welding speed (mm/min)	Tensile strength (MPa)
1	800	120	105.50
2	1000	105	124.66
3	1200	90	149.47
4	1400	65	158.61
5	1600	45	152.84
6	1800	35	142.90

The tensile strength test demonstrates the accompanying outcomes for each weld condition. At Low axle speed and high welding velocity, have an extremely least tensile strength it because of the poor plastic progression of material because of less frictional heat generation. Higher axle speed with low welding pace, frictional heat generation age is high which upgrades the plastic progression of material in this manner loses the device material contact. An ideal imperfection free welding is gotten at 1400 rpm axle speed with 65 mm/min welding rate gives a tensile strength of 158.61MPa.

C. *Micro-hardness*

For the hardness, spaces were made at the waist of the thickness of plate over the joints with a component of 15 mm x15 mm x 6 mm. Vickers hardness tests (200 gm., for 10 sec) along the transverse course of the cross weld segment, so as to recognize the impacts of the different zones Hardness of the heat affected zone and weld nugget zone were somewhat lesser than base metal [12].

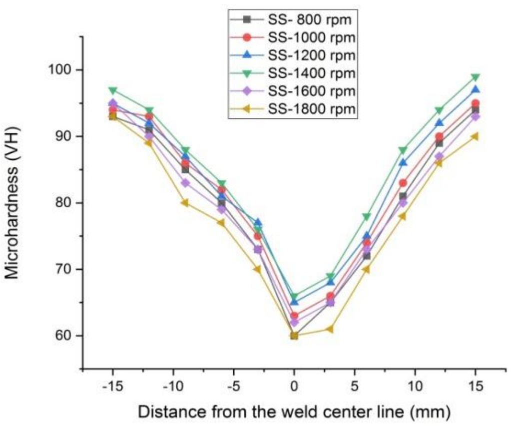

Fig 6 Micro hardness across the weld joint

The heat affected Zone and Weld Nugget zone is having fine friction stir in view of concentrated mixing. For the most part disappointment happened on the withdrawing side of the weldment because of the conditioning of the material. A miniaturized scale hardness worth fluctuates in the welded region and base material due to the autogenously stage changes of the base alloy and welded zone.

D. *Microstructure*

The examples were set up from a mid-welded bit to cover the whole three zones according to standard strategy of metallographies. Keller's reagent is used to carve aluminium alloy 6082-T6 to uncover their grain limits and direction. The metallurgy test was conveyed by FESEM [10, 13].

From the smaller scale basic perception, weld pieces, heat affected zone, and unaffected base material miniaturized scale auxiliary zones are distinguished. Weld pieces zones are all around recrystallized by high frictional heat generation [6].

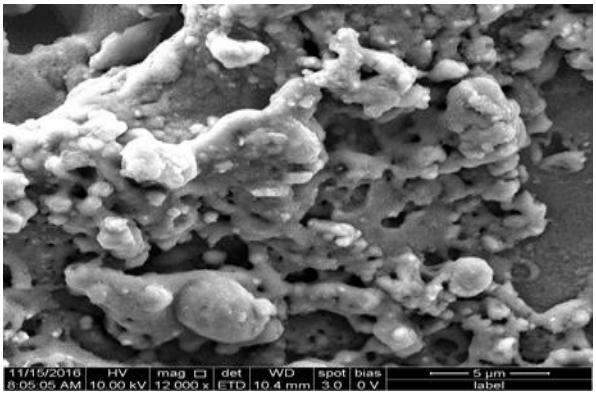

Fig 7 weld nugget zone for optimum weld

SEM metallographic examination appeared in nearness of Al-Si eutectic particles. Heat generation input legitimately relative to the apparatus rotational speed. Concentrated mixing and friction stiring of the material accomplish at higher apparatus rotational speed. In certain level it prompts extreme mixing as consequences of miniaturized scale voids. The grain size of the piece is diminishing with the expansion of heat generation inputs. Sub limits were shaped because of bigger high heat generation input, it prompts passage abandons. A consequence of higher grain development and grain coarsening structure are framed by less heat generation input.

Table 3 EDS results atom in %

Element	Atomic number	Series	Atom in percentage
Al	13	K	83.50
Zn	30	L	5.30
O	8	K	10.79
Mg	12	K	0.867
C	6	K	0.467

Electron dispersive spectroscopy is utilized to look at the components introduced in the Optimum welded material. From the table 3 results uncovered that the weld chunks had the extremely least magnesium substance contrasted with base metal on specific focuses.

Decrease of tensile strength and the area of the base hardness esteems in the heat affected zone and weld piece zone are to be identified with the system of decay of alloys nearness. It happens because of advancement of accelerate. So major combinations of aluminium compound 6082 T6 are found and filled in the welded locale. Nearness of magnesium in the welded zone is less contrasted with the base metal. So magnesium particles were filled in the weld zone and again mechanical test was carried. Magnesium particles filled in cross segment region of plate with standard separation of 2.5 mm, between two gaps.

Depth of hole is 2.5 mm, Size of holes (diameter) 1.5 mm, Total number of holes in plate - 26 no's.

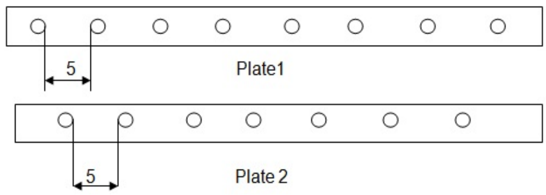

Fig 8 Cross section view-standard distance between two holes

Table 5 Testing paramters and tensile results

Experimental nature	Axle speed (rpm)	Welding speed (mm/min)	Tensile strength (MPa)
Optimum weld	1400	65	158.61
Optimum weld (with Mg alloy)	1400	65	173.61

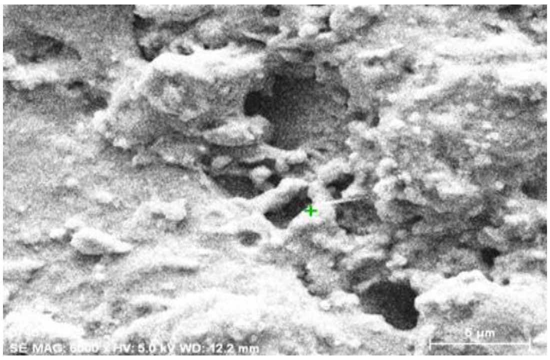

Fig 9 Weld nugget zone for optimum weld after magnesium powder added

Table 5 EDS results atom in % for Mg added

Element	Atomic number	Series	Atom in percentage
Al	13	K-Series	87.50
C	6	L-Series	6.30
O	8	K-Series	4.79
Mg	12	K-Series	1.03
Si	14	K-Series	0.79
Cu	29	L series	0.247

Expansion of magnesium to aluminium builds quality and solidifying capacity. Friction stir of magnesium and silicon produces magnesium silicate (Mg2Si).This formation gives quality without diminishing flexibility of the material.

IV. CONCLUSION

In this work, attempts to investigate the feasibility of joining aluminium compound 6082 in butt arrange apportion with including of magnesium by friction stir welding. Trail runs were led to anticipate the reasonable procedure parameter, for example, transversal speed and rotational speed. Experiments were carried out with the variations of axle speed and transvers speed with addition of magnesium and without addition of magnesium. Optimum porosity free results are arrived at1300 rpm axle speed, 65 mm/min transverse speed, tool penetration of 0.15mm with the standard distance of 3 mm in medium working conditions. The trial results showed that the mechanical properties and weld quality of Weldment not just rely upon process parameters; it is additionally affected by the presents of compounds in the welded zone. Further research will focused on significant of major and minor alloys presence on welded joint.

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REFERENCES.

1. Gopi, S. &Manonmani, K. 2012c, “Predicting Tensile Strength of Double Side Friction Stir Welded 6082-T6 Aluminium Alloy”, *Science and Technology of Welding and Joining*, Vol. 17 No.7, pp. 601-607.
2. Scialpi, L.A.C. De Filippis and P. Cavaliere, —”Influence of shoulder geometry on microstructure and mechanical properties of friction stir welded 6082 aluminium alloy,”‖*Materials and Design*, vol. 28, pp. 1124-1129, April 2006.
3. P. Cavaliere, A. Squillace and F. Panella, —”Effect of welding parameters on mechanical and microstructural properties of AA6082 joints produced by friction stir welding,”,‖*Journal of materials processing technology*, vol. 200, pp. 364-372, September 2007.
4. P. Cavaliere, A. De Santis, F. Panella, and A. Squillace, —”Effect of welding parameters on mechanical and microstructural properties of dissimilar AA6082–AA2024 joints produced by friction stir welding,”‖ *Materials and Design*, vol. 30, pp. 609-616, July 2008.
5. Gopi, S. &Manonmani, K. 2012a, “Optimization of Process Parameters on Joint Strength of Friction Stir Welded 6082-T6 Aluminium Alloy”, *International Journal of Materials Science*, Vol. 7 No.3, pp. 223-232.
6. S.Gopi,K.Manonmani,``Study of friction stir welding parameters in conventional milling machine for 6082-T6 aluminiumalloy``,*Australian Journal of Mechanical Engineering*, vol 10 No 2
7. C. Leitao, R. Louro and D.M. Rodrigues, —”Analysis of high temperature plastic behaviour and its relation with weldability in friction stir welding for aluminium alloys AA5083-H111 and AA6082-T6”,‖ *Materials and Design*, vol. 37, pp. 402-409, January 2012.
8. P.M.G.P. Moreira, T. Santos, S.M.O. Tavares, V. Richter-Trummer, P. Vilaça and P.M.S.T. de Castro, —”Mechanical and metallurgical characterization of friction stir welding joints of AA6061-T6 with AA6082-T6,”‖ ,‖ *Materials and Design*, vol. 30, pp. 180-187, April 2008.
9. Gopi, S. &Manonmani, K. 2012d, “Influence of shoulder profile and shoulder penetration on joint strength; of friction stir welded AA6082 inconventional milling machine”,*European Journal of Scientific Research*, Vol. 73 No.1, pp. 20-32.

10. Woo, W., Choo, H., Brown, D. W., Vogel, S. C., Liaw, P. K., &Feng, Z. 2006, "Texture analysis of a friction stir processed 6061-T6 aluminium alloy using neutron diffraction", *Acta Mater*, Vol. 54, pp. 3871-3882.
11. Singh, G., Singh, K. & Singh, J. 2011, "Effect of process parameters on microstructure and mechanical properties in friction stir welding of aluminiumalloy",*Trans. Indian Inst. Met.,* Vol. 64, No. 4-5, pp. 325-330.
12. Sasikumar, Gopi.S and Vadivel S.M " Effect of process parameters on joint strength in friction stir welding of aluminium alloy 6082 T6" *Industrial Engineering Journal*, 2016, volIX; No.11;PP 53-56. ISSN: 0970-2555.
13. J.Yasin, T.Pravinprabu and M.Saravanakumar, 2018. Influence of axlespeed and welding speed on mechanical properties of friction stir welding. *International Journal of Mechanical Engineering & Technology(IJMET)*-ScopusIndexed.Volume:9,Issue:11,Pages:802-809

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