Effects of Tool Materials on Friction Stir Welding of AA 6061

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Abstract- *Friction Stir Welding (FSW) is the direct conversion of mechanical energy into thermal energy process developed by the welding institute (TWI) in 1991. It is a solid state process without the use of conventional heat source to cause material to melt. This paper consists of a effect of tool materials on friction stir welding of AA 6061, tool rotational speed kept constant of 1000 rpm and traverse speed is changed. Tensile test and bending test is performed in order to know the ultimate tensile strength of the welded joint.*

I. FSW PROCESS

Friction stir welding is the solid state welding process in which the friction between the rotating tool and non rotating workpiece heat is generated results in the melting of the base metal. Due to the process of atomic diffusion the materials gets joined.

Fig 1: FSW process

Figure 1 shows the arrangement of the friction stir welding process. It consists of a fixture in order to hold the work pieces rigidly during the welding process. Appropriate tool is placed in the tool holder and axial force is applied on the workpiece. Due to the friction between the workpiece and the tool heat is generated results in the joining of the work pieces by the process of atomic diffusion, the process of the friction stir welding process is illustrated in the figure 1. The experiment is conducted by constant rotational speed of 1000 rpm and traverse speed of 20, 40 and 60 mm/min. there are two types of tool materials are used in this process one is OHNS die steel and EN9 as shown in the figure 3.

The experiment is conducted by using the universal milling machine as shown in the Figure 2.

Fig 2: universal milling machine

Exp No	Tool rotational speed (rpm)	Tool traverse speed (mm/min)	Tool offset	Tool materials
1	1000	20	0	OHNS die steel
2	1000	60	0	OHNS die steel
3	1000	60	0	EN9
4	1000	40	0	EN9
5	1000	20	0	EN9

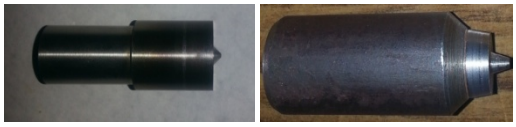

Fig 3: Different tool materials used

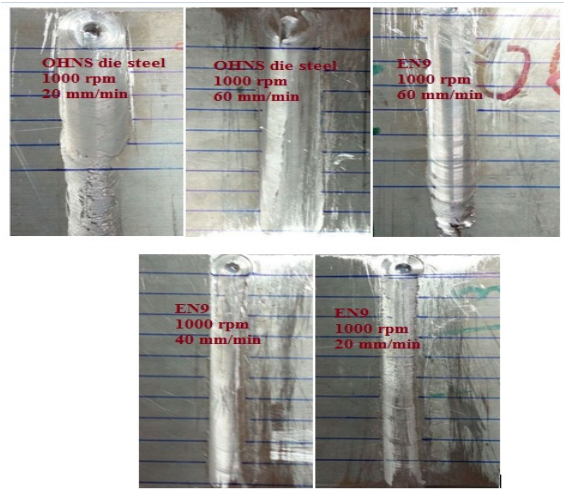

Fig 4: Welded AA 6061 plates

Figure 4 shows the welded aluminium plates, using these plates, 15 mm strips are prepared and used for tensile and bending tests.

II. TESTS CARRIED OUT

Tensile test

Fig 5: tensile specimens

The tensile specimens are prepared according to the ASTM standards using the universal milling machine. Figure 5 shows the typical tensile specimens prepared.

Fig 6: Tensometer

The tensile test is conducted using the tensometer. It is computer integrated machine where which gives the results itself so there is no need of calculating the results theoretically.

Table 2: process parameters of tensile test

Test sample	Traverse speed in mm/min	Break load (KN)	UTS (MPa)	% of Break Displacement
Exp -1	20	0.284403	171.715	24.202
Exp-2	60	1.745646	161.721	26.680
Exp-3	60	0.353052	121.269	17.311
Exp-4	40	0.441315	105.303	15.716
Exp-5	20	0.931.665	118.814	16.429

The Figure shows the graph drawn UTS versus of different traverse speeds. Figure 8 shows the tensile specimens after the test.

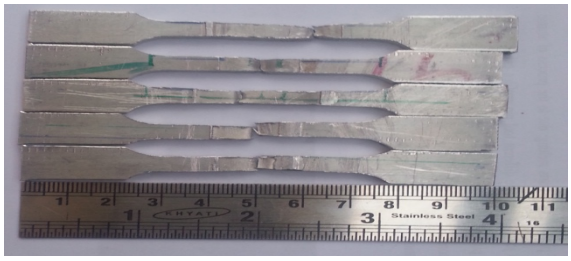

Fig 7: tensile specimens after the test

From the figure 5 and 8 it is clear that elongation of length in the tensile specimens.

Bending test

The bending test is performed using the Universal testing machine as shown in the figure 9. The 15 cm strips are prepared from the welded joint and used for bending test.

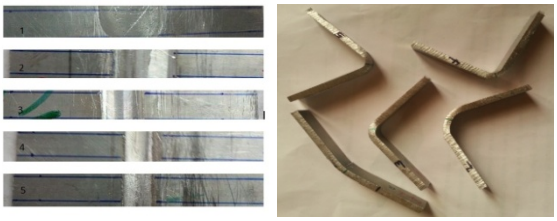

Fig 8: Bending specimens before and after test

Fig 9: Universal testing machine

Table 3: process parameters of Bending test

Exp No	Traverse speed (mm/min)	Peak load In KN	Ultimate compressive strength in MPa
1	20	0.54	9.88
2	60	1.08	21.19
3	60	1.26	22.74
4	40	1.68	32.98
5	20	1.38	28.91

III. RESULTS AND DISCUSSIONS

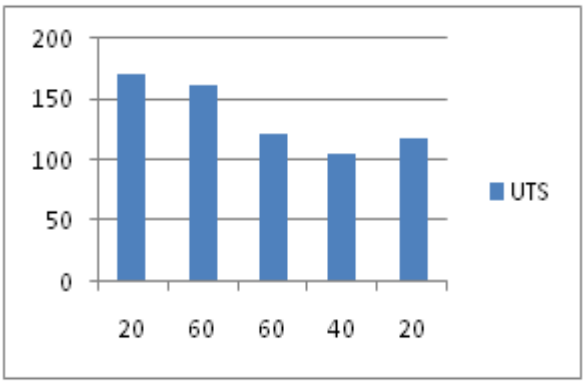

Fig 10: Comparison of UTS with different traverse speeds

From the figure 10 its clear that the maximum tensile strength value is found at the traverse speed of 20 mm/min and minimum tensile strength value at 60 mm/min. when the traverse speed is less which produces the high friction results in generation of high heat .so the good weld is obtained at the lower traverse speed using the OHNS die steel as a welding tool.

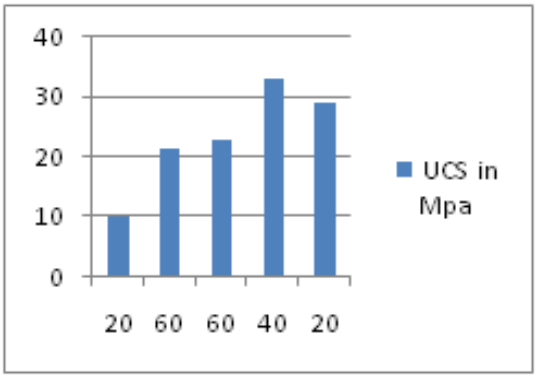

Fig 11: Comparison of compressive strength at different traverse speeds

Figure 11 shows the comparison of compressive strength at different traverse speeds, it is found that the maximum compressive value is found at the traverse speed of 40 mm/min. when the traverse speed is less the maximum compressive strength is obtained. At lower traverse speed due to high friction heat generated is more so it results in good welding.

IV. CONCLUSION

- Friction stir welding of AA 6061 is successfully performed at constant rotational and different traverse speeds.
- From the OHNS die steel at the traverse speed of 20 mm/min, the maximum tensile strength value is obtained.
- From the EN9 at the traverse speed of 40 mm/min maximum compressive strength is obtained.
- From the results the tool materials and traverse speed directly effects on the friction stir welding process.

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