Investigations on Different Parameters by using Friction Stir Processing

Shaik B*[1], Gowd GH[2], Prasad BD[3], Ali PS[1] and Rao MM[1]

[1]Ramachandra College of Engineering, Vatluru, Eluru-534007, Andhra Pradesh, India
[2]Madanapalle Institute of Technology and Sciences, Vatluru, Eluru-534007, Andhra Pradesh, India
[3]Jawaharlal Nehru Technological University Anantapuramu, Vatluru, Eluru-534007, Andhra Pradesh, India

***Corresponding Author:** Shaik B, Ramachandra College of Engineering, Vatluru, Eluru-534007, Andhra Pradesh, India, Tel: +91-9966786948, E-mail: drbazanishaik@rcee.ac.in

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ABSTRACT

Friction stir processing is a very promising method widely joining varieties of metals in other relatively marine, shipbuilding, automotive industries, aeronautical, and heavy machinery industries due to the following advantages i.e. low porosity, less tendency to cracking, and fewer defects. The research investigates the mechanical properties for input parameters welding speed, rotational speed, tilt angle, axial force and output parameters tensile strength, microhardness on aluminum alloys by using friction stir processing on based with cost Taguchi L9 used for the carrying with research on experiments with trailing on parent materials is different ranges of input responses on welding speed is 60 mm/min, rotational speed 1250 rpm, tilt angle 3^0, an axial force of 12 KN output responses tensile strength are 167 MPa measured based on ASTM on specimens and analysis for carrying and use design of experiments, the relations with empirical process useful for the development for automated design.

Keywords: Machinery Industries; Dissimilar Welding; Aluminum Alloys

Introduction

The Friction stir welding process is currently very useful for ship manufacturing and industry-oriented aircraft and automotive for butt, lap with the spot-on dissimilar joining of applicability Al- alloys and other materials of Mg-alloys, the production of a mass of light transportation systems and fuel consumption has significantly reduced [1] Studied resistance of ironing with process aluminum alloys are increased to improve the silicon oxide nanoparticles for the limit of iron [2] Studied mechanical properties and microstructural evaluation of AZ31B of sheets has 3 mm thickness welded of optimum conditions. The material of workpieces for joining is used friction stir processing with the tool shown in Figure 1 [3,4] Studied of tempered steel with quench property is feasible of tensile strength 1635 Mpa and research focus of different types of high carbon steels and medium are accepted successfully of friction stir welds. joining of Al6061 or NiTip composite with the distribution of homogeneous particle without product interface reaction is prepared successfully by friction stir processing took place combination of good damping with thermal physical properties on the treatment of heat process in the composite [5,6] AL-Li 2099T86 of stress corrosion cracking applications and developments of new alloy on aircraft industries are identified aluminum-lithium alloys with the substitute of high strength aluminum alloys on spacecraft manufacturing and launchers. The properties of strength, toughness, stiffness are adopted with aluminum alloys. the aluminum-lithium alloys advanced taken place with stress corrosion cracking on structural space applications. The parameters are used for welding have a cohesive band and circular shape and path studied of tool intention [7-15]. Parameters will be the changes that taken place more strength improving for different parts on the investigations to improving some difficulties of shoulder and plunge depth. The changes occurred due to different parameters suggesting improving technological order changes the condition satisfying throughout the process to have successful output general modifications done. Multi responses grey relational method used for similar considerations satisfying the improvement for present research play major role for eco-friendly and economical considerations.

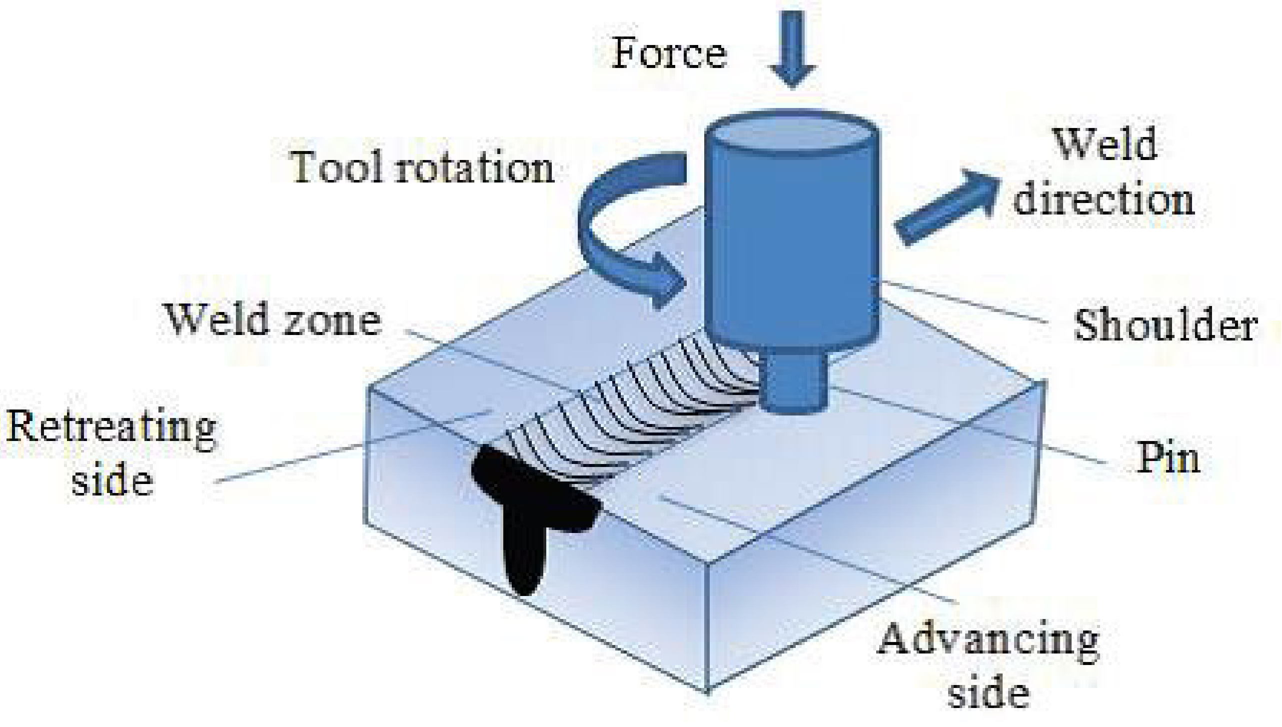

Figure 1: Friction stir welding process

Materials and Methods

The Friction stir process mainly involves the basic need with materials and methods influences with welding of dissimilar AA7075T651 and AA6082T651 with having a thickness of 6 mm and by using advanced numerically controlled stir process are carried out experiments based on a lot of literature survey and trail error methods on input parameters varying with proportionate condition done at Annamalai university. Chemical compositions with base material are shown in Table 1. The specimens of the plate taken dimensions based on the gap is 100 mm x 50 mm x 6 mm. the dimensions cut by the edges with smooth areas to do easily joining process of butt welding for the two dissimilar aluminum alloys are placed advancing side and retreating side are shown Figure 2

Elements	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Al
Al7075-T651	0.12	0.2	1.4	0.63	2.53	0.2	0.004	5.62	0.03	89.26
Al6082-T651	1.05	0.26	0.04	0.68	0.8	0.1	0.005	0.02	0.01	97.03

Table 1: The Chemical Compositions AA7075T651 and AA6082T651

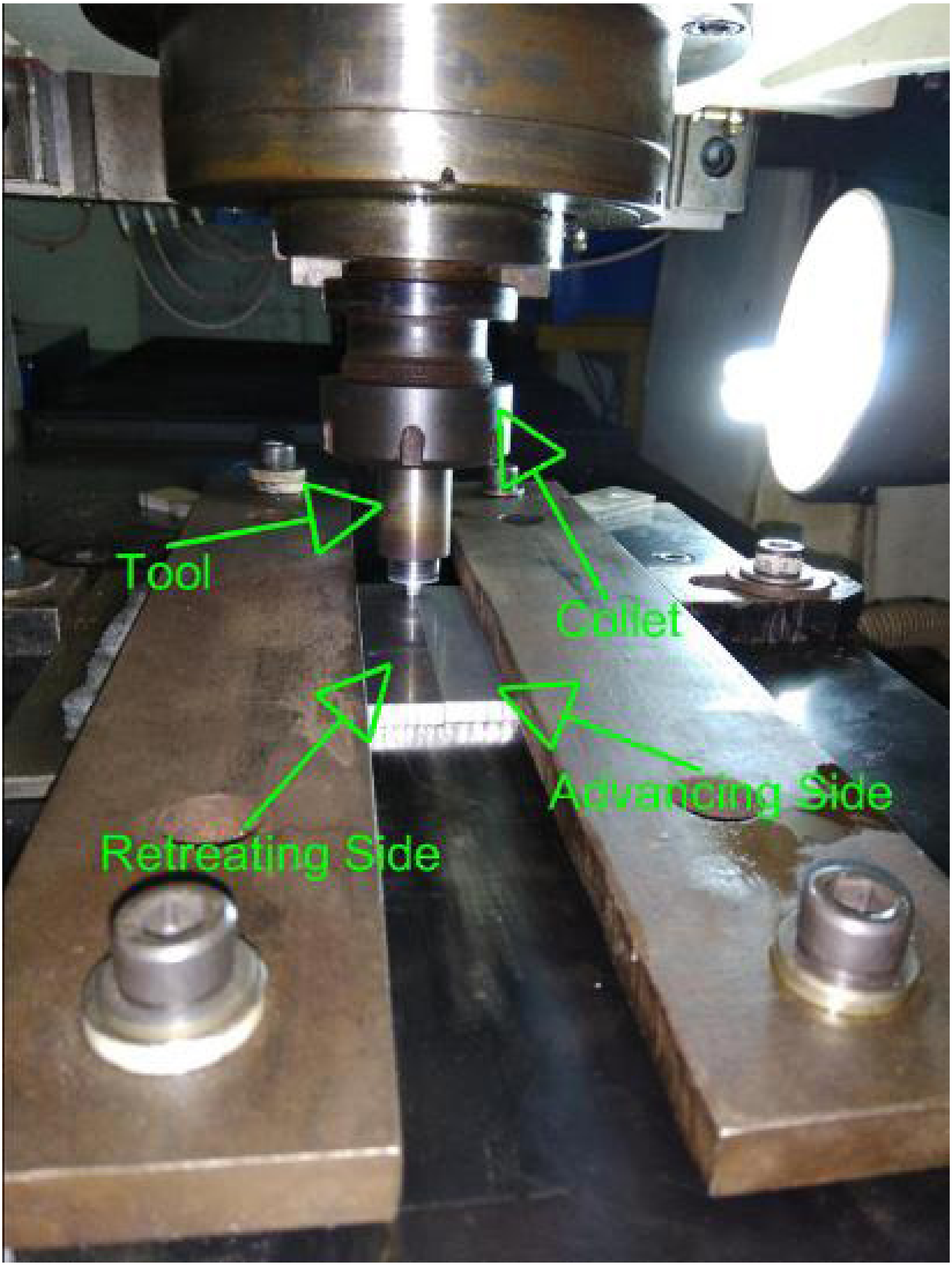

Figure 2: Weld Position of dissimilar aluminum alloys of friction stir welding

for the fixed clamps will be adjusted for specimens. The designed tool with advanced condition material taken as M2-Grade SHSS tool diameter of the shoulder is 18 mm and length of the probe is 6 mm. After the friction stir processing the weld zone appears perfectly, for the testing of the welding specimens are taken as standards of ASTM E8 and tensile test specimens before shown in Figure 3 and specimens after testing are shown in Figure 4. The combination and particular diameter of standards specimens are taken for the impact strength shown in Figure 5. The AA7075T651 advancing side and AA6082T651 in retreating side to have the

Figure 3: Specimens of Tensile test before testing with ASTM E8

Figure 4: Specimens of tensile test after testing

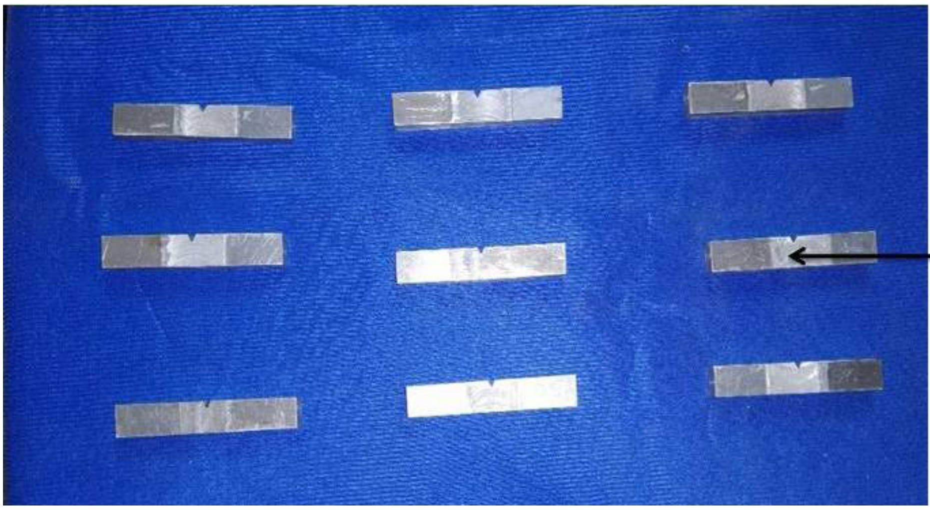

Figure 5: Specimens of Impact test

proper joining of materials and for the improvement of mechanical properties. The advanced methodology applied for different parameters to the obtained easy way of influencing the properties of mechanical by using dissimilar welding of notations and units is described Table 2 and experimental design of Taguchi model input parameters and output parameters shown in Table 3.

Sno	Parameters	Notation	Unit	Levels		
				1	2	3
1	Welding speed	WS	mm/min	40	50	60
2	Rotational speed	RS	rpm	1150	1250	1350
3	Axial Force	AF	KN	9	10.5	11

Table 2: Input Variables For Actual and Coded

Exp No		Input Process parameters			Output Responses		
	Rotational Speed (rpm)	Welding Speed (mm/min)	Tilt Angle (degree)	Axial force (KN)	Tensile Strength (MPa)	Impact Strength (J)	Elongation (%)
1	1150	40	1	10	162.00	10.55	9.60
2	1150	50	2	11	158.99	10.31	9.41
3	1150	60	3	12	155.00	9.00	8.50
4	1250	40	2	12	171.00	12.20	10.80
5	1250	50	3	10	164.99	11.16	10.05
6	1250	60	1	11	158.00	9.30	6.78
7	1350	40	3	11	174.99	13.10	12.15
8	1350	50	1	12	173.00	13.03	11.25
9	1350	60	2	10	167.00	11.30	10.10

Table 3: Experimental Design of Taguchi Model

Design of Expert

The design of experts in series with the test for the researcher useful for changes in input variables on a processor system is shown in Figure 6 due to the effect of variables of responses measured. The applicability of computer simulation models and physical on the factorial designs took place sensitively for the estimation of the combination of effect for two or more factors.

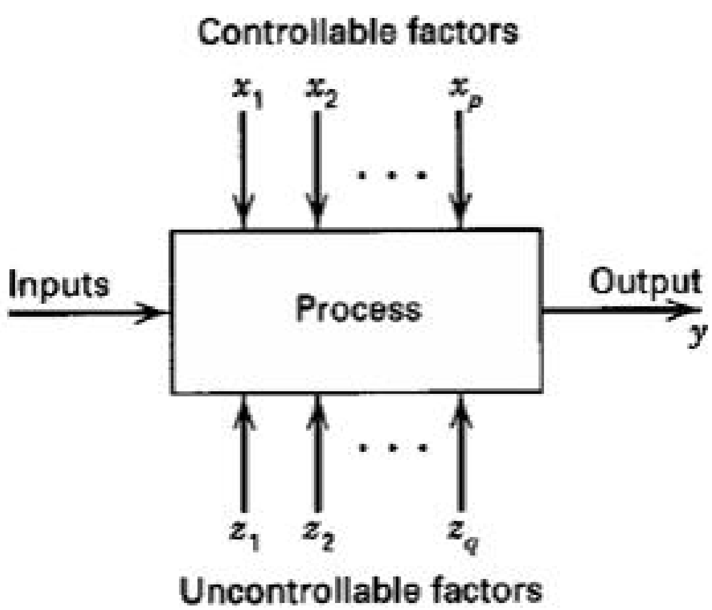

Figure 6: A process model of the design of expert

The design of experiments and methods of the traditional difference taken place approach in a better way of values on variables of parallel and it does not cover main effects on the variables on the different interactions and the possibility of approach for identifying optimal values on the variables of combination with experimental runs. The design of experiments is carried in four phases are Screening, Planning, Optimization, and Verification.

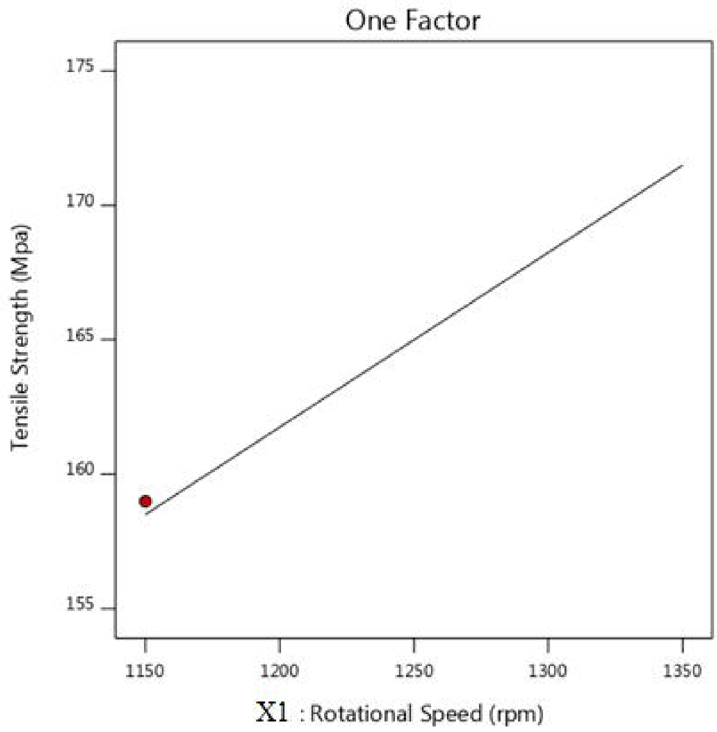

Figure 7: Influence with rotational speed on tensile strength

The influence of rotational speed on tensile strength has increased based on the tool welding speed varies the strength concerning the elongation has improved the maximum extent depends upon the rotational speed. Figure 7 shows the increases in rotational speed depends upon the heat increases at the welding zone area. The friction coefficient decreases with the melting condition. The friction stir process region intricate the fine particles will be distributed in the uniform portion. The effect of the tool stirred the position on the flow of metal optimum depends upon the increase of tensile strength.

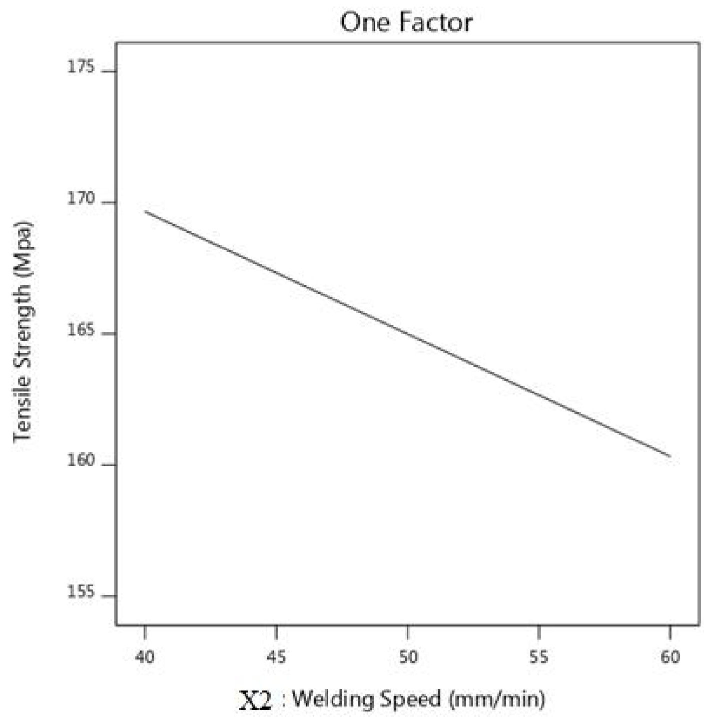

Figure 8: Influence with welding speed on tensile strength

The percentage of elongation along the transverse direction was obtained from the tensile test plotted against the welding speed. The plates Figure 8 shows welded with the rotational Speed is 1250 rpm and weld speed of 40 mm/min. while the plates were welded at 1150 rpm and 60 mm/min. The influence shows the properties of higher heat input based on influenced elongation.

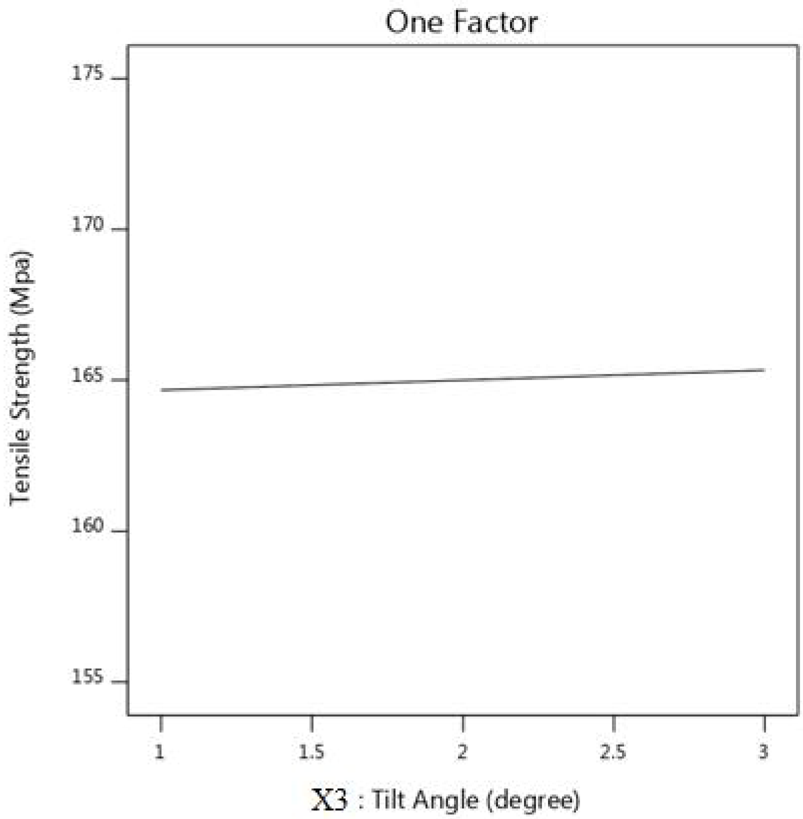

Figure 9: Influence with tilt angle on tensile strength

The influence of tilt angle on tensile strength Figure 9 shows the manner of the position at the bottom area of the welded part and it will be increased the position of tool speed concerning the material and designed shoulder based. The region of the position will be make difference between the tool changes the yield strength to improve the microstructure with ductility.

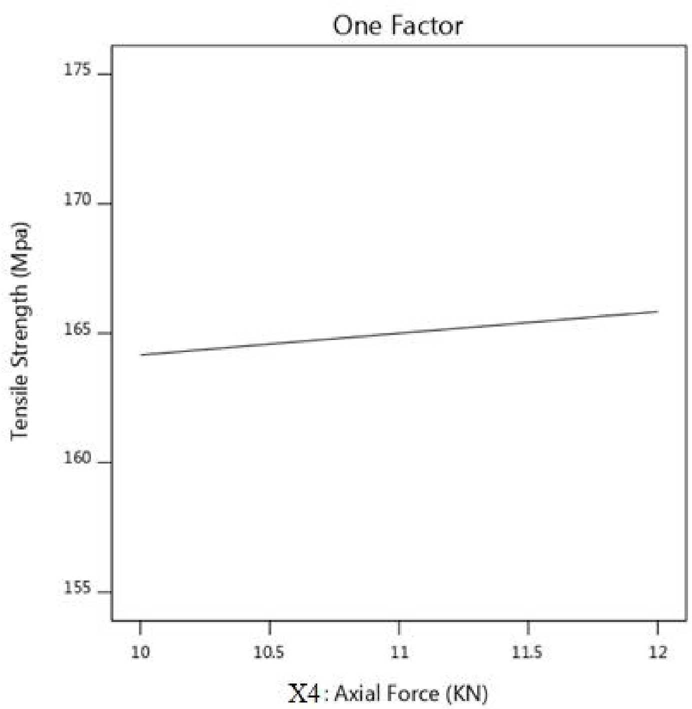

Figure 10: Influence with axial force on tensile strength

The influence with axial force on tensile strength Figure 10 shows the significance of friction stir processing at the joining area. The jointly taken place the position of rotational speed is 1250 rpm and tensile strength 164.99 MPa and the welding speed takes the major role due to increasing of force is 12 KN has the strength will be superior at the position of the part counter.

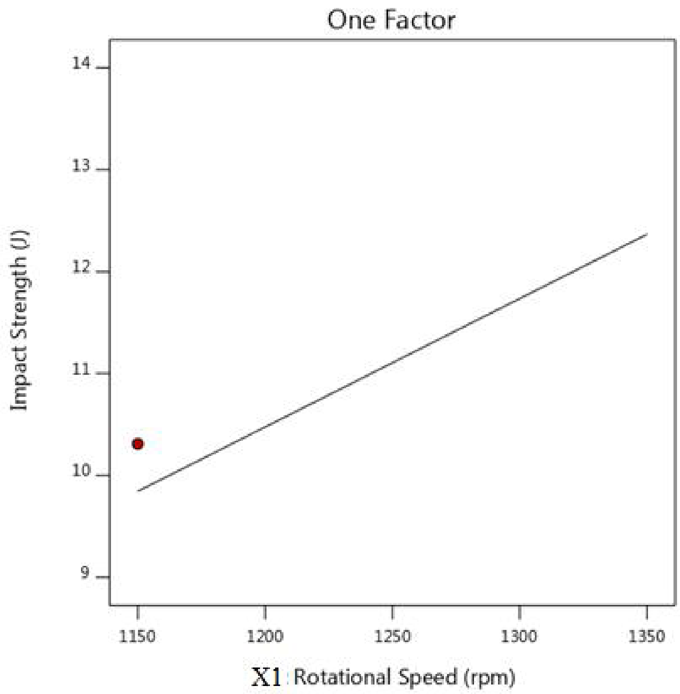

Figure 11: Influence with Rotational Speed on Impact Strength

The influence with rotational speed on impact strength produces Figure 11 shows the frictional heat required to plasticize the material and also effect in proper mixing of the dissimilar alloys. The changes of the position of the part speed will be low and having good mechanical properties at the welding speed is higher.

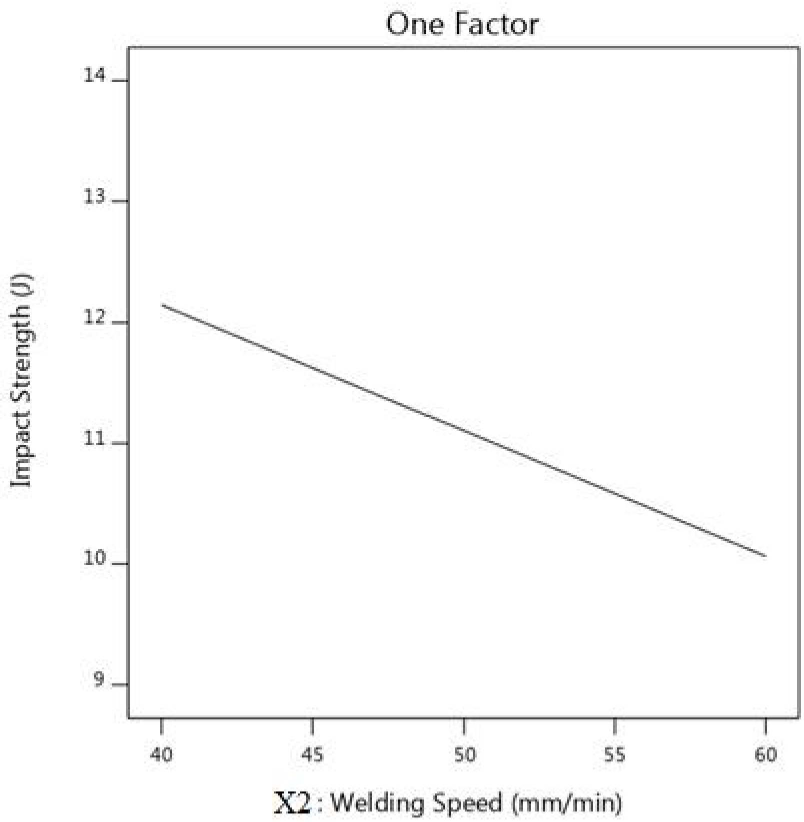

Figure 12: Influence with Welding Speed on Impact Strength

The influence of welding speed on impact strength shows in Figure 12 maintains the region with the center point of the notch makes the higher energy to analyze the impact energy at an instant with the increasing of welding speed 60 mm/min and impact energy of the notch shows 9.2 J.

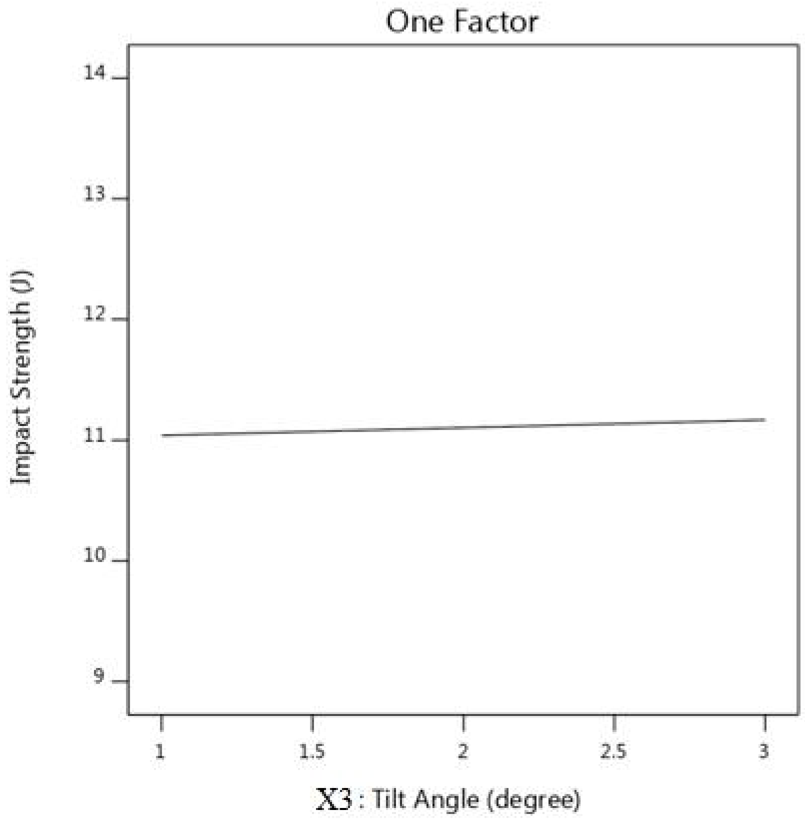

Figure 13: Influence with tilt angle on impact strength

The influence with tilt angle on impact strength shows the Figure 13 increasing of the impact energy with 11 J for the tilt angle 3 degrees will be maximum of increasing tool tilt angle.

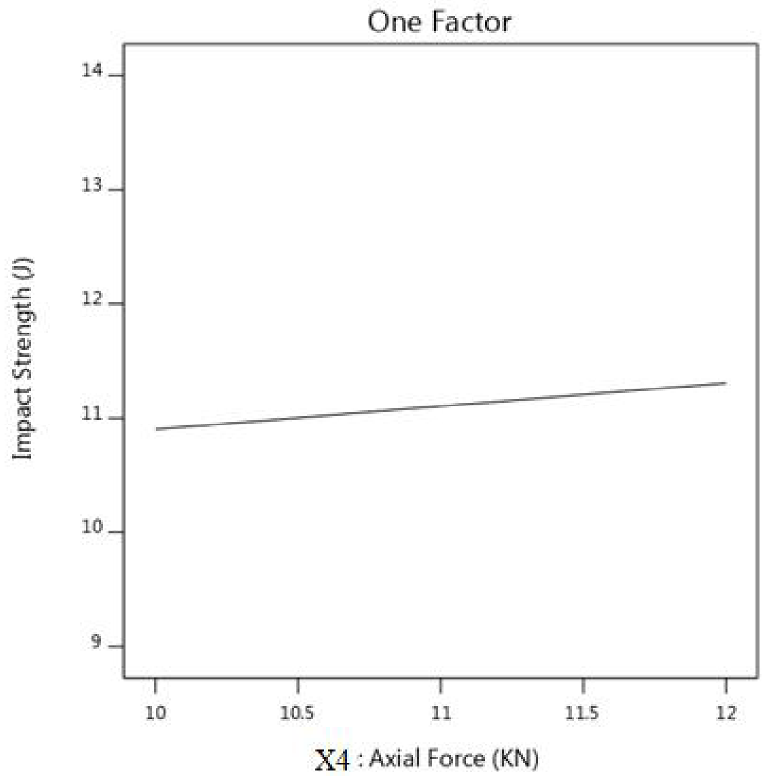

Figure 14: Influence with Axial Force on Impact Strength

The influence with axial force on impact strength Figure 14 shows the tool stirring action plays a major role of the part to increase the rotational speed with resultant of the weld area. The surfaces occur in grooves condition because insufficient material will be visible. The zone of the weld part decreases with rotational speed due to the effect of distribution with the temperature at the area of the weld zone.

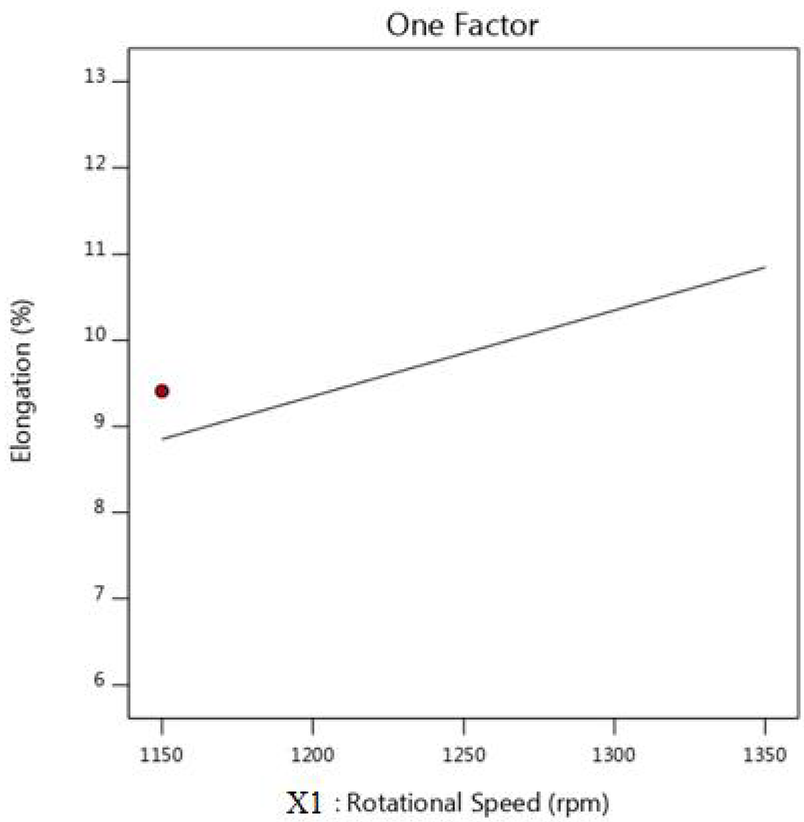

Figure 15: Influence with rotational speed on elongation

The influence of rotational speed on elongation shows in Figure 15 with the increase of rotational speed on the higher input of heat. The position of the tool will be the friction decreases with the heat input condition. The friction stir processing is the best condition for the optimized region on the fine particles with the distribution of uniform.

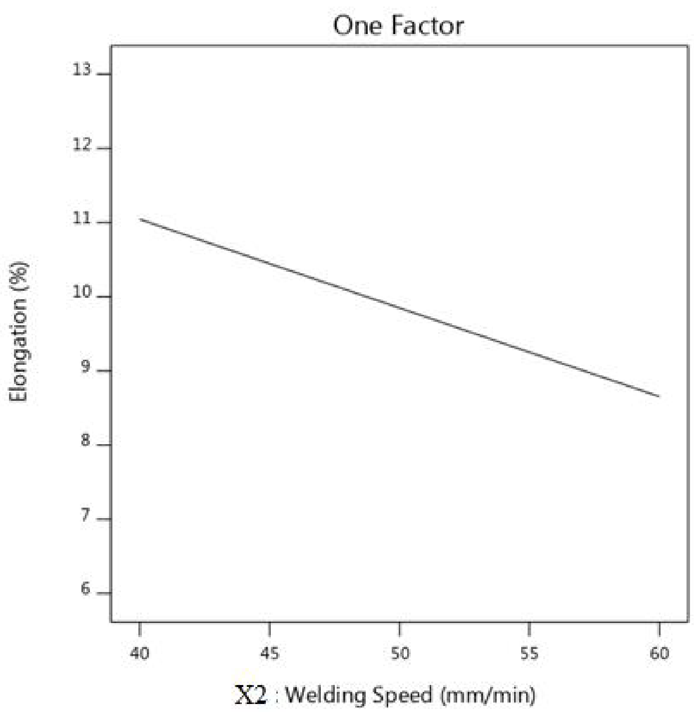

Figure 16: Influence with Welding Speed on Elongation

The percentage of elongation along the transverse direction was obtained from the tensile test plotted against the welding speed. Figure 16 shows plates welded with a rotational speed is 1250 rpm and weld speed of 40mm/min. While plates welded rotational speed is1150 rpm and welding speed 60 mm/min. The proportion area influences the heat input due to the elongation percentage of 11.25%.

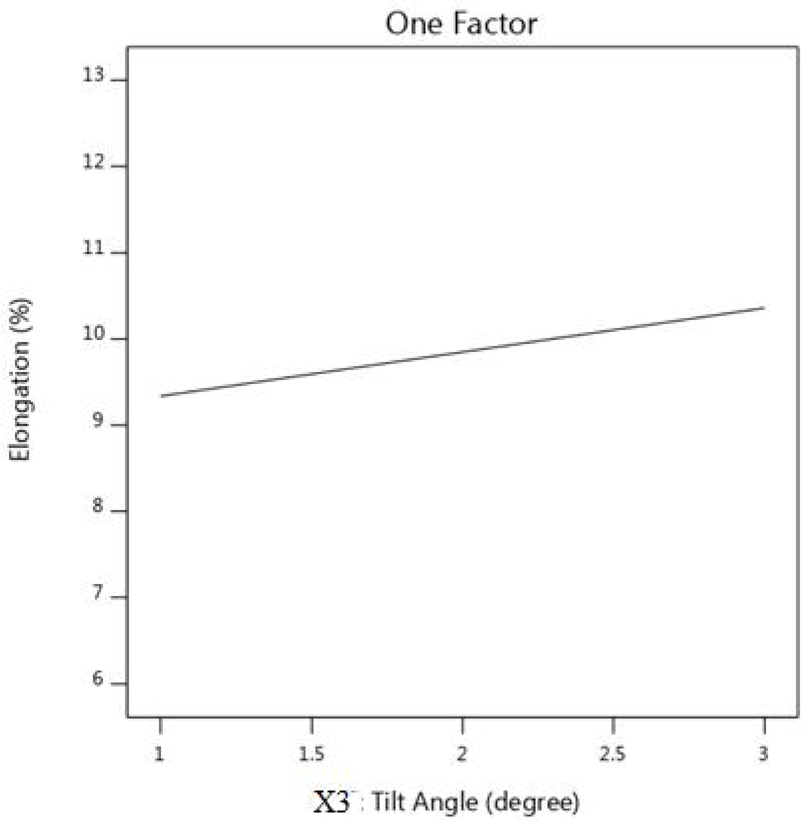

Figure 17: Influence with tilt angle on elongation

The influence with tilt angle on elongation shows in Figure 17 is the position of tool depends upon the material adjustment at the shoulder region of the part condition varies with the improvement condition in a friendly environment at the joining portion of the yield works due to the microstructure will give perfect condition in this region of the part due to tilt angle maximum 3 degree and elongation 9.7 %.

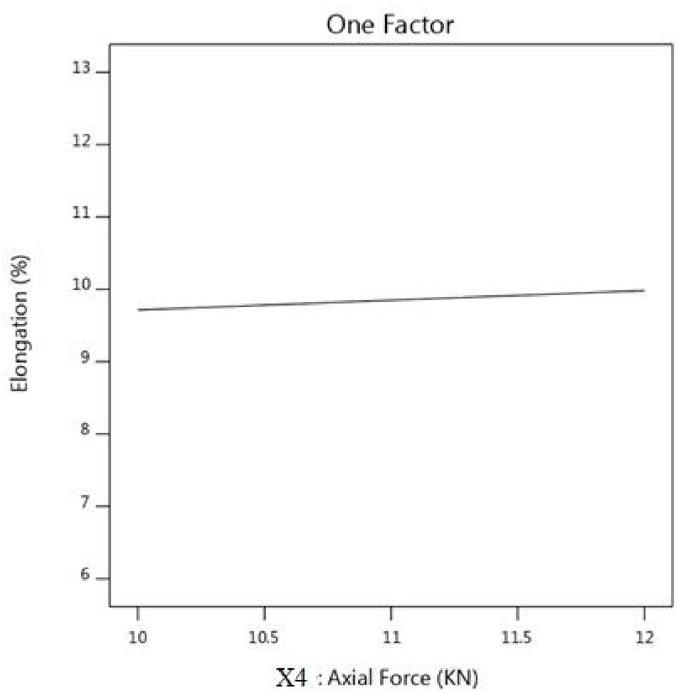

Figure 18: Influence with axial Force on elongation

The influence with axial force on elongation shows in Figure 18 with the flow of zone part due to higher heat input it occurs at the probe area. the tool pin changes the position to the actual flow of material to control the plastic deformation easily. The shoulder will be the major portion force that will increase the depth level of the plunge working the linear position. The axial force increases due to an increase in pressure to the higher extent the shoulder area will be stirred normal position easily.

Conclusions

The present investigation shows the aluminum alloys with the application of Taguchi design of experiments helped us in effectively conducting the experiments without losing accuracy. Two-dimensional plots are plotted between the input process parameter and the output responses using Design-Expert software. The tensile strength is increasing with the increase in rotational speed and the axial force values and the tensile strength is decreasing with the increase in the weld speeds. The Impact strength increases, when there is an increase in the values of rotational speed and the axial force. Whereas the impact strength tends to decrease with the increase in the weld speeds. The elongation also increases with the increase in rotational speed and axial force. The results presented in the work are analyzed based on analysis process conducted with microstructures with different zones on thermomechanical treatment zone has higher plasticity due to eutectic constituents Cu-Al precipitation on rolled condition and parent metal has rolled temper condition

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