DEIGN AND MICROSTRUCTURE ANALYSIS OF TIG WELDING WITH TWO DIS-SIMILAR MATERIALS

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Abstract:

In the present work, the effect of post weld heat treatment on the microstructure and mechanical properties of dissimilar weldments of Al6061and EN8 SS302,316L was investigated. The survey of microhardness profile in the as-welded samples showed fluctuations across the weld zone and a minimum in the hardness occurred in the heat affected zone (HAZ) of alloy 6061. In our present study we are conducting micro structural analysis and analyzing the mechanical properties of weld joints by using TIG welding process. These findings were done by using optical microscopy and scanning electron microscopy in different sectional areas like pin affected zone, shoulder affected zone, and swirling zone within the SZ and in this work mainly describes the effect of filler material on weld quality, strength and hardness of the joint. The OM approach for the weld aments of 200 µm.

Key words: TIG Welding, Dissimilar materials. Micro structural analysis

1.0 INTRODUCTION

Welding is a common process for joining metals using a large variety of applications. Welding occurs in several locations, from outdoors settings on rural farms and construction sites to inside locations, such as factories and job shops. Welding processes are fairly simple to understand, and basic techniques can be learned quickly Welding is the joining of metals at a molecular level. A weld is a homogeneous bond between two or more pieces of metal, where the strength of the welded joint exceeds the strength of the base pieces of metal. At the simplest level, welding involves the use of four components: the metals, a heat source, filler metal, and some kind of shield from the air. The metals are heated to their melting point while being shielded from the air, and then a filler metal is added to the heated area to produce a single piece of metal. It can be performed with or without filler metal and with or without pressure.

TIG Welding Technique

TIG welding is used in sites where the appearance of the weld is important. This presents special requirements for the accuracy of the welding job. Additionally, TIG welding is more demanding because there are more issues to control in this welding technique than in the other techniques. In TIG welding, the torch is moved with one arm while the other feeds the filler material to the molten weld. A TIG welder must, therefore, accurately control both arms and one cannot be used for supporting the torch as in MIG/MAG welding.

TIG welds and applications

In TIG welding (Tungsten inert gas), the welding arc is formed between a non-consumable tungsten electrode and the workpiece. The shielding gas is always an inert gas that does not affect the welding process per se. Usually, the shielding gas is argon and it protects not only the molten weld but also the electrode in the torch from oxygenation. The filler material may not be necessary for TIG welding.

The pieces can be fused also by melting the groove together. If a filler is used, it is fed into the molten weld manually and not through the welding torch as in MIG/MAG welding. Therefore, the TIG welding torch has a completely different structure than a MIG/MAG torch.

Introduction to dissimilar weld process:

Dissimilar welding refers to the process of connecting materials with different alloys through welding. The filler material and both metals need to be evaluated before choosing the best way to connect the metals. While fusion welding is a popular method, it does not work well for some combinations of metals. Other methods may provide a more durable hold, especially for uses in high-stress environments. When a welder joins two dissimilar materials, they must consider several factors before deciding the best welding method and tools to use. These factors depend on the composition of the metals because even alloys of the same metal fall under the category of dissimilar metals. For example, carbon steel and stainless steel have different properties and require just as much planning as welding together unalike metals, such as copper and aluminum

Applications Of Dissimilar Welds:

Many of the heavy industrial sectors around the world have seen a rapid increase in recent years in the rate at which they must turn around products due to a much higher demand. At the same time, many of these products feature dozens of different components and materials, all of which must work seamlessly together as though they were one.

Problem statement

Welding is well known for economically feasible process; low-cost assemblies can be fabricated with the help of welding in less time. Materials having similar properties can be joined easily, industrial requirements growing day by day, the utilization of different composites are necessary now to get good quality of the product assemblies. Much more researches needed in the area of dissimilar metal welds, with conventional welding processes of TIG welding. A variety of problems come up in dissimilar welding like cracking, large weld residual stresses, migration of atoms during welding causing stress concentration on one side of the weld, compressive and tensile stresses, stress corrosion cracking, etc. To overcome this causes there are required to study the effect of welding process parameter on mechanical property. The aim of this research is to predict and optimize TIG welding of some economically important dissimilar materials in industry through applying a full factorial design as a DOE approach to design the experiments, develop mathematical models and optimize the welding operation.

Objectives

- To check the method for TIG welding of ferrous and non- ferrous materials.
- To check the weld parameters of AL6061 with EN8 in butt weld.
- To verify the strengthening properties as well as NDT tests for better conclusions.

2.0 LITERATURE REVIEW

Paul Kah, Raimo Suoranta [1] Techniques for joining lightweight dissimilar materials, particularly metals and polymers, are becoming increasingly important in the manufacturing of hybrid structures and components for engineering applications. The recent drive towards lightweight construction in the aerospace and automotive industries has led to increased exploitation of lightweight metallic and non-metallic materials with the aim of achieving specifically optimized versatility. **M. Ravichandran, A. Naveen Sait [2]** TIG welding process parameters were analysed for joining duplex stainless-steel plates. Signal to noise (SN) ratio and Analysis of Variance (ANOVA) analyses were applied for investigating the selected welding parameters. The selected parameters were current (A), gas flow rate (L/min) and speed (mm/min). **I.O. OLADELE, O.T. BETIKU [3]** The demand of joints of dissimilar metal combination is rapidly increasing in many structural and industrial applications for special optimization of properties as well as to save cost. **Divya Deep Dhancholia [4]** These alloys faces problems like hydrogen solubility, formation of aluminium oxides, solidification shrinkage etc when welded with fusion welding process. Friction stir welding is the process which is able to successfully weld these dissimilar alloys of aluminium. **A. Suresh Kumar, et al [5]** The dissimilar material joining has been similar with metallic systems commonly used in industry including carbon and low-alloy steels, stainless steel, nickel, copper, and aluminum alloys. In the engineering application uses of these materials are grown because of corrosion and erosion resistance, high temperature strength. **Ramesh Rudrapati Nirmalendhu [6]** Tungsten inert gas (TIG) welding is widely used technique for dissimilar welding of metals. In the present work, TIG welding operation has been studied for favourable welding condition for maximizing the ultimate load and breaking load of weld specimen. **A. Subrammanian, D.B. Jabaraj [7]** In this paper, a review of research works done on resistance spot welding of stainless steel is presented. Most of the reported works on resistance spot welding of stainless steel have been on austenitic stainless steel, the most used variety of stainless steel. Though less, research works have been reported on other varieties of stainless steel also. **Mumin Sahin [8]** the aim to optimize the process parameters in the present study. The joints obtained with various process-parameter combinations were subjected to a tensile test. Empirical relationships were developed to predict the strength of the joints using RSM (the response-surface methodology) and the coherency of the model was tested. **Aravinthan Arumugam, et al [9]** Resistance spot welding is a process which is widely used in the automotive industry to join steel parts of various thicknesses and types. The current practice in the automotive industry in determining the welding schedule, which will be used in the welding process, is based on welding table or experiences. **Balaji, C., Abinesh, K.S.V [10]** Investigated inert gas tungsten arc welding parameters on the mechanical properties of SS 316 L weldments. 316 ASS rods of dimensions of 25 mm diameter and 75 mm length were used. Current, bevel angles gas volumes inputs were varied at different range of 90, 100 and 110 ampere, 60˚ 70˚ and 80˚ and 1.1, 0.9, 0.71 per litre respectively. Taguchi L-9 orthogonal array technique was used.

3.0 RESEARCH METHODOLOGY

The materials Al6061 with EN8, SS302, SS316 L is taken and as welding components for dissimilar weld amendment where the materials are machined for proper sampling for tests. In TIG welding a differentiation is made between two variants. On the one hand, it is welding with direct current, which is the most frequently used type. The tungsten electrode is positioned on the negative pole. This form of welding is used to join alloyed steels as well as non-ferrous metals such as copper or brass. On the other hand, it is welding with alternating current. This type of welding is used to join lightweight metals such as aluminium and magnesium, as the oxide layer is broken up. In exceptional cases, however, lightweight metals are also welded with direct current, in which case the electrode is attached to the positive pole. In general, however, it can be stated that each metal suitable for fusion welding procedure can be welded using the WIG procedure.

Procedures of welding

Metal plates of aluminium and SS 150mmx 80 mm with a standard thickness of 4mm and 3mm, the two plates are fixed to the base plate and brazing at the two ends. Welding rods of ϕ2.4mm alumna-steel used as filler metal. Use filter gas lens 3/32 and #6 diffuser cup and 3/32 tungsten for the initial weld and bed formed towards steel side with no pulse, once weld bead formed attaching steel plate as a first layer, the adjacent layer weld on second step. Press foot control to starting temp, about 25-35 amps, deposit 1 full droplet (liberally). Move rod back a little but keep it in the coverage zone to prevent oxidation on rod. Rapidly press foot control all the way down to max amperage. Rapidly depress the foot control back to starting amps. A complete pulse cycle should be done quickly- about 4-6 seconds, less if possible. Direct torch angle towards aluminum and deposit weld puddle overlapping 1st pass midway and partially onto aluminum.

1. Set Temperature to 160 amps. (DC same as steel or stainless steel)
2. Watch for droplet to flatten out, should have smooth surface, medium height, and rounded edge.

3. Increase temperature 5-10 degrees. Continue process
4. When droplet no longer has smooth appearance, (The surface will appear like the moon or cauliflower) (It will also be too flat and will deform the aluminum along the outer edge) Then it is too hot!
5. Reduce temperature back to setting with best appearance. The cad layout for fixing job shown below

Table 1: Properties of electrode materials

Material	Cu	P	Al	Si	Fe	C	O	Ca
Aluma-Steel	Bal.	5.0	0.4	0.7	0.2	13.2	3.3	0.1

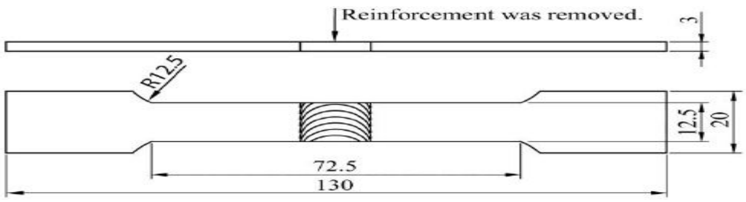

Figure 1: preparation drawing for tensile test

Figure 2: showing welding rod- filler rod

Method of TIG welding process for Al 6061and EN8

In TIG welding a differentiation is made between 2 variants. On the one hand, it is welding with direct current, which is the most frequently used type. The tungsten electrode is positioned on the negative pole. This form of welding is used to join alloyed steels as well as non-ferrous metals such as copper or brass. On the other hand, it is welding with alternating current. This type of welding is used to join lightweight metals such as aluminium and magnesium, as the oxide layer is broken up. In exceptional cases, however, lightweight metals are also welded with direct current, in which case the electrode is attached to the positive pole. In general, however, it can be stated that each metal suitable for fusion welding procedure can be welded using the WIG procedure.

Working procedure

For dissimilar material welds like EN8 and AL 6061 materials, primarily with aluma steel rod with #1 make a layer along the side of SS edge, make sure that the formation of layer should be even, wait up to the material cooled to ambient temperature. Take the AL6061 4mm plate and make sure that edges chamfer to fill the material layer between the two. The process will continue at filling layered between SS layer and aluminium plate with the second rod known as #2. The voltage should maintain between 120 to 140A to get good bead bind up after the weld.

Preparation of samples

Figure 3: Tensile and hardness testing samples

The materials Al6061 with EN8, are taken and as welding components for dissimilar weld amendment where the materials are machined for proper sampling for tests.

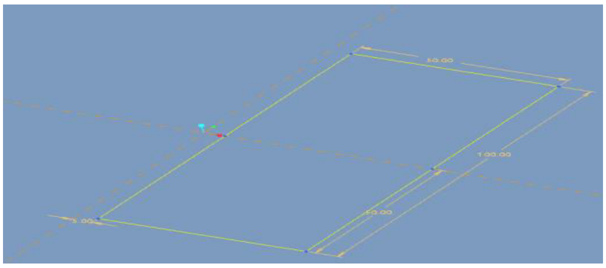

Figure 4: Drawing model

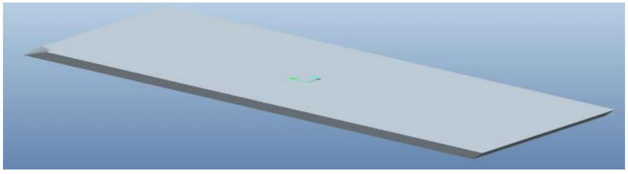

Figure 5: Al6061 plate

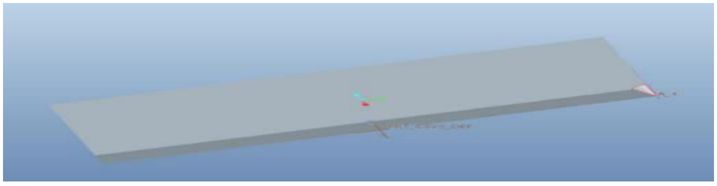

Figure 6: EN8 plate

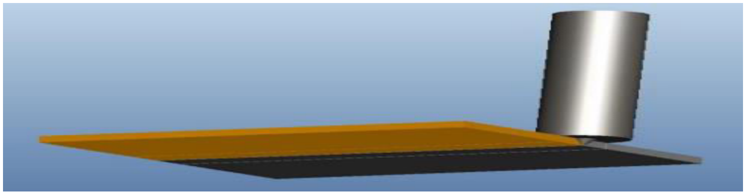

Figure 7: Assembled view

4.0 RESULTS AND DISCUSSIONS

The plates of Al6061 with EN8, SS302, SS316L is welded by using TIG welding methods. The quality of the weld depends upon various factors likewise welding speed, voltage.

Metallographic analysis of the bonding interface:

In this work Photomicrograph of the junctures between Al6061 with EN8, SS302, SS316L taken in the central region of the sample with an increase of 200X, the interface region is characterized by a straight line with some imperfections under the TIG welding process. For all the materials micro structural changes are not observed near the interface region as it occurs in fusion welding processes.

OM results for Al 6061 with EN8 weld:

In case of 20µm the weld bead strength is medium as the probability of crack propagation is influenced on Al6061 side

Table 2: Observed strengthening conditions for welded samples:

Distance	Al 6061 With SS316L	Al 6061 With SS302	Al 6061 With EN8
2	162	165	163
4	176	174	173
6	180	179	179

8	186	188	189
10	195	194	196

The graphical representation clearly shows the variation in Weld Strengths for all dissimilar welds at different distances of 2mm,4mm,6mm,8mm and 10mm. It is clearly observed the Al6061 with EN8, SS302, SS316 L weld is having high weld strength when compared with other two welds.

Table 3: Observed Crack propagation rate (m/cycle) for welded samples:

Distance	Al 6061 With EN8	Al 6061 With SS302	Al 6061 With SS316L
2	0.000076	0.000072	0.000075
4	0.000138	0.000139	0.000138
6	0.000148	0.000147	0.000150
8	0.000154	0.000153	0.000152
10	0.000168	0.000169	0.000169

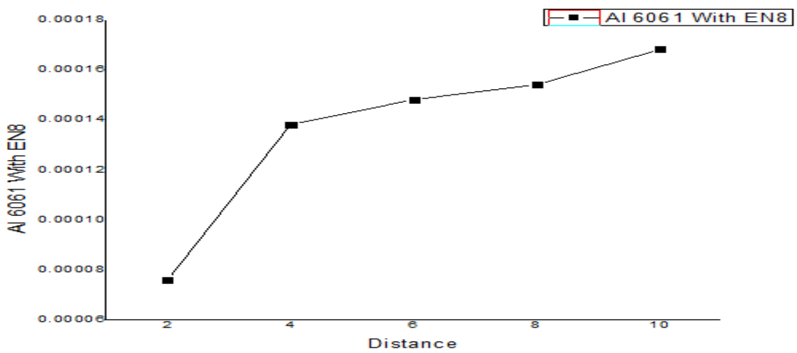

Figure 8: Crack propagation rate for different welded samples

Micro structural results:

The Al-EN8 plates are sold using stir welding techniques. The solder quality depends on many factors, such as welding speed, stress.

Sample-1 (Al6061&EN8) 60 Amps:

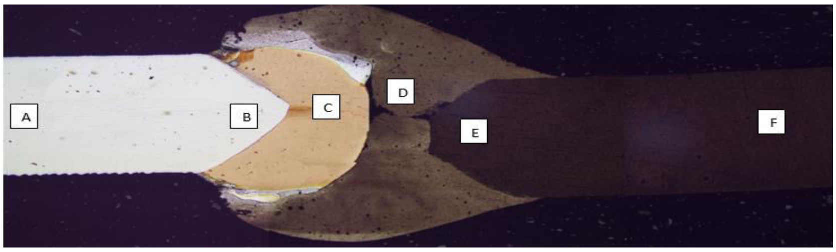

Figure 9: Welded Sample

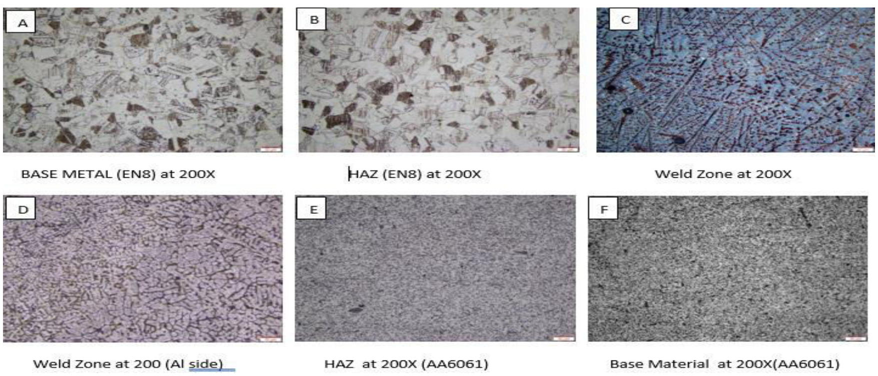

Figure 10: Sample-1 micro structure with different specimens in 60 Amps

Sample-1 (Al6061&EN8) 70 Amps:

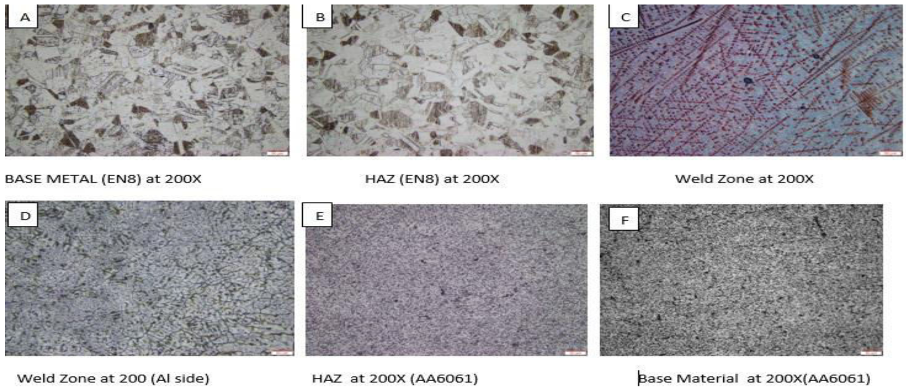

Figure 11: Sample-1 micro structure with different specimens in 70 Amps

Sample-1 (Al6061&EN8) 80 Amps

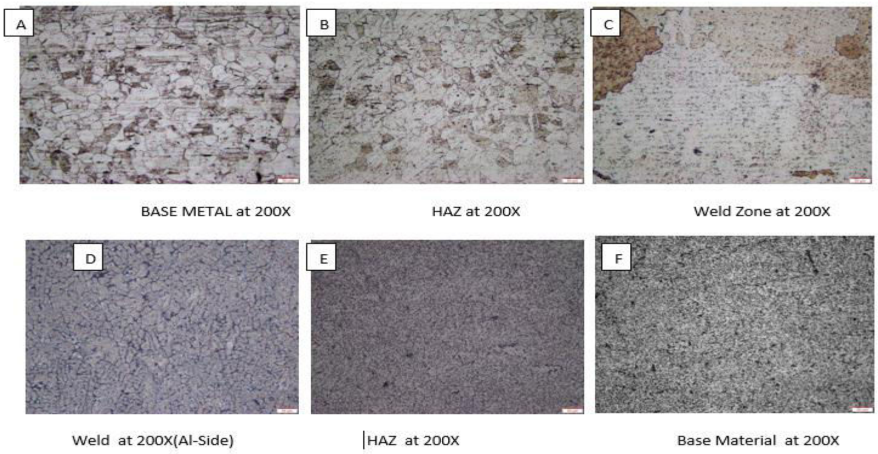

Figure 12: Sample-1 micro structure with different specimens in 80 Amps

Sample-2 (Al 6061&SS302) 60 Amps:

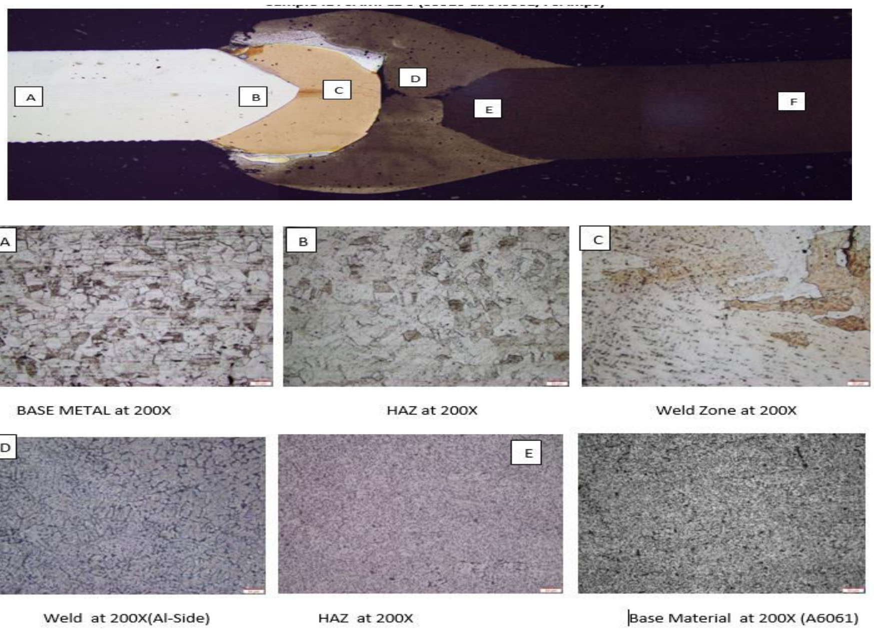

Figure 13: Sample-2 micro structure with different specimens in 60 Amps

Sample-2 (Al 6061&SS302) 70 Amps:

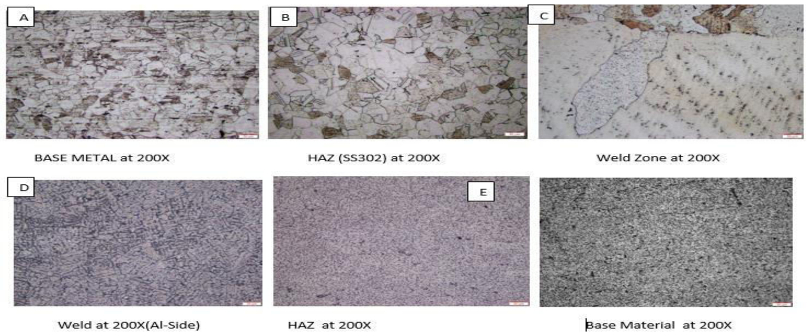

Figure 14: Sample-2 micro structure with different specimens in 70 Amps

Sample-2 (Al 6061&SS302) 80 Amps:

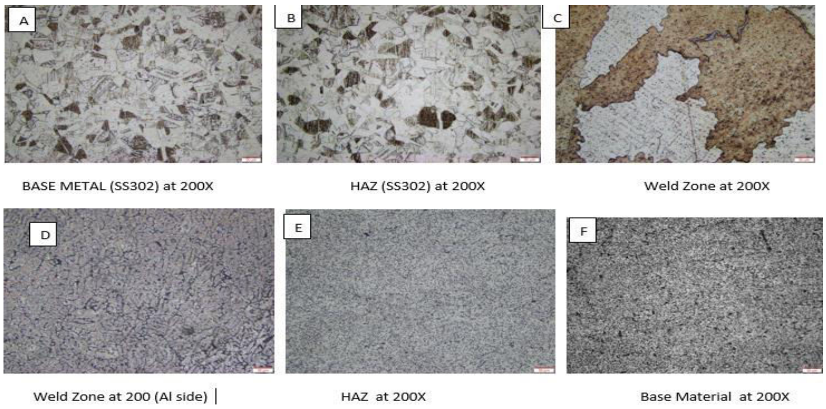

Figure 15: Sample-2 micro structure with different specimens in 80 Amps

Sample-3 (Al 6061&SS316L) 60 Amps:

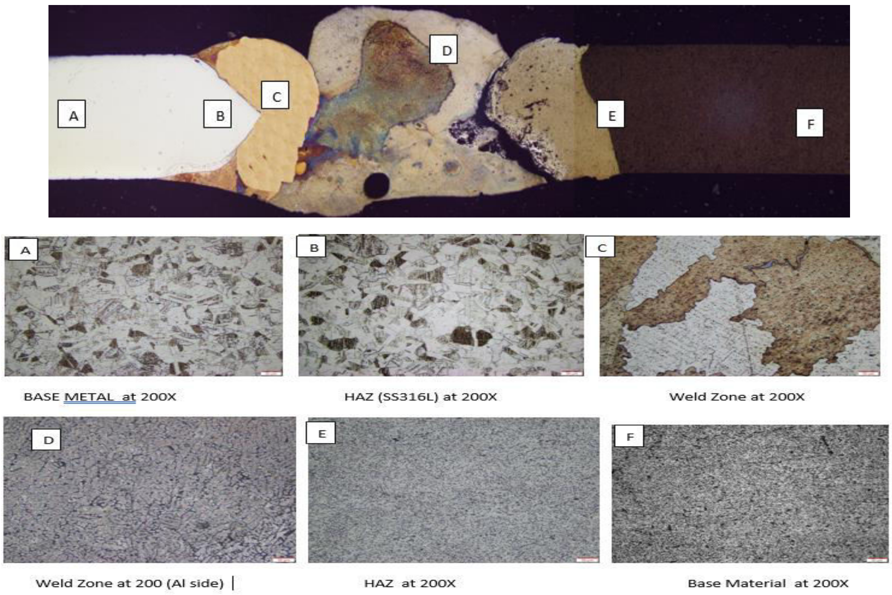

Figure 16: Sample-3 micro structure with different specimens in 60 Amps

Sample-3 (Al 6061&SS316L) 70 Amps:

Figure 17: Sample-3 micro structure with different specimens in 70 Amps

Sample-3 (Al 6061&SS316L) 80 Amps:

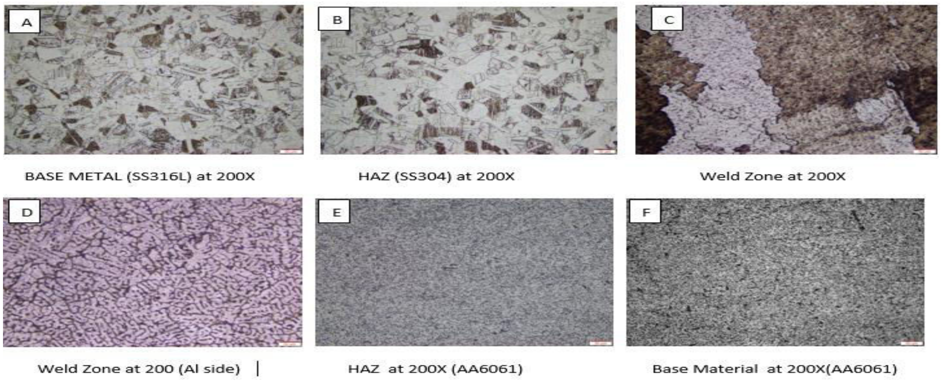

Figure 18: Sample-3 micro structure with different specimens in 80 Amps

Tensile:

Tensile testing is a destructive test process that provides information about the tensile strength, yield strength, and ductility of the metallic material. It measures the force required to break a composite or plastic specimen and the extent to which the specimen stretches or elongates to that breaking point. Tensile testing of composites is generally in the form of basic tension or flat-sandwich tension testing in accordance with standards

Sample-1 60 amps (Al6061&EN8)

Initial & Final Parameters			Observed Data			Speci. Values
Serial No		01	Ultimate Load	(kN)	5.48	
Specimen Type		Flat	Ult Tensile Strength	(MPa)	90.32	0
Specimen Width	(mm)	12.51	Disp at Ult Load	(mm)	4.80	
Specimen Thickness	(mm)	4.85	Maximum Disp	(mm)	7.20	
C/S Area	(mm²)	60.67	% Elongation	(%)	16.04	0
Original Gaugelength	(mm)	25.00	% Red in Area	(%)	87.09	
Final Gaugelength	(mm)	29.01	Breaking Load	(kN)	3.36	
Test Time	(min)	0:00.18	Breaking Stress	(MPa)	55.38	
			Yield Load	(kN)	2.28	
			Yield Stress	(MPa)	37.58	0
			Stress Rate	(MPa/S)	7.73	

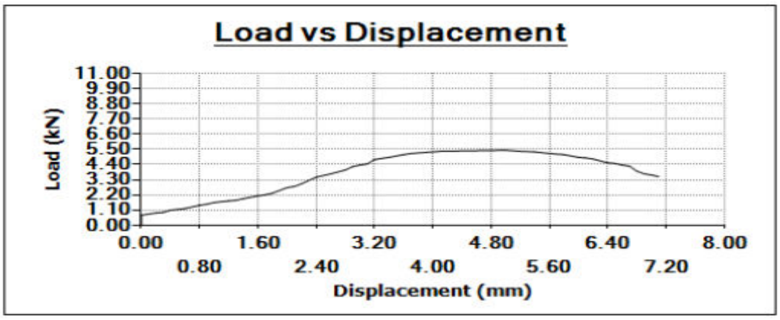

Figure 19: Load vs Displacement

Sample-1 70 amps (Al6061&EN8)

Initial & Final Parameters				Observed Data			Speci. Values
Serial No		:	02	Ultimate Load	(kN)	: 4.36	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	: 69.21	0
Specimen Width	(mm)	:	12.60	Disp at Ult Load	(mm)	: 3.00	
Specimen Thickness	(mm)	:	5.00	Maximum Disp	(mm)	: 3.00	
C/S Area	(mm²)	:	63.00	% Elongation	(%)	: 6.32	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	: 14.73	
Final Gaugelength	(mm)	:	26.58	Breaking Load	(kN)	: 4.36	
Test Time	(min)	:	0:00.11	Breaking Stress	(MPa)	: 69.21	
				Yield Load	(kN)	: 0.00	
				Yield Stress	(MPa)	: 0.00	0
				Stress Rate	(MPa/S)	: 4.42	

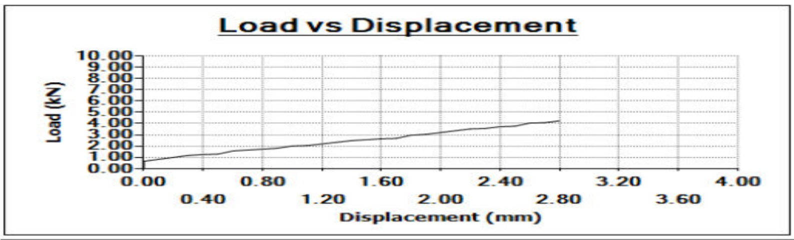

Figure 20: Load vs Displacement

Sample-1 80 amps (Al6061&EN8)

Initial & Final Parameters				Observed Data			Speci. Values
Serial No		:	03	Ultimate Load	(kN)	: 1.76	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	: 28.44	0
Specimen Width	(mm)	:	12.50	Disp at Ult Load	(mm)	: 1.20	
Specimen Thickness	(mm)	:	4.95	Maximum Disp	(mm)	: 1.20	
C/S Area	(mm²)	:	61.88	% Elongation	(%)	: 0.24	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	: 0.89	
Final Gaugelength	(mm)	:	25.06	Breaking Load	(kN)	: 1.76	
Test Time	(min)	:	0:00.05	Breaking Stress	(MPa)	: 28.44	
				Yield Load	(kN)	: 1.44	
				Yield Stress	(MPa)	: 23.27	0
				Stress Rate	(MPa/S)	: 7.03	

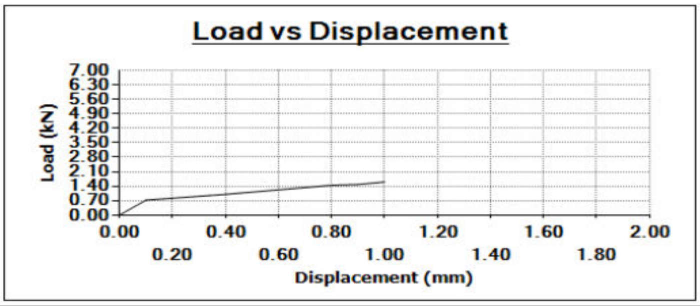

Figure 21: Load vs Displacement

Sample-2 60 amps (Al6061&SS302)

Initial & Final Parameters				Observed Data				Speci. Values
Serial No		:	04	Ultimate Load	(kN)	:	4.88	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	:	62.83	0
Specimen Width	(mm)	:	15.69	Disp at Ult Load	(mm)	:	3.60	
Specimen Thickness	(mm)	:	4.95	Maximum Disp	(mm)	:	3.60	
C/S Area	(mm²)	:	77.67	% Elongation	(%)	:	3.76	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	:	20.97	
Final Gaugelength	(mm)	:	25.94	Breaking Load	(kN)	:	4.88	
Test Time	(min)	:	0:00.09	Breaking Stress	(MPa)	:	62.83	
				Yield Load	(kN)	:	1.72	
				Yield Stress	(MPa)	:	22.14	0
				Stress Rate	(MPa/S)	:	5.14	

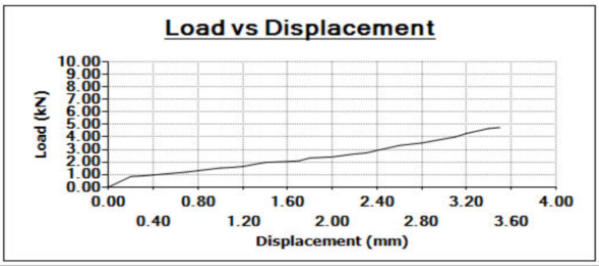

Figure 22: Load vs Displacement

Sample-2 70 amps (Al6061&SS302)

Initial & Final Parameters				Observed Data				Speci. Values
Serial No		:	05	Ultimate Load	(kN)	:	2.40	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	:	39.01	0
Specimen Width	(mm)	:	12.43	Disp at Ult Load	(mm)	:	2.10	
Specimen Thickness	(mm)	:	4.95	Maximum Disp	(mm)	:	2.20	
C/S Area	(mm²)	:	61.53	% Elongation	(%)	:	0.32	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	:	0.24	
Final Gaugelength	(mm)	:	25.08	Breaking Load	(kN)	:	2.28	
Test Time	(min)	:	0:00.09	Breaking Stress	(MPa)	:	37.06	
				Yield Load	(kN)	:	0.00	
				Yield Stress	(MPa)	:	0.00	0
				Stress Rate	(MPa/S)	:	4.37	

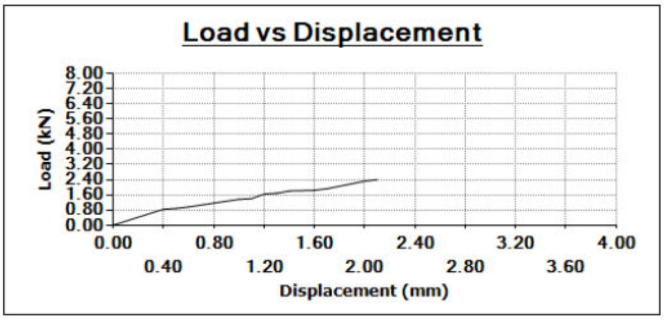

Figure 23: Load vs Displacement

Sample-2 80 amps (Al6061&SS302)

Initial & Final Parameters				Observed Data				Speci. Values
Serial No		:	06	Ultimate Load	(kN)	:	1.40	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	:	22.70	0
Specimen Width	(mm)	:	12.46	Disp at Ult Load	(mm)	:	1.20	
Specimen Thickness	(mm)	:	4.95	Maximum Disp	(mm)	:	1.20	
C/S Area	(mm²)	:	61.68	% Elongation	(%)	:	0.08	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	:	0.78	
Final Gaugelength	(mm)	:	25.02	Breaking Load	(kN)	:	1.40	
Test Time	(min)	:	0:00.04	Breaking Stress	(MPa)	:	22.70	
				Yield Load	(kN)	:	0.00	
				Yield Stress	(MPa)	:	0.00	0
				Stress Rate	(MPa/S)	:	10.40	

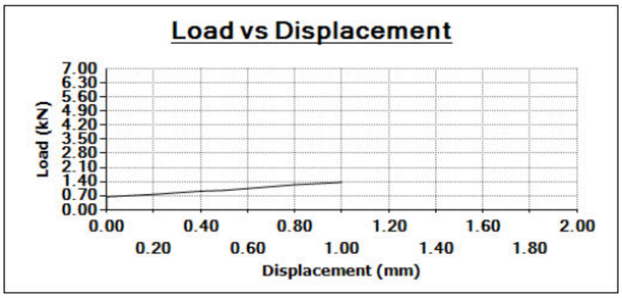

Figure 24: Load vs Displacement

Sample-3 60 amps (Al6061&SS316L)

Initial & Final Parameters

Serial No		:	07
Specimen Type		:	Flat
Specimen Width	(mm)	:	12.57
Specimen Thickness	(mm)	:	5.00
C/S Area	(mm²)	:	62.85
Original Gaugelength	(mm)	:	25.00
Final Gaugelength	(mm)	:	25.20
Test Time	(min)	:	0:00.06

Observed Data

				Speci. Values
Ultimate Load	(kN)	:	1.80	
Ult Tensile Strength	(MPa)	:	28.64	0
Disp at Ult Load	(mm)	:	0.90	
Maximum Disp	(mm)	:	1.10	
% Elongation	(%)	:	0.80	0
% Red in Area	(%)	:	0.29	
Breaking Load	(kN)	:	1.20	
Breaking Stress	(MPa)	:	19.09	
Yield Load	(kN)	:	1.36	
Yield Stress	(MPa)	:	21.64	0
Stress Rate	(MPa/S)	:	10.54	

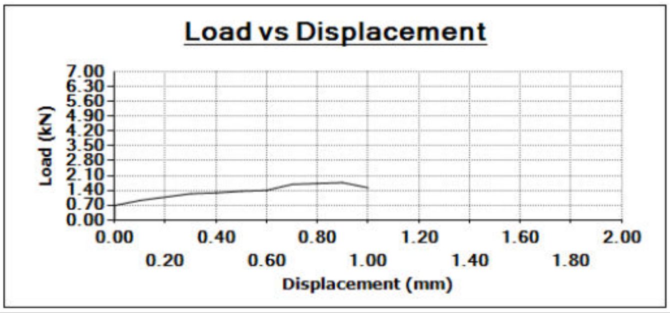

Figure 25: Load vs Displacement

Sample-3 70 amps (Al6061&SS316L)

Initial & Final Parameters

Serial No		:	09
Specimen Type		:	Flat
Specimen Width	(mm)	:	12.46
Specimen Thickness	(mm)	:	4.95
C/S Area	(mm²)	:	61.68
Original Gaugelength	(mm)	:	25.00
Final Gaugelength	(mm)	:	25.09
Test Time	(min)	:	0:00.05

Observed Data

				Speci. Values
Ultimate Load	(kN)	:	2.64	
Ult Tensile Strength	(MPa)	:	42.80	0
Disp at Ult Load	(mm)	:	1.80	
Maximum Disp	(mm)	:	1.80	
% Elongation	(%)	:	0.36	0
% Red in Area	(%)	:	0.86	
Breaking Load	(kN)	:	2.64	
Breaking Stress	(MPa)	:	42.80	
Yield Load	(kN)	:	1.96	
Yield Stress	(MPa)	:	31.78	0
Stress Rate	(MPa/S)	:	9.62	

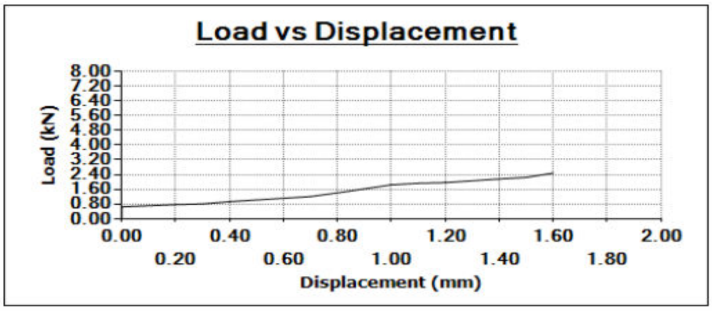

Figure 26: Load vs Displacement

Sample-3 80 Amps (Al6061&SS316L):

Initial & Final Parameters				Observed Data				Speci. Values
Serial No		:	10	Ultimate Load	(kN)	:	3.40	
Specimen Type		:	Flat	Ult Tensile Strength	(MPa)	:	54.95	0
Specimen Width	(mm)	:	12.50	Disp at Ult Load	(mm)	:	2.40	
Specimen Thickness	(mm)	:	4.95	Maximum Disp	(mm)	:	2.60	
C/S Area	(mm²)	:	61.88	% Elongation	(%)	:	0.36	0
Original Gaugelength	(mm)	:	25.00	% Red in Area	(%)	:	1.18	
Final Gaugelength	(mm)	:	25.09	Breaking Load	(kN)	:	3.32	
Test Time	(min)	:	0:00.09	Breaking Stress	(MPa)	:	53.65	
				Yield Load	(kN)	:	0.88	
				Yield Stress	(MPa)	:	14.22	0
				Stress Rate	(MPa/S)	:	4.30	

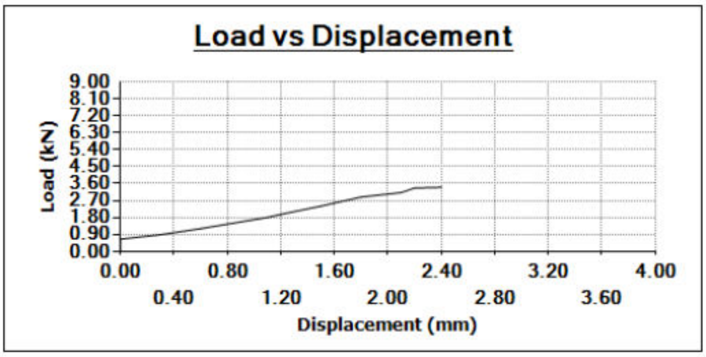

Figure 27: Load vs Displacement

Hardness test results:

Material **Hardness Testing** determines a material's strength by measuring its resistance to penetration. Hardness test results can be extremely useful when selecting materials, because the reported hardness value indicates how easily the material can be machined and how well it will wear. Hardness testing of metals is routinely performed to assess the value of treatments and coatings. Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation. More simply put, when using a fixed force (load) and a given indenter, the smaller the indentation, the harder the material

Table 4: Hardness test results in AA6061& EN8 Samples

S.ID	Sample ID	Observed Values in HV					
		BM EN8	HAZ EN8	Weld 1	Weld 2	HAZ AA6061	BM AA6061
1	**AA6061& EN8 (60Amps)**	180	218	131	101	33	39
2	**AA6061& EN8 (70Amps)**	181	209	141	107	31	36
3	**AA6061& EN8 (80Amps)**	164	203	146	108	35	38

Table 5: Hardness test results in AA6061& SS302 Samples

S.ID	Sample ID	Observed Values in HV					
		BM SS302	HAZ SS302	Weld 1	Weld 2	HAZ AA6061	BM AA6061
1	**AA6061& SS302 (60Amps)**	279	268	131	101	33	37
2	**AA6061& SS302 (70Amps)**	276	270	130	98	36	39
3	**AA6061& SS302 (80Amps)**	280	268	128	108	29	37

Table 6: Hardness test results in AA6061& SS316L Samples

S.ID	Sample ID	Observed Values in HV					
		BM SS316L	HAZ SS316L	Weld 1	Weld 2	HAZ AA6061	BM AA6061
1	**AA6061& SS316L(60Amps)**	264	186	165	106	36	39
2	**AA6061& SS316L(70Amps)**	261	179	160	103	36	39
3	**AA6061& SS316L(80Amps)**	260	183	162	101	36	37

Discussions

As per the specimens observed from the experiment's a flow has been taken from the initiation that dissimilar metal weld possibilities and its strengthening properties observed in a proper manner with the researched filler rods. The filler electrodes used in final Al 6061with EN8, SS302, SS316L weldment pre observed with dissimilar welds A big attractiveness of these joining methods results from many technical and economic advantages, such as high efficiency and stability of the process or better conditions of occupational safety and health than in the case of traditional welding technologies. However, recently, the most important seems to be the possibility of joining materials with different properties. Due to the fact that in the fusion zone between the two different materials the intermetallic compounds are formed and the joining process of dissimilar materials is often very difficult. To obtain high-quality joint it is necessary to know and analyze phase diagram of the two welded materials. Furthermore, the microstructure and different properties of intermetallic phases, such as crack sensitivity, ductility, and corrosion resistance, are also very important.

Conclusions and future scope

- The dissimilar joining between Al 6061with EN8, SS302, SS316L alloys by TIG welding process using Aluma-Steel welding rods.
- The main conclusion and aim to control the weld defects in dissimilar metal welds, the percentage of EN8with 0.15 control the thermal defect in aluminium, the procedure followed for TIG weld should be in a continuous manner.
- The temperature should be down to 30to 60^{0}c after each layer formed to reduce thermal cracking for next addition. By observing micro structures and mechanical properties TIG weld has speed and frequency on response variables such as weld bead hardness and impact strength has been thoroughly studied. The weld amendment is more significant process parameters for responses, weld bead hardness and impact strength.
- The process tested with all relevant materials before aluminium and SS metal welding. The thickness of materials varied by 4mm to 3mm respectively to check the irregularities of the filling.
- When there is misalignment, stress distribution becomes more complex. During the axial loading, eccentricity rises bending stresses near the vicinity of the weld. Therefore, total stress on the welded joint becomes the sum of axial stress as well as bending stress.

Future scope

- ➢ Present study given a base scope of elaborating aluminium and Ferro metal welds in a proper manner; this should be encouraged in an economical way for industries.
- ➢ More researches needed in filler materials i.e electrodes develop in such a way to control weld cost in structural sectors.

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