



Design and micro structure analysis of tig welding with to dissimilar materials

M C Ramanjaneyulu¹, Kandukuri Narendra², Gone Shanthi Raju³, Neelam Manoj Chandra⁴, Pidugu Durga Trinadh⁵, Yalakapati Eliya⁶

¹ Assistant Professor, Department of Mechanical Engineering, ABR College of Engineering and Technology, Andhra Pradesh- 533437

^{2,3,4,5,6} Students, Department of Mechanical Engineering, ABR College of Engineering and Technology, Andhra Pradesh- 533437

ABSTRACT:

In the present work, the effect of post weld heat treatment on the microstructure and mechanical properties of dissimilar weldments of Al6061 and 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 weldments 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 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.

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. 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 analyzed 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). The purpose of this work is to produce weld joints with maximum impact of strength and hardness. 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. Welding of dissimilar metals between stainless steel and carbon steel has been widely used in engineering practice over the years. Divya Deep Dhancholia [4] These alloys face 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 et al [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.

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.

TIG welding procedures: The designation TIG comes from USA and is an abbreviation of Tungsten Inert Gas. Tungsten - also called wolfram - is a metal with a fusion point of more than 3300°C, which means more than double the fusion point of the metals which are usually welded. Inert Gas is the same thing as inactive gas, which means a type of gas that will not combine with other elements.

Electric Safety in TIG Welding:

Electricity is a good servant, but a hard master. The electrical danger of electric arc welding is usually quite small if the necessary safety regulations are observed. Open Circuit Voltage Welding equipment must observe the allowed present open circuit voltages as indicated in the current electrical regulations. Equipment for manual or semiautomatic operation:

- Alternating current - 80 V (effective value)
- Direct current ripple voltage > 10% 80 V (effective value)
- Direct current ripple voltage < 10% 100 V (mean value)
- Transportable equipment for private use - 70 V (effective value)

Materials

The materials Al 6061 with EN8, i are taken and as welding components for dissimilar weld amendment where the materials are machined for proper sampling for tests.

Table: 3.1 Chemical compositions of materials used in present study

Materials	Young's Modulus (E)		Tensile Strength Mpa	Yield Strength Mpa	Elongation (%)
	Psi	Gpa			
Al6061 with EN18	297000ksi	215	440	370	15.0

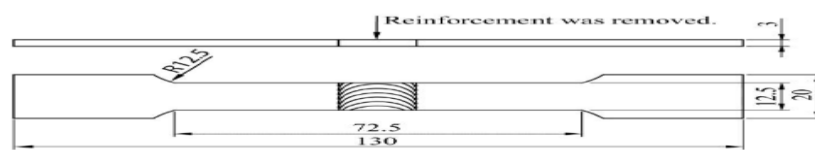


Figure 3.2 shows the preparation drawing for tensile test



Figure 3.3: showing welding rod- filler rod

Method of TIG welding process for Al 6061 and 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.

Preparation of samples



Table 3.4: Tensile and hardness testing samples



Table 3.5: Sample after etching for micro hardness



Figure 3.6 : Samples for SEM and XRD

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.

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 20 μ m the weld bead strength is medium as the probability of crack propagation is influenced on Al6061 side 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: 4.1 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

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:

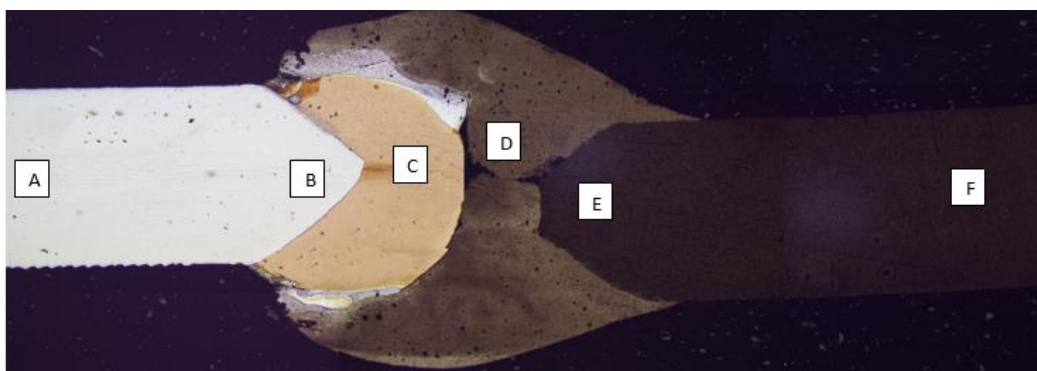


Figure 4.1 Welded Sample



Figure 4.2 : Sample-1 micro structure with different specimens in 60 Amps

Sample-1 (Al6061&EN8) 70 Amps:

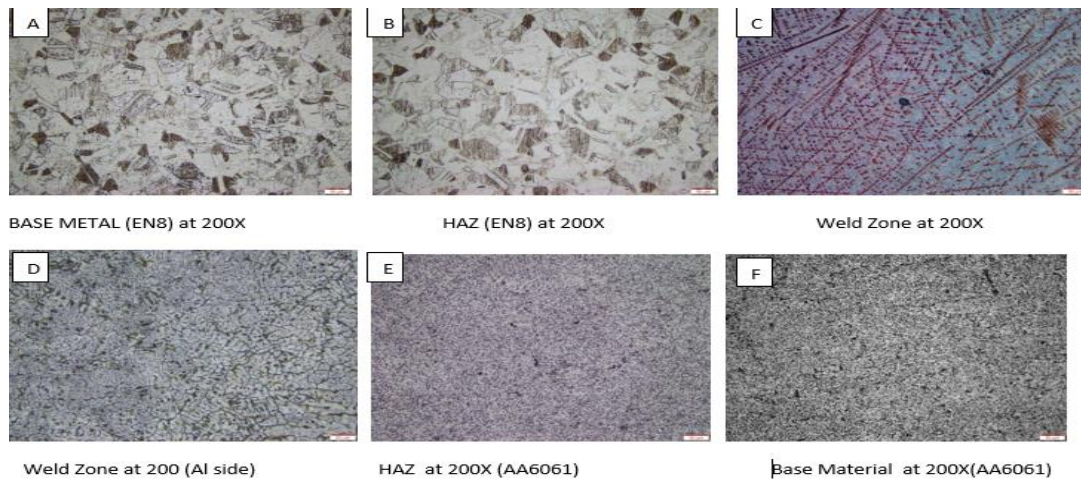


Figure 4.3 : Sample-1 micro structure with different specimens in 70 Amps

Sample-1 (Al6061&EN8) 80 Amps

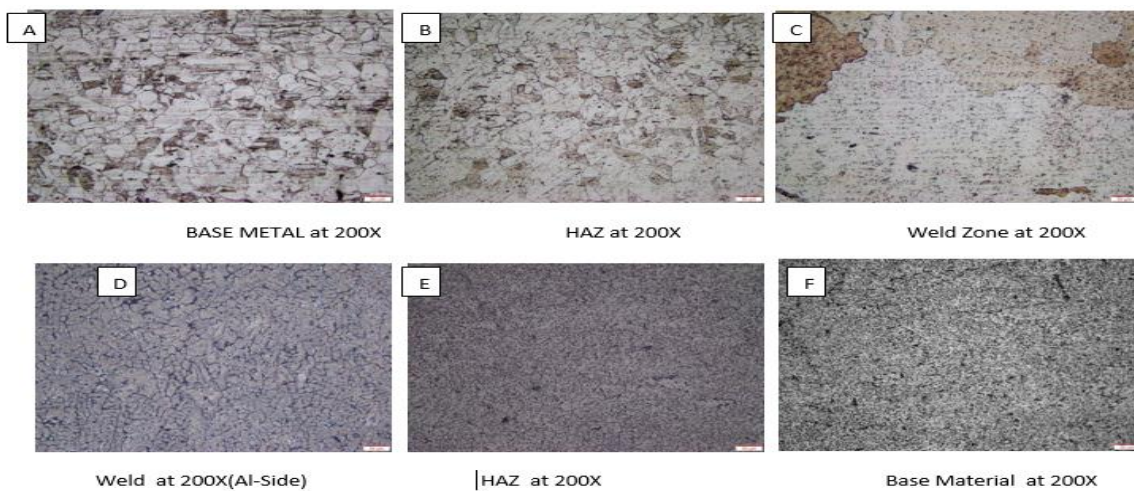


Figure 4.4: Sample-1 micro structure with different specimens in 80 Amps

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

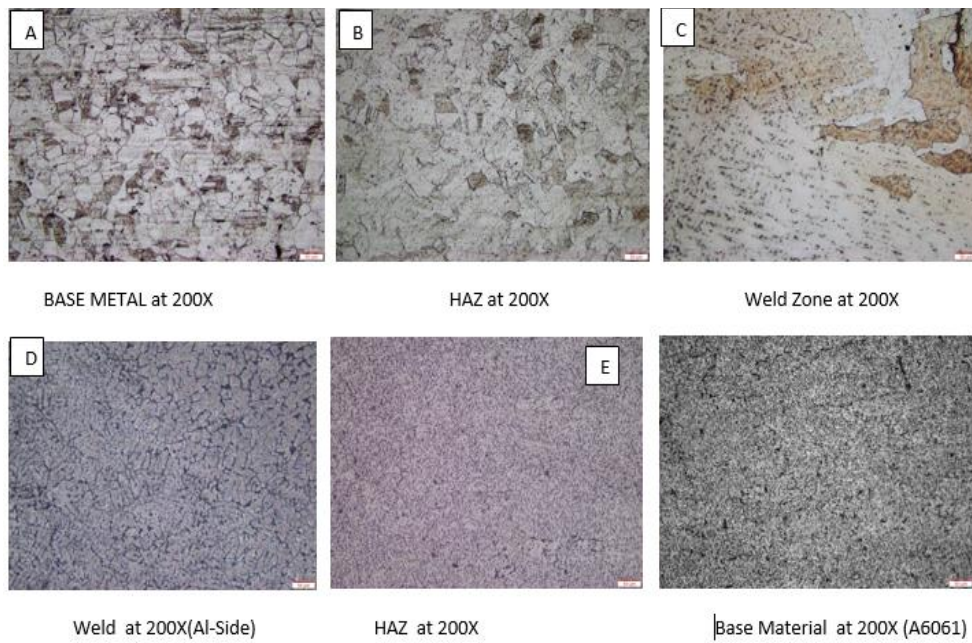
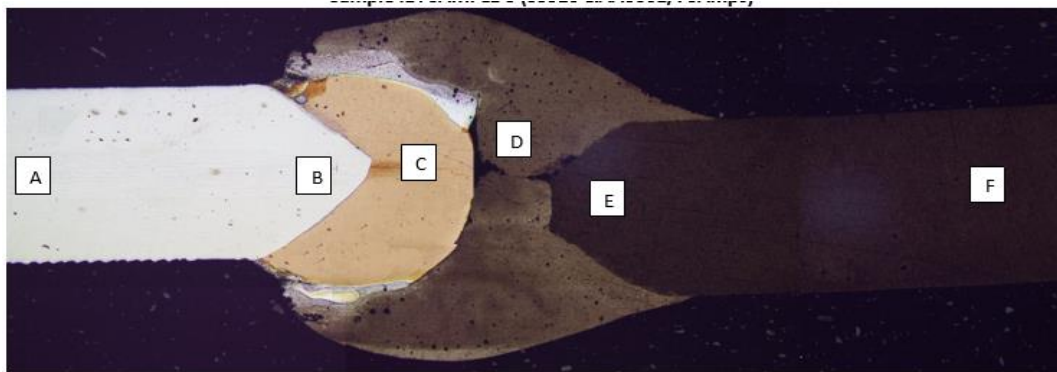


Figure 4.5: Sample-2 micro structure with different specimens in 60 Amps

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

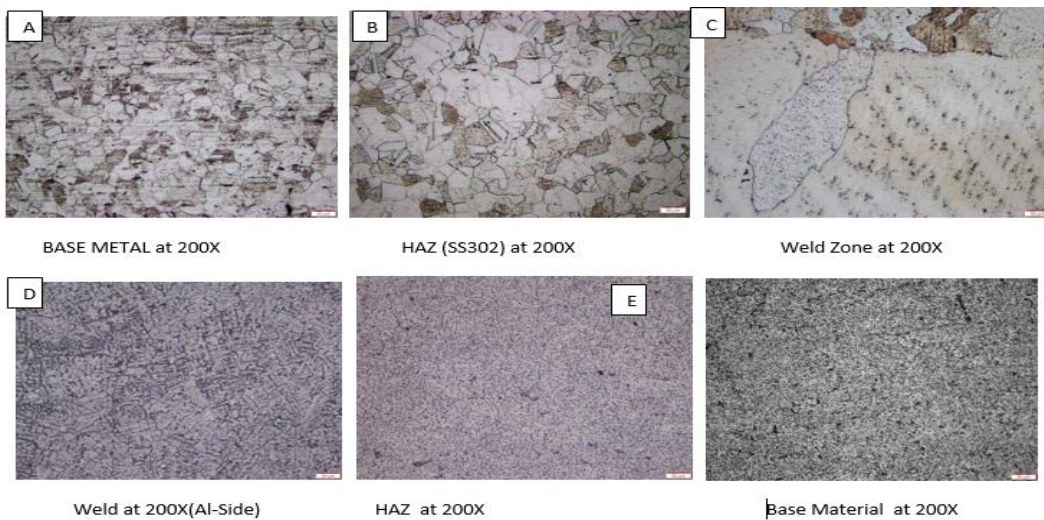
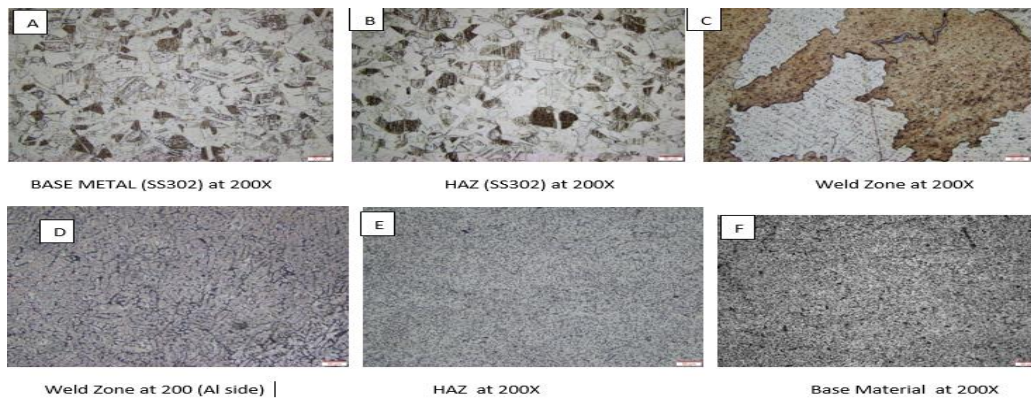
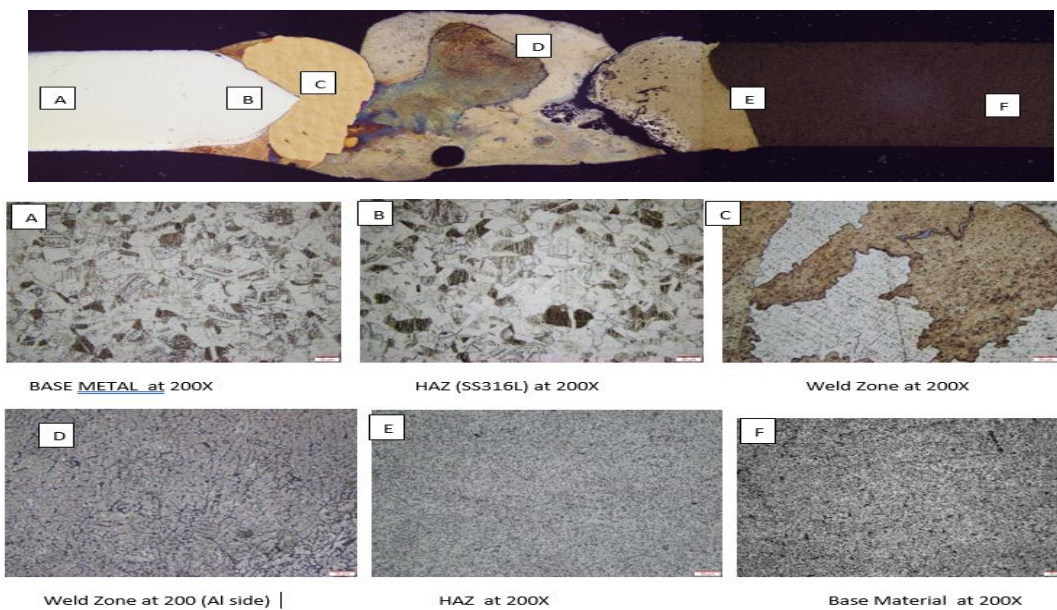
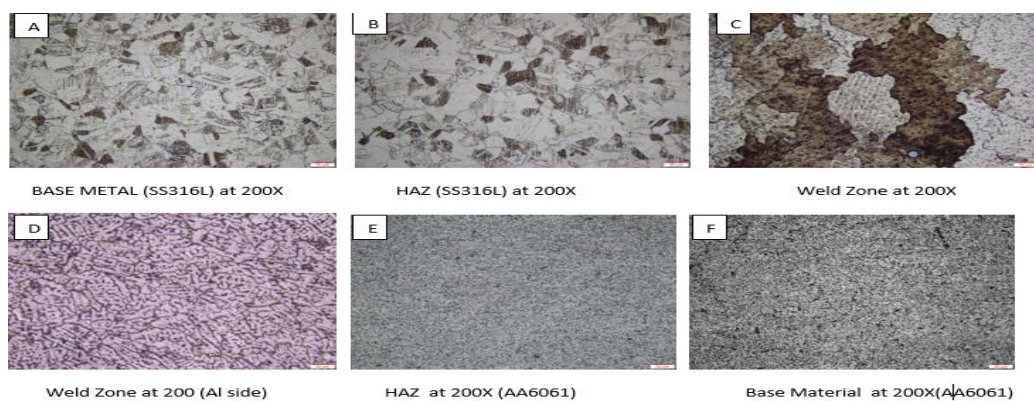


Figure 4.6: Sample-2 micro structure with different specimens in 70 Amps

Sample-2 (Al 6061&SS302) 80 Amps:**Figure 4.7: Sample-2 micro structure with different specimens in 80 Amps****Sample-3 (Al 6061&SS316L) 60 Amps:****Figure 4.8: Sample-3 micro structure with different specimens in 60 Amps****Sample-3 (Al 6061&SS316L) 70 Amps:****Figure 4.9 : Sample-3 micro structure with different specimens in 70 Amps****Sample-3 (Al 6061&SS316L) 80 Amps:**

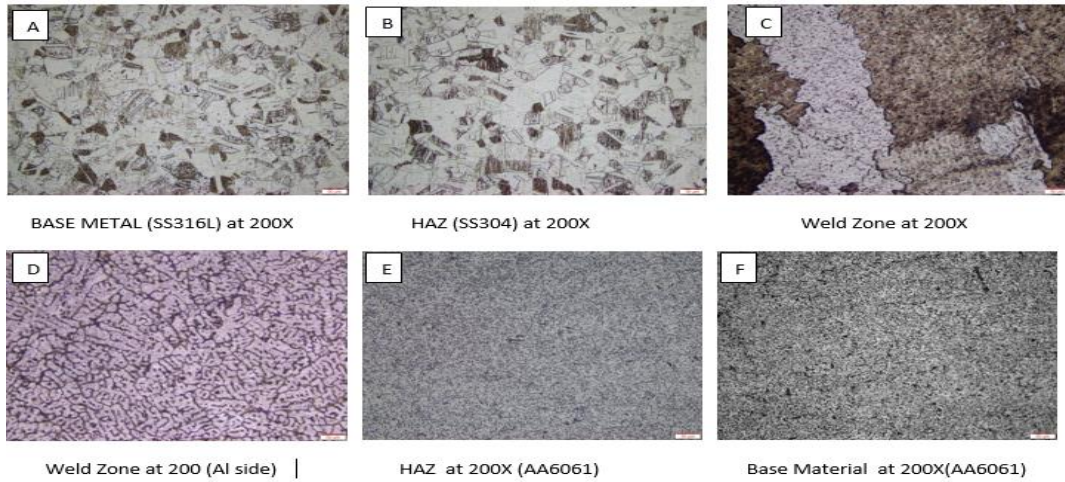


Figure 4.10 : Sample-3 micro structure with different specimens in 80 Amps

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)

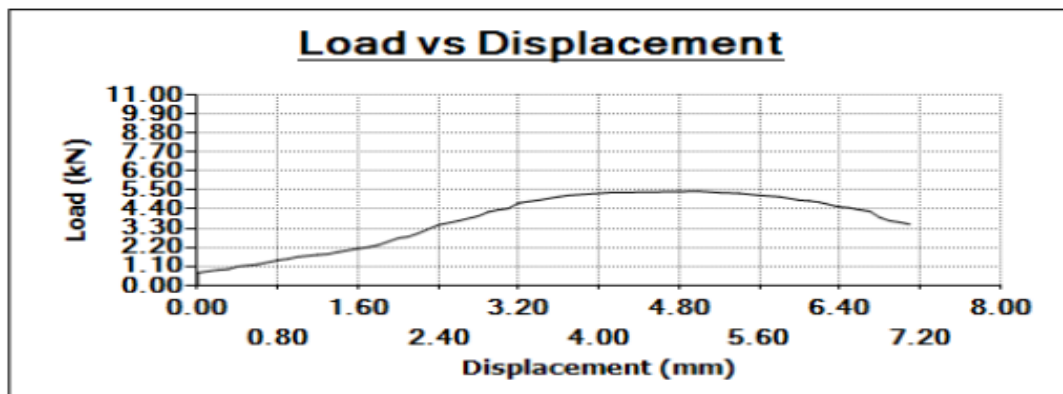


Figure 4.11 : Load vs Displacement

Sample-1 70 amps (Al6061&EN8)

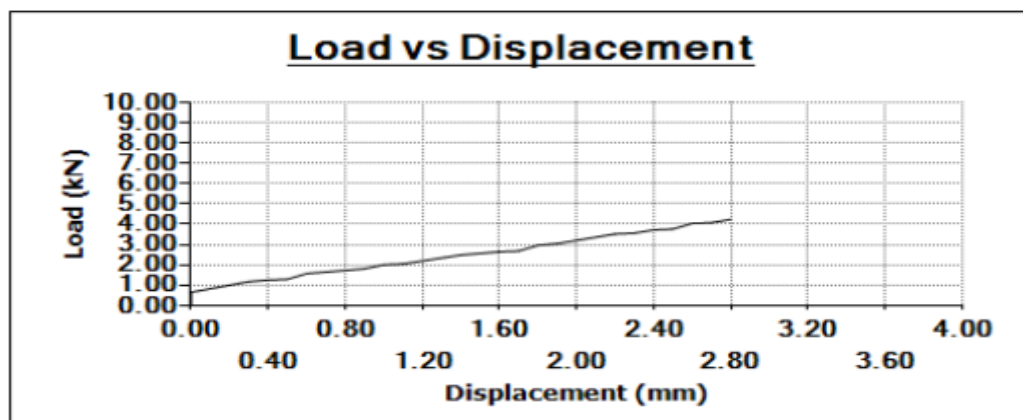


Figure 4.12: Load vs Displacement

Sample-1 80 amps (Al6061&EN8)

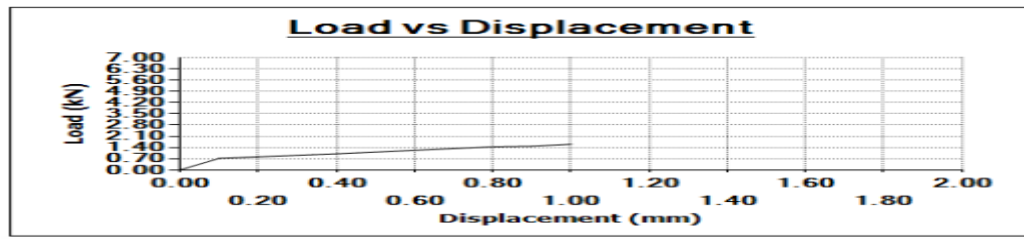


Figure 4.13: Load vs Displacement

Sample-2 60 amps (Al6061&SS302)

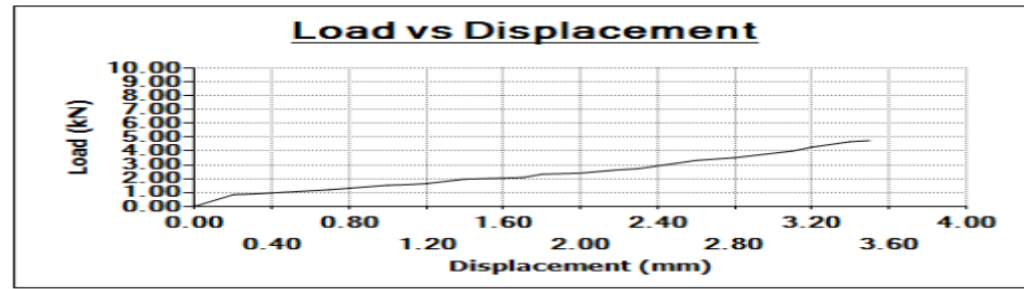


Figure 4.14: Load vs Displacement

Sample-2 70 amps (Al6061&SS302)

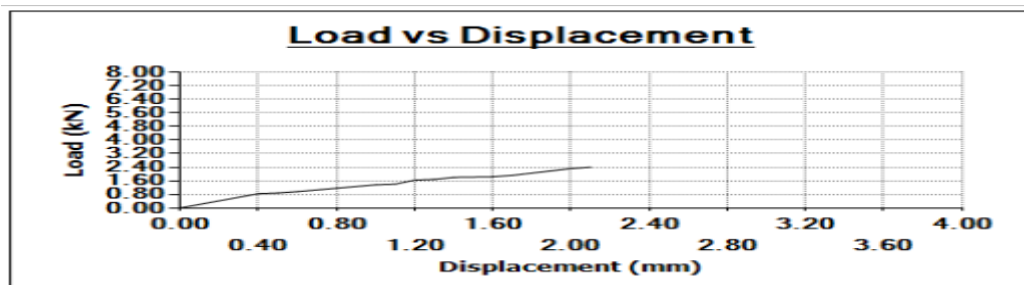


Figure 4.15: Load vs Displacement

Sample-2 80 amps (Al6061&SS302)

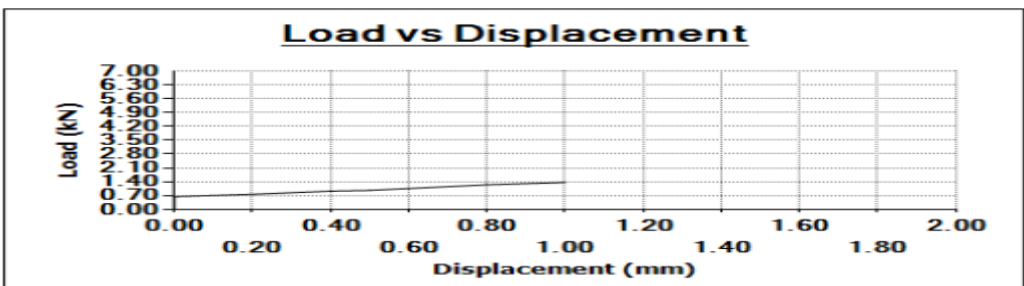


Figure 4.16: Load vs Displacement

Sample-3 60 amps (Al6061&SS316L)

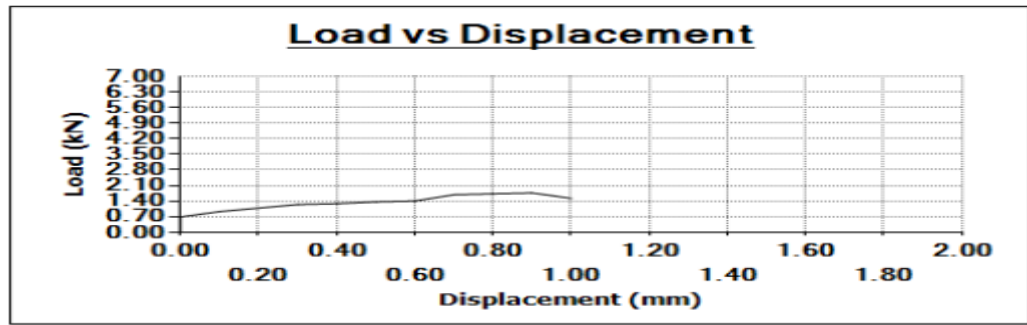


Figure 4.17 : Load vs Displacement

Sample-3 70 amps (Al6061&SS316L)

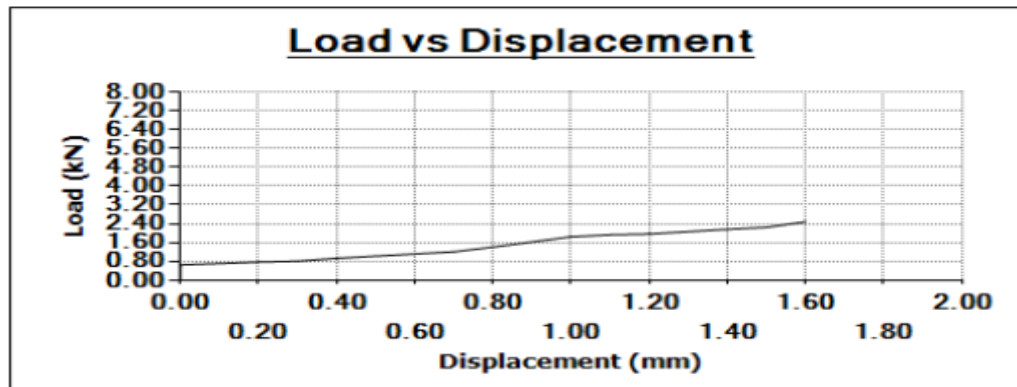


Figure 4.18: Load vs Displacement

Sample-3 80 Amps (Al6061&SS316L):

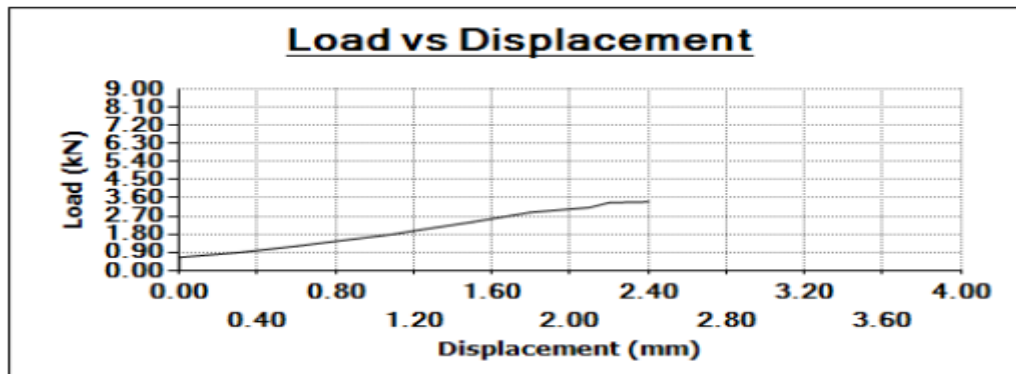


Figure 4.19: Load vs Displacement

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.

Table 4.2: 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 4.3: 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 4.4 : 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 6061 with 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 6061 with 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 EN8 with 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 30 to 60^oc 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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