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Analysis and Optimization of Shielded Metal Arc Welding Parameters on Mechanical Properties of Dissimilar Materials

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ABSTRACT

Shielded metal arc welding is the most efficient and economical process through which it can easily weld. Residual stress is prompt in the welding process. In, some of cases, there is entrapment and deformation that can endanger the coherence of welding properties. So, the mechanical properties of welded joints can be changed accordingly to the heat-affected zone. In this study, the joint between two dissimilar AISI304 steel and Mild steel having a thickness of 5mm which is welded through a shielded metal arc welding (SMAW) in the V-groove shaped has been produced. In this research, we examines the mechanical properties of the material and their experimental and numerical analysis can also be measured through the Ultimate Tensile test, which introduces the entrapment and distortion of the finite element. It mainly focusses on final outcomes of the accuracy and strength of the material has been investigated.

Keywords: shielded metal arc welding (SMAW); dissimilar materials; distortions; residual stresses; HAZ; Mechanical properties.

I. INTRODUCTION

1.1 General

Welding is a technique which made a contribution to the mechanical properties of the fabricated parts .Welding can be used in the field of engineering due to its advantages which offered in the terms of time saving , costs , design flexibility and time management. Now a days, many of the welding processes can used in the industrial sectors due to, it save their time management and improve the casting of the material in industrial sectors. All these welding process require the high heat and pressure which cause the material to fuse and create a strong metallurgical properties. Welding help us to create a significant properties to bulids a different types of welding parameter. In Industry likes in automotive, aerospace and in manufacturing it perform a variety of techniques. Welding can also be defined as joining process in

which attachment of two or more similar or dissimilar materials joint permanently or temporary.

The accurate evaluation of residual stresses induced by the fusion arc welding of steel joints is of great interest, especially for applications in power plants, where welded joints made of dissimilar materials are widely used to connect ferritic steel components and austenitic steel piping systems. It's important to note that residual stress cannot be completely eliminated from a welded component, but it can be minimized to a level that is acceptable for the intended application. Proper welding techniques and careful consideration of material properties can help to reduce the likelihood of residual stress and ensure a safe and effective weld.

In recent years, destructive and non-destructive techniques have been developed to obtain information regarding the stress–strain levels in welded structures in terms of both amplitude and distribution. However, their level of accuracy does not allow for the obtaining very accurate information, and the latest advances in numerical simulation can be very helpful.

1.2 Shielded Metal Arc Welding (SMAW)

Shielded metal arc welding is also known as Manual metal arc welding (MMAW) or Stick electrode arc welding. This welding is a type of fusion welding(In which the interface of the workpiece will melt because of heat). It is the single most used welding process in the world. In this welding process a coated electrode is used to produce arc which is the source of heat that melt the material.

The coating on burning will produce shielding gas which protect molten metal and electrode from ill effect of atmospheric gases like oxygen and nitrogen. In this welding process both AC and DC power supply can be used equally effectively.

1.3 Working Principal of SMAW

Shielded metal arc welding process is the most widely used process in different industry along the world. This process is very durable in nature.

a) The electrode arc is generated by touching the tip of electrode to the workpiece then it drawing the electrode to sufficient distance, So that electric arc will be stabilized it.
b) The weld pool produce in these welding depends upon diameter of the electrode and electric current.
c) The pool may vary from very small to fairly large.
d) Large sized pool is used in down hand welding.
e) This process is an all position welding and used for all types of job.

1.4 Objective

The objective of SMAW Process is to create a permanent and strong bond between two metals or components and resulting a strong or high quality weld having a good strength and durability which meets the application it is designed for.

- The main important objectives of SMAW process is that they have a good or high strength and having good durability.
- The filler metal and the base metal having good penetration rate which help to create a strong bond on the base metal.
- Its main objective is to promote minimal distortion which help to wrap or distort significantly.

II. LITERATURE REVIEW

Hassan et al. (2002);

He Studied the tensile strength of AA7010 joints. In this research, it examines the tensile strength is low with lowest the transverse spindle speed. The tensile strength is increases with increase the rotational speed of spindle.The nugget zone is more ductile compare to the base metal of the optimum spindle rotational speed.

Woei-Shyan Lee (2004);

In this paper, Mr. Woei-Shyan presented a study on dynamic shear deformation behavior of 304 stainless steel with the help of shielded metal arc welding. In this study,it examine the flow of residual stress , and total shear strain failure . In this the stainless steel

plates can be annealed at 1050 degree celcius for 1 Hour and after that we have allowed that to cool with the help of air in order to remove the residual stress. In this paper, author can investigate the mechanical properties of same material i.e. stainless steel (304L grade) to differenciate with similar material and they also found out that the residual stress is coming from the angle to the welded section.

Jayaram and Shiva (2011);

In this research, he observed and investigated the experiments with the help of taguchi Methods to optimize the shielded metal arc metal of similar joints. In this study, we find the mechanical properties like tensile strength with taguchi method. In this parameters such as axial force, welding speed were optimized to achieve the higher tensile strength at all levels of parameters. Experiments are conducted as per Orthogal Array and ANOVA(Analysis of variance).

Rohit Jha (2014);

In this paper Mr. Rohit jha investigated on the mild steels material through which he find out the tensile and other strength of the materials. In this he examine the optimum current of the welding. The component can be investigated with the help of tensile testing where he discover the max welding current of about 120amp. With increase the welding current on the specimen it obtained the optimum and maximum value of the tensile strength.

K. Karthick (2018);

In this study Mr. K Karthick discussed on different material like ferritic steel and Austenitic steels and weld with the help of shielded metal arc welding, when he performed the test he discover that the tensile strength of the material is low in comparision the other materials. From this the failure can be occurred at the outer of the heat effective zone on the Ferritic material. The presence of the carbon enriched are formed during the carbon migration this the only reason behined the increase of tensile strength on the other component of the material.

III. Material Selection

In this research paper we can examine or investigates the tensile strength of material with different welding parameters. In previous research papers the test of tensile strength basically done on the same material like mild steel, stainless steels and dissimilar materials like ASS and low hydrogen material like ferrite materials. So, here we can examine the tensile strength of dissimilar material with the combination of Mild steel and Stainless steel with different parameter (Voltage and current) with the help of SMAW(Shielded Metal Arc welding) process.

2.1 Mildsteel

Mild Steel is an most important material in which it carry iron alloy with carbon as its alloying element. Mild steel is the most commonly used material in all types of applications and it is the one of the widely used steel in Industry. The cost of the mild steel compare than other material is low and having good strength and excellent weldability and machinability. There is various types of grades of mild steel in which the composition of all the carbon content is different. In such of the cases some additional alloying element can be added to improve their strength , wear & tear resistance and corrosion resistance. Mild steel is basically made up of an iron (Fe) content with the combination of some amount of carbon. All the different level of carbon is present in different grades of mild steel. And another common alloying element which is also added in small amount is manganese (Mn).

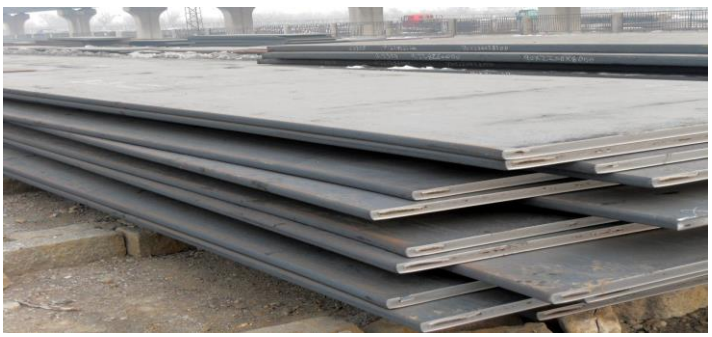

Fig-1 Mild Steel

Some Mechanical Properties of Mild Steel

Here the some of the mechanical properties present in different types of Mild Steel are listed below the table.

Table-1

Types of Mild Steel	Modulus of elasticity(Gpa)	Brinell Hardness	Ultimate Tensile Strength (Mpa)	Yield Strength(Mpa)	Elongation at Break(%)	Steel Density kg/m3
AISI 1008	200	95	340	285	20	7.87
AISI 1010	205	105	365	305	20	7.87
AISI 1015	205	111	385	325	18	7.87
AISI 1018	205	126	440	370	15	7.87
AISI 1020	186	121	420	350	15	7.87
S275 J0	205	121	430-580	275	21	7.85
S355 J0	210	146	510-680	355	20	7.80

2.2 Stainless Steel 304

Stainless steel 304 is the special type of stainless austenitic steel. This type of steel contains about 18% of chromium , 8% of nickel and combination of carbon about 0.08% carbon. This type of stainless steel is also called as Chromium-Nickel austenitic alloy.

Some of the characteristics of SS 304 are as follows:

1. These steel having a low temperature properties .
2. Easy to fabricate, cleaning , appearance is good.
3. Due to present of chromium content it is corrosion resistant.

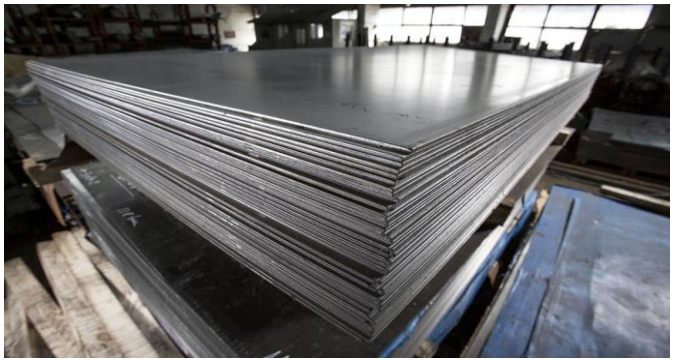

Fig-2 Stainless steel (https://www.metalsupplies.com/products/stainless-steel-sheet/)

Microstructure of Stainless Steel 304

These types of steels are basically used in industry because of corrosion resistance. Due to poor machinability, they have higher workhadening and having low thermal conductivity. High alloy element contains such as Manganese and Nickel, that stabilize austenite into the austenitic stainless steel at room temperature.

The finite element method is a very or most important tool to compare results and to observe temperature, strain and stress during the cutting process. Complimentary techniques allow observing strain induced martensitic and its formation can be related with chip formation can be reached during cutting. The main objectives of this work contains are:

1. The main objective is that to obtained the temperature distribution in chip throughout machining by means of finite element method.
2. These stainless steel is to detect the martensite formation in the chip formation obtained from machining. B
3. There is formation of strain- induced martensite and distribution of temperature gradients.

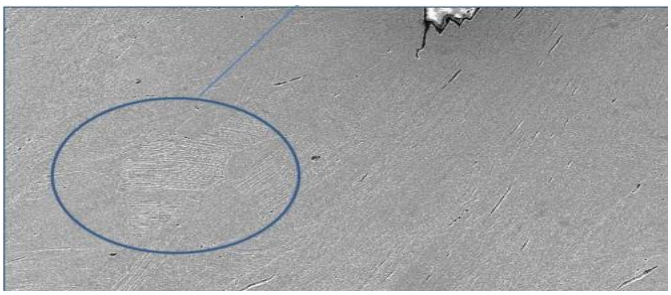

Fig-3 Microstructure of AISI 304 austenitic Stainless Steel

IV. Methodology and Experimentation

The material used in this experiments, is Mild Steel and Stainless Steel 304 with the length 50mm, Width 100mm and thickness 5mm. The welding joint was designed with V groove . The AWS6013 rod of 3.15*350mm diameter filler material was used for welding process. The strength of test of specimen was carrying out by tensile test which will be perform on Universal testing machine.

Fig-4 Test Specimen(Stainless Steel 304 and Mild steel)

S.NO.	Parameters	Specification	SMAW
1.	Current	Current Range	90-120 AMP
2.	Pass	Type	Single
3.	Filler Rod	Type and Material	Rod, AWS6013

Table-2 Parameters Used during welding Process

3.1 Experiment Procedure

Dilution In Welded Zone

Dilution is the process of mixture of base metal and deposited weld metal in the specimen. It can also can defined as the chemical composition of filler material deposited in the weld bead. Dilution effects the mechanical and corrosion properties. It can also be reduced by the welding techniques. High Dilution will decrease the effect of corrosion resistance this is due to higher carbon content. If we reduce the dilution, we increase the distance between the specimen and electrode.

The length of the welded zone of stainless steel through shielded metal arc welding is higher rate of dilution of the weld zone.

Tensile Test

Tensile Testing is the most important form of testing to find out the mechanical properties of any specimen. This type of testing is also called as a tension testing or a type of destructive testing where we test strength of the material. This testing is used to find the efficiency of the material that how strong the material. With the help of this method we usally find or determine the Young' modulus , poisson ratio, ductility, ultimate strength and yield strength of the material. Tensile Testing can be carried out by using universal testing machine of about 400KN capacity. Through this we can find out the mechanical properties of SMAW welded dissimilar welds of Stainless Steel 304 and Mild Steel respectively. The strength of tensile test is vary from 394 MPa to 457 Mpa its all depending on the welding condition. All the test specimen broken in the weld region.

Shielded Metal Arc welding is a flux coated electrode in which it build the arc between the work piece and electrode. In this phenomena molten metal is travels via electric arc and have been deposited into the work piece. SMAW is the most oldest form the welding process, this welding process is the most simplest process among the other welding with good efficiency and good profile in nature. In this process the flux coated is used to protect the welding metals from the oxidation. When it is deposited into the weld metal, it resurfaces the slag formation into the weldments. These shielded metal arc welding are most versatile in nature and have quite good due to its portability. In industries these welding process help us to generate

good efficiency with proper work and it have more volatile in nature. These welding cause more effects among than other welding process.

		Tensile Strenght of SS304 Join with Mild Steel(MPA)		
Test Samples	Current(Amp)	Tensile Strenght(MPA)	Welding Electrode Dia(mm)	Welding Electrode Grade
TS 1	90	164	2.5	E6013
TS 2	100	182	2.5	E6013
TS 3	110	189	2.5	E6013
TS 4	120	193.2	2.5	E6013

Table-3 Mechanical Properties of SMAW welded SS304 and Mild Steel

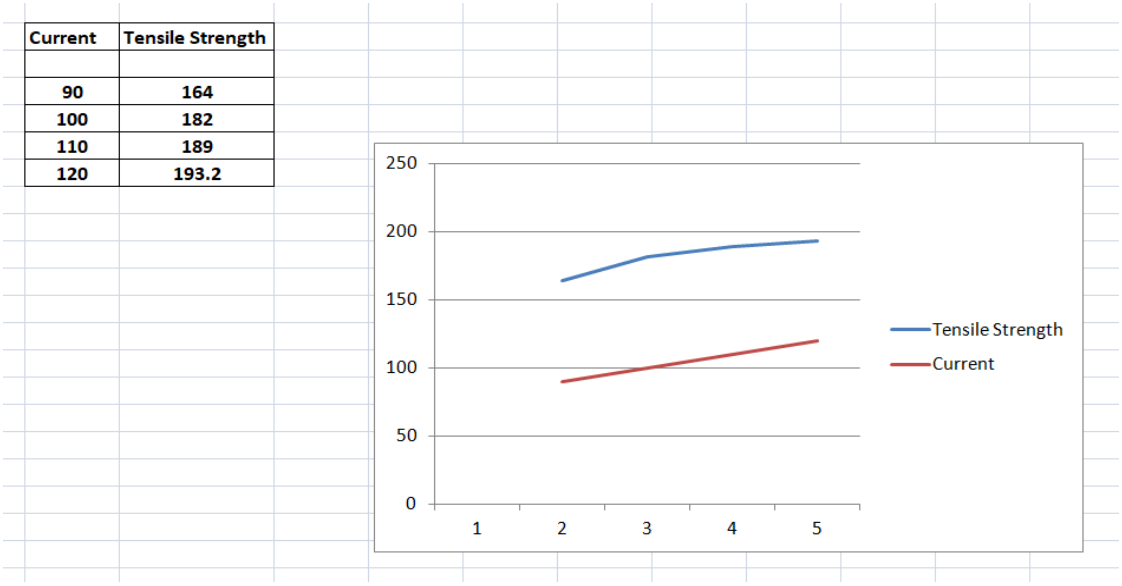

Fig-4 Graph Represent the Variation of tensile strength with respect to the welding current

V. RESULT AND CONCLUSION

The welding assessment of Stainless Steel 304 and Mild Steel have been conveyed. On the welding zone of the specimen is dilate and it have been computed. The tensile test have been conveyed to every test samples welded from Shielded Metal Arc Welding.

1. As we shown on graph Fig 4, the variation of tensile strength with respect to the welding current, which indicates that welding current varying the rate of penetration increases which increase the ultimate tensile strength of the material. And also when tensile strength results, when we increases the current from 90Amp to 120Amp the values of tensile strength of material also increases which results, the best yield quality while we use with the help of the SMAW process.

2. Through around the above research we find that the when we varies current then the welding voltage also varies. Through which we saw that during welding the stainless steel 304 have very poor ability to weld, it does not resist and not conveinient than other materials while in case of mild steel it have good weld ability and very durable in nature.

3. The rate of weakening of Stainless steel 304 may higher in Shielded metal arc welding process during

joint with mild steel due to carbon passing throughout the joints which brings the erosion.

VI. Future Scope and needs

Shielded Metal Arc welding process is the main and very important process used in Industries, Factories and Automotive plants etc. This welding process is most preferably and in past is most widely used different industries. There are some points are mentioned below which introduce the future scopes of these materials in different areas.

As per future aspects, we examination on stainless steel 304 and Mild steel in which Stainless steel 304 material have very poor ability to build with SMAW process But in case of Mild Steel they have good weld ability and also very durable in nature these steel help us to create some better phenomena to established things easily in industry like in ship buildings, Farm machinery, pipelines and in oil industries etc So, as we seen in case of mild steel the SMAW process behaves as good durability and resist easily, in automotive industry these type of steel are widely used to prepare the parts of vehicles in different areas and also it is very suitable in fabrication processes.

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