Study the Mechanical Properties of Dissimilar Metal Joint (SS-304 & MS-2062), Welded using Shielded Metal Arc Welding

Anil Kumar[1] Naveen Kumar[2] Sachin Kaushik[3]
[1]M. Tech Student [2]Head of the Dept. [3]Assistant Professor
[1,2,3]Department of Mechanical Engineering
[1,2,3]GRD IMT, Dehradun, UK, India

Abstract— The objective of this paper is to evaluate suitable welding condition for welding of dissimilar metal and check their Mechanical properties. They provide good combination of mechanical properties like strength, corrosion resistance with lower cost. The results indicate the optimum value of current and voltage which will be applied to developed good welded joint and it was observed that SMA welded dissimilar metal joints have better physical properties than MIG welded joints.

Keywords: Mild Steel (2062, Grade-B), Stainless Steel (SS-304), SMA Welding, Weld Dissimilar Steels, Tensile Strength, Impact Strength, Hardness, Radiography Testing, Ultrasonic Testing

I. INTRODUCTION

Welding differing materials, such as Mild steel (MS-2062, Grade-B) and stainless steel (SS-304), can be a much more economical choice than fabricating a structure entirely with stainless steel. Base materials used for welding application will match perfectly in chemical and mechanical composition. However, companies in manufacturing, fabricating, construction and other industries may occasionally find it necessary — both for cost and service condition requirements - to weld together Mild steel (MS-2062, Grade-B) and stainless steel (SS-304). The welding of unlike materials is common in certain power generation facilities such as power plants, electronic, chemical industries, petrochemical and nuclear reactors principally to get suitable properties and reduce weight, as well as in many mining and mineral processing facilities. Corrosion resistance of stainless steel is often necessary for equipment in those facilities. Welded dissimilar metals Mild steel (MS-2062, Grade-B) and stainless steel (SS-304) have crop up as structural materials to provide good combination of mechanical properties like strength, corrosion resistance with lower cost for various industrial applications. Stainless steels have good mechanical properties and corrosion resistance properties that make Stainless steel to be used in many equipment and food processing plants and surgical implants, low and high pressure boilers and vessels, fossil-fired power plants and flue gas desulphurization equipments.

Welding application, attaining success when welding dissimilar steels (SS 304 & MS grade-B) requires the careful selection of filler metals and the proper welding procedures. The topic of joining dissimilar metal spans an enormous number of materials and fabrication processes. Suggestions & advice offered in this article apply to the commonly used Mild steel (MS-2062, Grade-B) and stainless steel (SS-304) combination. In order to avoid potential trouble during welding of Mild steel (MS-2062, Grade-B) and stainless steel (SS-304), it is crucial to pay attention to mechanical properties and corrosion resistance properties. For choosing the right filler metal can help reduce concerns. Coordinating mechanical properties of each type of material is important, as well. Attaining a mechanical match is a function of having the correct chemistry, and also a reflection of the heat created by the welding procedure. As a general rule, while welding of Mild steel (MS-2062, Grade-B) and stainless steel (SS-304), the filler metal should have identical or slightly higher the mechanical properties of the weaker of the two materials.

II. MATERIAL AND EXPERIMENTAL PROCEDURE

Stainless Steel (SS –304) is the standard "188" stainless steel, which includes 18% chromium and 8% nickel; it is the most compliant and universally used stainless steel.

Elements	C	Si	Mn	Ni	Cr	N	P	S
Weight %	0.08	0.75	2.0	8-10.5	18-20	0.1	0.045	0.03

Table 2.1: Chemical composition of SS-304 base metal, wt %

Hardness		Yield strength (N/mm²)	Tensile strength (N/mm²)	% Elongation
Rockwell B (HR B) max	Brinell (HB) max			
76	201	205	515	40 %

Table 2.2: Mechanical properties of SS-304 base metal

Mild Steel (Grade-B; IS: 2062)

Elements	C	Si	Mn	P	S	Fe
Weight %	0.18	0.40	0.90	0.04	0.04	Balance iron

Table 2.3: Chemical composition in weight % of Mild Steel (IS-2062; Grade-B)

Hardness Rockwell (HRB) max	Density,ρ Kg/mm³	Yield strength (N/mm²)	Tensile strength (N/mm²)	% Elongation
86	7.85	250	450-550	30 %

Table 2.4: Mechanical properties of Mild Steel (IS-2062; Grade-B)

A. Shielded Metal Arc Welding Process (SMAW)

The welding machine used in the present work for the welding of Stainless steel (SS-304) & Mild Steel (IS; 2062; Grade-B) plate are shown in fig 2.1. Its specifications are summarized in Table 2.8.

Fig. 2.1: ESAB make welding machine

Model	ESAB Arc 250
Manufacturer	Esab india limited, Kolkata
Mains voltage V/ph, Hz	230/1, 50
Setting range (DC) A	5-180
Open circuit voltage, V	60-75
Dimensions l*w*h, mm	380*180*300
Weight, kg	8

Table 2.5: Specifications of welding machine

Parameter	1st pass	2nd Pass
Current	80	90
Voltage	28	30
Polarity	DCEP	DCEP
Electrode	E309L	E-309L
Electrode Dia.	3.15mm	3.15mm
Electrode length	350mm	350 mm
Welding position	2G	2G
Welding speed	250mm/min	250mm/min

Table 2.6: SMA welding parameters for further two pass

B. Welding Electrode:

ANSI/AWS A5.4 & ASME SFA 5.4 E 309L-16

Elements	Wt. %	Elements	Wt. %
C	0.4	Ni	12-14
Mn	0.5-2.5	Mo	0.75
P	0.04	Co	0.75
S	0.03	Normal Ferrite	4-10
Cr	22-24		

Table 2.7: Chemical composition of E-309 L electrode, wt. %

III. Result and Discussion

A. Rockwell Hardness Measurement:

Table 3.1 presents the variation of hardness values obtained from the different sources such as base metal, as-welded condition. The hardness value of as welded specimen, Stainless steel (SS304) has greater hardness than metal (Mild steel), due to extra coarse grains and spots of ferrite in the HAZ region. The HAZ region of the weldment microstructure has High hardness value obtained.

Sr.No	Distance from Fusion zone	Hardness	
		SS (HRB)	MS (HRB)
1	2	82	82
2	4	82	82
3	6	83	81
4	8	82	78
5	10	83	76

Table 3.1: Hardness results

B. Impact Test:

The energy absorbed by breaking the test samples using charpy impact tester is measured in joules. The results are shown

Fig. 3.1: Impact test specimens after fracture

Source	Charpy impact test values (J)
Stainless Steel	315
Mild Steel	27
At Ambient temperature	66
AT 0°C	51

Table 3.2: Results of Impact toughness testing

Table 3.2 shows the results of impact toughness observed from the base metal, as-welded condition at Ambient temperature 27°C and 0°C.

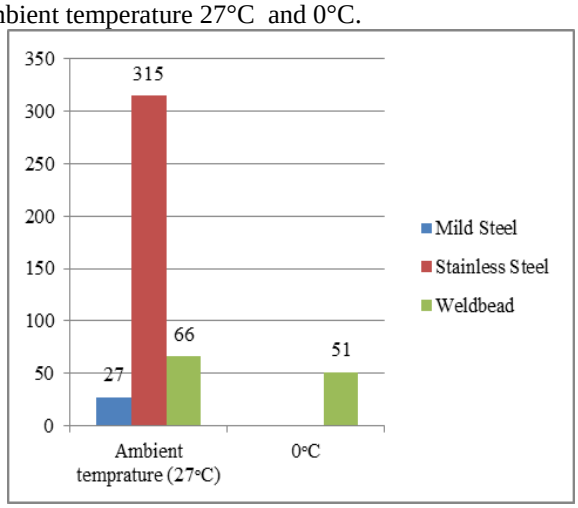

Fig. 3.2: Impact toughness

C. Tensile Test:

1) Test Method:

ASME Sec.IX:2017, Sample type: - Rectangular bar, Area: - 176.700 mm², Width: -19mm, Thickness: - 9.3mm, Gauge length: - 35mm, Final Gauge length: - 44.04mm

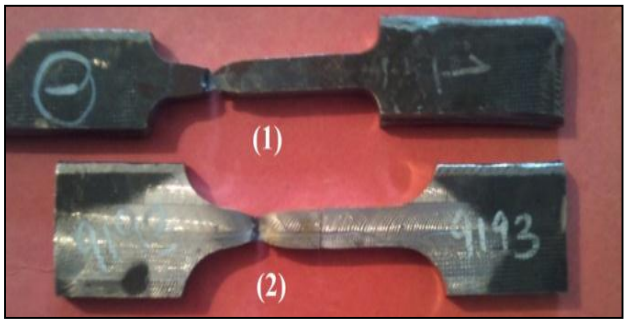

Fig. 3.3: Tensile test specimens after fracture

Source	Yield Strength (MPa)	Tensile Strength (MPa)
SS-304	215	505
MS-2062,B	250	410
After Welding	369	579

Table 3.3: Results of tensile testing

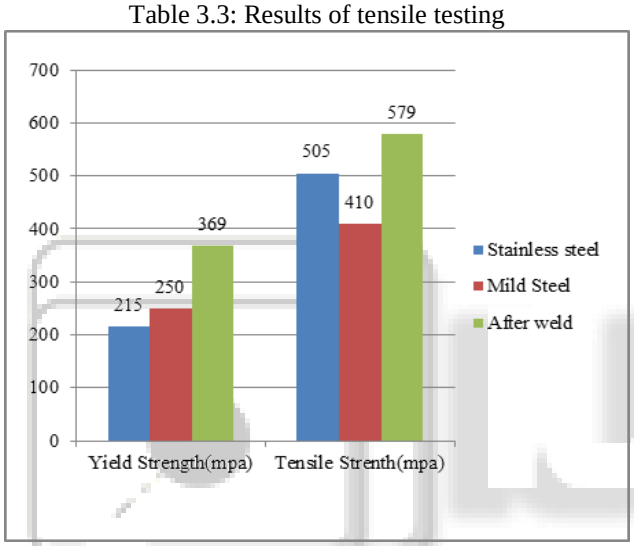

Fig. 3.4: Tensile strength/Yield Strength

IV. Conclusions

From the study, following conclusions can be drawn:

1) SMA welding process provides good strength. The presence of free carbon in low percentage allows the product better corrosion resistant, ductile and strength.
2) The main flaw which occurs in welding dissimilar material by SMAW is the development of cracks, Porosity and LOF during the welding, which needs more effort for achieving weld by SMA welding.
3) The yield strength of dissimilar joint of SS 304 and mild steel is best for SMA welding process.

References

[1] Shameel K1, Dr NM Nagarajan2,'Comparative studies on joint design of mild steel using MAW and MIG welding". Volume 02 - Issue 05 || May 2017 || PP. 27-37
[2] Radha Raman Mishra1," A STUDY OF TENSILE STRENGTH OF MIG AND TIG WELDED DISSIMILAR JOINTS OF MILDSTEEL AND STAINLESS STEEL". Vol.3, No.2,April 2014, DOI : 10.14810/ijamse.2014.3203 23
[3] Raghuram Pradhan," EXPERIMENTAL INVESTIGATION AND COMPARATIVE STUDY OF MIG &TIG WELDING ON SS202 AND SS304 MATERIALS". Vol. 10, Issue, 04(A), pp. 31678-31683, April, 2019
[4] Rakesh Kumar Raushan," Optimization of the process parameters for MIG welding of dissimilar welding using Taguchi method". ISSN : 2454-9150 Vol-04, Issue-08, Nov 2018
[5] Prasenjit Mondal1, Dipankar Bose2," OPTIMIZATION OF THE PROCESS PARAMETERS FOR MIG WELDING OF AISI 304 AND IS 1079 USING FUZZY LOGIC METHOD". Volume: 02 Issue: 08 | Nov-2015.
[6] A. Suresh Kumar1," OPTIMIZATION OF DISSIMILAR MATERIALS ON STAINLESS STEEL (316L) AND MILD STEEL (IS2062) IN MIG WELDING PROCESS".DOI:10.23883/IJRTER.2018.4211.52GPY.
[7] Md. Gaffar†*, Mudavath Shankar," Experimental Investigation on Welded Joints of Dissimilar Steels". Vol.7, No.3 (June 2017).
[8] Sharmistha Singh," Analysis of Hardness in Metal Inert Gas Welding Of Two Dissimilar Metals, Mild Steel & Stainless Steel". Volume 13, Issue 3, Ver. I (May- Jun. 2016), PP 94-113.
[9] M. S. Harne1, S. S. Sathe2," A Review on Effect of Various Process Parameters on Weld Joint of Dissimilar & Similar Metals in Tig Welding". Volume 4 Issue 4, April 2015.
[10] A.M. OKORO," COMPARATIVE INVESTIGATION OF THE MECHANICAL PROPERTIES AND CORROSION BEHAVIOR OF DISSIMILAR METAL WELD FUSION ZONE, HEAT AFFECTED ZONES AND BASE METALS" ISSN 1584 - 2665 (printed version); ISSN 2601 - 2332 (online); ISSN-L 1584 – 2665

