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Evaluation of Mechanical and Metallurgical Characteristics of the Butt Welding of Different Steels by Gas Metal Arc Welding Process

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A B S T R A C T

A common Butt Welding is made between two metals AISI 1018 & SS17-4PH by (SMAW)shield metal arc welding process, The metallurgical and mechanical properties of the butt joints are compared in the area where the welding is made ,mild steel to mild steel(AISI1018), Stainless steel to stainless steel (SS17-4ph),and dissimilar joint (AISI1018 & SS17-4PH),and some testing like Tensile test ,charpy impact test, bend test ,analysing the micro structure and macro structure and finally chemical composition of the materials are done in the various parts of the weld joints.

Keywords: Butt welding, mechanical properties, tensile test, impact test and micro structure.

1. Introduction

In the field engineering there are many ways found to join the metal or metal joining process ,in that the simplest and foremost type of metal joining process is welding ,welding plays the vital role when it comes to joining the metals it can be achieved in similar metals as well as dissimilar metals, here we are going to discuss about welding of dissimilar metals ,while going deep into study about welding here it is achieved by using one type of welding method called as SMAW(shield metal arc welding), Smaw is also known as manual metal arc welding ,or informally as stick welding where it uses a consumable electrode covered with a flux to lay the weld ,an electric current in the form of either alternating current or direct current from a welding supply is used to form an electric arc between the electrode and the metals to be joined, and these are widely used in the area of pipeline industries ,industrial fabrication of dissimilar metals ,such as stainless-steel ,iron aluminium, nickel ,finally the two dissimilar metals which we have taken for this study is carbon steel AISI1018 & SS17-4PH ,and SMAW is suitable for welding of these two metals.

In this study AISI1018 &SS17-4PH metals were joined in various ways by using SMAW shield metals arc welding process to find the better joints for the application, The welding parameters such as current voltage travelling speed are same and constant for all the various joints.180A to 220A current ,25V volt and travelling speed of 40cm/min is followed, the length of 50cm and breath about 25 cm plate of each material are machined finally welded in above mentioned parameters.

2. Experimental Procedure

In this process the specimens (AISI1018 & 17-4PH) were prepared according to the dimensions followed 500mmx250mmx50mm. The specimen of 5mm plates is welded by using SMAW process. The welding was done according to the parameters which were mentioned above. The welding was carried out with three various joints such as AISI1018 to AISI1018, AISI1018 to SS17-4PH and SS17-4PH to 17-4PH, the filler rod used here was pinnacle alloy ER80S-B2 is one of the low alloy coppers coated solid wire. Once after the welding is done the specimens were cut by using wire cut EDM for various test to get the mechanical properties. Tensile test was done by using INSTRON 8801 UTM according to ASTM E8/E8M standards. The microstructure was examined by using metallurgical microscope using etchant with some etching time of 10 seconds and magnification upto 100x was carried out to find the microstructure of various zones. Table 1 and 2 shows the chemical composition and mechanical properties of the base metal.

Table 1 Chemical composition of the base AISI 1018 and SS17-4HP.

Elements	Fe %	Si %	Mo %	C %	Mn %	P %	S %	Cr %	Ti %	V %	Cu %	N %
AISI 1018	97.72	0.50	0.01	0.05	1.38	0.021	0.01	0.04	0.007	0.006	0.04	0.83
SS17-4PH	70.78	1.14	0.22	0.04	0.85	0.026	0.009	18.48	0.001	0.036	0.05	0.21

Table 2 Mechanical properties of the base AISI 1018 and SS17-4HP.

Properties	**AISI 1018**	**SS17-4PH**
Ultimate tensile strength (in MPa)	250	260
Yield tensile strength (in MPa)	480-650	480-680
% Elongation	20	25
Vickers hardness number (VHN)	200	210

Tensile Test: Each specimens undergo two trails and average value of two trails are mentioned above in the table of tensile test weld samples. The maximum average value of 525Mpa was found in combination of similar metal weld joints. Three-point bend test: The ductility of the material l can be evaluated by using is this bend test, by testing all the samples similar and dis-similar welds each of two trails, there are no crack or fractured to be found in any of the samples and so this states that they are having very good ductility. Microstructure analysis: To examine the microstructural the samples are first polished and etched with etchant with time period of ten seconds, The etchant used here is 4%Nital & Glycaemia, finally specimens magnified upto 100x and magnification is observed by using metallurgical microscope. It states that interdimeric structures are formed in the weld. the fusion of weld and base briefly shown in HAZ microstructure. Macroscopic analysis: Likewise, the macrostructure was also examined the etched samples are viewed under stereo microscope upto 10x magnification and it results in zero pin hole, zero porosity, crack free zone, no tear, pattern or flakes. Figure 1 illustrated the butt-welding joints of different material combinations. The welding processes parameters of AISI 1018 and SS17-4PH has been shown in the table 3.

Table 3 Butt welding processes parameters of AISI 1018 and SS17-4HP.

Sample	**Material combination**		**Welding current (A)**	**Welding Voltage (V)**	**Welding speed (cm/min)**
1	AISI 1018	AISI 1018	200	25	40
2	SS17-4PH	SS17-4PH	200	25	40
3	AISI 1018	SS17-4PH	200	25	40

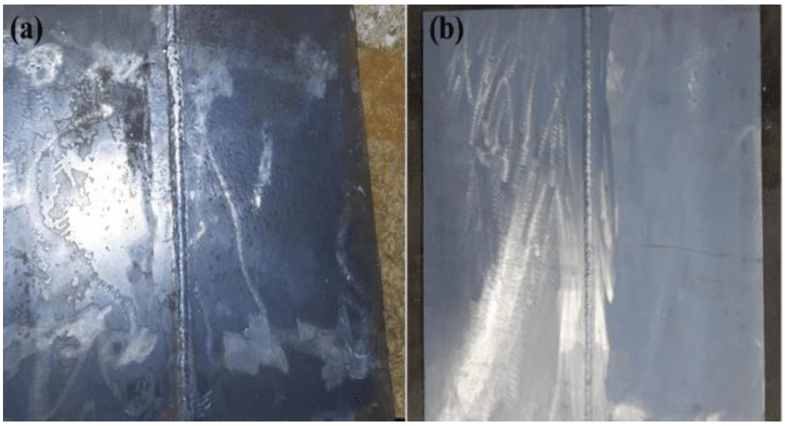


Fig. 1 – Welded plates of (a) AISI 1018 with AISI 1018; (b) SS17-4PH with SS17-4PH

3. Result and discussion

Therefore, the strength of material and weld strength if briefly studied here, the maximum tensile strength (525.10MPa) is found in similar welded metals (SS17-4PH) & second highest tensile strength (521.99MPa) results in dissimilar metals AISI 1018 to SS17-4PH. And we observed that tensile strength lies according to the weld speed and if the weld speed is decreased it results in high tensile strength. The table 4 illustrates the ultimate tensile strength and yield tensile strength of the welded samples. Figure 2 presented the tensile fractured welded samples.

Table 4 Tensile strength result of butt welded samples

Sample	**Material combination**		**Ultimate tensile strength (MPa)**	**Yield strength (MPa)**	**% Elongation**	**Fractured area**
1	AISI 1018	AISI 1018	498.63	386	10	HAZ
2	SS17-4PH	SS17-4PH	525.1	440	14	HAZ
3	AISI 1018	SS17-4PH	521.99	428	12	HAZ

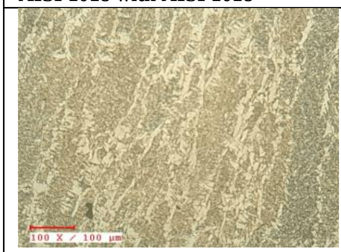
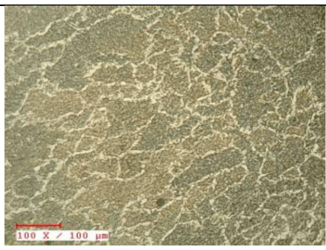
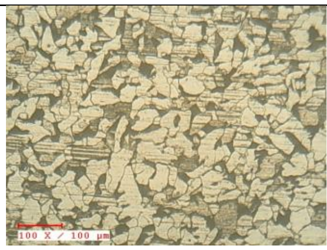
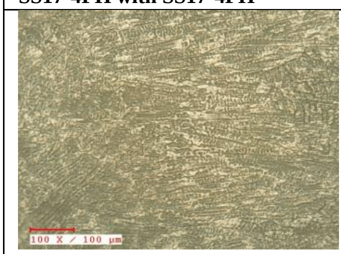
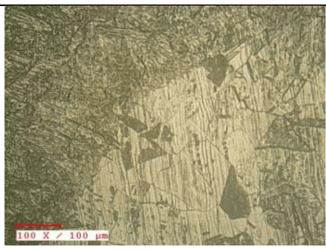
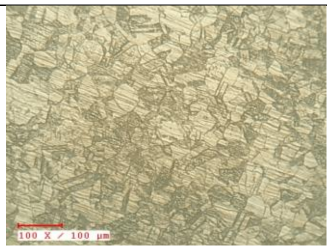
Fig. 2 – Tensile fractured samples

Chemical composition test also conducted to crosscheck the material grade standard and it matched perfectly with the standards. The bend test shows that there are No side-effects or damages are found during or after the weld this proves that the metals have very more ductility and are very good in nature. The bend test is one method for evaluating ductility, but it cannot be considered as a quantitative means of predicting service performance in all bending operations in mandrel in four times of thickness in welded samples. Testing of 2 trail sample none of the samples are fractured or cracked. So all the samples are having greater ductility.

	
Impact test sample	Bend test sample

Fig. 3 – Impact and bend test samples

The microstructure and macrostructure examination are done and it states that the metals are interdimeric, zero pinhole, zero porosity and crack free. The sample are prepared for the microstructural evaluation under metallurgical microscope. The specimen first polished and then etchant is applied on the surface of the specimen for the dwell time of 10sec. The etchant used is 4% Nital & Glyceregia. The microstructures are carried under 100x magnification. In the weld interdendritic structure formed. In the HAZ microstructure shows complete fusion between weld & base.

Base	**Weld**	**HAZ**
AISI 1018 with AISI 1018		
		
SS17-4PH with SS17-4PH		
		

AISI 1018 with SS17-4PH

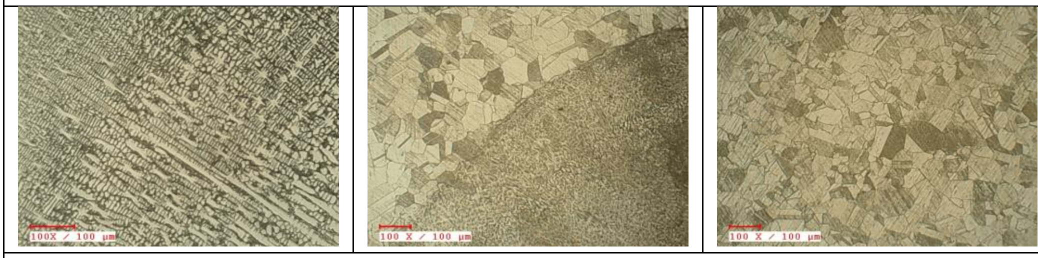


Fig. 4 – Micro structural analysis of welded samples.

Likewise, the macrostructure was also examined the etched samples are viewed under stereo microscope upto 10x magnification and it results in zero pin hole, zero porosity, crack free zone, no tear, pattern or flakes.

AISI 1018 with AISI 1018	SS17-4PH with SS17-4PH	AISI 1018 with SS17-4PH

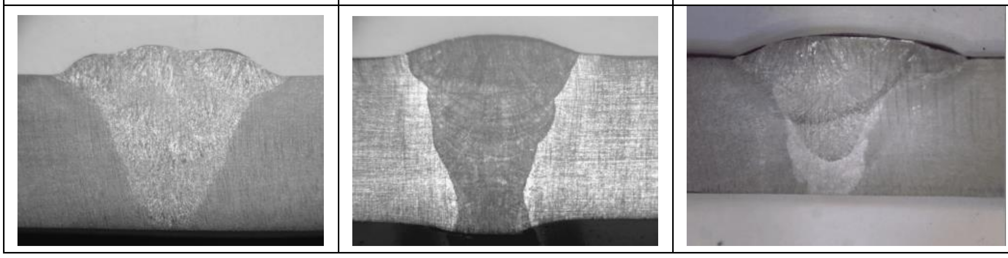


Fig. 5 – Macro structural analysis of welded samples.

4. Conclusion

Therefore, the strength of material and weld strength if briefly studied here, the maximum tensile strength(525.10Mpa) is found in similar welded metals (SS17-4PH) & second highest tensile strength (521.99Mpa) results in dissimilar metals AISI 1018 to SS17-4PH. And we observed that tensile strength lies according to the weld speed and if the weld speed is decreased it results in high tensile strength. In charpy impact test observed that the weld is stronger in similar metals AISI1018 than that of AISI1018 & SS 17-4PH With average value of 276J. Chemical composition test also conducted to crosscheck the material grade standard and it matched perfectly with the standards. The bend test shows that there are No side-effects or damages are found during or after the weld this proves that the metals have very more ductility and are very good in nature. The microstructure and macrostructure examination are done and it states that the metals are interdendritic, zero pinhole, zero porosity and crack free.

References

D. G. R. William D. Callister, Jr., Materials Science and Engineering an Introduction, vol. 1. 2010

O. Brien, Welding Handbook, Ninth Edit., vol. 2. American Welding Society, 2004.

Arun, K.L., Udhayakumar, M. and Radhika, N., 2023. A Comprehensive review on various ceramic nanomaterial coatings over metallic substrates: applications, challenges and future trends. Journal of Bio-and Tribo-Corrosion, 9(1), p.11.

Udhayakumar, M., Saravanan, P. and Parammasivam, K.M., 2022. Experimental study of a winglet added small wind turbine with a flanged diffuser for domestic applications. International Journal of Ambient Energy, 43(1), pp.5825-5829.

P. Borda and S. Datalde, “A simulation model for designing the automation of future’ s factory.

Ahmadi et. al, “Tecnology Pangelinan dan Perala tan las SMAW.” Jakarta, 2019

S. Bahrain, M. M. Noor, S. K. A. Kadir, and K. R. Ahmad, “Mechanical Properties of Dissimilar Welds Between Stainless Steel and Mild Mechanical Properties of Dissimilar Welds Between Stainless Study the effect of shielded metal arc welding process parameters, cryo-treatment and preheating on welding characteristics and modelling by an artificial neural network