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A Comparative Analysis of Mechanical Behaviour on Dissimilar Weld Joints by Using GMAW Process

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ABSTRACT

Welding is among the most significant permanent fastening techniques and adaptable fabrication technologies that the industrial sector has at its disposal. This is due to the fact that it is among the most crucial tools at an engineer's disposal when trying to cut expenses associated with fabrication, production, and maintenance. A heat source must create a high temperature zone in order for the material to melt during the welding process, which is essentially the art of joining metals together by heating and pressing them together. Applications for welding include building ships, bridges, pressure vessels, industrial machinery, automobiles, rolling stock, and many other fields.. The medium carbon steel underwent welding operations and then heat treatment, or annealing. A heat treatment furnace was used to heat treat the specimen at the weld zone to a temperature of 550°C. The best tensile strength and good penetration depth were achieved by GMAW butt welding of AISI 4340 & AISI 4140 steel during the gas metal arc welding process. Tensile strength attained by the PWHT procedure is, in comparison, higher than that of the WOPWHT test plate. The tensile strength of AISI 4340 and AISI 4140 steel rose by 43% throughout the PWHT process.

1. Welding over view

The method of joining two materials together with intense heat, pressure, and/or fillers is called welding. Welding procedures have evolved to meet every conceivable industrial requirement. Arc and gas arc welding are the two forms of welding that are most commonly used.

1.1 MIG welding

Gas's "Metal" The wire used to initiate the arc is referred to as metal arc welding. In addition to serving as a filler rod, the feeding wire shields it with inert gas. Since MIG welding is a semi-automated process, it is quite simple to learn and utilize. The electrode melts inside the arc during the MIG welding process and is deposited as filler material. In addition to protecting the weld during solidification, the shielding gas utilized prevents air contamination. In addition to helping to stabilize the arc, the shielding gas facilitates the seamless transfer of metal from the weld wire to the molten weld pool. The main advantage of the MIG welding technology is its versatility. Although flat horizontal is the most ideal, it may be used to join most kinds of metal and in the majority of places.

2. Introduction post welds heat treatment welding

We apply enough heat throughout the welding process to melt the base material. The base material undergoes microstructural changes as a result of this high temperature, which can alter crucial material characteristics like toughness, ductility, hardness, and tensile strength. The base material's chemical makeup and the rate at which it cools after welding determine how much these qualities are affected. PWHT treatment specifications are usually determined by codes, standards, and any unique needs resulting from the welded structure's service conditions. The necessity to prevent brittle fracture through post-heating and to relieve residual strains through stress relieving motivates the usage of PWHT in steel manufacturing.

2.1 Post heating

The main purpose of post-heating is to prevent hydrogen-induced cracking (HIC), which is sometimes referred to as cold cracking or hydrogen-assisted cracking (HAC). Three conditions need to be met for HIC to happen.

1. A basic material microstructure that is vulnerable (often because of high carbon levels)
2. Threshold level of hydrogen

3. Elevated stress levels (internal or external)
4. Diffusible hydrogen is lowered below the threshold level through post-heating, which permits hydrogen to diffuse out of the weld and eat affected zone (HAZ). Read Preventing Hydrogen Induced Cracking for further details on avoiding HIC.

3. Work material details

Work material –AISI4340 & AISI4140 steel

Work material size–100mmX100 length 6 mm thickness

3.1 AISI4340

AISI4340 steel is a popular grade of through-hardening alloy steel due to its excellent machinability in the "T" condition. AISI4340 is used in components such as gears, shafts, studs and bolts, its hardness is in the range 248/302 HB. AISI4340 can be further surface-hardened to create components with enhanced wear resistance by induction or nitriding processing.

3.1.1 Application

AISI4340 Material is used in tooling applications requiring a high degree of accuracy in hardening, such as High strength shafts, Punches die, Drill bushings and Retaining rings.

3.2 AISI 4140

AISI 4140 alloy steel is a chromium-, molybdenum-, and manganese-containing low alloy steel. It has high fatigue strength, abrasion and impact resistance, toughness, and torsional strength. The following datasheet gives an overview of AISI 4140 alloy steel.

3.2 .1 Application

(AISI4140) Material is used in tooling applications requiring a high degree of accuracy in hardening, such as shear blades, gauges, threading tools, measuring tools, broaches, plastic moulds and guide rails.

4. FCAW Process parameters and their levels of with post heat treatment and without post heat treatment

Table: 1 Process parameters and their levels

Levels	**Process parameters**		
	Weldingcurrent Amps I	**Arc Voltage V**	**Bevel angle Degree**
1	**140**	**18**	**60**
2	**160**	**20**	**65**
3	**180**	**22**	**70**

Table: 2 welding parameters of both welding process

Sl.no	**Current**	**Voltage**	**Bevel angel**
1	140	18	60
2	160	20	65
3	180	22	70
4	140	18	60
5	160	20	65

6	180	22	70

4.1Rockwell hardness test

The hardness number in a Rockwell Hardness system is determined by a direct read-out equipment using the depth of penetration of a steel ball or a diamond tip. Deep penetration suggested a low Rockwell Hardness value for the material.

Table:3 Hardness value-HRB value-after weld

SAMPLES		S1	S2	S3
WOPWHT	AISI4340	86	78	88
WOPWHT	AISI4140	81	86	85

Hardness graph of WOPWHT

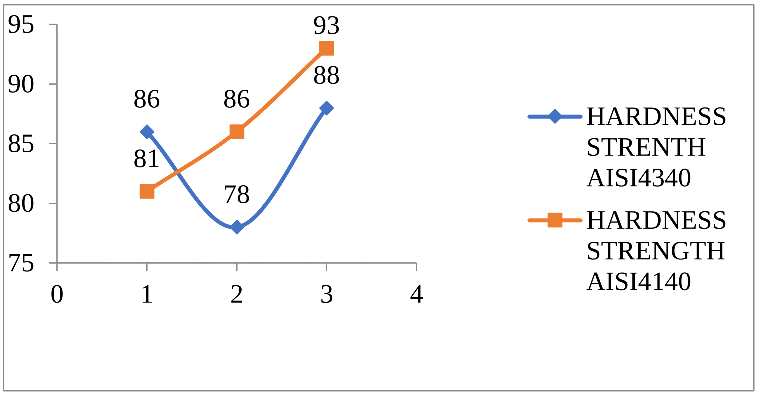

Figure 1 Comparison graph of hardness analysis PWHT and WOPWHT

4.2 Tensile test &Elongation

To evaluate the mechanical characteristics of friction-processed joints, tensile testing is performed. Utilizing a tensile test, ascertain tensile characteristics such as modulus of elasticity, percentage of elongation, yield strength, tensile strength, and percentage of area reduction. The welding parameters were chosen at random from the range that the machine might have used. Random parameters were used to design the joints, and their tensile strength and burn off were evaluated. Following that, the metallurgical and mechanical qualities were evaluated and the joints were built. The friction-welded specimens were prepared in accordance with ASTM specifications. The test was run using a 40-ton FIE universal testing machine (UTM).

4.3 Tensile strength result of with PWHT and WOPWHT

Table: 3 Tensile strength value of WOPWHT&WPWHT

Test plate no	Identification	Current	Volt	Bevel Angle°	Tensile Load	Tensile Strength
1	WOPWHT	140	18	60	42.18	451.51
3		160	20	65	34.29	359.66
5		180	22	70	43.19	456.74
2	WPWHT	140	18	60	58.46	624.97
4		160	20	65	51.29	543.44
6		180	22	70	60.26	609.79

4.4 Comparison of tensile load analysis PWHT and WOPWHT

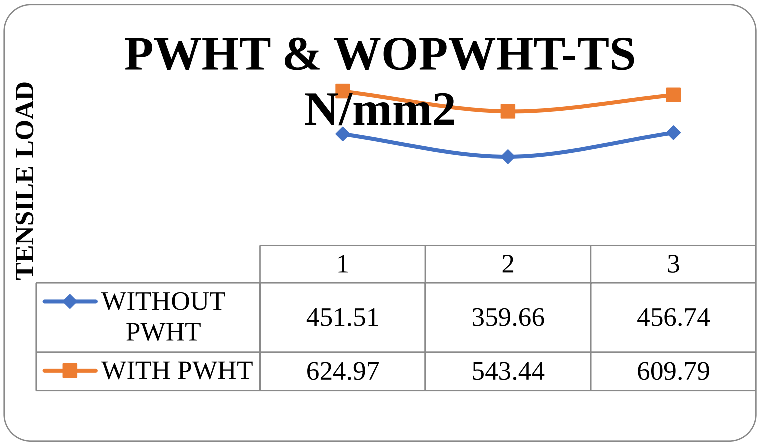

Figure 2 Comparison graph of hardness analysis PWHT and WOPWHT

5.Result& Conclusion

The joints were developed with random parameters, and their tensile strength and burn off were evaluated. Following that, the joints were fabricated and the mechanical and metallurgical characteristics evaluated. The preparation of the friction-welded specimens was done in accordance with ASTM recommendations. For the test, a 40-ton FIE universal testing machine (UTM) was utilized. High impact strength is another effect it has. In the end, we determined that the optimal parameter for AISI4340 & AISI4140 -6 mm thickness plate in this project investigation was the 180 AMPS VOLT-22 Bevel angle 70º. This allowed us to get a suitable weldment condition for the GMAW process with post weld heat treatment plate. Tensile strength attained by the PWHT procedure is, in comparison, higher than that of the WOPWHT test plate. The tensile strength of AISI 4340 and AISI 4140 steel rose by 43% throughout the PWHT process.

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