STRENGTH ANALYSIS OF TIG AND SMAW WLEDING

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ABSTRACT

Now a days every industries reveal with producing high quality products at minimum cost and increase productivity. TIG and SMAW welding's are mostly used for joining of two similar or dissimilar elements with heating the material or using the different types of filler material for increasing productivity with less time and low cost. This project deals with the strength analysis of TIG and SMAW weddings for mechanical properties and showing the optimum process parameter for SMAW and TIG welding.

Keyword: - *ANOVA SMAW, TIG, UTS, Groove angle, Root face and Root gap.*

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1. INTRODUCTION

Welding is a joining process which is used to join different types of materials like metals, alloys, at the time welding the work pieces to be joined are melted at the meet and after solidification a permanent joint can be reach. Sometimes some amount of filler material is added to form a weld pool of molten material which after solidification shows strong bonding in the joint. Weld ability of a material depends on the different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification and reaction of materials with atmosphere and tendency of crack formation in the joint.

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2. TYPES OF WELDING PROCESS

Different types of welding processes are used in industry like Arc Welding, Gas Welding, Resistance Welding, High Energy Beam Welding, and Solid-State Welding. Tungsten inert gas welding and shielded metal arc welding is type of an arc welding process.

A. Tungsten inert gas (TIG) welding

Welding process is type of an arc welding process uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere with a shielding gas generally Argon or Helium or sometimes mixture of both. A filler metal may also feed manually for better welding. GTAW most commonly called as TIG welding process, with the development of TIG welding process, welding of difficult to weld materials e.g. Aluminium and Magnesium become possible. The use of TIG today has spread to a variety of metals like stainless steel, mild steel and high tensile steels, Al alloy, Titanium alloy etc. Like other welding system, TIG welding power sources have also improved from basic transformer types to the highly electronic controlled power source. Among these entire arc welding processes, SMAW and TIG welding are the most preferred welding processes for many applications. The dissertation highlights comparative strength analysis between SMAW and TIG welding of AISI 304 stainless steel material.

B. Shielded metal arc welding (SMAW)

This is most common type of arc welding process, where a flux coated consumable electrode is used. As the electrode melts, the flux disintegrates and generates shielding gas that protect the weld area from atmospheric gases and produces slag which covers the molten filler metal as it transfer from the electrode to the weld pool. The slag floats to the surface of weld pool and protects the weld from atmosphere as it solidifies.

3. NEED FOR ANALYSIS AND OBJECTIVE

In the world there are number of process are used in industries. In which different joints are prepared by different joining processes and different welding geometries on different materials or same materials. After some time there will be failure of weld joints. There are number of reasons for failure. By doing study it is found that in process and shipping industries the welding plays an important role. If the strength is not proper then there is possibility of early failure of the joint. In butt weld joint there are so many parameters such as groove geometry, root gap, root face etc. on which the strength of weld joint dependant. The main objective is

- Identification of process parameter like groove angle, root face and root gap and response variables such as ultimate tensile strength and hardness in SMAW and TIG welding process.
- Design of experiments to perform experiments.
- Analysis of response variables using the Minitab-17 software.
- To do comparative study between TIG and SMAW process and suggest of best welding method.

4. EXPERIMENTAL

A. Material Selection for Work piece and Filler Metal

The experimental work is to be carried out to strength analysis and compare the both welding for tensile test, hardness and distortion of V grooves butt weld joint of AISI 304 stainless steel material, Which are used for work piece and Stainless steel 308L has excellent corrosion resistance in wide variety of environments and when in contact with different corrosive media for filler metal. The following table shows average ultimate tensile strength of AISI 304 stainless steel base metal is 664 ± 4 (MPa), yield strength 362 ± 5 (MPa) and % elongation 43 ±1.

TABLE I

Mechanical Properties of 304 Stainless steel

Sample No.	**Ultimate Tensile Strength (MPa)**	**Yield Strength (MPa)**	**% Elongation**
1	669	364	44
2	663	357	44
3	661	366	43
Average	664 ± 4	362 ± 5	43 ± 1

B. Process Parameters and their Level for Experimentations

Following table shows the values of the selected process parameters, three parameters with three levels. All these values are selected on the basis of literature review, by using Design of Experiments by Taguchi Method, L_9 orthogonal array is selected for experiments. The columns of L_9 orthogonal array are shown in following table.

TABLE II

Process Parameters and their Level for Experimentations SMAW & TIG

Levels	Groove Angle	Root Face (mm)	Root Gap (mm)
Level 1	30	1	0
Level 2	45	1.5	1.5
Level 3	60	2	2

C. Design of Experiments

Design of experiments is a method of designing experiments, in which only selected number of experiments are to be performed. In the present day fabrication industry, welding has become one of the major manufacturing processes frequently used in all types of works. Quality of a weld joint is influenced by welding input parameters that are to be controlled to establish a proper welding work. The input parameters selected vary with the type of welding process, and type of material used. In order to developed the correct combination of input parameters, trail experiments are to be performed which consume a lot of time and increase manufacturing cost. Hence statistical techniques are utilized to avoid trial experiments and reduce the manufacturing cost. For that purpose experiments are to be conducted in a sequential manner according to the type of statistical technique selected. Statistical techniques like Factorial Method, Response Surface Method and Taguchi Method are adopted in Design of Experiments to optimize the required output parameters. A thorough review on application of Taguchi Method on various fusion arc welding processes is presented in the following sections. The objective of the Taguchi Method is to determine the optimum settings of input parameters, neglecting the variation caused by uncontrollable factors or noise factors. Factor here refers to an input variable where by the state can be controlled during the experiment. Taguchi Method, a systematic application in design and analysis of experiments, is used for designing and improving product quality. The orthogonal array formed by design of experiments by Taguchi method, obtained in Minitab 17 software shows in following table. It is L_9 orthogonal array, means numbers of experiments should be performed to get the required results. After performing all experiments, the values of response variables are fed into software for analysis.

TABLE IIII
L_9 Orthogonal arrays for SMAW & TIG Experimentations

Groove Angle (Degree)	Root Face(mm)	Root Gap (mm)
30	1	0
30	1.5	1
30	2	1.5
45	1	1
45	1.5	1.5
45	2	0
60	1	1.5
60	1.5	0
60	2	1

D. Sample Preparation

After the orthogonal array has been selected, the second step in Taguchi parameter design is running the experiment. The AISI 304 stainless steel material was used in mostly aerospace and pressure vessels industry. All the welds were performed in plates rolled to 5 mm thickness perpendicular to the rolling direction in a butt joint arrangement with straight edge preparation. Plates of 120 mm x 60 mm x 5 mm were welded along their long edge. The groove angle, root gap and root face prepared as per L_9 orthogonal array before and after welding as shown in following figures. After welding, specimens are producing and mechanical tests are carried out. The tensile tests are performing on UTM machine. Specimens are taking from each welded plate for tensile tests, with geometry. All mechanical trials are performing at room temperature. In the experiment, take a specimen of (100x10x5) mm dimension. A V groove formation will take place with the help of milling machine.

Fig.1 Weld Joints Geometry

Fig.2 Sample of SMAW

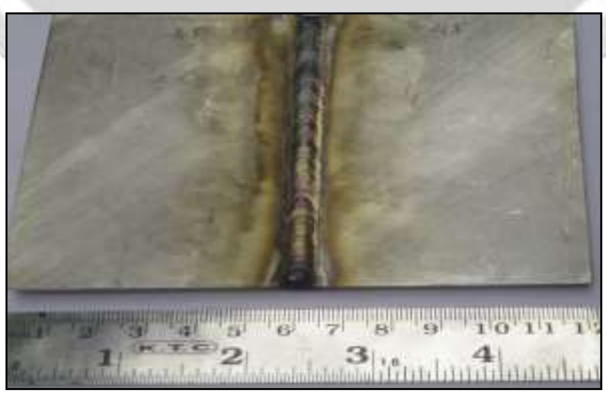

Fig.3 Sample of TIG

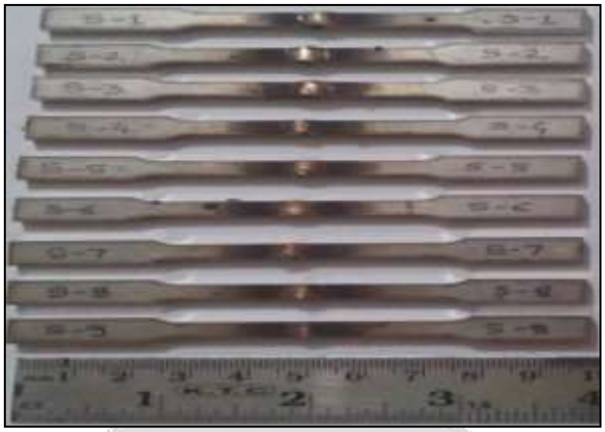

Fig.4 Tensile Test Sample for SMAW Joints

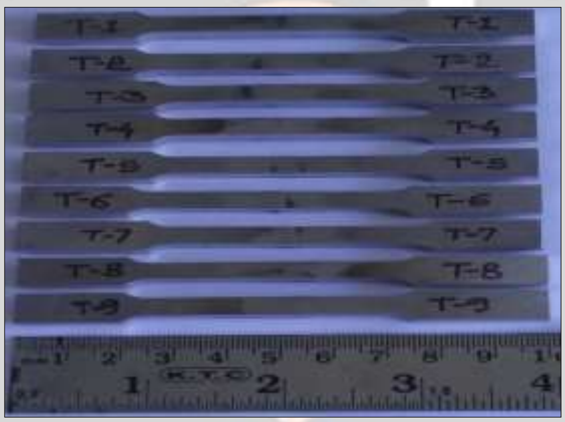

Fig.5 Tensile Test Sample for TIG Weld Joints

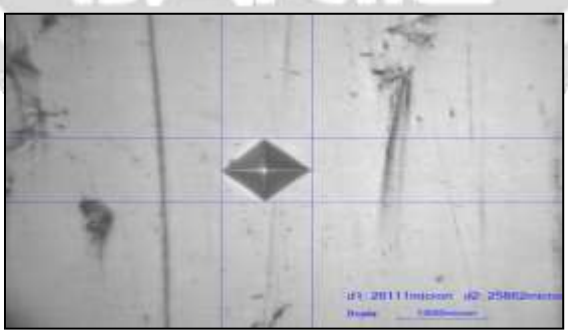

Fig.6 Indentation of Micro hardness testing of SMAW

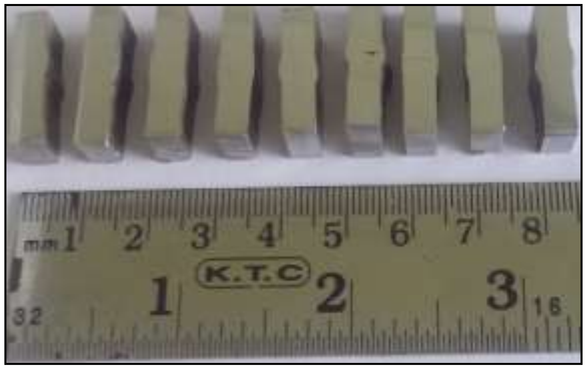

Fig.7 Micro hardness Sample of SMAW

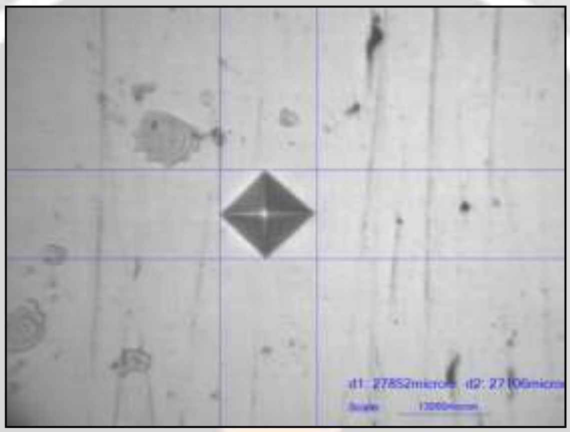

Fig.8 Indentation of Micro hardness Testing TIG

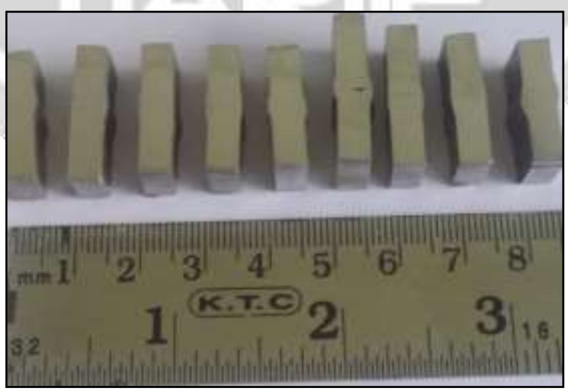

Fig.9 Micro hardness Sample of TIG

A total of L_9 experiments are conducted during this process. After the welding of the specimen all the specimen are prepared as per ASTM standards. This is the main requirement of the welded piece for testing.

4. RESULT AND DISCUSSION

After performing all the experiments with predetermined values of process parameters, the tensile strength is measured and the micro hardness is measured.

TABLE IV

Ultimate Tensile Strength and Micro hardness of SMAW & TIG for Experimentation

Groove Angle	Root Face	Root Gap	SMAW		TIG	
			UTS (MPa)	($Hv_{0.1}$)	UTS (MPa)	($Hv_{0.1}$)
30	1	0	304	209	358	220
30	1.5	1	275	210	324	221
30	2	1.5	222	216	261	227
45	1	1	542	215	638	226
45	1.5	1.5	549	218	646	230
45	2	0	541	214	637	226
60	1	1.5	546	224	641	236
60	1.5	0	494	217	581	228
60	2	1	487	219	573	231

After performing final experiments, analysis of experimental data is done by using MINITAB-17 software. The effect of various input parameters on output responses will be analysed using analysis of variance (ANOVA).

E. Analysis of Tensile Strength for SMAW And TIG Joint

Analysis of variance (ANOVA) test is performed to identify the process parameters that are statistically significant and which affect the tensile strength of SMAW and TIG joints. The ANOVA results for tensile strength are given in following figures. Figures indicate that one process parameter significant and influencing ultimate tensile strength at 98 % confidence level.

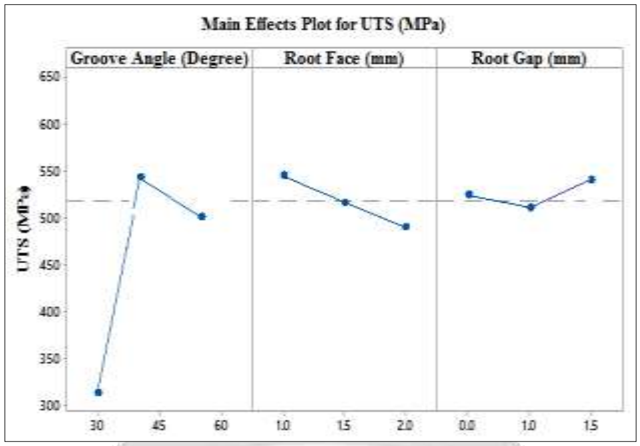

Fig.10 Main Effects Plot for UTS (MPa) of SMAW Welding

The Main effect plot for ultimate tensile strength is as a groove angle increases ultimate tensile strength also increases, highest tensile strength is obtained at 549 MPa. it can be seen that UTS is higher 549 MPa at 45 degree groove angle, 1 mm rib face and 1.5 mm root gap.

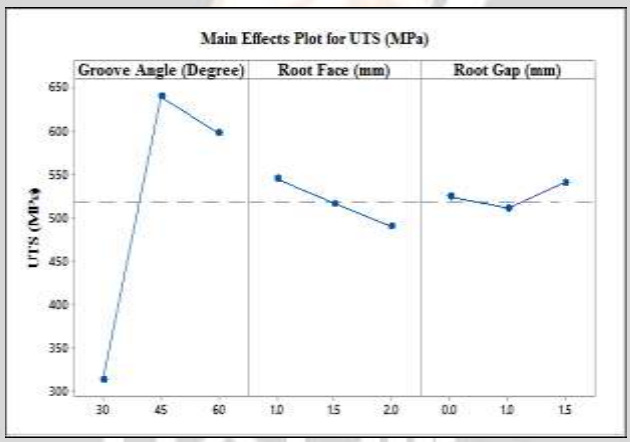

Fig.11 Main Effects Plot for UTS (MPa) of SMAW Welding

It is clear that as groove angle up to 45 degree increasing UTS increase after that UTS decrease. It was observed that as root face goes on increasing the UTS goes on decreasing. The effect of root gap increase to increase UTS.it can be seen that tensile strength is higher 646 MPa at 45 degree groove angle, 1 mm root face and 1.5 mm root gap.

F. Analysis of Micro hardness for SMAW And TIG Joint

After performing final experiments, analysis of experimental data is done by using MINITAB-17 software. The effect of various input parameters on output responses will be analysed using analysis of variance (ANOVA). The two process parameter significant and influencing tensile strength at 99% confidence level. The highest value is 222 Hv. Main effect plots for hardness are as shown in following fig. In order to see the effect of process parameter on micro hardness using L_9 orthogonal array and experiments are performed and both the data are agree with each other. It is clear that as groove angle goes on increasing, micro hardness also goes on increasing. It was observed that as root gap goes on increasing micro hardness goes on increasing. It was observed that as root face goes on increasing up to 1 to 1.5 mm the micro hardness goes on decreasing. The root face 1.5 to 2 mm micro hardness is observed to be increasing.

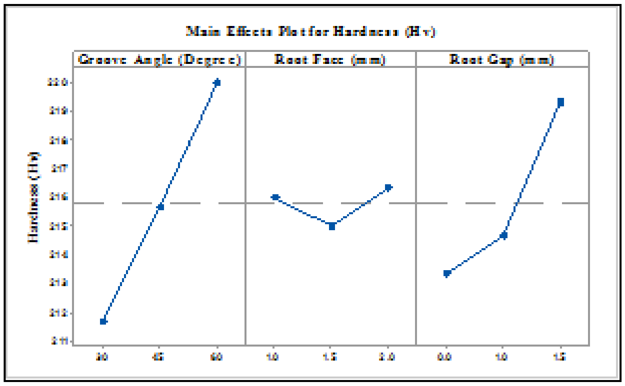

Fig.12 Main Effects Plot for Micro hardness of SMAW Joints

The higher values are 232. Main effect plots for micro hardness are as shown in following figure. In order to see the effect of process parameter on micro hardness using L_9 orthogonal array and experiments are performed and both are agree with each other. It is clear that as groove angle goes on increasing, hardness also goes on increasing. It was observed that as root face up to 1.5 mm micro hardness goes on decreasing after that 1.5 mm to 2 mm micro hardness goes on increasing. It was observed that as root gap goes on increasing so hardness also goes on increasing.

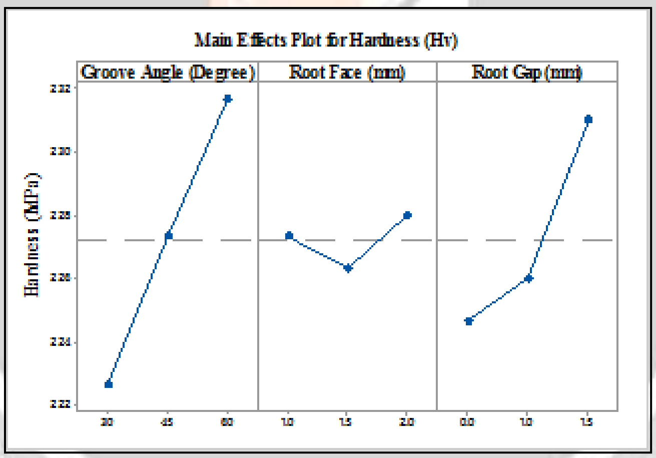

Fig.13 Main Effects Plot for Micro hardness of TIG Joints

II. Conclusion

The higher ultimate tensile strength 549 Mpa produced at 45 groove angle, 1.5 mm root face, and 1.5mm root gap in SMAW. The ultimate tensile strength of SMAW butt welds reaches to 83 % of the base metal ultimate tensile strength (i.e. 664Mpa).The higher ultimate tensile strength 646 Mpa produced at 45 groove angle, 1.5 mm root face and 1.5mm root gap in TIG welding. The ultimate tensile strength of TIG butt welds reaches to 97 % of the base metal ultimate tensile strength (i.e. 664mpa).The higher micro hardness 224 Hv produced at 60 groove angles, 1 mm root face and 1.5 root gaps in SMAW and higher micro hardness 232 Hv produced at 60 groove angles, 1 mm rib thickness and 1.5 root gaps in TIG welding. The TIG welding process shows good result as compare to SMAW process.

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REFERENCES

[1] G. Magudeeswaran, V.Balasubramanian, G. Madhusudhan Reddy, "Effect of Welding Processes and Consumables on Fatigue Crack Growth Behaviour of Armour Grade Quenched and Tempered Steel Joints.

[2] M. Ericsson, R. Sandstro "Influence of welding speed on the fatigue of friction stir welds, and comparison with MIG and TIG" International Journal of Fatigue 25 (2003) 1379–1387

[3] S.C. Juang and Y.S. Tarng, 2002, "Process Parameter Selection for Optimizing the Weld Pool Geometry in the Tungsten Inert Gas Welding of Stainless Steel" Journal of Materials Processing Technology 122, pp. 33–37

[4] G. Magudeeswaran, Sreehari R. Nair, L. Sundar and N. Harikannan, 2014, "Optimization of Process Parameters of the Activated Tungsten Inert Gas Welding for Aspect Ratio of UNS S32205 Duplex Stainless Steel Welds", Science Direct, Defence Technology 10, pp.251-260

[5] Bhawandeep singh, Avtar simgh "Performance of activated TIG process in mild steel welds" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) Volume 12, Issue 2 Ver. IV (Mar - Apr. 2015), PP 01-05

[6] M. A. Bodude, I. Momohjimoh "Studies on Effects of Welding Parameters on the Mechanical Properties of WeldedLow-Carbon Steel" Journal of Minerals and Materials Characterization and Engineering, 2015, 3, 142-153.

[7] Talabi, S.I., Owolabi, O.B., Adebisi, J.A., Yahaya, T. "Effect of welding variables on mechanical properties of low carbon steel welded joint" Advances in Production Engineering & Management, Volume 9 Number 4 December 2014 pp 181–186.

[8] Murakawa hidekazu,Sano Masanori, Wang Jiangchao, "Influence of root gap and track weld on transverse shrinkage during welding" Transaction of JWRI,Vol.41(2012),No.1