A REVIEW ON EVALUATION OF THE EFFECTS OF WELDING CURRENT ON MECHANICAL PROPERTIES OF BUTT WELDED JOINTS .

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Abstract - Welding is a very important fabrication process which is widely used in different industry, so its study is very important. In this study I take a review on evaluation of the effects of welding current on mechanical properties of welded joints between mild steel. Many researchers have a lot of study on the welding in which they have a taken different parameter and find their effect on the mechanical property. As it is finding that there is a huge effect, on the mechanical property like hardness, impact strength, toughness, tensile and compressive strength near the fusion zone and heat affected zone (HAZ).

Key Words: Mild Steel, Tig, Mig, Welding Current, Impact Testing, Hardness,

1. INTRODUCTION

welding is a very important technique/process to fabricate or join two similar (same material) or dissimilar (different material) metal by using heat from different source like electric current, heat due to chemical reaction, heat due to friction, or by any other means. In welding some time pressure and filler material may or may not be used. So welding can be defined as a process of joining two metals which may be similar or dissimilar. Welding is a permanent joining process, it means that when two metal be joint through welding it can't be again separated with the same dimension without any damage. Welding have huge application in different industry[1]. High strength low alloy (HSLA) steels with excellent strength characteristics have been widely used in various applications together with cars, trucks and cable-stayed bridges. Now days an ample variety of metal joining processes are used in manufacture industries. The welding is majorly used for metal joining. In this process arc i.e. electric emancipation between electrode and parent metal is familiar

2. LITERATURE REVIEW.

S.R. Ren et all -2006 carried out several experiments and explain about hardness Al–Mg–Si alloy plates friction stir welded at a tool pass through alacrity of 400 mm/min exhibit advanced tensile strength with 45^0 shear fracture, whereas minor tensile strengths with almost vertical fractures were observed for samples welded at a minor alacrity of 100 mm/ min. The fracture paths corresponded well with the lowest hardness portion profiles in the joints. The heat index cannot be used as parameter to estimate the thermal input , mechanical properties and fracture approach

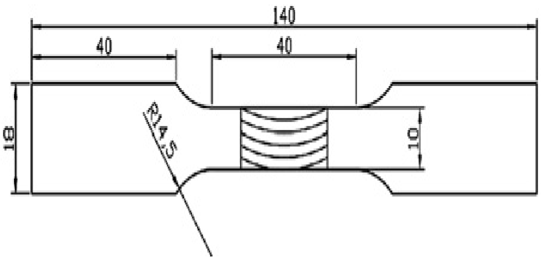

Fig 1. Configuration and size of tensile specimens.

The following conclusions are conclude by the researcher
1. For FSW 6061Al–T651, the lowly hardness allotment profiles were a 45^o angle with the butt facade of the joints welded at the major traverse alacrity of 400 rpm, whereas the lowest hardness profiles nearly vertical to the butting surface were observed at the minor traverse alacrity of 100 mm/min.
2. FSW 6061Al–T651 joints welded at 400 mm/min exhibited major strength with a 45^o shear fracture, whereas a minor tensile strength with nearly vertical fractures were observed for the samples welded at 100 mm/min. The fracture paths corresponded well with the lowest hardness distribution profiles.

C-H Lee et all -2008 carried out several experiments and researcher says that With the increased use o f stainless steels in construction, it has become of critical importance to estimate the magnitude and distribution of welding residual stresses in a welded structure made of stainless steels. Simulation tools based on the finite element (FE) method are very useful to predict welding-induced residual stresses. Welding residual stresses in carbon steel welds have been thoroughly investigated through numerous FE models.[3]

In summary, the following observations and conclusion by the researcher.
1. The max out temperature at the welded zone of carbon steel butt welds is superior than that of stainless steel butt welds owing to the larger specific heat at high temperatures. However, the carbon steel welds have a major cooling rate, which originates from the major thermal conductivity and heat transfer rate.
2. The longitudinal residual stresses at the base metal near the weld area in stainless steel butt welds are major than

those in carbon steel butt welds. Moreover, the range where tensile stress is induced is wider in the stainless steel welds. The larger coefficient of thermal expansion together with the major strain-hardening rate of the stainless steel gives rise to the major tensile longitudinal stresses balanced by the major compressive stresses away from the weld. In addition, the minor thermal conductivity and heat transfer rate in conjunction with the larger coefficient of thermal expansion of the stainless steel contribute to the larger tensile stress distribution region.[8]
3. The strain-hardening behavior has a significant influence on the longitudinal residual stresses in the weld and its vicinity, especially for stainless steel butt welds which have a major strain hardening rate compared with carbon steel butt welds, and hence the strain-hardening effect cannot be disregarded during the welding process. However, the hardening behavior has little influence on the transverse and through-thickness residual stress components, and the effect becomes negligible away from the weld in both the carbon and stainless steel welds.

X. Cao et all -2009 carried out several experiments and explain the effect of welding alacrity ranging from 5 to 30 mm/s on 2-mm butt joint quality of friction stir welded AZ31B-H24 magnesium alloy was investigated to determine defects, microstructures, hardness and tensile properties. High welding alacrity over a wide range can be used to weld this material at high tool revolution rates indicating the great potential of this technique for magnesium alloys. Equiaxed grains were observed in the stir and thermo mechanically-affected zones. The grain size in the stir zone decreases with increasing welding alacrity due to minor heat input. Major welding alacritys produce slightly major hardness in the stir zone. The yield strength mounting with increasing welding alacrity. The tensile strength mounting first with mounting welding alacrity but remains constant from 15 to 30 mm/s. A Hall–Petch linear relationship between yield strength and inverse square root of grain size in the stir zone illustrates the strong relationship between these parameters.[9]

The influence of welding alacrity ranging from 5 to 30 mm/s on 2-mm butt joint quality of friction stir welded AZ31B-H24 magnesium alloy was investigated by examining welding defects, microstructures, hardness and tensile properties. Some conclusions can be drawn as follows:
1) The grains in the stir zone and the thermo-mechanically affected zone underwent dynamic recrystallization and the grain shape became equiaxed after friction stir welding. In the heat-affected zone, some partial recrystalization occurred.[5]
2) Compared with the base metal, grain growth appears at an advancing rate (welding alacrity/tool revolution rate) less than 0.6 mm per revolution. Above this threshold, the grains in the stir zone and the thermo-mechanically affected zone are slightly refined. The grain size in the stir zone decreases with increasing welding alacrity due to minor heat input.

Zakaria Boumerzoug et all -2010 carried out several experiments and the researcher find the effect of arc welding on microstructures and mechanical properties of industrial low carbon steel (0.19 wt. % C) was studied. This steel is used for making gas storage cylinders. In order to realize the objective, optical microscopy, EBSD, X-ray diffraction, and hardness tests were used. Different zones and some phases are recognized. New microstructural phenomenons are observed by using EBSD technique.[6]

This work represents a involvement to the study of the effect of shielded metal arc welding on industrial low carbon steel (0.19 wt. % C). The microstructures in different zones are determined from the base metal to the weld metal. The microstructure of the center of weld zone is completely different from the heat-affected zone. The HAZ contains Widmanstatten ferrite, large grains of ferrite and colonies of pearlite. We have observed that bands of coarse grains grow along a certain preferred crystallographic directions. Moreover, we have found that maximum hardness values are situated in the area of weld metal and HAZ which indicates its specificity.

Hongqiang Zhang et all -2014 carried out several experiments In this study, resistance spot welding (RSW) experiments were performed in order to estimate the microstructure and mechanical properties of single-lap joints between DP780 and DP600. The results show that the weld joints consist of three regions including base metal (BM), heat affected zone (HAZ) and fusion zone (FZ). The grain size and martensite volume fractions increase in the order of BM, HAZ and FZ. The hardness in the FZ is considerably major than hardness of base metals. Tensile properties of the joints were described in terms of the failure modes and static load-carrying capabilities. Two distinct failure modes were observed during the tensile shear test of the joints: interfacial failure (IF) and pullout failure (PF). The FZ size plays a dominate role in failure modes of the joints.[11]

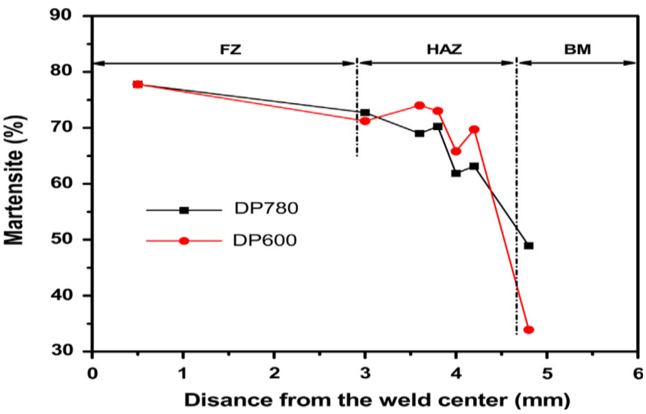

Fig. 2. The martensite volume fraction of the weld joint.

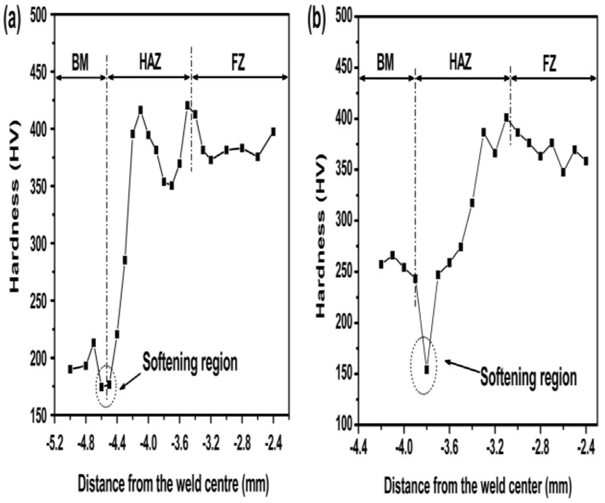

Fig. 3. Typical hardness profile between DP600 and DP780 after RSW with 8.0 kA, 4.0 kN and 18 cycles (a) DP600 and (b) DP780.

Microstructure and mechanical properties of RSW dissimilar thickness DP780/DP600 joints were examined. Some consequences can be concluded as following:
(1) The microstructure of FZ consists of large lath martensite and ferrite. The grain size and martensite volume fractions increase in the order of BM, HAZ and FZ. The allocation of alloying elements is uniform in the FZ.
(2) The hardness in the FZ is appreciably major than the base metals. There are softening regions in the subcritical HAZ near base metals due to the martensite tempering.
(3) During the quasi-static tensile-shear test, the IF and PF modes were experimental in the DP780/DP600 joints. IF and PF are competitive with each other and adjusting process parameters can transit from IF to PF.
(4) The failure modes are mainly dependent on the FZ size and 6.6 mm is the critical FZ size of the transition between the failure modes in this study

Wei Guo et all -2015 carried out several experiments on mpact test and demonstrated that the grain size of fusion zone and heat affected were predominately martensite and some self-tempered martensite,. The tensile properties of the laser welded joint matched those obtained for the base material, with failure occurring in the base material away from the weld. While the welded joint performed well when subjected to bending, the impact toughness was reduced when compared with that of the base material.
From this investigation the following conclusions were by the researcher:
(1) It is possible toweld 8mmthick S960 HSLA steel plates in a single weld pass, without any macroscopic defects, using an autogenous laser welding process with a laser power of 6.5 kW and welding alacrity of 1.08 m/min.
(2) The tensile strength of the laser welded specimens matched the strength of the BM, with all welded specimens failing in the BM. The laser welded joint also performed well in bending tests.[12]
(3) Autogenous laser welding produced a fusion zone microstructure comprising very coarse lath martensite, with some self-tempered martensite. In the heat affected zone, the microstructures were also predominantly martensitic with some self-tempered martensite, with the prior austenite grain size reducing gradually moving from the CGHAZ to ICHAZ. The SCHAZ retained the microstructure of the BM.
(4) The maximum hardness coincided with the FGHAZ, where the average value was approximately 385 HV0.3, for the welding parameters used in this study. The average hardness in the FZ was approximately 375 HV0.3. The hardness in the HAZ dropped rapidly when moving from the FGHAZ to the SCHAZ. There were narrow hardness "valleys" in the SCHAZ, in which the hardness locally dropped below that for the base material.
(5) The generation of martensite in the FZ and HAZ led to increased hardness in the weld zone, but also a reduction in the impact toughness in comparison with the base material.

Oluwasegun Biodun Owolabi, et all -2016 carried out several experiments and explains the welded joints samples were cut machined and subjected different destructive tests and their mechanical properties were determined. Generally, as the welding current mounting, hardness of the weld mounting for the two samples up to 115A and 116A for mild steel and low carbon steel respectively but shows a decrease with a further increase in welding current. The ultimate tensile strength decreases with increase in welding current but mounting at the welding current of 200A and 115A for mild steel and low carbon steel] respectively.[14] The yield strength and impact strength shows a decrease for the two samples with an increase in the welding current.

In this paper the researcher conclude that with the increase in welding current ultimate tensile strength decreases

Qiao Li, et all -2017 carried out several experiments and explain that by bending test is used to verify the plasticity and bending performance.[16] After cold drawing, the microstructures in the heat-affected zones (HAZs) were refined and the microhardnessin the HAZs increased. The tensile strength of the joint increased to 830 MPa, with 6.2% elongation. The 40-μm-thick weld obtained at the welding current of 45 A consisted of a reaction layer and a NiTi molten zone.[17]

Munaf Hashim Ridha et all -2019 carried out several experiments and the mechanical properties of welded joint were implement using (TIG Welding) to join Low carbon steel 1020 AISI, at variable DC current and steady voltage, wire filler ER70S-3 with argon fruitful case. Some of preparing sheet metal was subjected to shot peening by steel ball in diameter 1.25mm for half an hour before welding then to be welded at the same welding conditions. The objective of the current work is to be find optimum working conditions and parameters for welding thick low carbon steel plates. Hardness, tensile, bending, microstructure was tested.[18] The result shows an improvement of 12% in the tensile strength of the welded joints comparing with the base metal. The tensile strength of the welded joints of the shot peening metal was 8% major than the tensile strength of the welded metal without shot peening. The best tensile result was increased when increased the heat input due to the change in used current and the number of passes. The increasing in bending strength of the shot peening weld joints was11.15%. Major than the bending strength of the welded metal without shot peening. The hardness of the welds joint was increased for all joints because of the change in the chemical composition of the weld pool for the weld area.

Table -1: The chemical composition of AISI (1020)

Cu	Mo	Ni	Mn	Si	C	Elements wt%
0.44	0.005	0.04	0.5	0.009	0.2	Real value
-	-	-	0.3-0.6	0.01	0.18-0.2	Standard value
P	S	Ti	Al	Co	Elements wt%	
0.04	0.05	0.009	0.009	0.009	Real value	

In this research the researcher explain that for current and other parameter argon inert gas welding method is best suited for low carbon steel plate. Using multi pass variable current method improved the mechanical properties of the weldments.

3. CONCLUSIONS

After study the result of many researcher find countless result but there is a research gap which need further study so, following points have conclude which are:

1. Hardness of a material have a huge effect on the welding current as hardness increase or decrease with the increase or decrease in welding current.
2. Hardness of a material have a huge effect on the notch angle as hardness increase or decrease with the increase or decrease in notch angle.
3. Hardness of a material has a huge effect on the plate thickness as hardness increase or decrease with the increase or decrease in plate thickness.
4. Impact strength of a material have a huge effect on the welding current as Impact strength increase or decrease with the increase or decrease in welding current.
5. Impact strength of a material have a huge effect on the notch angle as Impact strength increase or decrease with the increase or decrease in notch angle.
6. Impact strength of a material have a huge effect on the plate thickness as Impact strength increase or decrease with the increase or decrease in plate thickness.
7. Tensile/compressive strength of a material has a huge effect on the welding current as Tensile/compressive strength increase or decrease with the increase or decrease in welding current.
8. Tensile/compressive strength of a material has a huge effect on the notch angle as Tensile/compressive strength increase or decrease with the increase or decrease in notch angle.
9. Tensile/compressive strength of a material has a huge effect on the plate thickness as Tensile/compressive strength increase or decrease with the increase or decrease in plate thickness.

So, above points must be study carried out the effect welding current on impact strength, hardness and Tensile/compressive strength.

REFERENCES

[1] W.M. Thomas, E.D. Nicholas, J.C. Needham, M.G. Murch, P. Templesmith, C.J. Dawes, GB Patent Application No. 9125978.8, December 1991.
[2] R.S. Mishra, Z.Y. Ma, Mater. Sci. Eng. R 50 (2005) 1.
[3] W. Tang, X. Guo, J.C. McClure, L.E. Murr, J. Mater. Process. Manu. Sci. 7 (1998) 163.
[4] Y.J. Kwon, N. Saito, I. Shigematsu, J. Mater. Sci. Lett. 21 (2002) 1473.
[5] Y.S. Sato, M. Urata, H. Kokawa, Metall. Mater. Trans. A 33 (2002) 625.
[6] T. Hashimoto, S. Jyogan, K. Nakata, Y.G. Kim, M. Ushio, in: Proceedings of the First International Symposium on Friction Stir Welding, Thousand Oaks, CA, June 14–16, 1999.
[7] Taljat, B., Radhakrishnan, B., and Zacharia, T. Numerical analysis of GTA welding process with emphasis on post-solidification phase transformation
effects on the residual stresses. Mater. Sci. Engng A, 1998, 246, 45–54.
[8] Hibbitt, H. D. and Marcal, P. V. A numerical thermomechanical model for the welding and subsequent loading of fabrication structure. Comput. Struct., 1973, 3, 1145–1174.
[9] E. Bayaraktar, D. Kaplan, L. Devillers and J. P. Chevalier, “Grain Growth Mechanism during the Welding of Interstitial Free (IF) Steels,” *Journal of Materials Processing Technology*, Vol. 189, No. 1-3, 2007, pp. 114-125.
[10] A. Güral, B. Bostan and A. T. Özdemir, “Heat Treatment in Two Phase Region and its Effect on Welding of a Low Carbon Steel,” *Materials and Design*, Vol.28, No. 3, 2007, pp. 897-903.
[11] Eroglu and M. Aksoy, “Effect of Initial Grain Size on Microstructure and Toughness,” *Materials Science and Engineering A*, Vol. 286, No. 2, 2000, pp. 289-297.

[12] O. Grong and O. M. Akselsen, "HAZ Grain Growth Mechanism in Welding of Low Carbon Microalloyed Steels," *Acta Metallurgica*, Vol. 34, No. 9, 1986, pp. 1807-1815.
[13] Sun Z, Karppi R. The application of electron beam welding for the joining of dissimilar metals: an overview. J Mater Process Tech 1996;59:257–67.
[14] Khan MI, Kuntz ML, Biro E, Zhou Y. Microstructure and mechanical properties
of resistance spot welded advanced high strength steels. Mater Trans 2008;49:1629–37.
[15] J. Oñoro, C. Ranninger, Fatigue behaviour of laser welds of high-strength low-alloy steels, J. Mater. Process. Technol. 68 (1997) 68–70.
[16] W. Yan, L. Zhu, W. Sha, Y. Shan, K. Yang, Change of tensile behavior of a high-strength low-alloy steel with tempering temperature, Mater. Sci. Eng. A 517 (2009) 369 374.
[17] H. Xie, X. Dong, K. Liu, Z. Ai, F. Peng, Q. Wang, et al., Experimental investigation on electroplastic effect of DP980 advanced high strength steel, Mater. Sci. Eng. A 637 (2015) 23–28.
[18] Efzan, E., Kovalan, K.V., Suriati, G. 2012. A Review of Welding Parameter on Corrosion Behavior of Aluminum, Int. J. Eng., 1(1), 2305–8269.
[19] Mohammed, G., Ishak, M., Aqida, S., Abdulhadi, H. 2017. Effects of heat input on microstructure, corrosion and mechanical characteristics of welded austenitic and duplex stainless steels: A review, Metals, 7(2), 39.
[20] Raj, J., Agrawal, N., Thakur, M., Raj, J., Baghel, A. 2017. A Review on TIG/MIG Welded Joints, Int. J. Sci. Technol. Eng., 4(1), 65–71.