Diyala Journal of Engineering Sciences

ISSN 1999-8716

Vol. 03, No. 01, pp. 79-89, June 2010

State Some Mechanical Properties for Al- Alloy Welded by Seam Welding Technique

Latfe Y. Zedan, Ahmed F. Hassn

Department of Mechanical Engineering, College of Engineering, University of Diyala
(Received:6-6-2009; Accepted:22-3-2010)

ABSTRACT - The aim of this paper was perpetrated lap joint welding samples welded by seam welding method ,2014 heat treatable aluminum alloy, the paper studied some groups at different variable welding, welding time was studied at electrode pressure 1,1.5 KN with thickness 1.5 mm and another group at 2 mm. after welding process shear strength, Vickers hardness were tested at different variables. The paper stated the best shearing strength at 1.5mm thickness with 45 KA welding current at 1.5 KN electrode pressure. Increase 0.5 mm in thickness lead to decrease 20% of shearing strength.

Keywords: - 2014 heat treatable aluminum alloy, Seam welding, Mechanical properties.

1- INTRODUCTION

Fusion welding, the joint is affected directly between the parts being joined by the application of heat to melt the interfaces and so cause the materials to fuse together. Fusion welding thus requires the melting point of the components to be exceeded.

There are four main types of process used for fusion welding.

1. Electric arc.
2. Electrical resistance
3. Radiation
4. Thermo chemical.

The aluminum alloys and copper are difficult to weld because of the high thermal conductivity, high thermal expansion and a tendency to give porous welds(1).

Lightweight Al. alloys with high specific strength are widely used in industry, chemical and physical properties of Al. alloy in fluency its welding characteristics, although there are different techniques to join this alloy. the specific properties that affect the welding of Al. alloy are its oxide characteristics , the solubility of hydrogen in molten Al. alloy , its thermal , electrical and non magnetic characteristics , its alloys ,wide range of mechanical properties and melting point [2].

Al- alloys can be classified two types: -

1. Wrought aluminum alloy

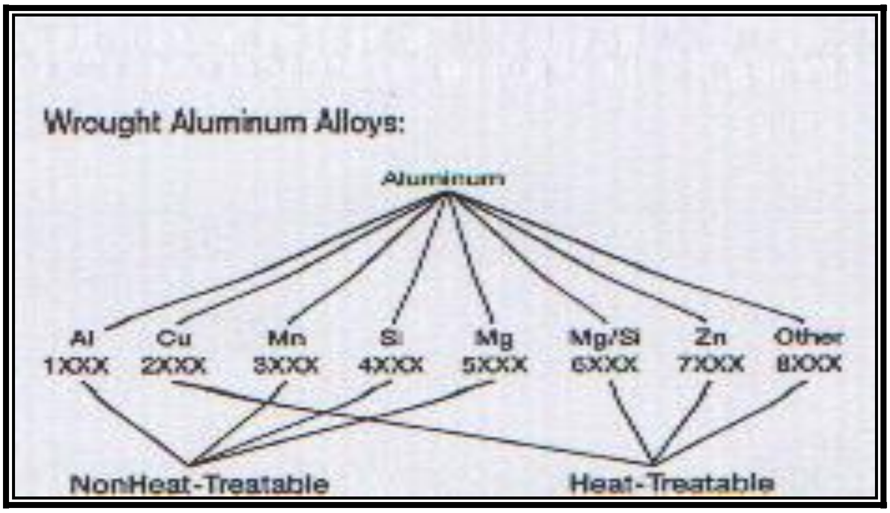


Fig. (1):- wrought aluminum alloy

2. Cast aluminum alloy

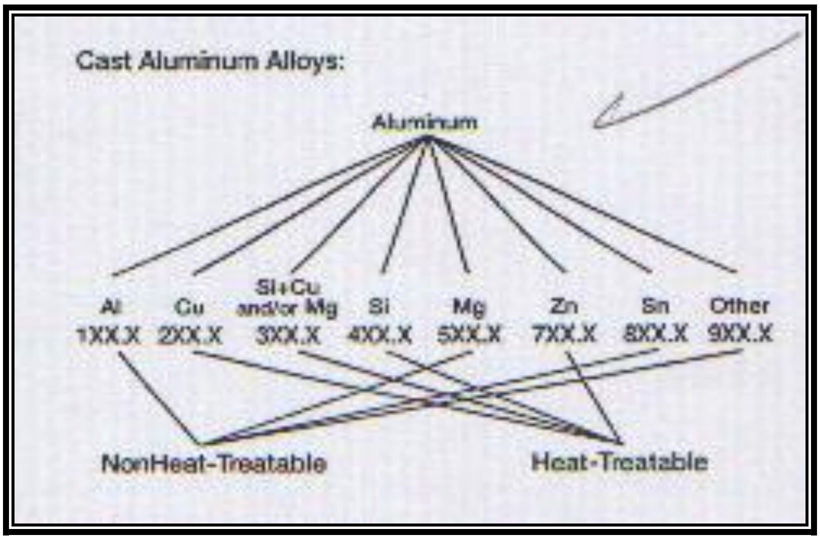


Fig. (2):- Designation of cast aluminum alloy [3]

Aluminum alloys have been widely used in welded structures and are most promising material for aerospace applications. They have been studied extensively because of their benefits such as formability, weld ability and low cost, comparing to other alloys. AA6000 series alloys are used for applications such as rocket shells, cryogenic tanks, engine casings and other medium strength structures. These alloys are preferred mainly due to their specific strength and good corrosion resistance [(4)].

The concept of MIG welding was developed in the 1920s, but commercial exploitation did not begin until 1948. Initially it involved a high current density, small diameter metal electrode and inert gas for arc shielding. It was primarily used for welding aluminum, and the term MIG welding (metal arc inert gas) was employed. With advancements in the process, the term gas metal arc welding (GMAW) is now becoming a more common description, because both inert and reactive gases (particularly CO_2) are now employed1. MIG welding is a well-established way of joining various aluminum alloys, although some alloys, notably those in the 2XXX and 7XXX series, are difficult to fusion weld. MIG welding employs an electric arc, struck between the filler rod and the material being welded, to generate localized heat. The heat melts both the parent plate and the filler metal, mixing of the two occurs, and upon cooling fusion of them occurs. The filler wire is continually fed through to the weld pool; this is generally automated, thereby maintaining the arc length and the supply of filler material. Due to the reactive nature of aluminum, the arc is shrouded by an inert gas, generally argon, protecting the base metal from contact with oxygen, nitrogen or hydrogen. Figure (3) show a typical automated MIG welding set up[(5)].

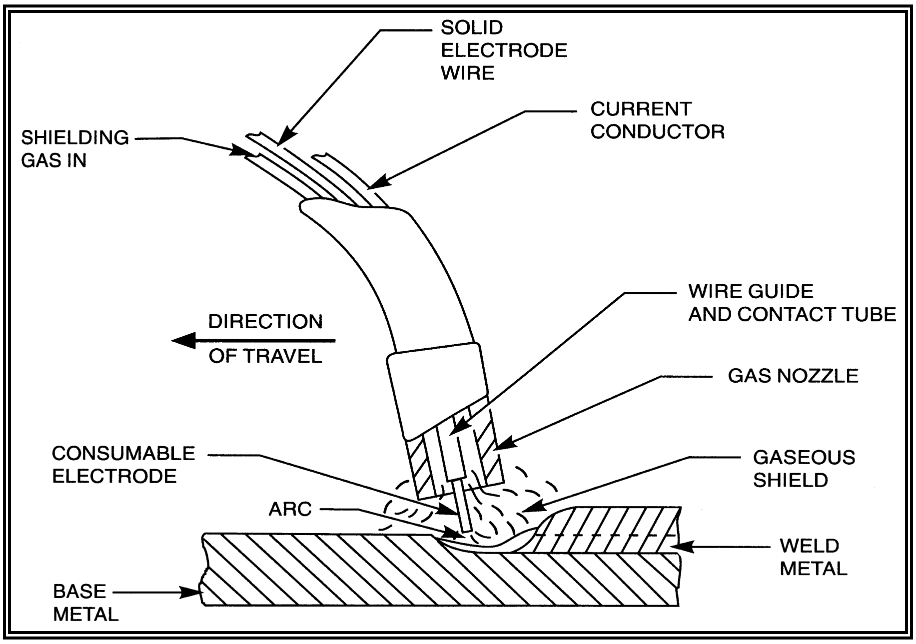


Fig. (3):- show a typical automated MIG welding set up[(5)]

Li yajlang studied in 2004, the finite element analysis of residual stress in the welded zone of a high strength steel, from the study , the stress gradient near the fusion zone is higher than any other location in the surrounding area , in order to avoid such welding crack the thermal stress in the weld joint has to be minimized by the controlling the weld heat input [(6)].

Visniakov state modeling of thermal process in dissymmetric welded cast aluminum design ,Basanaviciaus Number of constructions, produced from eutectic silumins are continually increasing, therefore problem of their welding became very actual. Eutectic aluminum – silicon alloys are sensitive to changes of a welding thermal cycle.

These cast aluminum alloys constructions after welding have large residual stresses, and mechanical properties of welded joint deteriorate. Most useful way to define heat input, optimal welding current and speed is simulating of welding process using finite elements method (FEM). The mentioned method enables to achieve lower size of the heat affected zone and better quality of welded joint(7).

Zettler study the fusion boundary microstructure evaluation in aluminum alloys , aluminum alloys exhibit a variety of microstructures within the fusion zone adjacent to the fusion boundary. Under conventional weld solidification conditions, nucleation occurs off grains in the heat-affected zone (HAZ) and solidification proceeds along preferred growth directions.. Fusion boundary behavior was studied in experimental alloy compositions which were produced by making bead on plate welds using an alloy 5454-H32 base metal and 5087 or 5025 filler metals. For comparison purposes fusion boundary behavior was studied in commercially available aluminum alloys 5454-H34, 6061-T6, and 2219-T8. In the context of the alloys, compositions and substrate conditions examined a mechanistic model for EQZ zone formation is proposed. This model can be helpful in adjusting base metal compositions and/or substrate conditions to control fusion boundary microstructure(8).

Al zawa et al in 2003 studied the application of magnetic pulse welding for Al. alloys and steel sheet joints, this paper study the earlier Al. alloy type (A10SC, A20A, A3004 and A7075) and joints in steel sheets, were investigated ,and the welding process parameter and characteristics reported (9).

Loutfy study in 2008 studied the optimum zing the process of resisting spot welding for 2014 Al –alloy sheet, the result show that the best current is 45 kA, best time welding 10 cycle ,and electrode pressure 3kN(10).

2- EXPERMENTAL WORK

1- Materials

The material studied was the heat treatable aluminum alloy (2014) in a thickness of (2,1.5)mm in the mill – finished as received condition and was not cleaned prior to welding.

The specified chemical composition and mechanical properties are shown in Table (1 and 2), Fig. (4) explain the sample of welding for shear test.

Table (1):- Chemical composition

Cr	Cu	Mg	Ti	Si	Zn	Fe	Al
0.1	4.2	0.6	0.15	0.7	0.2	0.5	Remaine95.17

Table (2):- Mechanical properties

Properties	Value
Tensile strength	470 MPa
Shear strength	293 MPa
Elongation	7%
Density	2.89 g/cm3
Charpy impact	16.2j

2- Equipment

Semiautomatic welding machine was used for welding the plate at different parameter (MIG- Type).

3- experimental procedure

Two over lap specimen are preparing Ted as shown in Fig (4) .each tow specimen are weld with different parameter as the following:-

A- first group

Experimented were designed and conducted under different welding time. With electrode pressure (1, 1.5) KN, with thickness 1.5 mm.

B- second group

Experimented were designed and conducted under different welding time, with thickness (2) mm.

C- Third group

Experimented were designed and conducted under constant electrode pressure 1.5 KN and thickness 1.5 mm.

4- Tensile test

Weld quality was assessed by tensile. Shear strength test (instron -machine) according to the ASTM B 831 as shown in Fig (4)[11].

5- Hardness test

Vickers hardness test were carried out on the welded joint[12].

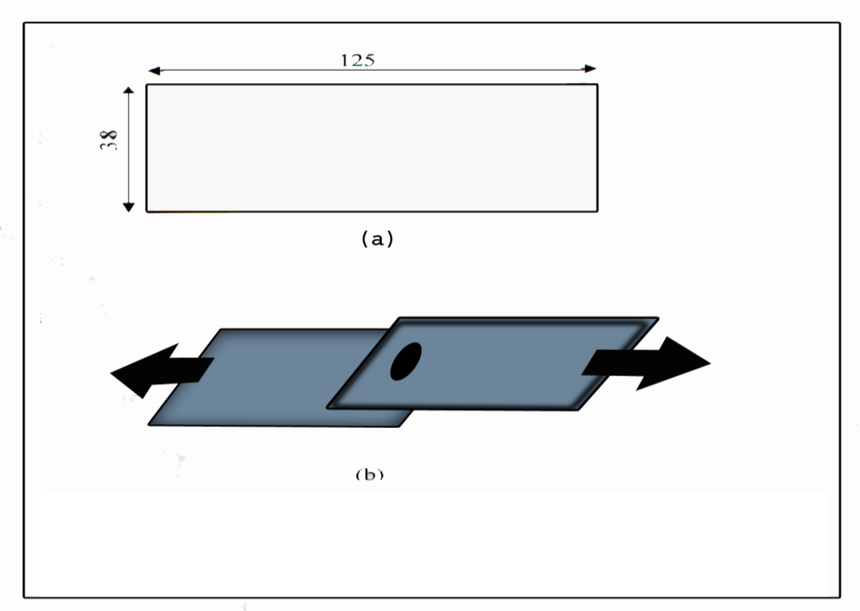


Fig. (4):- a- specimen after preparation (dimension in mm)

b- Tow over lap specimens under shear

6- Welding efficiency calculation

The welding efficiency calculates by using the equation below[13], table (3) explain the process parameter to state the welding strength.

$$\eta = \frac{S_w}{S_m} \qquad .....(1)$$

Where

η= welding efficiency.

S_w= maximum strength for welding samples MPa.

S_m= strength of the base metal MPa.

$$S_w = \frac{p}{2 * 0.707 * h * l} \qquad .....(2)$$ [14].

Where

S_w= maximum strength for welding samples MPa

P= maximum tensile shear force for welding sample KN .

h = plat thickness mm.

l = plate length mm.

Table (3):- Process parameter for stat welding strength

Symbol	Thickness (mm)	Electrode force KN	Welding time cycle	Welding current KA	Maximum tensile shear force KN
A	1.5	1.5	7	45	1900
B	1.5	1	7	45	1400
C	2	1.5	10	45	2000
D	2	1	10	45	1500

3-RESULTS AND DISCUSSION

Aluminum is alloyed with arrange of other metals to change its properties to suit specific application aluminum is light weight ,has high thermal conductivity which mean heat is easily conducted away from the welding area it is essential that the heat source is powerful enough to rapidly reach Aluminum low melting point , Aluminum coefficient of thermal expansion is high so it is prone to distortion and stress inducement if the proper welding procedure is not followed [15].

Figure (5 and 6) explain the relation ship between shear force (KN) and welding time (cycle) with thickness (1.5,and 2)mm respectively at constant current (45)KA ,the figure show the value of shear force increase with increasing welding time to reach at maximum value at (7and 10) cycle for thickness (1.5and 2)mm respectively .then the value decrease gradually ,increasing in the length of welding time cause large temperature range and increase the heat effective zone (HAZ) so the strength reduce because of residual stress result from plastic metal flow[14].

Figure (5 and 6) also explain the value of shear force at (1.5)KN load more than (1)KN load ,applying an external force to maintain the weld in compression ,external force reduce longitudinal residual stress[5].

Figure (7) explain the relationship between shear force (KN) and welding current (KA) ,the figure show the value of shear force increase with increasing welding current to reach at maximum value at (45) KA then decrease slowly ,the paper explain before Aluminum alloys needs to high current because of high thermal conductivity and thermal expansion.

When heat increase up to (45) KA for this alloy with this parameter led to decrease the value of shear force due to increase plastic deformation during fusion and that’s cause differences in microstructure and increase residual stress(14,16).

The results of hardness test are showed in table (4),the value of hardness in sample 2 with thickness 2 mm have the value of hardness more than sample 1 with thickness 1 mm ,so the value in cross section higher than surface of the weld.

Table (5) shows the welding efficiency values for welded samples, the results show maximum welding efficiency at sample (A) and decrease in another samples.

4-CONCLUSIONS

The shearing strength in seam welding for aluminum alloy 2014 is influenced by many variables. Some was studied in this research and their results are:

1. The best shearing strength occurs at thickness layer of (1.5) mm for welding strip.
2. When the thickness of welding layer increased by (0.5) mm the shearing strength tend to we get decrease by20percentage.
3. The best shearing strength by using welding current set at (45) KA.
4. We get the best shearing strength by using pressure for the welding wheel set at (1.5) KN.

REFERENCES

1. Bolten .W, "engineering material technology" (1998),prentice hall.
2. .Kulekci .M, Metallurgy ,vol .44,No.3,(2005).
3. www.harriscal .com , Aluminum welding guide.
4. Ramanaiah. N, International Symposium of Research Students on Materials Science and Engineering December 20-22, 2004, Chennai, India Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras.
5. O'Brien, Jefferson's Welding Encyclopedia , American Welding Society, Miami, 1997 , RL (*editor*), (1997), ISBN 0-87171-506-6
6. Li, yajang and et ul ,bull-material sciences, vol.27,no.2,2004 .
7. Višniakov . N, . 4th International DAAAM Conference "INDUSTRIAL ENGINEERING – INNOVATION AS COMPETITIVE EDGE FOR SME" 29 - 30th April 2004, Tallinn, Estonia.
8. Zettler .R , WELDING IN THE WORLD ABSTRACTS Volume 50 Issue 11/12 November/December 2006.
9. Azawa .T ,welding journal ,vol.86,2007.

10. Latfe, diyala journal ,vol 1,No.1,2008.
11. Bobyles, welding journal,67,(12),1988.
12. Stephen .T ,hand book testing and data requirement for aluminum alloy ,USA ,gate way technology ,2007.
13. Hosseini .H, Material science and engineering ,A335,(2002).
١٤. دعبد الرزاق إسماعيل ,تصنيع المعادن ,بغداد و١٩٨٢.
15. AFSA, The welding of aluminum MIG,TIG fusion ,2nd edition ,2004 (www.afsa.org.za).
16. Gene , Mathers ,The welding of aluminum and its alloy ,crc press ,Cambridge ,England ,2002.

Table (4):- Vickers hardness of weld sample at different location

Sample No.	HV(On the surface of the weld)	HV(On the cross section of the weld)
1*	31.8	33.5
2**	36	37

- *(load 1.5 KN & current 45 KA and thickness 1.5 mm)
- **(load 1.5 KN & current 45 KA and thickness 2 mm)

Table (5):- Welding efficiency

Symbol	Welding efficiency
A	2.4
B	1.6
C	1.9
D	1.4

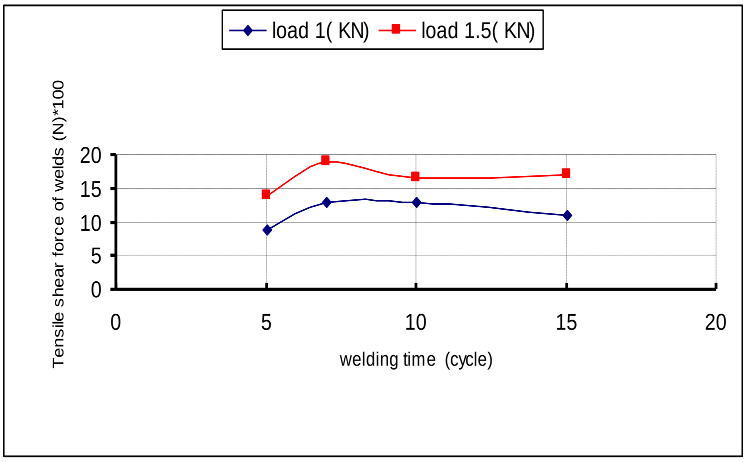


Fig. (5):- Effect of increase time (cycle) on weld quality at constant current and thickness (I=45& t=1.5mm)

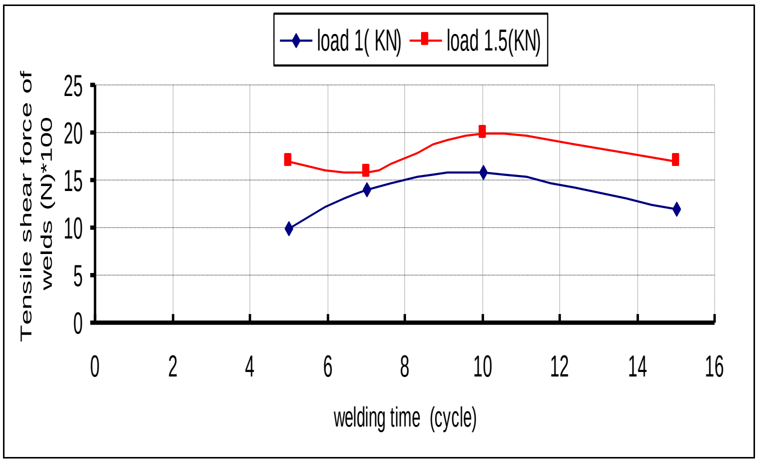
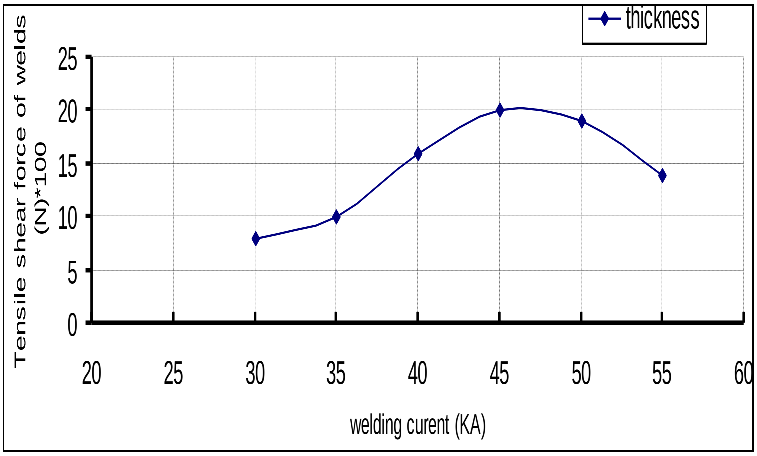


Fig. (6):- Effect of increase time (cycle) on weld quality at constant current and thickness (I=45& t=2mm)



Fig(7):- Effect of welding current (KA) on weld quality at constant electrode pressure and thickness(p=1.5KN& t=1.5mm)

حالة بعض الخواص الميكانيكية لسبائك الألمنيوم الملحومة بطريقة اللحام الخطي

د. لطفي يوسف زيدان
أستاذ مساعد
كلية الهندسة . جامعة ديالى

أحمد فالح حسن
مدرس
كلية الهندسة . جامعة ديالى

الخلاصة

تهدف الدراسة الحالية إلى تحضير وصلات لحام تراكبية ملحومة بطريقة اللحام الخطي ,حيث تم استخدام سبيكة الألمنيوم (٢٠١٤) القابلة للتعامل الحراري ,تم دراسة متغيرات عملية اللحام وفق مجاميع مختلفة . تم دراسة زمن اللحام عند ضغط اليكترود ،KN(١,١.٥) بسمكmm ١.٥ والمجموعة الأخرى بنفس الظروف ولكن بسمك (MM٢) وبعد إجراء عملية اللحام تم حساب مقاومة القص بالظروف المختلفة وكذلك حساب الصلادة المجهرية عند خط اللحام وبجانبه .ومن الدراسة لوحظ أن أفضل مقاومة قص لوصلة اللحام كانت عند سمك mm ١.٥ وتيار لحام KA٤٥ عند KN١.٥ ضغط اليكترود. كما لوحظ أن زيادة السمك بـmm ٠.٥ تنخفض قيمة مقاومة القص إلى ٢٠٪.

الكلمات الدالة:– سبائك الالمنيوم ٢٠١٤ , خصائص ميكانيكية, اللحام الخطي.