Effect of Welding Parameters on Mechanical Properties of Friction Welded 17-4 Ph Stainless steel

A.Murugesan[1], D.Karthikeyan[2], D.Noorullah[3], K.Venkatesan[4], P.Sundararaj[5]

[1,2]II nd year M.E Welding Technology, Govt. College of Engineering Salem, India
[3,4,5]Associate Professor, Department of Metallurgical Engineering, Govt. College Of Engineering, Salem, India.

Abstract - *Friction welding is one of the best method for joining rods and tubes. In Current trend friction welding is established as one of the most economical and highly productive method. Friction welding overcomes the difficulties in joining similar and dissimilar metals and usage of friction welding increase day by day in all industries. In this present study the effect of welding parameters on mechanical properties of friction welded 17-4 PH stainless steel and the optimization of friction load, friction time, with response to microstructure analysis and mechanical properties were carried out from the experiments. From this experiments carried out, it was found that the optimized welding parameters were the friction load 850 Kg, forging load 850Kg,and friction time 25 sec, forging time 5 sec. The quality of the joint was evaluated by means of tensile strength, micro hardness, Microstructural and SEM analysis.*

Key Words: friction welding, dissimilar metals, forging load.

1. INTRODUCTION

Friction welding is one of the solid-state welding processes. Here material is joined by means of frictional heat and pressure, because of the frictional heat the metal converted in to forging state and due to pressure its get joined easily. Friction welding is not under fusion welding. For friction welding specimen preparation required, it should be a smooth surface. In friction welding one piece is stationary and another piece is rotary by motor drive to create friction. At the time of forging state the soften metal is squeezed out in the form of flash after it can be machined. Friction welding has been used to join steel rod up to 80 mm in diameter and tubes with outer diameter up to 100 mm.

1.1 Machine Specification

Model – FW30

Max Forge Load – 30KN

Spindle Speed – 3000rpm

Spindle Power-12Kw

Axis Travel – 300mm

Weldable Range 5-10mm Diameter

Controller- Force and position control mode control

Data acquisition- Spindle rpm, axis velocity and force against time

Fig-1: photograph of Friction Welding Machine

1.2 Material Specification

Precipitation-hardened (PH) stainless steels have been widely used because of their good mechanical properties and corrosion resistance at typical service temperatures below 300ºC

Table - 1: Chemical Composition of 17-4PH

Fe	Cr	Ni	Mn	Si	Ta	Nb)	C	P	S
73	15.0	3.0	3.0	1.0	0.45	0.45	0.070	0.040	0.030

2. EXPERIMENTS

The samples were prepared as per the available machine requirements.

Length before face turning – 81mm

Length after face turning – 80mm

Diameter- 14.3mm

No .of samples - 9

The prepared samples were friction welded with constant spindle speed of 1100 rpm, friction time, forging time and varying the friction load, forging load. The welding parameter for each sample is shown in table 2.

Before welding the sample is face turned into smooth surface. After welding the flash is removed by turning operation. Welded samples are shown in figure 2.

Table -2: Welding Parameters

S.NO	FRICTION LOAD(KG)	FORGING LOAD(KG)	FRICTION TIME(S)	FORGING TIME(S)	FLASH LENGTH(MM)
1	850	850	25	5	6
2	850	900	25	5	6
3	850	950	25	5	6
4	900	850	25	5	4
5	900	900	25	5	7
6	900	950	25	5	6
7	950	850	25	5	6
8	950	900	25	5	5
9	950	950	25	5	5

Fig -2: Photograph of Welded Samples

2.1 Bend Test

Type **-** Roller type guided bend test.

Machine - UTM with attachments.

Load applied -1000N.

Bend angle – 30^0

Fig -3: Photograph of Bend Testing

Bend testing results shows that there is breakage of weld metal without any deformation.

2.2 Tensile Testing

Welded specimens are prepared as per E8 standard for tensile test. The specimen is shown in figure 3. The tensile strength value is observed for each specimens and tabulated in table 3.

Fig - 4: Photograph of Tensile Specimens

Table -1: Sample Table format

SAMPLE NO	ULTIMATE TENSILE STRENGTH (MPa)
T1	333.00
T2	197.00
T3	226.00
T4	305.00
T5	279.00
T6	135.00
T7	228.00
T8	171.00
T9	148.00

2.3 Microstructure Analysis

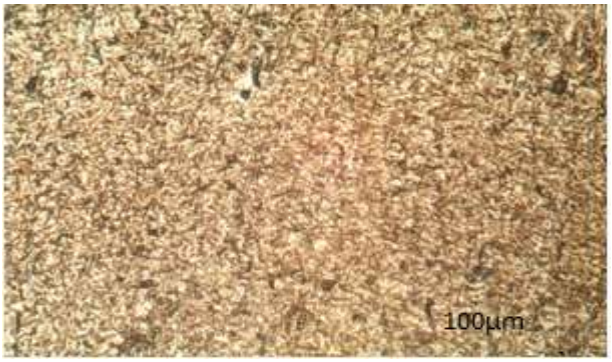

Fig -5: HAZ / Weld Interface Microstructures

In microstructure observation ferrite and martensitic structure were observed.

2.4 Microhardness

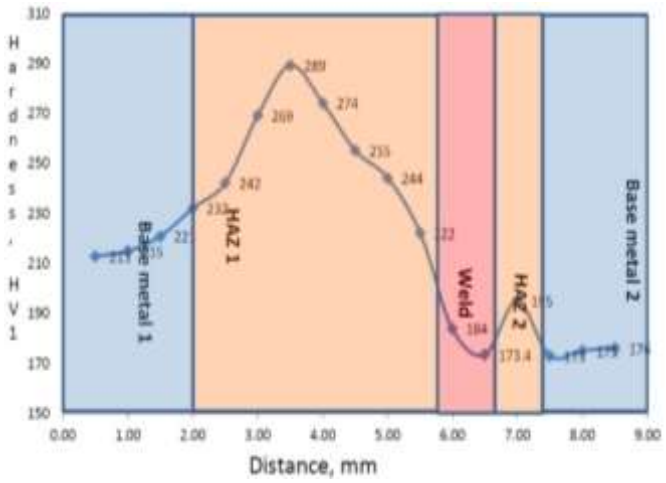

Chart- 1: Microhardness Survey

2.5 SEM analysis

Fig -6: Photograph of SEM Specimen

It shows brittle failure, voids are visible on the surface and dimples are also present indicating pure brittle failure

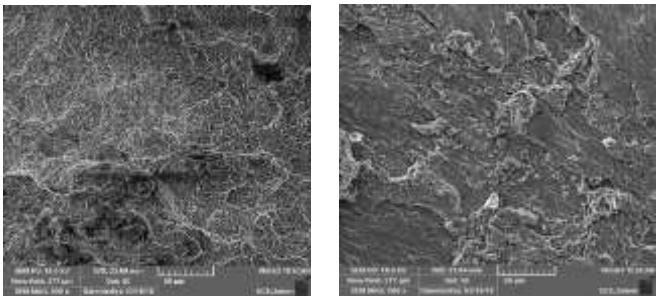

Fig-7: SEM Image

3. CONCLUSIONS

- Mechanical properties and Microstructural features of base metal 17-4PH SS were investigated. The weld is obtained by the process parameters based on optimal values are drawn on the trend of the values
- Then the welded samples are bend tested to clarify the welding parameters like friction load, forging load, friction time, forging time which takes a major role in weld joint of the 17-4PH SS.
- Based on the above the obtained mechanical properties, the weld parameters are modified and nine samples are welded.
- Tensile test conducted to find mechanical property of the weld metal this test give better result.
- Microstructure of the parent metal 17-4PH SS reveals the presence of Martensite phase in major percentage with small amount of ferrite phase.
- The microstructure of the weld metal area has shown the mixture of martensite and ferrite phase.
- The Micro hardness survey reveals the hardness value of the weld area is greater than the parent metal.

REFERENCES

[1] S. Sun, M. Brandt, J. Harris, Surf. Coat. Technol. 201 (2006) 998–1005.

[2] J. D. Bressan, D. P. Daros, A. Sokolowski, R. A. Mesquita C.A.Barbosa,J. Mater. Proc. Technol. 205 (2008) 353–359.

[3] S.V. Raj, L.J. Ghosn, B.A. Lerch, M. Hebsur, L.M. Cosgriff, J. Fedo, Mater. Sci. Eng. A 456 (2007) 305–316. ASTM, 1995. Designation: G99-95;

[4] Standard Test Method for Wear Testing with a Pin-on-Disk Apparatus, pp. 336–390.

[5] Bressan, J.D., Hesse, R., 2001. Construction and validation tests of a pin-on-disc equipment. In: XVI CongressoBrasileiro de EngenhariaMecanica, ABCM (Ed.), COBEM, Uberl ˆ andia/MG, ˆ dezembro.

[6] Ludwigon DC, Hall AM. Physical metallurgy of precipitation hardenable stainless steels. OfÀce of Technical Services, U.S. Dept. of Defense (Code PB 15 1067). Washington, DC,1959.

[7] Robers DA, Roach DB, Hall AM. Physical and mechanical properties of precipitation hardenable stainless steels. OffÀce of Technical Services. U.S. Dept. of Defense (Code PB 15 1068), Washington, DC, 1959

[8] S. Sun, M. Brandt, J. Harris, Surf. Coat. Technol. 201 (2006) 998–1005. [2] J.D. Bressan, D.P. Daros, A. Sokolowski, R.A. Mesquita, C.A. Barbosa, J. Mater. Proc. Technol. 205 (2008) 353–359.