Effect of repair welding on microhardness of dissimilar materials pipes by using GMAW

Nur Izan Syahriah Hussein[1], Suraya Laily[1,*], Mohd Shukor Salleh[1], Mohd Nizam Ayof[1], Nadia Mazwa Abdul Wahid[1]

[1]Fakulti Kejuruteraan Pembuatan, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

[*]Corresponding e-mail: surayalaily@gmail.com

Keywords: Repair welding; orbital welding; gas metal arc welding

ABSTRACT – Repair welding on dissimilar material is not only saves cost, but the usage is more economical and lighter. Microhardness testing in which to measure the hardness of welded specimen: Stainless Steel 304 (AISI 304) and Carbon Steel 1387 (BS 1387) by using Vickers Hardness Test and compare it with base specimen. The microhardness of repair welding was assessed by using Taguchi method with three times repetition. In this article, it shows that low current with high rotational speed contribute to high hardness value, while the hardness of weld metal was lower than base metal and HAZ.

1. INTRODUCTION

The popularity of dissimilar metal welding is getting higher in industrial application. This is because the application of dissimilar joints provides a lot of advantages, included the cost reduction of material and development in design flexibility [1]. In this paper, the materials used were AISI 304L which categorized in austenite stainless steel, where they have a good performance in corrosive working environment while BS 1387 which was categorized in low carbon steel can be applied in boilers, pressure vessels, heat exchangers, and piping application [2].

Repetitive welding is one of the processes of important maintenance and repair. In joining industry, repair welding is one of processes which more advanced than manufacturing [3]. The weld area had to remove by grinding process to ensure the effective removal can be reweld [4]. Beside saving on cost, the application of repair welding could benefit on prolong the service life instead of purchase the new part. Indirectly, objective of this paper is to relate the interaction of microhardness testing on repair welding by using gas metal arc welding (GMAW).

2. EXPERIMENTAL

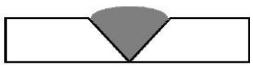
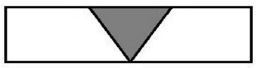
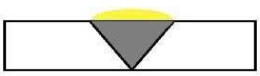
Turning process using a lathe machine was carried out in order to get the pipes in original condition as showed in Figure 2 while Table 1 shows the schematic view of repair welding.

Table 1 shows the machine setup for dissimilar material welded while Figure shows the how the mchine setup.All the 9 samples by using Taguchi Method were welded by using GMAW with current 150-170 A and travel speed 50-100 rpm.

Figure 1 Machine setup of rotating jig welding

Figure 2 Grinding using lathe machine

Table 1 Schematic view on repair welding process

Process welding	Description
	The original welding had been done by using original parameter
	The weldment had been grinded by using lathe machine. The new weldment were produced through repair welding
	The new weldment had been performed on repair welding process

3. RESULT AND DISCUSSION

Table 2 shows the hardness value of AISI 304 and BS 1387. Clearly, it shows the different hardness value, where due to carbon content that affected the hardness of material [4-5]. Table 3 shows result on signal to noise ratio for microhardness testing by using Taguchi method with three times of repetition for every sample.

Table 2 Microhardness value for base metal

Base metal	AISI 304	BS 1387
Hardness value (VHN)	184.80	183.90

Table 3 Signal to Noise ratio for microhardness testing

Run	**current**	**Jig rotational speed (rpm)**	**MEAN2 (avrg for 3 times repetition)**
1	150	50	174.133
2	150	75	187.233
3	150	100	190.033
4	160	75	174.800
5	160	100	169.000
6	160	50	175.967
7	170	100	179.000
8	170	50	167.233
9	170	75	174.967

S/N response graph of microhardness testing as show in Figure 3 described that the main effect of welding parameters to microhardness testing. Furthermore, the highest peak of main effect graph which are 150A and 100rpm shows the optimum parameter that effectively gave a highest value on microhardness. The increase hardness value indicate that the welded joint is prone to brittleness due to carburization process [5]. Besides, Table 4 shows the S/N ratio table that indicate the rank of parameter that influenced microhardness value.

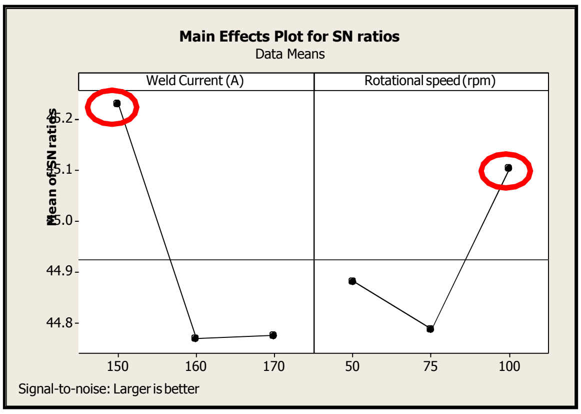


Figure 3 Main effects plot for S/N ratios of microhardness response

Table 4 Response table for S/N ratio of microhardness testing

Level	**Weld Current**	**Rotational speed**
1	45.23	44.88
2	44.77	44.79
3	44.78	45.10
Delta	0.46	0.31
Rank	1	2

4. CONCLUSIONS

Microhardness response shows that the heat input is inversely proportional to cooling rate. When apply the increasing of heat input, the cooling rate were decrease which cause to increasing of pearlite and lead to decreasing of hardness. It can be concluding that weld current is most significant factor affected microhardness value.

ACKNOWLEDGEMENT

Authors are grateful to the Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka for the facilities support. This research is funded through FRGS Grant numbered FRGS/1/2015/TK03/FKP/02/F00280.
.

REFERENCES

[1] A. Aloraier, A. Al-Mazrouee, J.W.H. Price, T. Shehata, "Weld repair practices without post weld heat treatment for ferritic alloys and their consequences on residual stresses: A review", *Int.Journal of Pressure Vessels and Piping*, no. 87, pp. 127-133, 2010.

[2] H. Eisazadeh, J. Bunn, H.E. Coules, A. Achuthan, J. Goldak, and D.K. Aidun, "A Residual Stress Study in Similar and Dissimilar Welds," Welding Research Journal, vol. 95, pp. 111-119, 2016.

[3] P. Varghese, M.S. Prasad, F. Joseph, M.J. Varkey, K. Anthony, and A. Sreekanth, "The effect of repeated repair welding on the corrosion behavior of austenitic stainless steel and mild steel dissimilar weldment", *in Proceeding of International Conference on Advanced in Materials, Manufacturing and Applications*, 2015, pp. 864-869.

[4] S. Debnath, M. Mukherjee, and T.K. Pal, "Study on microstructure and mechanical properties of thick low-alloy quench and tempered steel welded joint", *Material Performance and Characterization,* vol 3(1), pp. 23-48, 2004.

[5] C.C. Hsieh, D.Y. Lin, M.C. Chen, and W. Wu, "Microstructure, recrystallization, and mechanical property evolutions in the heat-affected and fusion zones of dissimilar stainless steels", *Materials Transactions,* vol. 48(11), pp. 2898-2902, 2007.