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Welding Shape Control of Cross Member Backbone Assembly by Automatic Gas Metal Arc Yaskawa-MA1440 Type

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Abstract. In order to prevent distortion caused by heat which affects the material deformation, the properties controlled are required. The properties changes and the placement of the mounting position will effect the weld strength that causes cracks and broken joints, therefore it affects the safety of machine construction. Thus, the objective of this paper is to control the shape of cross member backbone assembly by gas metal arc welding (GMAW). The welding is produced by an automatic robot Yaskawa-MA1440 type. In order to obtain the good quality of the result, the welding shape is controlled by a parameters combination of voltage, current, and speed. Yaskawa-MA1440 type is used as the automatic welding machine. The main material used is cold rolled steel coil sheet MJSC270D-OD with a thickness of 1.2 mm. In addition, to control the welding shape, the specified shape design standard is followed include travel speed, gas flow, welding direction, torch tip distance to the workpiece, torch angle and welding angle. The results of visual and dimensional were also examined in this research. Furthermore, the macrostructure i.e. leg length, fusion penetration, throat thickness have been analyzed and confirmed based on the standards used in the auto body vehicle part company. The appropriate parameters for the finest welding shape are defined at the horizontal position using an electric current of 120 A and the welding voltage of 18 V (± 1 V). Thus, the measurement control of macrostructure is defined as reference parameters for mass production of cross member backbone assembly.

Introduction

The welding process is undergoes heating which causes a change in the structure or physical properties of the material. The physical properties change is affect changes in mechanical properties in the raw material [1-5]. The changes in these properties will result in changes in the weld strength that causes cracks and broken joints, therefore it affects the safety of machine construction [6]. Placement of the mounting position also affects the safety of the construction of the machine, this is because each welding has a surface and roots that are not always the same cross-sectional area so that the strength is also different. The heat in welding is comes from a combination of voltage, current, and speed which influence on the quality of welding results [7].

The trial of the production phase is the stage of searching for the best production process to obtain the products that match by the specifications specified. One of the production trials conducted is to control the appropriate welding parameters with the standard. The control of welding shape is regulated by the current, voltage, travel speed, gas flow, and welding angle. Welding is carried out on the holder table or jig, in order to prevent distortion caused by heat which affects the material shape changes. Welding shape is controlled by conducting the experiments with various parameters, each product is inspected to find out whether the quality is to meet the specifications or not.

Quality inspection of welding results are consists of visual and macrostructure testing, in accordance with the standards specified. Visual inspection is carried out to ensure there is no welding defects form on the surface with porosity. In addition, to measure the width of the welding bead is in accordance with the standard is inspected by the visual test. The macrostructure test of the welding is carried out to determine the dimension of leg length, fusion penetration, and throat thickness which meet the standard. Thus, by controlling the welding shape through parameters, these research will be useful and applicable as an automatic gas metal arc welding reference condition when in the mass production, especially in the cross member backbone assembly.

Experimental Procedure

The workpiece were prepared and divided into two, MJSC270D-OD and Muffler Hanger SS400B. The dimension of specimen is 1.2 mm height and 12 mm in diameter. The welding process is carried out on work table and the workpiece placed on jig. Horizontal welding is carried out on Muffler Hanger. The 45° tilt angle is placed on jig, which the electrode wire of Yaskawa-MA1440 welding robot size is MG-51T with diameter of 1.2 mm, commercialized by Kobelco.

The welding parameters are controlled by the electric current from 100 to 190 A, and by the welding voltage of 15, 17, and 20 V as the most important heat input besides the welding speed. The electric current is proportional to the speed and inversely proportional to the welding voltage. These phenomena occur because the welding voltage is the most important parameter to obtain the heat. In this research, the welding parameters are set in constant. The welding parameters are consist of the travel speed of 40 cm/min, gas flow of 15 ltr/min, horizontal welding direction, torch angle of 45°, tip distance of 15 mm, torch tip distance to workpiece of 0.5 mm, welding angle of 5°, and the wire feed is determined automatically by the welding machine.

In order to control the welding shape, the visual checking and dimensions of welding are important to optimized [8, 9]. The visual checking and dimensions are carried out by determining the bead welding and by visual eye whether the defects on the welding surface is occurs. The physical part change in the dimension is investigated by a checking fixture (C/F) jig instrument, includes the datum position, side measurement i.e. cross member assembly and muffler section, also arc welding measurement. After visual and dimension inspections, the welding part is cutted and grinded on the weld center using plasma followed by grind polish. The flat weld surface is inserting into a chemical solution of 3 ml nitric and 1 ml of 70% alcohol, then, dipped into a water vessel to clean the remaining chemical solution. The macrostructure is analyzed on the penetration, bead welding width, though, leg length, undercut, crown and porosity. The welding area measurement is carried out on each side of surface using a Keyence VHX700f optical microscope.

Fig. 1 and Table 1 are the standard of appropriate welding shape that should be controlled [10]. The appropriate welding parameters is defined by results per sub variable or mean, and defined by the highest pass variable or OK judgment on each criteria.

Results and Discussion

The results of the visual inspection are found several defects of welding, i.e. undercut, porosity, incomplete fusion, excessive spatter, and distortion. The undercut defect is found at the test with welding currents above 130 A, this specimen is the judge as not good or NG in the overdraft form. Meanwhile, the porosity defect occurs when the welding currents is set at below 100 A. In addition, incomplete fusion is the unexpected welding results due to imperfections in the joining process. The excessive spatter result is found at the welding current of 130 A. Furthermore, distortion is found at material changes due to excessive heat during the welding process with 140 A current. Fig. 2 and Fig. 3 are shows the visual inspection of welding defects include the distortion, undercut, porosity, incomplete fusion and the excessive spatter.

The dimension of welding is carried out at the datum position which is intended as a measurement reference. In order to prevent the shape change of welding due to distortion, the measurement of each side is confirmed. Meanwhile, the muffler section has confirmed after welding is in the permitted position. Afterward, in the arc welding section has clarified to measure the length and condition of bead welding. Fig. 4 is shows the jig of dimension welding during inspection. The datum position on the dimension welding is set from each side by measurement tools as shown in Fig. 5.

1	Criterion		Checking result		Judgement	3	Criterion		Checking result		Judgement
Leg length	≧	1.20	S1	4.14	OK	Leg length	≧	1.20	S1	5.13	OK
			S2	4.44	OK				S2	2.86	OK
Fusion peneration	≧	0.30	D1	0.91	OK	Fusion peneration	≧	0.30	D1	1.66	OK
			D2	1.30	OK				D2	0.43	OK
Throat thickness	≧	1.20	C	3.13	OK	Throat thickness	≧	1.20	C	3.05	OK

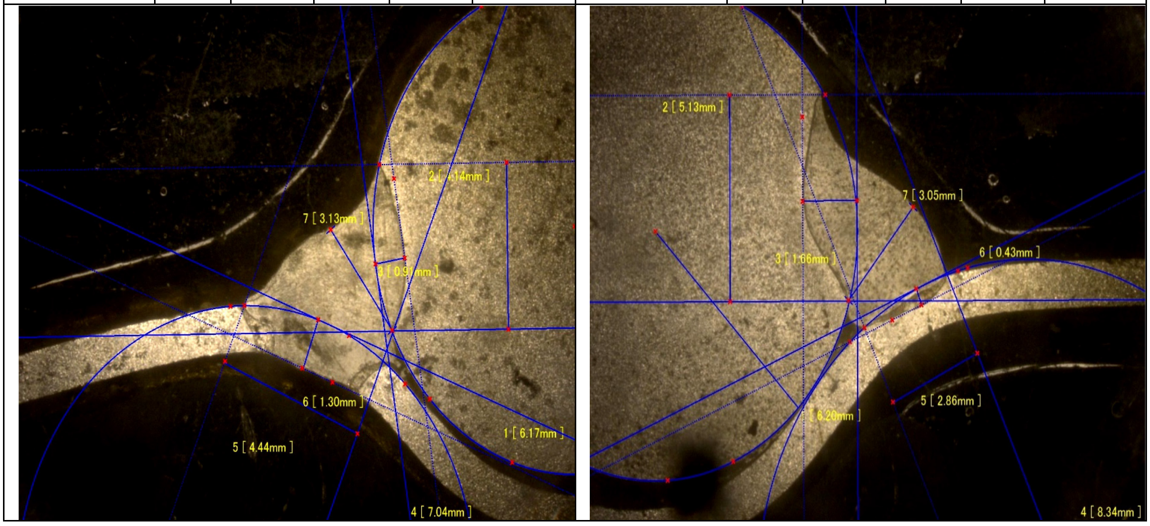
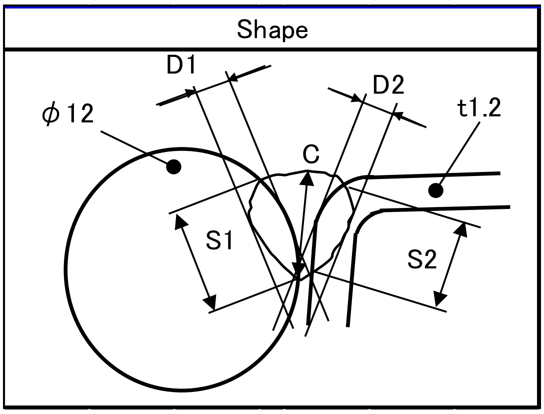


Figure 1. Judgment standard of the ideal welding shape [10].

Table 1. The standard measurements of the ideal welding shape [10].



No. 1-4	Symbol
Leg Length	S1, S2
Fusion Penetration	D1. D2
Throat thickness	C

No. 1-4	Criteria
Leg Length	≥ 1.20
Fusion Penetration	≥ 0.30
Throat thickness	≥ 1.20

Figure 2. The visual inspection of welding defects on the distortion.

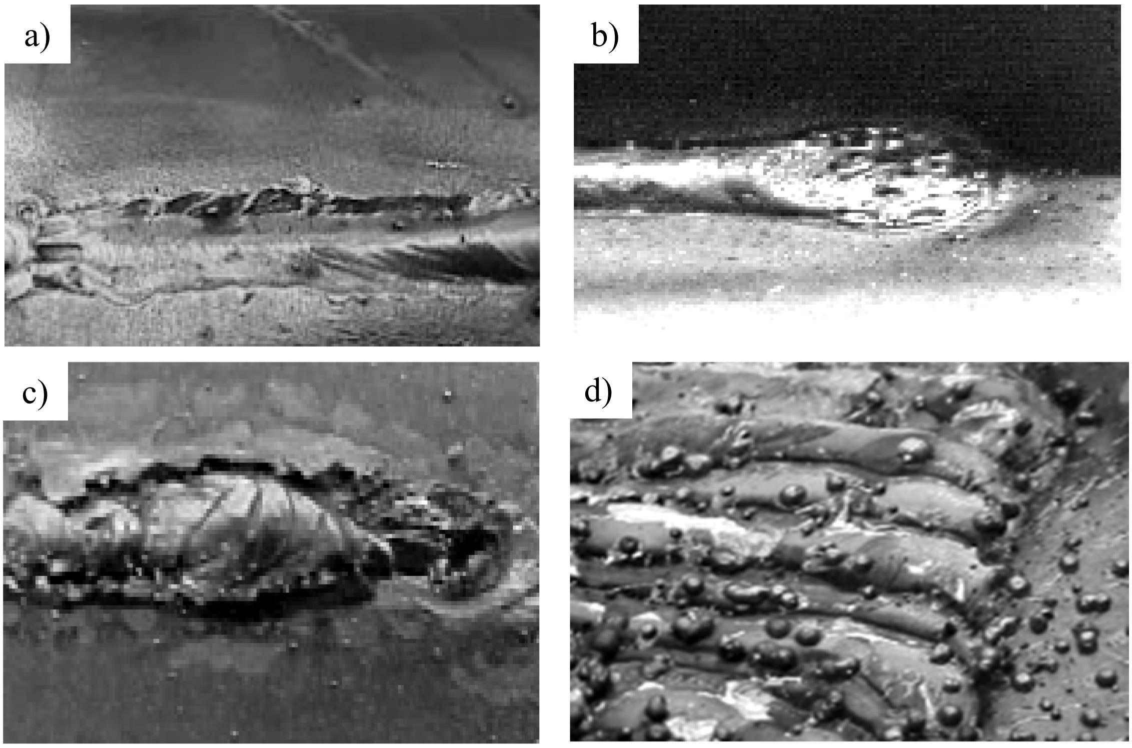


Figure 3. The visual inspection of welding defects on the (a) undercut, (b) porosity, (c) incomplete fusion, and (d) excessive spatter.

In order to check the welding penetration, each condition of the welding parts, and measure the welding thickness has confirmed by macrostructure image. Fig. 6 is shows the macrostructure of welding surface obtained at each region. Each region is measured to confirm the results of the leg length, the fusion penetration and the throat thickness. From the results has obtained that the workpiece number 12 with 120 A and 18 V is the appropriate condition for welding shape control, as shows in the Table 2.

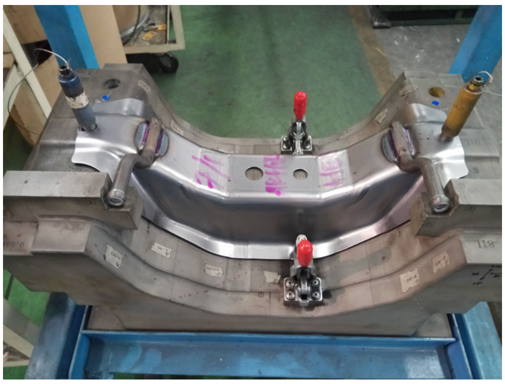


Figure 4. The measurement preparation of welding dimension by jig checking fixture.

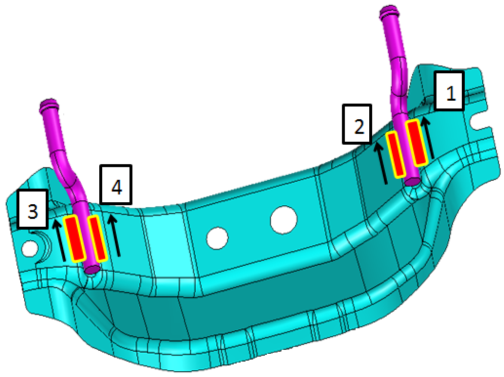


Figure 5. A side of measurement of welding dimension from each point.

Table 2 shows a number of experiments from 1 to 12. The workpiece No. 8 is conducted the first experiment (No. 1), until workpiece No. 19 conducted experiment No. 12. From the results shown that almost all workpieces and experiments obtained that the welding dimension was unsuccessful or NG, it means less than a minimum limit on the measurement value. The only one that has criteria above the minimum limit or OK is the sample No. 12 or experiment No. 5. Therefore, the sample is stated as the most appropriate welding parameters and suitable for cross member backbone assembly application. The repeatability of welding parameters on sample No. 12 also has been validated. Thus, the most appropriate welding parameters are determined as 120 Amperes electric current and 18 (± 1) Voltages.

Table 2. The results of welding dimension with judgment OK for above minimum limit and NG (not good) for less than minimum limit of measurement value.

No	Work piece	Current [A]	Voltage [V]	Leg Length		Fusion penetration		Throat thick-ness	Leg Length		Fusion penetration		Throat thick-ness
				S1	S2	D1	D2	C	S1	S2	D1	D2	C
1	8	110	15	1.20	2.10	0.10	0.42	2.10	OK	OK	NG	OK	NG
2	9		18	3.20	4.15	0.20	0.12	2.30	OK	OK	NG	NG	NG
3	10		20	2.32	2.50	0.30	0.23	2.42	OK	OK	OK	NG	NG
4	11	120	15	2.00	2.24	0.20	0.42	2.50	OK	OK	NG	OK	NG
5	12		18	4.14	4.40	0.90	1.20	3.00	OK	OK	OK	OK	OK
6	13		20	5.20	5.30	0.20	0.30	3.10	OK	OK	NG	OK	NG
7	14	130	15	4.10	4.20	0.28	0.31	1.16	OK	OK	NG	OK	NG
8	15		18	6.00	6.10	0.56	0.21	3.20	OK	OK	OK	NG	NG
9	16		20	2.00	2.23	0.29	0.50	3.40	OK	OK	NG	OK	NG
10	17	140	15	3.20	3.10	0.20	0.40	2.50	OK	OK	NG	OK	NG
11	18		18	5.10	5.05	0.13	0.34	2.89	OK	OK	NG	OK	NG
12	19		20	2.40	2.65	0.23	0.28	2.35	OK	OK	NG	NG	NG
Mean				1.2	1.2	0.3	0.3	1.2					

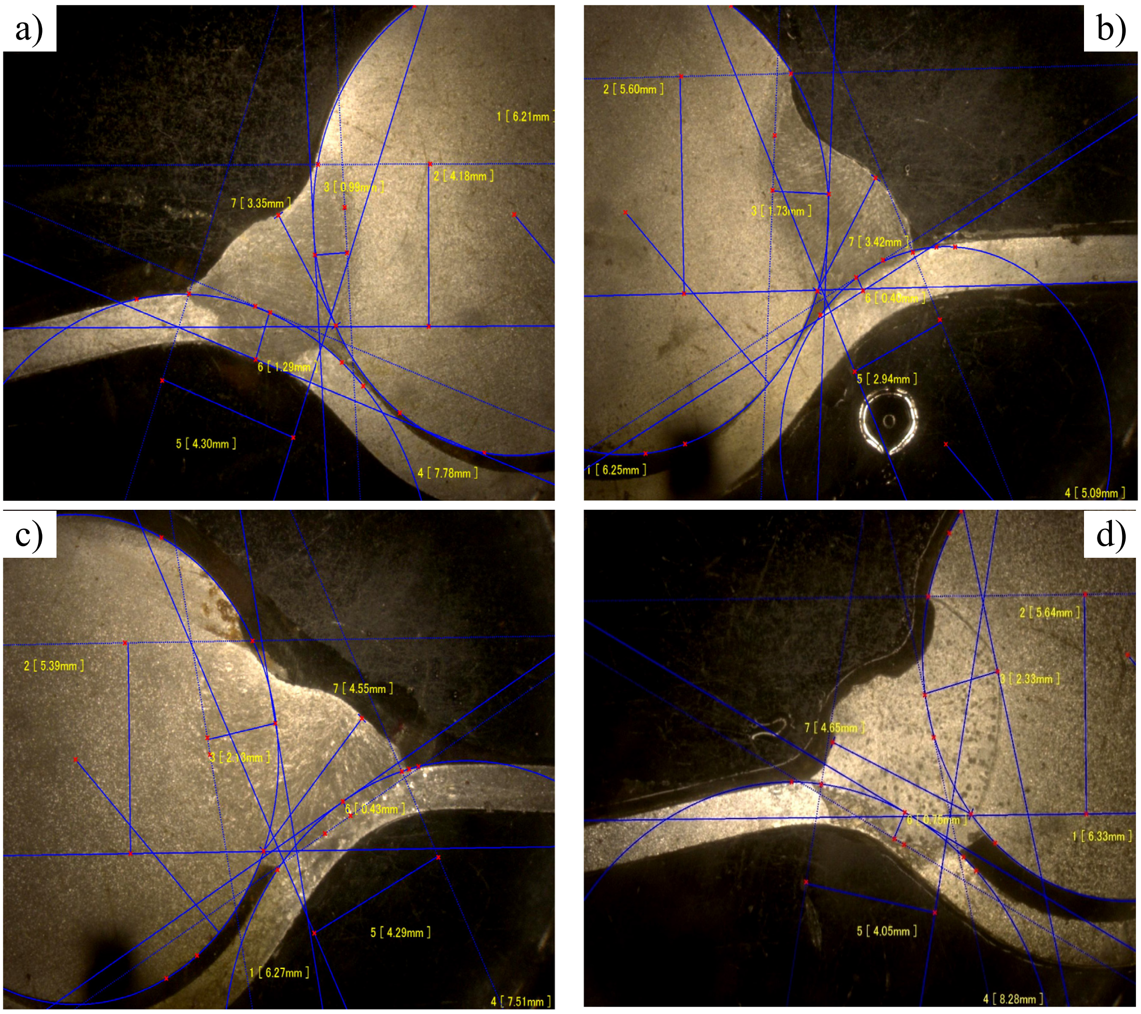


Figure 6. The macrostructure of welding on the (a) region I, (b) region II, (c) region III, and (d) region IV.

The parameters is defined as the standard with the travel speed of 40 cm/min, gas flow of 15 ltr/min, horizontal welding direction, 45° torch angle, tip distance of 15 mm, torch tip distance to the work piece of 0.5 mm, 5° welding angle, electric current of 120 A, electric voltage of 18 V (± 1 V), and the wire feed is determined automatically by the welding machine. Thus, by the measurement control of macrostructure are defined as reference parameters for mass production of cross member backbone assembly.

Conclusions

Based on the optimization of welding shape of cross member backbone assembly using automatic GMAW Yaskawa-MA1440 type, the conclusions are as follows:

1. By optimization of the greater electric current is tends to obtain deeper penetration of welding.
2. By increasing the voltage is brittle material easier to create.
3. The appropriate parameters for the finest welding shape are defined at the horizontal position using an electric current of 120 A and the welding voltage of 18 V (± 1 V).

Thus, by measurement control of macrostructure are defined as reference parameters of cross member backbone assembly for mass production can be produced.

References

[1] M. Rodríguez: Food Research International, Combined effect of plasticizers and surfactants on the physical properties of starch based edible films, Vol. 39(8), (2006), pp. 840-846.

[2] H. N. Yoshimura: Ceramics International, Evaluation of aluminum dross waste as raw material for refractories, Vol. 34(3), (2008), pp. 581-591.

[3] L. Anggraini: Solid State Phenomena, Hardenability of ASSAB 760 Steel during Tempering for Punch Holder Applications, Vol. 266, (2017), pp. 13-18.

[4] N. K. A. Utomo and L. Anggraini: Journal of Mechanical Engineering and Mechatronics, Finite Element Analysis with Static And Dynamic Conditions of Spare Wheel Carrier for OH1526 Fabricated by SAPH 440 Hot Rolled Steel, Vol. 4(1), (2019), pp. 34-44.

[5] L. Anggraini: Prosiding Seminar Nasional Pakar, Analisa Struktur Mikro pada Proses Firing dalam Fabrikasi Welded Beam dengan Bahan SM490YB, (2018), pp. 363-367.

[6] K. Masubuchi: Elsevier, Analysis of welded structures: residual stresses, distortion, and their consequences, Vol. 33, (2013).

[7] E. Karadeniz, U. Ozsarac, and C. Yildiz: Materials & Design, The effect of process parameters on penetration in gas metal arc welding processes, Vol. 28(2), (2007), pp. 649-656.

[8] Y. Li: IEEE Transactions on Instrumentation and Measurement, Measurement and defect detection of the weld bead based on online vision inspection, Vol. 59(7), (2009), pp. 1841-1849.

[9] P. Rodríguez-Gonzálvez: Automation in construction, 3D reconstruction methods and quality assessment for visual inspection of welds, Vol. 79, (2017), pp. 49-58.

[10] Kobelco Welding Handbook: Welding consumable and processes, Kobe Steel, LTD., Welding Company, (2012), pp. 276-279.