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KOBELCO WELDING TODAY

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KOBELCO Puts the Customer First with All-in-One Product and Service

KOBELCO

FAMILIARC™ MG-1T(F) controls wire feeding in high speed welding of thin steel plates

A method that controls wire feeding in high-speed welding of thin steel plates is being applied mainly by car manufacturers as a new technology that greatly reduces spatter generation even at the globular transfer area in high current welding. With this method of welding, wire feeding is controlled so as to alternately change the wire-feed direction from forward and backward, as shown in Figure 1.

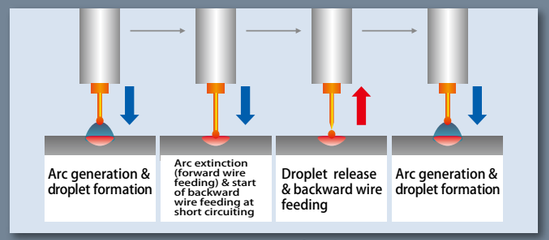

Figure 1: Method to control wire feeding

While an arc is generated and forming a droplet, the welding current is reduced. At the instant the droplet touches the molten pool (short circuiting), the welding current is increased and the wire is fed backward, thus easily releasing the droplet from the wire end under enlarged magnetic pinch force. The welding current is then decreased again so as not to generate an arc at droplet release, and afterwards the arc is re-generated. Then, the cycle is repeated. However, a drawback of this method is that it causes heavy wear in the contact tip, resulting in the deterioration of welding quality caused by an unstable arc.

F MG-1T(F), one of the new F Series solid wires, can minimize rapid wear of contact tips by reducing physical friction-resistance as well as improving electricity supply by means of its special wire-surface treatment.

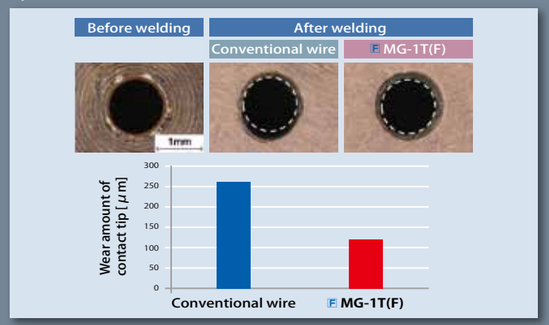

Figure 2: Comparison of wear amounts of contact tips
Note: One hour continuous welding at 200A-25V, 100% CO_2 gas

Figure 2 compares the amount of wear at the contact tips after one-hour continuous welding between a conventional wire and F MG-1T(F). The amount of wear at the F MG-1T(F) contact tip is one half that of the conventional wire's. The surface treatment has also improved wire feedability and arc stability in addition to reducing wear at the contact tip.

The time variation of welding current, arc voltage and wire feed resistance between a conventional wire and F MG-1T(F) were measured as shown in Figure 3, and the result is shown in Figure 4. The difference in wire feed resistance is clearly seen. F MG-1T(F) shows much less fluctuation than the conventional wire.

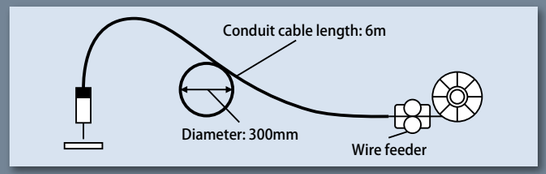

Figure 3: Schematic drawing of wire feeding test

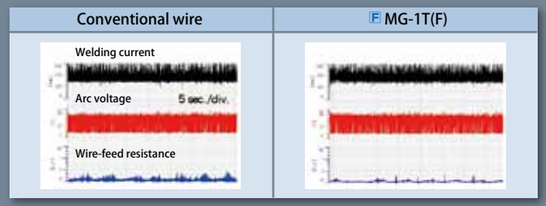

Figure 4: Time variation of welding current, arc voltage and wire feed resistance between a conventional wire and F MG-1T(F)

Tables 1, 2 and 3 show the typical wire chemical compositions, mechanical properties of the all-deposited metals and chemical compositions of the all-deposited metals of F MG-1T(F), respectively.

Table 1: Typical chemical compositions of F MG-1T(F) wire

Wire	C	Si	Mn	P	S	Cu *1
F MG-1T(F)	0.05	0.89	1.40	0.006	0.015	0.24
JIS Z 3312 YGW12	0.02-0.15	0.55-1.00	1.25-2.00	≤0.030	≤0.030	≤0.50

Note: *1: Cu value contains Cu coating.

Table 2: Typical mechanical properties of all-deposited metal

Wire	0.2%OS (MPa)	TS (MPa)	El (%)	Absorbed energy at 0°C (J)
F MG-1T(F)	420	530	29	110
JIS Z 3312 YGW12	≥390	490-670	≥18	≥27

Table 3: Typical chemical compositions of all-deposited metal

C	Si	Mn	P	S	Cu
0.06	0.60	1.00	0.012	0.013	0.24

KOBELCO's pioneer and leader of overseas business: TKW in Thailand

Dear KWT readers! I'd like to express my sincere gratitude for your kind and continuous patronage of KOBELCO products.

The year 2018 is a profoundly memorable year for our global business. THAI-KOBE WELDING CO., LTD. (TKW) has celebrated the 50th anniversary since it was established. As the first overseas production operation of the entire KOBE STEEL group, the establishment of TKW was an important turning point in the KOBELCO group's long-lasting history over 110 years.

As a member of the overseas business, I was honored to be present on such a memorable day after half a century and felt very proud. I would like to pay my respects to our senior members as well as everybody who was involved. Looking back over the last 50 years, I understand both the difficulties the company has faced in doing business abroad but also the value of this long, successful history. I am especially grateful for the continuous support that people, including KWT readers, has extended to TKW.

It was always natural and consistent that senior members have maintained their deep respect for the Kingdom of Thailand as well as strong passion toward the development of TKW. While recognizing the differences in Thai and Japanese cultures and finding solutions to difficulties in working with colleagues, they have succeeded in building the welding business of TKW. Such important experiences as cultivating the mental attitude of treasuring customers and partners and developing codes of conduct for employees at TKW have been inherited by us. I am grateful for having received an education as well as guidance from TKW. New overseas bases that followed and grew since then have prospered by remembering the phrases "Learn from TKW" and "TKW must be a guide." Although our overseas business has currently expanded to 13 subsidiaries in 9 countries, there is no changing the fact that the welding business in Thailand will continue to function as a key base of the welding business in the future. I believe that it will develop and grow as the leader among the 13 overseas bases, becoming the largest production base in the Welding Business group as well as a base of research and development that responds to the needs of local customers.

Over the next 50 years, it will be important for TKW to have energy and contribute to the development of the welding industry in order to support not only Thailand's but also the Southeast Asian region's industrial advancement.

Maintaining the Thai business and strengthening the ties between TKW and the KOBELCO group in other Southeast Asia countries is the way to achieve our Welding Business slogan: Take the overwhelming No. 1 position in Asia. I promise that we, in the Global Operations and Marketing Department, will mobilize all of our available resources and tightly cooperate with overseas companies. It is, therefore, highly appreciated if you could extend your kind support to our Thai business.

Koichi (Jay) Sugiyama
General Manager
Global Operations & Marketing Department, Marketing Center
Welding Business
KOBE STEEL, LTD.

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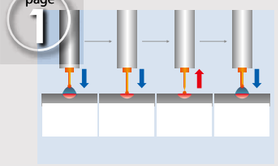
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TKW's 50th and KMWT's 30th anniversaries in Thailand

Note:
F, T, P in trade names indicate FAMILIARC™, TRUSTARC™, PREMIARC™.

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"1Z Series" welding consumables for galvanized steel sheets

KOBELCO WELDING TODAY
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1 Preface

Thanks to superb corrosion resistance and economical efficiency, galvanized steel sheets or zinc (Zn) coated steel sheets are currently applied in many fields such as automobiles, building materials, electric appliances, water pipes and supporting stands of solar panels, improving the quality and extending the life of the steel structural products that utilize these sheets.

However, galvanized steel sheets are known for poor welding usability, as they can generate spatter and fumes and cause porosity defects as well.

The 1Z Series welding consumables for galvanized steel sheets were developed in order to improve usability and porosity resistance during welding. A variety of galvanized steel sheets and the 1Z Series welding consumables are discussed in this article.

2 The features of different kinds of galvanized steel sheets

A wide range of galvanized steel sheets are available in the market. Some typical sheets and the composition of their coating films are shown in Table 1.

2-1. Hot-dip galvanized steel sheets

These are steel sheets produced under the most common method in which steel sheets are dipped and galvanized in a high temperature bath of pure molten zinc. A similar method is the hot-dip galvannealed method, where the sheets are plated in a molten mixture of Zn and 8-10% iron alloy. Hot-dip galvannealed steel sheets, which are called GA steel sheets, are the main steel materials for car manufacturing.

2-2. Electrogalvanized steel sheets

Electrogalvanized steel sheets are electroplated with Zn while dipped in a bath of molten Zn. They feature a thin and uniform coating and are mainly applied in electric appliances.

2-3. Electrogalvanized steel sheets prepainted with organic film

They are galvanized steel sheets on which the Zn coating is coated with an additional layer of organic resin or film. This provides better corrosion resistance and looks attractive, too.

3 Porosity defects on galvanized steel sheets

The biggest problem in welding galvanized steel sheets is the generation of porosity defects such as blow holes, pits and spatter. The welding usability of galvanized steel sheets varies depending on the weight per unit area of Zn film coating (hereinafter referred to as Zn coating mass) on the steel sheets. Where the Zn coating mass is higher, the occurrence of porosity defects and/or spatter increases. Figure 1 is a schematic drawing that shows the mechanism of porosity generation in lap fillet welding of galvanized steel sheets.

When Zn, which has a boiling point of about 900°C, is heated by the arc and decomposes pyrolytically, it vaporizes and generates a large amount of gas. Porosity forms from the vaporized Zn gas that remains in the molten pool. The effects of porosity include poor bead appearance, low tensile strength caused by cross-sectional defects and reduced productivity due to repairs, all of which are problems linking quality and cost.

Furthermore, the vaporized Zn gas prevents stable droplet transfer. The gas disturbs the arc as it ejects underneath, causing the droplets to become larger and unable to transfer smoothly to the molten pool; instead, they are short-circuited by the molten pool, generating a large amount of spatter.

4 Welding consumables for galvanized steel sheets

The Zn coating mass is so influential in welding galvanized steel sheets that the selection of welding methods and consumables is extremely important. Table 2 shows the features of the newly-developed 1Z Series welding consumables for galvanized steel sheets while Table 3 shows the chemical compositions and mechanical properties of their deposited metals.

Table 1: Typical galvanized steel sheets

Kinds of galvanized steel sheets		Composition of steel sheet coating film	Zn coating mass (g/m²)
Hot-dip galvanized steel sheets	Hot-dip galvanized steel sheets	Zn / Steel sheet	60-1000
	Hot-dip galvannealed steel sheets	Zn-Fe alloy / Steel sheet	30-120
	Hot-dip Zn-5% Al alloy-coated steel sheets	Zn-5%Al alloy / Steel sheet	60-250
	Hot-dip Zn-55% Al alloy-coated steel sheets	Zn-55%Al alloy / Steel sheet	60-200
	Hot-dip Zn-Al-Mg alloy-coated steel sheets	Zn-Al-Mg alloy / Steel sheet	60-450
	Double layered hot-dip galvannealed steel sheets	Fe-Zn alloy / Zn-Fe alloy / Steel sheet	3-6/20-60
Electro-galvanized steel sheets	Electrolytic galvanized steel sheets	Zn / Steel sheet	3-50
	Electrolytic Zn-Ni or Fe or Co alloy-coated steel sheets	Zn-Ni alloy or Zn-Fe alloy or Zn-Co alloy / Steel sheet	10-40
Prepainted steel sheets	Prepainted hot-dip galvanized steel sheets with organic resin	Organic resin / Zn or Zn alloy / Steel sheet	25-200μm/ 60-300
	Prepainted electrogalvanized steel sheets with organic film	Organic film / Zn+Ni alloy / Steel sheet	1μm/20-30

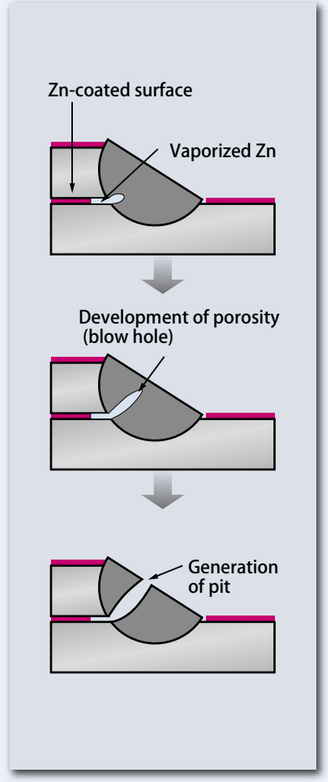

Figure1: The mechanism of porosity generation in lap fillet welding

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4-1. Solid wires

F MG-1Z, a solid wire exclusively developed for welding galvanized steel sheets, is designed to produce higher viscosity in the molten metal than solid wires for general use in order to increase porosity resistance further.

High viscosity prevents the molten metal from flowing directly under the arc and helps vaporized gas to discharge easily, thus providing excellent porosity resistance.

Another solid wire, F SE-1Z, which is non-Cu coated, has also been added to the same product range. Standing for Smooth and Ecology, F SE-1Z offers smooth wire feedability and electric conductivity even without a copper coating. Due to the non-Cu coating, Cu flaking, which is usually caused by the pressure of a pressing roller or by contact with the liner inside a conduit cable, never happens, and accordingly, poor wire feeding does not occur. In addition, it can maintain sufficient corrosion resistance because special anti-corrosion treatment prevents the local cell action (caused by dissimilar metal contact between Fe and Cu) from occurring. F SE-1Z is also designed to obtain higher than usual viscosity of the molten metal, and the wire' s superb feedability and stable arc reduces spattering as shown in Figure 2.

As for the shielding gas, CO_2 gas is the most suitable for both wires; on the other hand, neither Ar-CO_2 mixed gas nor the pulsed MAG process are recommended from the viewpoint of porosity resistance.

Sheet thicknesses of between 1.6 and 6.0 mm and the horizontal and flat welding positions are recommended.

Although F MG-1Z and F SE-1Z offer higher porosity resistance than solid wires for general use, the gas metal arc welding (GMAW) process is no better in terms of porosity resistance than the flux cored arc welding (FCAW) or shielded metal arc welding (SMAW) processes. The recommended Zn coating mass on both F SE-1Z and F MG-1Z is equal to or less than 100g/m².

Figure 3 shows the bead appearance and cross-sectional macrostructure in both horizontal fillet welding and lap fillet welding of F SE-1Z .

Table 2: Features of 1Z Series welding consumables for galvanized steel sheets

	Trade names	Shielding gas	Polarity	Dia (mm)	AWS/JIS	Recommended Zn coating mass(g/m²)
Solid wire	F SE-1Z	CO_2	DC(+)	1.0 1.2	AWS A5.18 ER70S-G	≤100
	F MG-1Z	CO_2	DC(+)	1.0 1.2	AWS A5.18 ER70S-G	≤100
Gas-shielded FCW	F MX-1Z	CO_2	DC(+)	1.2	AWS A5.20 E70T-1C	≤150 *1
	F MX-100Z	CO_2	DC(+)	1.2	AWS A5.20 E71T-1C	≤150 *2
	F DW-1SZ	CO_2	DC(-)	1.4	JIS Z 3313 T 49 0 T5-1 C A	≤550
Covered electrode	F Z-1Z	---	AC, DC(±)	3.2 4.0 5.0 6.0	JIS Z 3211 E4340	≤550
Self-shielded FCW	F OW-1Z	---	DC(-)	1.2	AWS A5.20 E71T-GS	≤550

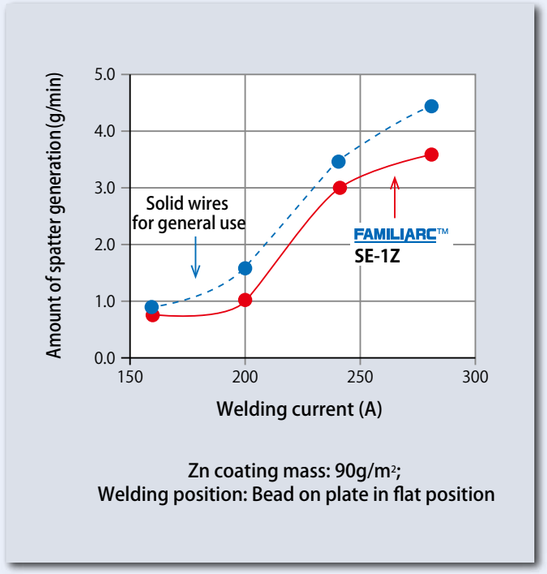
*1. It is recommended for not less than 200A.
*2. It is recommended for equal to or less than 200A.

Table 3: Typical mechanical properties of all-deposited metals

	Trade names	Chemical compositions(%)						Tensile properties			Absorbed energy
		C	Si	Mn	P	S	Al	0.2% OS (MPa)	TS (MPa)	El (%)	0°C (J)
Solid wire	F SE-1Z	0.10	0.49	1.10	0.009	0.009	-	430	540	30	110
	F MG-1Z										
Gas-shielded FCW	F MX-1Z	0.05	0.50	1.52	0.011	0.010	-	480	570	26	83
	F MX-100Z	0.10	0.40	1.55	0.011	0.012	-	480	590	27	100
	F DW-1SZ	0.12	0.15	1.48	0.010	0.005	-	420	560	26	60
Covered electrode	F Z-1Z	0.09	0.15	0.48	0.015	0.005	-	380	450	26	100
Self-shielded FCW	F OW-1Z	0.25	0.23	0.91	0.008	0.002	2.38	---	---	---	---

4-2. Flux cored wires

When the Zn coating mass of the galvanized steel sheet is equal to or less than 150g/m², F MX-100Z or the newly-developed F MX-1Z are recommended, depending on the applicable welding current zone. F MX-1Z provides excellent arc stability at the



Zn coating mass: 90g/m²;
Welding position: Bead on plate in flat position

Figure 2: Comparison of spatter generation between F SE-1Z and solid wires for general use

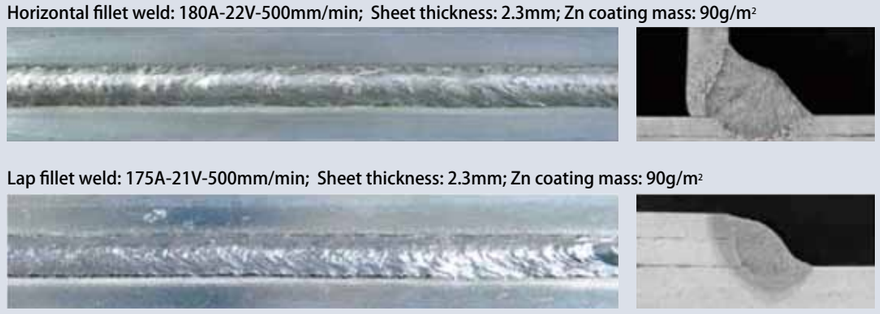


Figure 3: Bead appearance and cross-sectional macrostructure of F SE-1Z (1.2mm dia.) weld

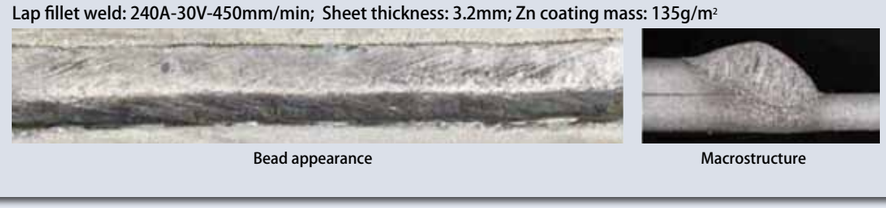


Figure 4: Bead appearance and cross-sectional macrostructure of F MX-1Z (1.2mm dia.) weld

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welding current of not less than 200A while F MX-100Z does so in the low current zone equal to or less than 200A.

By contrast, when the Zn coating mass is equal to or more than 150g/m², F DW-1SZ is suitable.

F DW-1SZ features excellent porosity resistance, small-sized spatter and a stable arc; in addition, it is suitable for all position welding. However, it can only be utilized with direct current electrode negative (DCEN).

4-3. Covered electrode

F Z-1Z is another newly-developed covered electrode for welding galvanized steel sheets. Its special features include strong arc blow and an excellent arc concentration. As it provides good arc stability, spattering is reduced.

F Z-1Z's recommendable Zn coating mass is equal to or less than 550 g/m², and it is suitable for welding hot-dip galvanized steel sheets as well as normal steel plates.

Figure 5: Bead appearance and cross-sectional macrostructure of F MX-100Z (1.2mm dia.) weld

Figure 6: Bead appearance and cross-sectional macrostructure of F DW-1SZ (1.4mm dia.) weld

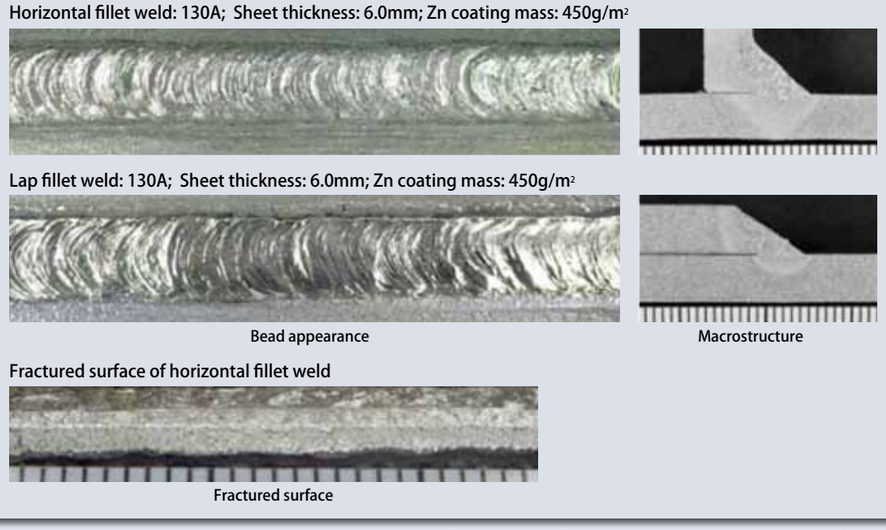

Figure 7: Bead appearance, cross-sectional macrostructure and fractured surface of F Z-1Z (4.0mm dia.) weld

Figure 7 shows the bead appearances, cross-sectional macrostructures in both horizontal fillet welding and lap fillet welding and the fractured surface of horizontal fillet welding of a F Z-1Z (4.0mm dia.) weld.

4-4. Self-shielded flux cored wire

F OW-1Z is a self-shielded flux cored wire (FCW) that does not require shielding gas and is suited to outdoor welding. Its high porosity resistance minimizes porosity defects even in welding galvanized steel sheets with rather high Zn coating mass of up to 550 g/m².

However, sufficient care must be paid during use, because it has to be utilized with DCEN polarity only, it is limited to sheets with plate thickness from 1.0 to 6.0 mm and it should not be applied to weld joints requiring high notch toughness.

Figure 8 shows the bead appearances and cross-sectional macrostructures of F OW-1Z (1.2mm dia.) in horizontal fillet welding and lap fillet welding.

The photos in Figures 9 and 10 show the welding of a frame structure for a bus with F SE-1Z and of a water pipe with F Z-1Z.

5 Postscript

In welding hot-dip galvanized steel sheets, welding efficiency can be improved by selecting the most suitable combinations of welding method and consumable and taking into consideration the type of galvanized steel sheet as well as its Zn coating mass.

The 1Z Series welding consumables for galvanized steel sheets are suitable for sheets with a wide range of Zn coating mass and can be utilized under a range of welding procedures. They are also designed to reduce porosity defects and spatter generation.

Note: Welding galvanized steel sheets generates more fumes than does welding normal steels. Please pay special attention, therefore, to environmental safety and hygiene by ensuring appropriate ventilation as well as by using respiratory protection devices.

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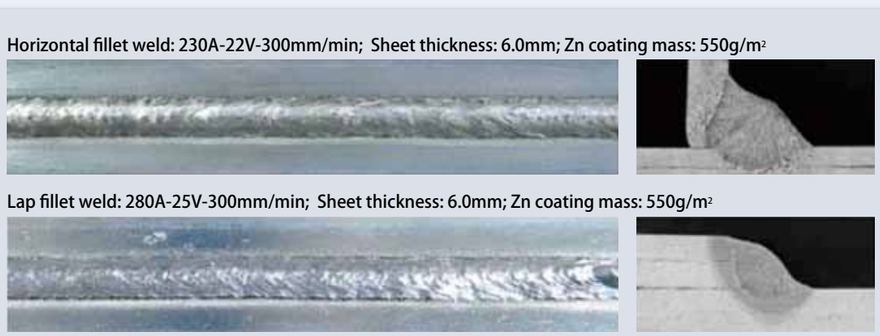

Figure 8: Bead appearance and cross-sectional macrostructure of F OW-1Z (1.2mm dia.) weld

Figure 9: Welding a frame structure for a bus with F SE-1Z

Figure 10: Welding a water pipe with F Z-1Z

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TKW's 50th and KMWT's 30th anniversaries in Thai land

Overview of TKW and KMWT

Formal sutra chanting by monks

Ceremony of monks walking for alms

The memorial plate was presented by Thai Shin-Yo-Kai

On August 8, 2018, a party was held to celebrate both the 50th anniversary of THAI-KOBE WELDING CO., LTD. (TKW) and the 30th anniversary of KOBE MIG WIRE (THAILAND) CO., LTD. (KMWT) of their establishment.

TKW was the first company operated abroad by not only the Welding Business but also the whole KOBE STEEL group. The fact that TKW has existed for as long as 50 years is a testament to the extraordinary achievements of our senior members who were involved in the TKW business at the beginning.

The ceremony started at the plant at 7:30 in the morning. Participants, comprising visitors as well as all the employees, recited a Buddhist sutra in front of the monument erected at the plant site. Holding incense sticks that were twice as big and long as those we use in Japan, the participants walked to the monument and placed them in the incense holder while praying to show gratitude toward the past activities.

Soon after, nine monks arrived at the site and at first collected alms from the participants. Each monk held a metal bowl in his arms, and participants placed their offerings into them. As soon as the small bowl was filled, an employee aside a monk would quickly transfer the offerings into a plastic bag. I wondered what would happen to these offerings, and I was told that because monks cannot touch money, they cannot go shopping and must eat only the food that they receive during their morning alms walks.

After the alms ceremony, nine monks recited a sutra upon a dais as shown in the picture above.

Sitting in a line and grasping a thread, all nine monks chanted the sutra. Toward the end of the chanting, one monk stood up and splashed holy water on all of the

Entertainment featuring a mix of Thai and Japanese cultures

Presentation of the memorial gift from KOBE STEEL, LTD.

A famous Thai singer (center) and her fans, posing at the dinner show

All the participants including employees of TKW and KMWT are posing in front of the office.

participants.

After the prayer ceremony by the monks was over, the labor unions of KOBE STEEL, LTD. , TKW and KMWT exchanged commemorative goods, and all the participants including all employees took photographs in front of the office.

At the evening party, which was held at a hotel in Bangkok, 220 participants were on hand for the presentation of anniversary gifts from KOBE STEEL, LTD. as well as Thai Shin-Yo-Kai (Welding distribution network in Thailand). Everybody enjoyed the entertainment featuring a mix of Thai and Japanese cultures as well as a dinner show by a Thai singer.

As I watched two female dancers, one with a headdress that looked like a Thai temple and the other with one that looked like a crane, dancing to the rhythm of the drums, I had a little strange feeling wondering what Japanese culture might look like to Thai people. I was also surprised to hear the master of ceremonies describe the crane as a Japanese Flamingo, perhaps because flamingos may be more familiar than cranes in such a hot country as Thailand.

I got the impression that because many participants at the party have been deeply involved with TKW's and KMWT's business, they expect to return to the 70th and 50th anniversaries of TKW and KMWT.

At present, I cannot imagine at all how the world will be like in the next 20 years, but I really hope that I can take part in the ceremony once more.

Reported by
Keiichi Hayano
Staff Member of Global Operations and Marketing Department, Marketing Center, Welding Business