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The first greeting of the Reiwa Era from the Head of the Welding Business

Dear KWT readers! I wish all KWT readers a Happy New Year! And I would like to express my heartfelt gratitude for your kind patronage of KOBELCO group products.

In Japan, calendars can mark the years using both the Christian – or Common – era as well as the Japanese era, which gets reset each time a new emperor starts his reign. Although we are now in the 2nd year of the Reiwa era, we just celebrated the first New Year of the Reiwa era, which started in May 2019, following the Heisei era. While people in the West are familiar with a year being divided into the twelve months of the Zodiac, in Japan – as in most of East Asia – it is the years that follow the twelve-year cycle of the Chinese animal zodiac. 2020 is the Year of the Mouse - the first in the cycle of twelve animals. I wish for this year to be a real New Year for the future generation, in Japan and around the world. I would like to welcome the new era together with KWT readers.

At the Welding Business group, we have been acting under the slogan, “aiming to be the most reliable welding solutions company in the world.” Currently trade friction all over the world has influenced our environment, and shipbuilding, offshore structures as well as the automobile industries have remained stagnant. On the other hand, expectations for further automation in welding are continuing to increase. As we are the only group in the world that provides welding consumables, robotic welding systems, and power sources - in addition to technologies and products related to IoT and AI – we can be optimistic about the future. In order to respond to market expectations, we are continuing to do our best to develop new technologies day by day.

The welding solutions we aim to achieve are not limited to automating robotic welding but for solving the whole range of problems customers experience in relation to welding. We want customers to utilize KOBELCO products with ease, thus contributing to their MONODZUKURI (production system innovation).

We promise to continue improving marketing capabilities from establishing appropriate product strategies in particular markets, and making and executing sales plans with all of our group’s strength. We will continue contributing to respective enterprises, regions and countries, meeting customers’ needs while developing our welding and joining technologies.

The overall welding environment has been changing rapidly – as have our clients’needs. By responding promptly to those changes, we will provide products that match our client’requests, and in this way, we can differentiate ourselves and add more value in the future.

The customers’needs are in the voices of our KWT readers. When KOBELCO associates visit your countries and regions this year, please let them hear your voices, and know your needs and problems.

And finally, I wish all of you and your family a prosperous 2020!

Akira Yamamoto
Managing Executive Officer
Head of the Welding Business
KOBE STEEL, LTD.

ARCMAN™A40: The new robot for overhead welding systems

1 Preface

Launched in May, 2019, the small-sized ARCMAN™ A40 (Figure 1) is an advance on the earlier ARCMAN™ SR robot (hereinafter called SR) that was highly rated by customers.

The ARCMAN™ robot series is generally used in welding systems that target medium to heavy steel plate applied in construction machinery, steel fabrication, bridge construction and rolling stock.

Figure 2 shows the line-up of the four robots in the ARCMAN™ series. When a welding system is assembled, it is the arm length of the welding robot that determines the suitability of the robot to a particular system.

In the welding of medium to heavy steel plate, workpieces can be so large that the movable range of a single robot cannot cover all of the required welding areas. An example of such a welding system is shown in Figure 3.

A robotic welding system is composed of a moving device mounting the robot, and a positioner that fixes the workpiece to an optimum welding position. If the welded portion is located in the middle of a large workpiece, an overhead system mounted with a small-sized robot is advantageous because the robot can approach from above. This is a solution preferred by many customers.


Figure 1: ARCMAN™ A40

The earlier small-sized SR had an arm size suitable for overhead systems. It received high marks from customers needing a system that could fit into a narrow installation area and was lower than a crane path.

How the new ARCMAN™ A40 (hereinafter called A40) improves upon the earlier SR is the topic of this article.

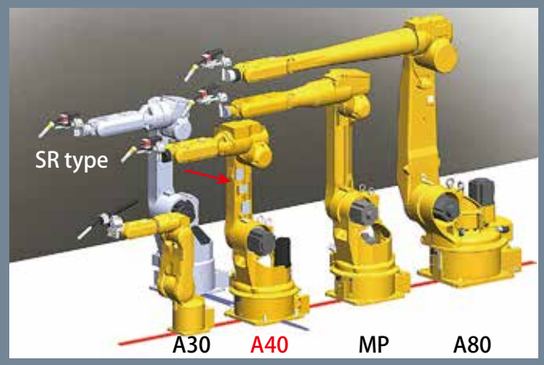

Figure 2: ARCMAN™ Series line-up

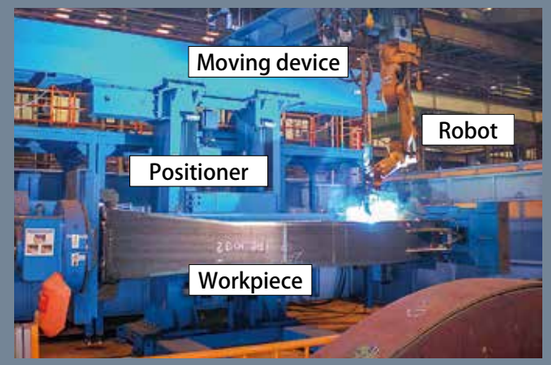

Figure 3: A typical welding system

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2 Features of ARCMAN™ A40

The main features of A40 and SR are compared in Table 1.

Table 1: Comparison of SR and new A40

	Items	SR	A40	Advantage
New function	Installation of torch cable	Wired outside.	Built-in to S1 axis.	Torch cable interference is minimized.
Improved function	Movable range of upper arm (S3 axis)	140°	260°	Reverse elbow posture is possible, expanding the application range.
Improved function	Load capacity	6 kgs	8 kgs	Welding torch for Ultra High Current GMAW Process can be mounted.
New function	Controller	CA type	CB type	CPU treatment speed is increased. Sensing time is reduced.
Improved function	Teaching pendant	Black & white	Color	Icons and touch panel design allow more instinctive and user-friendly teaching pendant operation.
Others				Teaching locus is usable by other units.

2-1. Improvement of functions for overhead systems

①Newly-installed function:
Installation of the torch cable

Figure 4 shows how the torch cable is installed on an SR mounted on an overhead system. In order for the torch cable to trace the robot movement, the balancer is placed near the robot' s turning part to accommodate the torch cable.

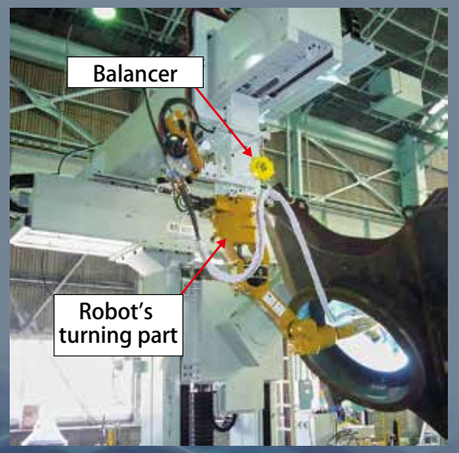

Figure 4: Placement of torch cable on the SR robot

However, this arrangement was known to cause problems such as the torch cable winding around the robot' s turning part, or the robot being unable to take up a position due to the interference between the torch cable (or balancer) and the workpiece. In response to these issues, the torch cable on the A40 is designed to go through the S1 (turning) axis and to move along with the robot' s arm as shown in Figure 5. This prevents the torch cable from winding around the robot when the robot turns. In addition, the torch cable' s interference with the workpiece is minimized by letting the torch cable move along with the robot's arm. These changes should greatly expand the adaptability of robotic welding.

Figure 5: How a torch cable is treated on the A40 robot

②Improved Function:
Movable range of the upper arm (S3 axis)

The A40 features a reverse elbow posture that allows the upper arm (S3 axis) to bend to the back side of the robot because the moving area of the upper arm (S3 axis) has been expanded.

How a robot approaches a workpiece from overhead is shown in Figure 6. The left image shows how the reverse elbow posture and expanded upper arm allows the robot to reach a welding spot. In contrast, the right image shows how the arm of the SR encounters interference and cannot reach the same spot.

As the reverse elbow posture expands the means of avoiding interference, the robot moves faster and cycle time can be cut, accordingly.

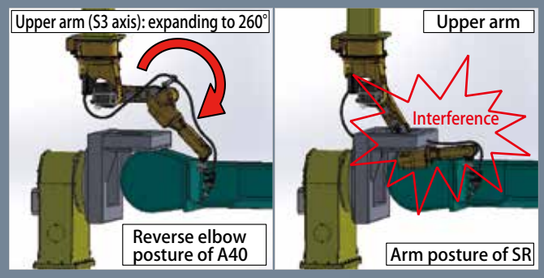

Figure 6: Ways that an overhead welding robot can approach a workpiece

2-2. Suitable specifications for welding medium to heavy steel plate

①Load capacity

Compared with the SR, the load capacity of the A40 is increased from 6 kgs to 8 kgs. Table 2 shows the welding torches available to each robot.

Table 2: Welding torches available to the SR and A40 robots

Type of robot	Type of welding torch		
	Single	Tandem	Ultra High Current GMAW process
A40	○	○	○
SR	○	○	X

Note: ○: Possible to mount
X : Not possible to mount

The application range of the A40 has been extended to include the Ultra High Current GMAW Process. As it requires a specially-designed welding torch for high welding current and is much heavier than conventional torches, the SR could not accommodate it. As a result, the A40 is expected to apply higher current welding methods in the future.

②New controller and improved teaching pendant

The ARCMAN™ robotic welding systems include the CB-type controller in which a diverse range of functions for the welding of medium to heavy steel plates is installed.

The principal characteristics of the CB-type controller are as follows:

- High quality:
  Increased CPU processing speed reduces sensing time and tact time.
- High functioning:
  Visualization of production, supported by high functioning of automated welding conditions.
- Simple operation:
  In addition to color display, the teaching pendant offers instinctive operation by icons and a touch panel.
- Others:
  Features collision detection function, multi-language display and light weight.

For more detailed information on the CB controller, please refer to the catalog: WELDING ROBOT ARCMAN™ WELDING SYSTEM LINEUP and the Technical Highlight of KOBELCO Welding Today Vol. 19 2016 No. 3.

3 Postscript

This article discussed the new ARCMAN™ A40 robot which comes mounted on an overhead welding system mainly for medium to heavy steel plates. The A40 offers a significant advance over the earlier ARCMAN™ SR robot in terms of improved design and functions.

There is much more information about the A40 that is certain to satisfy customers. Please contact KOBE STEEL offices or agents for more details.

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A new function for the ARCMAN™ robotic welding system: root gap detection by laser sensor

1 Preface

KOBE STEEL's ARCMAN™ robotic welding systems are used by many customers in the building construction and construction machinery fields, which fabricate structural steels from middle to heavy plate thickness as shown in Figures 1 and 2. One of the advantages of robotic systems is to increase production efficiency. However, in order to achieve this in welding, it is essential to shorten tact time while maintaining welding quality. A robot simply performs whatever an operator teaches; however, depending on the accuracy of the workpieces and/or grooves, cases may occur in which a robot cannot perform precise welding under a set welding condition. Welding defects may result because large structures that employ plates of middle and heavy thickness can generate distortion and/or assembly errors. As a result, repair is required at the post-process stage, and overall production efficiency drops. During welding, welders keep their eyes on the workpiece shape and/or root gap and adjust their welding accordingly. To conduct high quality welding with a robot, then, it would seem necessary to provide the robot with eyes.

Currently, touch sensing offers the alternative to actually fitting a robot with eyes. It allows a workpiece position to be detected by utilizing the voltage applied to a welding wire that changes once the wire touches the workpiece. However, touch sensing is known to have weaknesses such as accuracy, the inability to function with certain groove shapes, and sensing movements that take more time than planned. In order to overcome these weaknesses, KOBE STEEL has developed a new system based on root-gap detection utilizing the company's exclusive CB-Type Controller and a laser sensor. In this article, the features and actual usage of a laser sensing function will be discussed.

Figure 1: ARCMAN™ structural steel large assembly "2-arc" robotic welding system

Figure 2: ARCMAN™ robot welding system for arm of construction machinery

2 Outline of the laser sensor

2-1. Advantage of the laser sensor

There are three advantages when a laser sensor is applied for the robotic welding system.

① Wide range of joints

As shown in Figure 3, root gap detection has been applied not only to the conventional single-V and single-bevel grooves but also to the flare groove and T joint that could not be covered by the touch sensing method.

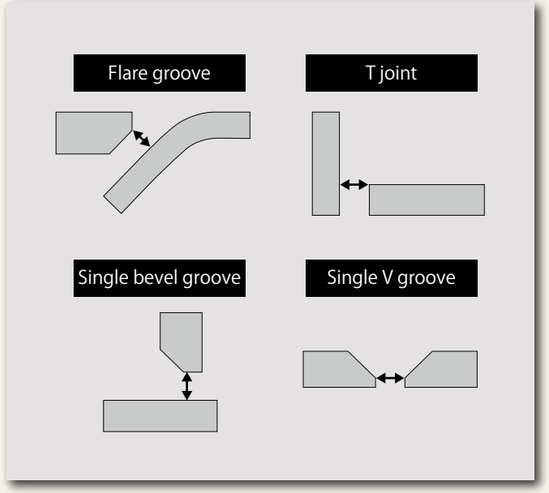

Figure 3: Groove shapes applicable to detection by laser sensing

② Highly accurate measurement

Because the maximum measurement resolving power of the laser is 0.1mm or less, highly accurate measurement is possible, depending on the condition of measurement and workpiece.

③ Reduction of cycle time

Because the action of irradiating against a groove and measuring the root gap with the linear laser beam needs to occur only one time, the sensing cycle time is shortened. By contrast, the touch sensing method as shown in Figure 4, requires repeated operations for detecting the workpiece and measuring the root gap.

The robot's operation orbit varies, depending on measuring and workpiece conditions.

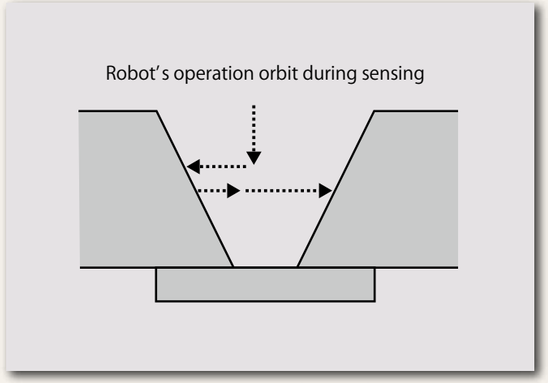

Figure 4: Root gap measurement by touch sensing method

2-2. Disadvantages associated with laser sensing

Despite the advantages of applying the laser sensor to the robotic welding system, some problematic issues have held back the adoption of laser sensing systems.

① Decreased operation ratio

Because the laser sensor must be placed close to the welding torch so that the laser sensor can additionally be mounted onto welding systems, the robot's operation ratio may drop due to the laser sensor's possible interference with workpieces.

② Necessity of safety measures

The installation and use of laser equipment require particular safety measures in accordance with standards by laser classification, because of the need to protect human bodies against harmful exposure to laser beams.

③ Influence of workpiece condition

As measurement is performed by reflecting the laser beam against a workpiece, the surface condition of the workpiece and/or any imperfections may have a large influence on the results.

2-3. A solution to laser sensing's disadvantages

In order to resolve the issues raised above, KOBE STEEL has partnered with SERVO-ROBOT INC to offer the SFK350 laser sensor, which is custom-made and specially designed for the ARCMAN™ robotic welding systems. How the SFK350 (see Figure 5) improves the productivity of laser sensors is discussed below.

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Figure 5: The custom-made SFK350 Laser Sensor

① Slim body allows the SFK350 to be used in confined spaces.

Table 1 compares the size of the custom-made SFK350 with that of the conventional laser sensor. It is clearly seen that the SFK350 has been reduced in size by about 50 % and weight by about 10 %; thus, the drop of operation ratio is surely restrained.

Table 1: Custom-made SFK350 laser sensor vs conventional laser sensor

	SFK350	Conventional laser sensor
Cubic volume (cm^3)	368	749
Weight (g)	600	670

② Laser classification is less restrictive

According to the Safety of Laser Products (JIS C 6802: 2018), the conventional sensor is classified as Laser Class 3B, which requires isolation of the operating environment; however, the custom-made SFK350 is classified as Laser Class 2M, which does not, thereby allowing the system to be applied more widely.

Table 2 displays an excerpt from Hazards and Preventive Measures against Damages Caused by Laser Beam, provided by the Head of Standards Bureau of the Ministry of Health, Labor and Welfare (Japan) for reference.

Table 2: Action standards by class of laser equipment

	Class 2M	Class 3B
Protective equipment ・Safety glasses ・Working clothes with little exposure of skin	Not required	Required
Peripheral isolation	Not required	Required
Designated laser-controlled area	Not required	Required
Designated laser safety officer	Not required	Required

Because the conventional laser sensor has a strong output laser beam, it is classified as Laser Class 3B, and a number of hazard prevention measures are required. In addition to peripheral isolation, wearing protective equipment, and setting a designated laser-controlled area as well as a laser safety officer are required.

The specifications of SFK350 are listed in Table 3. A laser sensor with seam-finding function for detecting root gaps, it is enclosed in a strong casing that can tolerate any welding environment. Moreover, the algorithm that measures workpieces fabricated from steel plates of middle to heavy thickness steel plates that KOBE STEEL is known for is programmed in every groove configuration.

Table 3: SFK350 specification

	SFK350
Laser classification	Class 2M
Type of measurement	Seam-finding
Dimension (width x height x depth)	63 mm x 139 mm x 42 mm
Depth of field	350 mm
Stand off	200 mm
Close plane (Field of view)	39 mm
Far plane (Field of view)	111 mm
Lateral resolution	0.07 mm (@350 mm)
Depth resolution	0.48 mm (@350 mm)

③ Reduction of influence on workpiece surface condition

In laser sensing, scanning is conducted to reduce the influence of the surface condition of the workpiece. Adhesions from welding fume or spatter to the surface of the workpiece or the inside of the groove, or even the scars left from processing or assembly, can change the apparent groove shape in a particular spot, resulting in incorrect measurements when one point only is measured by the laser sensor.

For these reasons (as shown in Figure 6), the laser sensor first scans a certain distance along the direction of the welding line in order to obtain measuring data, which are then averaged, thereby reducing the possibility of using incorrect measurements.

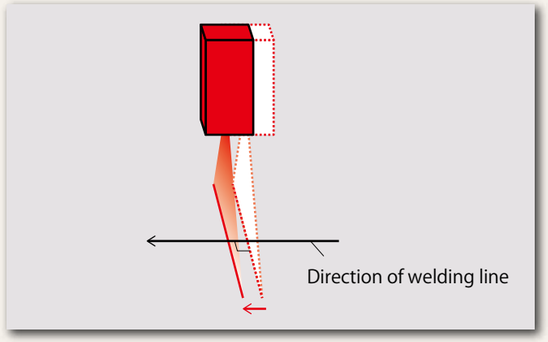

Figure 6: Laser sensor scanning operation

2-4. Comparison of laser sensing with touch sensing

Table 4 shows a comparison between laser sensing and touch sensing. Because both sensing methods have advantages and disadvantages, it is necessary to determine first whether the use of the laser sensor is applicable to a particular target workpiece.

Table 4: Comparison of laser sensing with touch sensing

	Laser Sensing	Touch Sensing
Applicable joint	Many	Few
Measurement resolving power	0.1 mm or less	About 0.5 mm
Sensing time	About 1 sec. (scanning time)	About 10 sec. (detection time)
Influence on operation ratio	Yes	No
Influence of surface condition	Influenced by reflection	Influenced by non-conductive parts
Influence from disturbance	Direct sunlight Arc light	No
Accuracy (i.e. difference in sizes and processing conditions between the workpiece and drawing)	Necessary for adding the sizes and measurement of the workpiece based on processing conditions.	The same setting can be applied even if there is some extent of dispersion.
Cost	High	Low

Note: Blue text indicates advantages.

3 System components

The laser sensing system is composed of a laser sensor, the ARCMAN™ robot and CB controller, shown in Figure 7.

When laser sensing is carried out, groove information on the target workpiece is sent from the CB controller to the laser sensor, and then sensing is conducted by means of an algorithm based on the groove information. The CB controller acquires the results measured by the laser sensor such as the distance up to the groove center, the root gap (or gap width) and other characteristics of the target groove. The accumulated information is displayed as laser sensing results on the screen of the teaching pendant as shown in Figure 8.

The teaching program is made by utilizing the exclusively programmed command for laser sensing (see Figure 9). It should be noted that laser sensing is composed of three treatments (or functions): laser radiation, measurement and acquisition of results. Although it is possible to use more than one command in combination with the versatile command for each function, it is also possible to carry out laser sensing by executing the one exclusively programmed command.

The detailed contents fall under three points as follows:

① Groove configuration or algorithm number to measure

② Storage location of correction amount measured by laser sensor

③ Storage location of root gap measured by laser sensor

The root gap detection function in combination with measured root gap and robotic functions enable welding under the welding condition adjusted to the measured root gap. Details of the teaching method are provided in the SFK350's laser sensing operation manual.

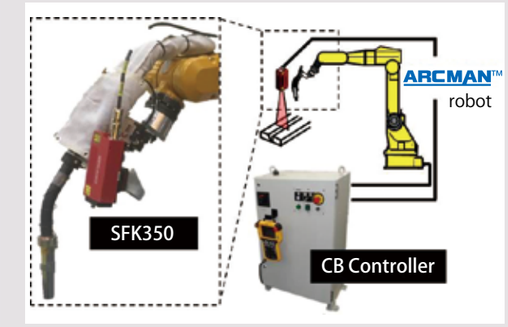

Figure 7: Laser Sensing System components

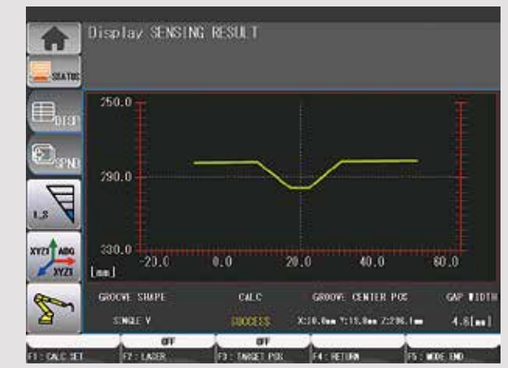

Figure 8: Screen of laser sensing result display

```
0 PROGRAM_NAME
1 LMOVE XYZ1
2 TOOL2
3 LMOVE XYZ1
4 LASER_GROOVE V,RVN1,RCN1
5 LMOVE XYZ1
6 LMOVE XYZ1
```

Figure 9: Laser sensing teaching program

4 Contribution to higher quality welding

An important contribution to high quality welding is the gap sensing function, which automatically adjusts welding conditions according to the measured results of root gaps that vary in size in the groove. Changes in the root gap must be measured in advance of the welding of a workpiece.

Figure 10 shows a root gap with a tapered shape in a groove that changes from 8 mm to 4 mm. In this case, teaching would be programmed with the 4 mm root gap.

Even though the root gap on the actual workpiece differs from that of the teaching workpiece, the weaving width as well as the welding speed is automatically adjusted to provide uniform reinforcement of the bead.

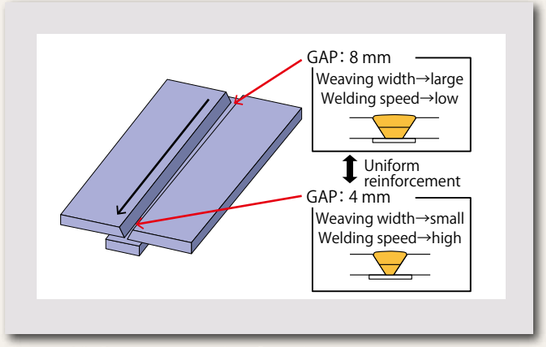

Figure 10: Root gap sensing function

5 Postscript

This report discussed the laser sensor's root gap detection function, which allows robotic welding systems to carry out higher quality welding. Specifically, the article examined some of the differences between laser sensing and touch sensing, and their respective features and discussed examples of actual application.

As the basis of developing this function, the following two functions are added:
① Exclusively programmed command for laser sensing
② Screen to display sensing results

These functions provide easier operation of the ARCMAN™ robotic welding systems that have a laser sensor installed.

KOBE STEEL will continue developing such products so that all of our customers will experience complete satisfaction with robot welding.

[References]

1. JIS C 6802: 2018, Safety of Laser Products; Japanese Industrial Standard (February, 2005)
2. Notification from the Head of Standards Bureau of Ministry of Health, Labor and Welfare, No. 0325002 (March 25, 2005)
3. Operation Manual of Laser Sensing Function (for SFK350) Chapter 2, Column 1 Teaching Method of Root Gap Detection Command, KOBE STEEL, LTD.

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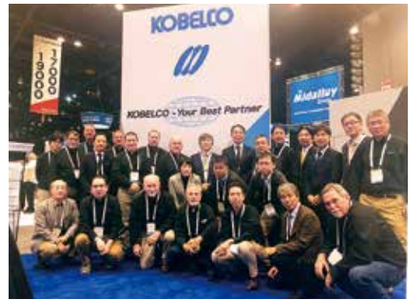
Your best partner KOBELCO brings Total Welding Solutions to FABTECH 2019

FABTECH, one of the biggest annual exhibitions in North America, is held in Chicago and then either Atlanta or Las Vegas every other year. Besides the main exhibition, FABTECH exhibitions are held in Canada and Mexico as well. It targets not only welding-related industries but also metal forming, fabricating and finishing industries and welcomes manufacturers as well as processers. In 2019, FABTECH was held in McCormick Place in Chicago, drawing around 50,000 attendees from 95 countries as well as 1,700 exhibitors over four days from November 11. In 2020, FABTECH will move to Las Vegas.

FABTECH has many sides, serving not only as a place for carrying out business but also networking and job seeking and recruitment. I noticed the following:

- Exhibits and sales: FABTECH allows business negotiations and on-the-spot purchasing. Machinery sellers, for example, offered special FABTECH prices.
- Recruiting: I wondered why so many students were taking part in the exhibition. Then I saw that both new graduates and those changing jobs used the exhibition for seeking employment.
- Business: At FABTECH, participants forge business alliance (partnerships, investments, M & A), carry out negotiations, and build relationships through conversations and networking.

KOBELCO booth



Posing at the booth entrance are the attendants of KWAI and KSL Japan

This year, KOBELCO WELDING OF AMERICA INC. (KWAI), a yearly participant at FABTECH, organized its booth under the same slogan used since 2018: "Your Best Partner KOBELCO." The displays had the following goals in order to grow awareness of the KOBELCO brand in the market as a welding solutions company as well as to encourage sales.

① Grow awareness of the KOBELCO brand as welding solutions company

On display was an operational ARCMAN™ robotic welding system composed of the ARCMAN™MP, laser sensor and F MX-50R, the flux cored wire for robotic welding and flat & horizontal position welding. A video display showed an actual example of the robotic system carrying out welding for steel frame fabrication at a North American customer.

② Display the line-up of flux cored wires for steel fabricators

Featured was F DW-50, the flux cored wire for positional welding that matches AWS D1.8/D1.8M: 2016 Structural Welding Code – Seismic Supplement. Also on display was F OW-S50P, a self shielded flux cored wire for steel fabricators that provides high notch toughness in positional welding.

③ Promote a wide variety of stainless steel flux cored wires

This display featured the DW Series for flat and horizontal position welding, the DW-P Series for positional welding, the DW-G Series for thin sheet welding and the XR Series flux cored wires with low hexavalent Cr.

The KOBELCO exhibit presented the ARCMAN™ robotic welding system as the solution for automating welding and maintaining high quality. The display of flux cored wires for steel fabricators was new this year, and clients showed a keen interest in the line-up as well as the catalog. As FABTECH brought together KWAI's sales associates from all over the USA, I could see that they enjoy meeting each other and working with their customers in harmony as a team.

Taking this exhibition as an opportunity, I will do my best to further promote sales throughout North America.

Reported by
Marie Ichikawa,
Global Operations & Marketing Department, Marketing Center, Welding Business