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KOBELCO WELDING TODAY

Vol.18
2015 No.2

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What is CTOD?

In the design of steel structures, steel plate thickness, one of the most critical elements, is determined based on the tensile strength (TS) and/or yield strength (YS). However, if a steel structure has a critical defect, the extent of future problems might not be apparent if the whole design is carried out based on TS and/or YS obtained from a defect-free test specimen.

Figure 1: Fracture strength property of defective specimen

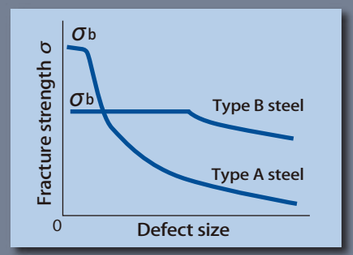


Figure 3: Load vs crack opening displacement curves showing three types of fracture behaviour

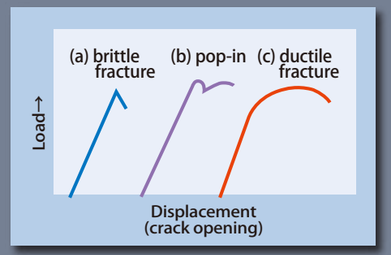
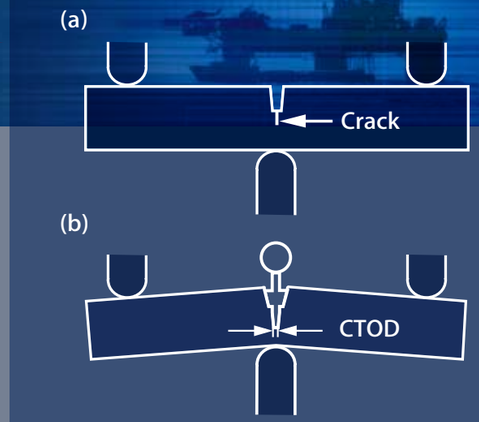


Figure 1 shows that the high TS does not necessarily prevent defects. The Type A steel, with high TS (σ_b), retains high fracture strength only when its defect size is zero. Indeed, it becomes much weaker than the Type B steel as the defect size becomes larger – even though the Type B has lower TS.

The fracture of steel structures can be prevented through fracture mechanics, which provides useful parameters that indicate the strength properties of steel structures that have defects such as those described above.

Figure 2: Schematic CTOD test



Crack Tip Opening Displacement (CTOD) is one of the parameters that can reveal the strength properties of steel structures. It was first proposed by The Welding Institute in the UK and has now been adopted worldwide. Figure 2 illustrates a CTOD test. A bend test is performed on a specimen in which a notch has been machined (a). By gradually applying a bending load, a fatigue crack is carefully induced at the base of the notch, so that the crack tip (which has a curvature radius of zero) opens little by little until it reaches a limit and the specimen suddenly breaks as shown in (b). At this point, the break progresses rapidly without any increase in the bending load. This sudden break is called an "unstable fracture."

CTOD indicates up to how many mm the crack tip opens from a curvature radius of zero. In other words, it shows how much opening a crack tip can bear and tolerate before an unstable fracture occurs. The more ductile the material, the more opening it can tolerate, and, accordingly, the higher its CTOD value.

While the test is in progress, the results are recorded automatically on a load/displacement chart as shown in Figure 3. Three basic types of fracture behavior can be investigated with this test: brittle fracture, pop-in, and ductile. Curve (a) shows a test specimen fractured in a brittle manner with little or no plastic deformation, while curve (b) shows a pop-in, where the crack initiates in a brittle manner but is soon arrested by tougher and more ductile material. This behavior can occur many times giving the curve a saw tooth appearance. And curve (c) illustrates a completely plastic or ductile behavior.

High quality products and services: The basis of a trusting relationship

Dear KWT readers! My name is Fusaki Koshiishi, the Head of the Welding Business. I'd like to express my heartfelt gratitude for your kind and continuous patronage of Kobelco products. Last year, I had a chance to visit China as well as Korea, Singapore, Malaysia and could confirm that our business related to offshore structures, LNG storage tanks and transportation systems has continued to expand.

We believe that a trusting relationship is most important in doing business and that this relationship can only be established by providing high quality products as well as services. It is, therefore, essential that we maintain superior technology and quality over our competitors and construct a sales network through which we can provide far better marketing and technical services than our competitors. Our business in the Japanese and ASEAN markets has been supported by "SHINYOKAI," a Kobelco distribution network. In the Chinese market, the sales and marketing functions of the Welding Business, which had been scattered across the country, were integrated into Kobe Welding of Shanghai Co., Ltd. (KWSH) last year as a first step, and sales and marketing activities through the distribution network have recently commenced.

We promise that we will continue supplying Kobelco's high quality products and services all over the world this year, too. I plan to visit many different markets in order to listen to your opinions and find out how you evaluate our products and services. Please join me for delicious meals and drinks then, and let's build a mutual trusting relationship.

By the way, the Rugby World Cup 2015 is going to be hosted in England from September, and some members of Kobe Steel rugby team have been selected to represent the Japanese team. I'm very much looking forward to it.

Lastly, I wish all of our KWT readers much success and good health. See you again in the very near future!

Fusaki Koshiishi
Head of the Welding Business
Kobe Steel, Ltd.

KOBELCO WELDING TODAY No.2 2015

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KOBELCO WELDING TODAY
is published by
Marketing Department
Welding Business, Kobe Steel, Ltd.
URL: http//www.kobelco.co.jp/english
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TIG welding consumables for 490 MPa high tensile strength steels

1 Preface

490 MPa high tensile strength (HT) steels are common in a wide range of industrial fields. For efficiency and ease of welding, gas metal arc welding (GMAW) or flux cored arc welding (FCAW) is generally used, but for root-pass (one-side) welding of pipe to pipe joints where the afore-mentioned high deposition methods are problematic, gas tungsten arc welding (GTAW) is applied in all position welding. GTAW is also suitable for the welding of such critical members as pipes, flanges of chemical plants because it yields extremely low oxygen weld metals that offer high cleanness as well as high quality.

Kobe Steel manufactures TIG rods for 490 MPa HT steels (see Table 1). FAMILIARC™ TG-S70S2 and FAMILARC™ TG-S70S3 rods have been newly developed to meet market demand. Table 2 lists the chemistries of TIG (filler) rods and Table 3 details the mechanical properties of weld metals from the AWS A5.18 specifications. This article will discuss the properties of Kobe Steel's TIG rods in Table 1 in detail and suggest some tips for better welding results with GTAW.

Table 1: List of TIG rods for 490 MPa HT steels

Product name	AWS A5.18	ASME F-No.	ASME A-No.
TG-S50	ER70S-G	6	1
TG-S51T	ER70S-6	6	1
NO65G	ER70S-2	6	1
TG-S70S2 *	ER70S-2	6	1
TG-S70S3 *	ER70S-3	6	1

Note: *= New product

Table 2: AWS A5.18 specifications on TIG rod chemistries (mass%)

Classification	C	Si	Mn	P	S	Ni	Cr	Mo	V	Cu	Ti	Zr	Al
ER70S-2	0.07	0.40-0.70	0.90-1.40	0.025	0.035	0.15	0.15	0.15	0.03	0.50	0.05-0.15	0.02-0.12	0.05-0.15
ER70S-3	0.06-0.15	0.45-0.75									—	—	—
ER70S-6		0.80-1.15	1.40-1.85								—	—	—
ER70S-G	(not specified)												

Note: Single values are maximum

Table 3: AWS A5.18 specifications for mechanical properties of weld metals

Classification	Tension test			Impact test	
	TS (MPa)	YS (MPa)	El (%)	Test temp. (°C)	Absorbed energy (J)
ER70S-2	490min	400min	22min	-30	27min
ER70S-3				-20	
ER70S-6				-30	
ER70S-G				As agreed between supplier and purchaser	

2 Properties of FAMILIARC™ TG-S50

TG-S50 is classified as ER70S-G in AWS A5.18. It is, however, a C-Si-Mn type of rod that exhibits excellent tensile strength and impact properties for GTAW welding of 490 MPa HT steels. It provides superior usability through fluidity of molten metal and wetting of the bead surface, and it can be applied to not only the root-pass welding of pipe joints but also almost all joints as well as welding positions. It has been Kobe Steel's most highly reputed GTAW rod and has been adopted in a wide range of applications.

TG-S50 is well-suited to post welding heat treatment (PWHT), and as a matter of fact, has undergone PWHT when applied to large-scale structural members such as chemical reactors. However, users should note the recommended PWHT condition of around 625°C×5 hours (hr) because the YS decreases during PWHT.

Table 4 shows the typical chemistry of TG-S50 weld metal, and Table 5, the typical mechanical properties in as-welded and PWHT (625°C × 5hr) conditions. Figure 1 shows the tensile properties in relation to the test temperatures. TS increases at a temperature range of 200 – 350°C in the as-welded condition; this is known as the blue brittleness phenomenon.

Table 4: Typical chemistry of weld metal (mass%)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V
0.10	0.76	1.43	0.011	0.015	0.20	0.01	0.02	<0.01	<0.01

Table 5: Typical mechanical properties of weld metal

	Tensile test at RT*			Absorbed energy (J)			
	YS (MPa)	TS (MPa)	El (%)	-40°C	-30°C	-20°C	0°C
As-welded	485	586	36	163 168 142	192 198 198	216 238 218	244 256 230
PWHT 625°C×5 hr	393	530	39	176 148 145	220 208 232	225 230 221	246 242 268

Note: *RT = Room temperature

Figure 1: Tensile properties of weld metal

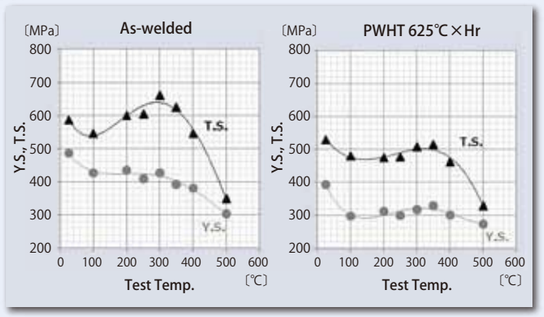

Figure 2 shows back bead appearance after root-pass welding in the 1G position by TG-S50 (2.4mm dia.). The groove configuration was of single 60°V, with a root gap of 3.0-3.5mm. The welding conditions were 110A-12V and without back-shielding.

Figure 2: Back bead appearance in 1G position

3 Properties of FAMILIARC™ TG-S51T

Like TG-S50, TG-S51T is a C-Si-Mn type of rod - but equivalent to AWS A5.18 ER70S-6. With higher amounts of C, Si and Mn contents, it yields higher TS and YS levels than TG-S50; however, the impact properties of TG-S51T weld metal are nearly the same as those of TG-S50.

Similar to TG-S50 in usability, bead appearance and ease of use, TG-S51T is also used across a wide range of applications.

Because TG-S51T weld metal retains sufficient tensile properties of 490 MPa HT steels, even over longer periods of PWHT, it can be applied to joints of large-scale structural members that require stress relief annealing.

Tables 6 and 7, and Figure 3 show the typical chemistry of TG-S51T weld metal, the typical mechanical properties in as-welded and various PWHT conditions and the tensile properties in relation to the Larson-Miller Parameters, respectively.

Table 6: Typical chemistry of weld metal (mass%)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V
0.11	0.82	1.55	0.011	0.012	0.20	0.01	0.01	<0.01	<0.01

Table 7: Typical mechanical properties of weld metal

PWHT	*1 L.M.P. (×10³)	Tensile test at RT			Absorbed energy (J)
		YS (MPa)	TS (MPa)	El (%)	-30°C
As-welded	—	523	621	35	168, 174, 160
625°C × 8 hr	18.77	422	562	37	194, 176, 176
625°C ×14 hr	18.99	414	550	37	188, 172, 191
625°C ×30 hr	19.29	396	535	37	160, 178, 172
625°C ×45 hr	19.44	382	524	38	184, 156, 158

Note: *1 L.M.P. = Larson-Miller Parameter

Figure 3: Tensile properties of weld metal

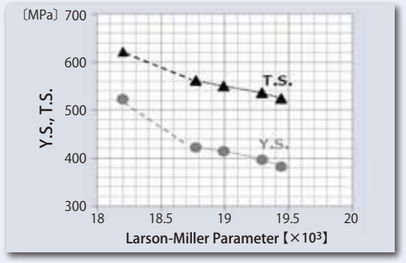

Figure 4 shows back bead appearance in the 1G position . The groove configuration was of single 60°V, with a root gap of 3.0-3.5mm. The welding conditions were 110A-12V and without back-shielding.

Figure 4: Back bead appearance in 1G position

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4 Properties of FAMILIARC™ NO65G

NO65G TIG rod, equivalent to AWS A5.18 ER70S-2, contains less C, Si and Mn contents than TG-S50 or TG-S51T; instead, Al, Ti and Zr are specially added. These elements help to decrease the amount of oxygen in the molten pool, allowing NO65G to provide a weld metal of relatively high cleanness. On the other hand, it is a little inferior to TG-S50 or TG-S51T in terms of fluidity of molten metal, because of which its surface tension increases while the oxygen content in the molten metal is decreased.

Because Al, Ti or Zr is an element with high oxygen affinity, slag can be generated on the bead surface after a part of the element combines with oxygen in the molten metal during welding. Users are therefore advised to beware of weld defects, such as poor bead appearance or slag inclusion, caused by the slag.

Each chemical element in NO65G rod is strictly controlled to maintain a narrow range within the AWS A5.18 ER70S-2 specification so that it can meet the tough requirements set out by Japanese clients for mechanical properties in critical structural projects.

Table 8, Table 9 and Figure 5 show the typical chemistry of NO65G weld metal, the typical mechanical properties in as-welded and PWHT (625°C×8 hr) conditions and the absorbed energies in relation to the test temperatures, respectively.

Table 8: Typical chemistry of weld metal (mass%)

C	Si	Mn	P	S	Cu	Al	Ti	Zr
0.04	0.50	1.20	0.007	0.012	0.22	0.06	0.05	0.02

Table 9: Typical mechanical properties of weld metal

	Tensile test at RT			Absorbed energy (J)		
	YS (MPa)	TS (MPa)	El (%)	-40°C	-30°C	-20°C
As-welded	584	635	29	Av 165	Av 200	Av 215
625°C×8 hr	545	615	30	Av 138	Av 160	Av 175

Figures 6 and 7 show face side bead appearance after root and second passes and back bead appearance after root-pass welding in 1G and 3G (uphill) positions by NO65G (2.4mm dia.), respectively. Figures 8 and 9 exhibit macro-structures of root-pass and second-pass welding in 1G and 3G (uphill) positions, respectively. The groove configuration was of single 60° V, with a root gap of 3.0-3.5mm. The welding conditions were 110A-12V for root-pass without back-shielding and 160A-13V for second pass welding, respectively.

Figure 5: Impact properties of weld metal

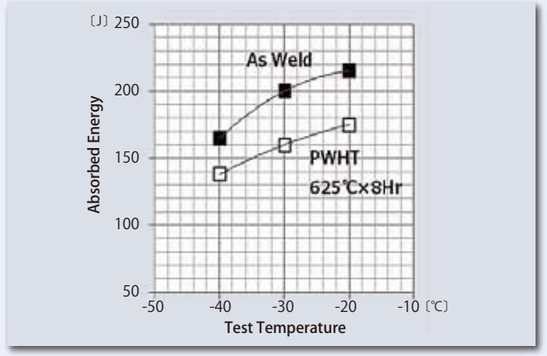


Figure 6: Bead appearance in 1G position

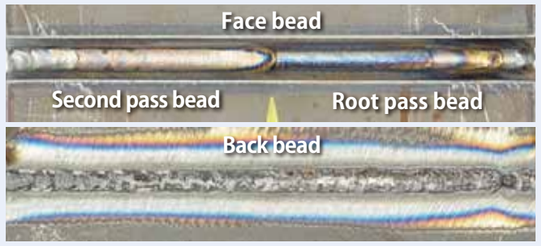


Figure 7: Bead appearance in 3G (uphill) position

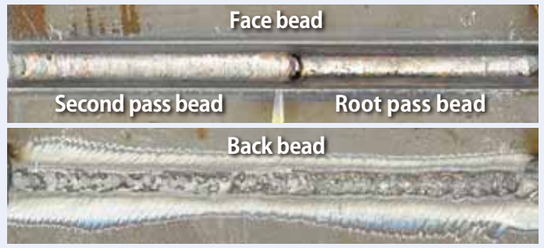


Figure 8: Macro-structures in 1G position

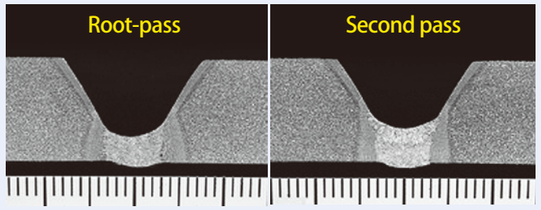
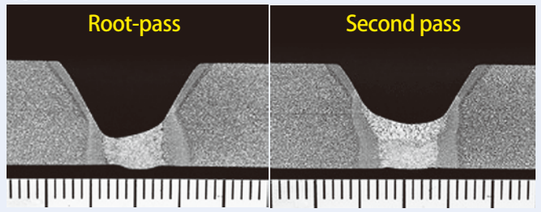


Figure 9: Macro-structures in 3G (uphill) position



5 Properties of FAMILIARC™ TG-S70S2

Like NO65G, TG-S70S2 is designed to fulfill AWS A5.18 ER70S-2 specifications though it has some key differences. TG-S70S2 is targeted toward a comparatively more versatile set of structures that fall under the AWS A5.18 ER70S-2 requirements, and its chemistries are wider than those of NO65G within the ER70S-2 specifications.

Because TG-S70S2 contains higher amounts of Al, Ti and Zr, increased slag generation and slightly inferior impact properties may result in comparison with NO65G, in which these elements are more tightly controlled. Higher amounts of Al, Ti and Zr cause impact properties to begin to fluctuate.

Tables 10 and 11, and Figure 10 show the typical chemistry of TG-S70S2 weld metal, the typical mechanical properties in as-welded and PWHT (625 °C×8 hr) conditions and the absorbed energies in relation to the tested temperatures, respectively.

Table 10: Typical chemistry of weld metal (mass%)

C	Si	Mn	P	S	Cu	Al	Ti	Zr
0.05	0.42	1.05	0.010	0.009	0.11	0.09	0.06	0.04

Table 11: Typical mechanical properties of weld metal

	Tensile test at RT			Absorbed energy (J)		
	YS (MPa)	TS (MPa)	El (%)	-40°C	-30°C	-20°C
As-welded	563	622	28	Av 125	Av 205	Av 247
625°C x 8 hr	526	604	30	Av 107	Av 156	Av 180

Figure 10: Impact properties of weld metal

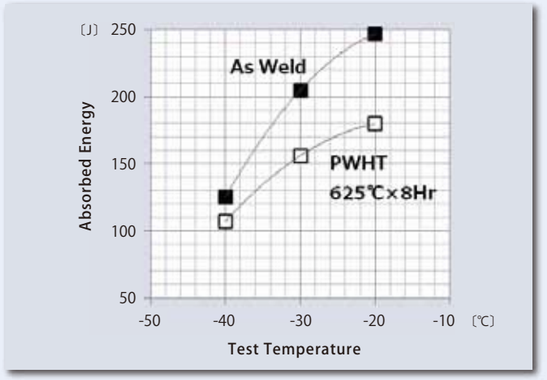
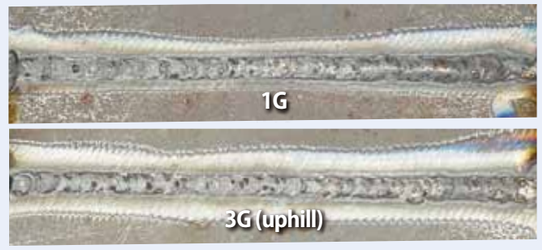


Figure 11 shows back bead appearance in 1G and 3G (uphill) positions by TG-S70S2 (2.4mm dia.).

Figure 11:
Back bead appearances of weld metal in 1G and 3G (uphill) position



6 Properties of FAMILIARC™ TG-S70S3

TG-S70S3 is a C-Si-Mn type of rod, like TG-S50 or TG-S51T, but it is designed to meet the AWS A5.18 ER70S-3 specifications It is, however, designed to contain lower amounts of C-Si-Mn than TG-S50, resulting in the lower tensile properties of the weld metal. Therefore, PWHT is not recommended but for the as-welded condition only.

Tables 12 and 13 show the typical chemistries and mechanical properties of TG-S70S3 weld metal in the as-welded condition, respectively.

Table 12: Typical chemistry of weld metal (mass%)

C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V
0.10	0.53	1.11	0.010	0.015	0.13	0.01	0.02	<0.01	<0.01

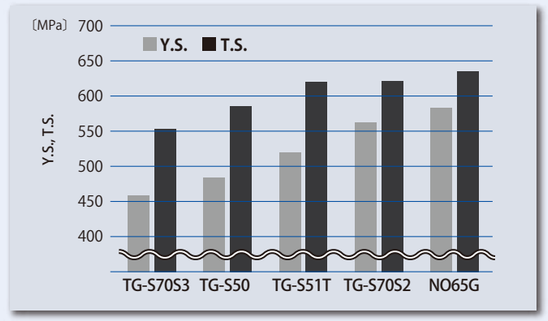
Table 13: Typical mechanical properties of weld metal

	Tensile test at RT			Absorbed energy (J)		
	YS (MPa)	TS (MPa)	El (%)	-40°C	-20°C	0°C
As-welded	460	553	36	200 170 190	240 240 245	255 260 286

7 Comparison of tensile properties

Figure 12 compares the tensile properties of weld metals by five TIG rods that meet AWS A5.18 specifications.

Figure 12: Comparison of tensile properties



It can be seen that the rod with the highest tensile and yield strength is NO65G, while these properties are lowest in TG-S70S3. These rods are sequenced in terms of tensile properties as follows:

NO65G>TG-S70S2>TG-S51T>TG-S50>TG-S70S3

8 Tips for better welding results in GTAW

An advantage of using TIG welding process for 490 MPa HT steels is the ability to obtain weld metal with high cleanness due to the low oxygen content in the weld metal when utilizing pure 100 % Ar shielding gas. On the other hand, hardness may increase in as-welded and not-reheated zones such as after the final pass in multilayer welding or single pass fillet welding.

When the final pass weld metal of a pipe joint with increased hardness is exposed, for example, to an ambience filled with hydro-sulfide (H_2S), the hydrogen, having a small atomic radius, diffuses in the weld metal and may increase the risk of delayed cracks.

When TIG welding is applied to structures that will be exposed to an atmosphere containing H_2S, the following tips are recommended to avoid increased hardness and prevent delayed cracking:

(1) Prevent excess hardening by maintaining a low cooling rate of the weld metal while applying high heat input.
(2) Prevent excess hardening by maintaining a low cooling rate of the weld metal while applying high interpass temperature or preheating.
(3) Provide an as-welded weld metal with re-heating by PWHT. (This process shall not be utilized on structural members that shall be left in an as-welded condition.)
(4) It is also effective to apply FAMILIARC™ TG-S35.

TG-S35 is designed to be used for mild steels with low TS and limited to final pass welding only. It is not classified in AWS A5.18 but in Japanese Industrial Standard (JIS) Z3316 W35A0U 10 (Table 14)

Table 14: AWS and JIS classifications of TG-S35

AWS A5.18	ASME F-No.	ASME A-No.	JIS Z3316
—	6	1	W35A0U 10

The typical chemistry of TG-S35 weld metal and the JIS specification of the rod chemistry are shown in Table 15.

Table 15: Typical chemistry of TG-S35 weld metal and JIS specification

	C	Si	Mn	P	S	Cu	Ni	Cr	Mo	V
TG-S35	0.01	0.02	0.44	0.012	0.008	0.17	0.01	0.01	<0.01	<0.01
JIS Z3316 W35A0U 10	0.02 max	0.20 max	0.70 max	0.025 max	0.025 max	0.50 max	0.15 max	0.15 max	0.10 max	0.05 max

The typical mechanical properties of TG-S35 weld metal and JIS specification of mechanical properties both in as-welded condition are shown in Table 16.

Table 16: Typical mechanical properties of TG-S35 weld metal

	Tensile test at RT			Absorbed energy (J)		
	YS (MPa)	TS (MPa)	El (%)	-30°C	-20°C	0 °C
TG-S35	335	405	37	36 46 32	154 132 136	212 226 228
JIS Z3316 W35A0U 10	250 min	350-450	22 min	0℃		
				47 J min		

For reference, the hardness test result of TG-S35 weld metal in comparison with TG-S50 weld metal is shown in Figure13.The hardness was measured as shown in the drawing below.

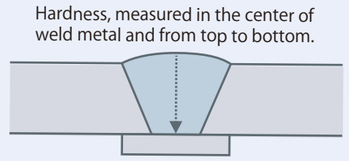
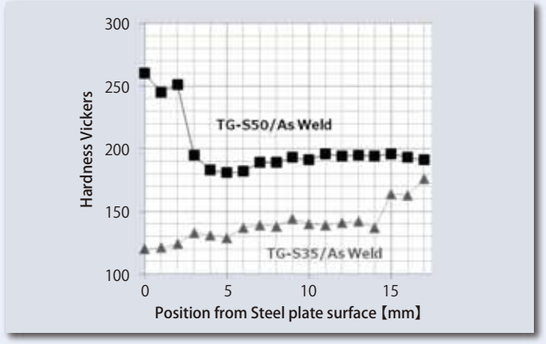


Figure 13: Hardness comparison between TG-S35 and TG-S50 weld metals



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India Essen Welding & Cutting 2014

The 6th India Essen Welding & Cutting Exhibition (India Essen 2014 – organized by the Essen Welding & Cutting Exhibition, Germany) was held in Mumbai, India's most populous city (estimated as 18.4 million) and most important financial and commercial center, from October 28 to 30, 2014.

I was fortunate to visit India Essen 2014 as well as Weld India 2014, which was held in New Delhi in April, 2014, in collaboration with FABTEC (the same organizer as the AWS Welding Show). I'd like to report on my experiences at both exhibitions.

At India Essen 2014 there were around 130 exhibitors – mainly Indian companies and organizations as well as some from Germany and China. As no major European or American manufacturers of welding consumables and equipment were participating, the displays of the many Indian manufacturers focused more on products for general purposes. By contrast Weld India 2014 featured many of the latest technologies, equipment and welding methods that had been introduced at several global FABTEC exhibitions.

At India Essen 2014, the newly-established Kobelco Welding India Pvt. Ltd. played an active role. The exhibit featured a live demonstration of ARCMAN™ –MP, Kobelco's welding robot, in combination with FAMILIARC™ MX-A100, the metal cored wire. High-quality welding consumables for heat resistant (Cr-Mo) and stainless steels that meet the needs of boiler and reactor fabricators were also featured.

Also on display were "MX-series" metal cored wires as well as "US-29 x AF490E" and "US-36 x AF490AS", which are submerged arc welding wire and flux combinations for use with direct current. We could meet and greet many visitors, including well-known Indian fabricators and distributors among the nearly 400 that visited our booth.

During the exhibition, a technical seminar was held by the Indian Welding Society (IWS), a co-organizer of India Essen 2014. Mr Maruyama, Manager of the Technical Center in the Welding Business, delivered a presentation called "Basic Welding of Heat-Resistant Cr-Mo Steels." It was well-received by the audience, and some IWS board members later came to the Kobelco booth to express their gratitude for his presentation.

My overall impression was that India Essen 2014 was a great three-day exhibition. I felt that Kobe Steel is both trusted and relied upon by many Indian customers.

Reported by **Shunji Oki**
Manager in charge of Indian Market,
International Sales and Marketing Section,
Marketing Department, Welding Business

Kobelco Welding India's booth

Entrance to Hall 6 where Kobe Steel booth was located

Mr Maruyama, third from the left, together with IWS board members

A Memorable reception with Dutch King and Queen

At the end of last October, His Majesty King Willem-Alexander and Her Majesty Queen Maxima in the Netherlands visited Japan as state guests. One year after the King's coronation, Japan was honored as the first country outside the EU to receive the royal couple. The friendly relationship between Japan and the Netherlands has been cultivated for a long time, and the Netherlands is Japan's biggest investment partner ever in the EU.

Royal family

Kobe Steel operates Kobelco Welding of Europe B.V. (KWE), a manufacturer and seller of flux cored wires, in Heerlen City, in the Dutch province of Limburg. This year marks the company's 20th anniversary, and because of this relationship, I was honored to be invited to represent Kobe Steel at the reception held by the King and the Queen at the embassy of the Netherlands on October 30, 2014.

At the reception

At the start of the reception, a photograph was taken of all participants together with the King, who then shook hands with us as we introduced ourselves one by one. During the dinner, the King and the Queen walked up to each dinner table and conversed with the guests on diverse subjects including some related to their nation's companies. At our dinner table, when we were discussing mainly issues related to a foreigners living in the Netherlands, the King joined in with a smile on his face. We could have an enjoyable conversation with the King who spoke in a friendly tone.

After the dinner, I also had a chance to have an intimate talk with the Amstelveen City Mayor, M. M. van't Veld. Finally Mr Henk Kamp, the Minister of Economic Affairs of the Netherlands, closed the reception with a speech.

It was a very wonderful and memorable reception and I, myself, was able to spend a fruitful and enjoyable time.

Reported by
Fusaki Koshiishi,
Head of the Welding Business

Beginning of trade between Japan and the Netherlands(1641-)

(📍 is the author.)

Memorial shooting with the royal couple and the invited guests.

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Impressive Chinese people and life in Qingdao

Dear KWT readers! My name is Kazuhiko Ito, Managing Director of Kobelco Welding of Qingdao Co., Ltd. (KWQ) in Shandong Province, Northeast China. Almost a year has passed since I was assigned to KWQ last May, and I'm pleased to be able to share my views on Qingdao as well as KWQ with you. At the beginning of my assignment, I was optimistic about communicating in a foreign language because it was my second time to work abroad after the USA; however, the language barrier has been and still is much greater than I had imagined. This year seems to have flown by in an instant, probably because my daily life here is challenging yet satisfying.

My Chinese colleagues at KWQ are generally cheerful, kind and sociable, once you make friends with them. The key point is how soon you get along with them. And they are never shy, which is what I, as a Japanese, am envious of. At the KWQ's year-end party, when employees and their children performed dances and KARAOKE songs, they dressed up and danced so enthusiastically, they looked like pop idols as shown in the photo.

Jiaozhou Bay Bridge.

My colleagues seem to have a quite different character from ordinary Japanese, which I guess originates from their education in childhood. This unexpected side to the people here has given me a different impression of Chinese people from what I had imagined while I was in Japan.

At KWQ, about 130 employees are involved in manufacturing or selling flux cored wires (FCWs) for carbon steel. The company was established in 2008 and is still a young company, in which the average age is 32 years old. The volume of production as well as sales at KWQ has steadily been increasing, and we have more rooms for expansion. Therefore, we hope that prospective customers in China and around the world will recognize and use KWQ's FCWs more and more.

Situated along the Yellow Sea, Qingdao is a city with delicious and fresh seafood. The taste of Qingdao cuisine is rather mild in comparison with Chinese food elsewhere, which can be heavy with seasoning. It accompanies the well-known Qingdao beer very well. You might be interested to know that Qingdao beer has recently released a black beer, called "Qingdao Stout," as well as the premium "Augerta 1903," so that there are more choices of beer to match with the food.

Another point that I'd like to mention is the Jiaozhou Bay Bridge. (See photo)

The world's longest bridge over water, with a total length of 41.6km, it opened in June 2011. Because I live in central Qingdao City with my family, I have to commute to KWQ, which is located to the other side of Jiaozhou Bay, every day, and half of my commute involved crossing this bridge.

I look forward to seeing you somewhere, someday. And please consider visiting Qingdao, which is developing remarkably well and where a subway is currently under construction. Zai Jian (see you again) !

A pop idol dance performance? No! They are KWQ employees at the last year-end party!

Mr Ito (second from the left in the back row) with KWQ employees and families at the last year-end party