KOBELCO WELDING TODAY

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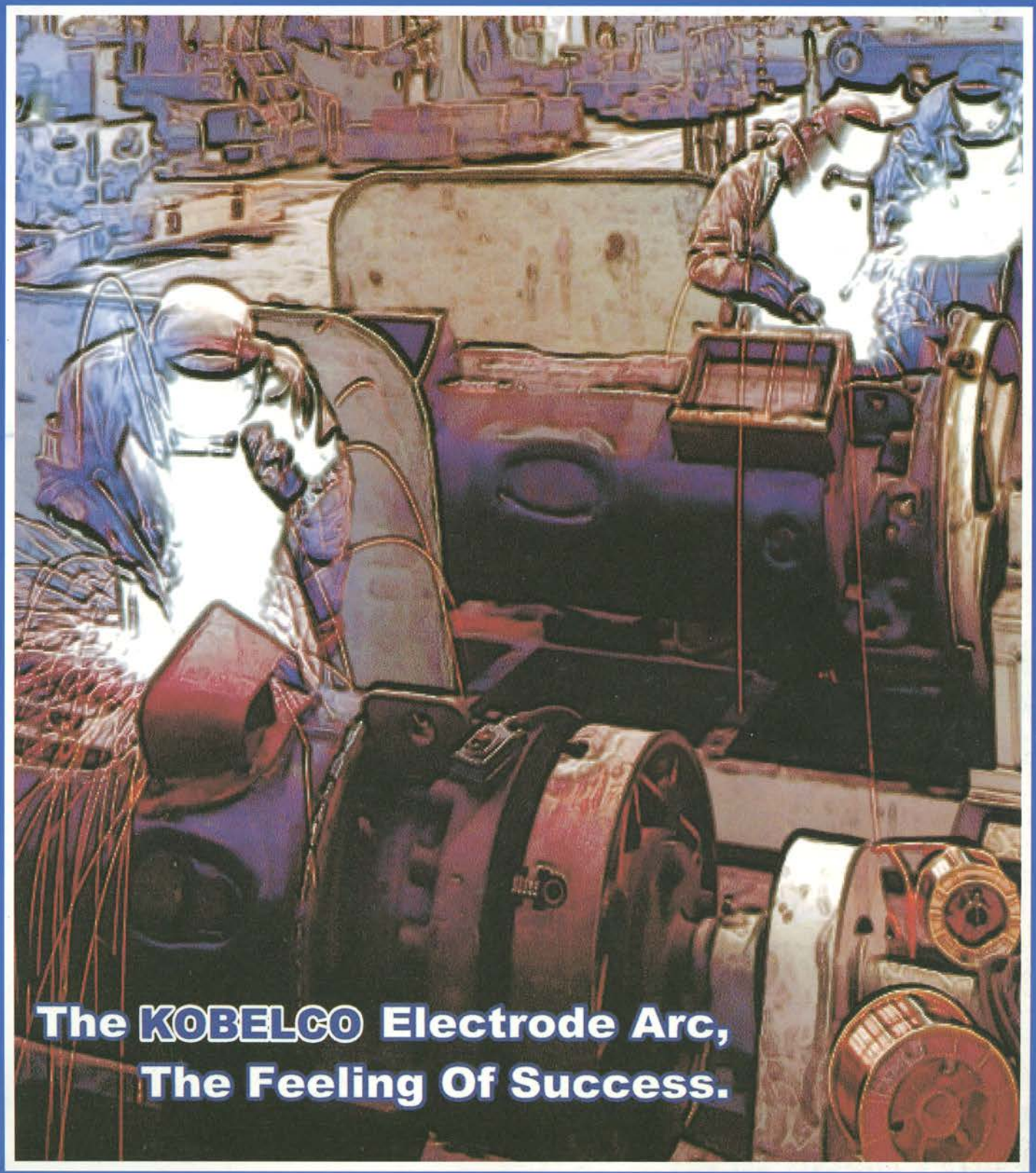
Vol.3 (No.2)



Mercon Steel in the Netherlands Builds a "New Miracle" by Using Excellent Flux-Cored Wires

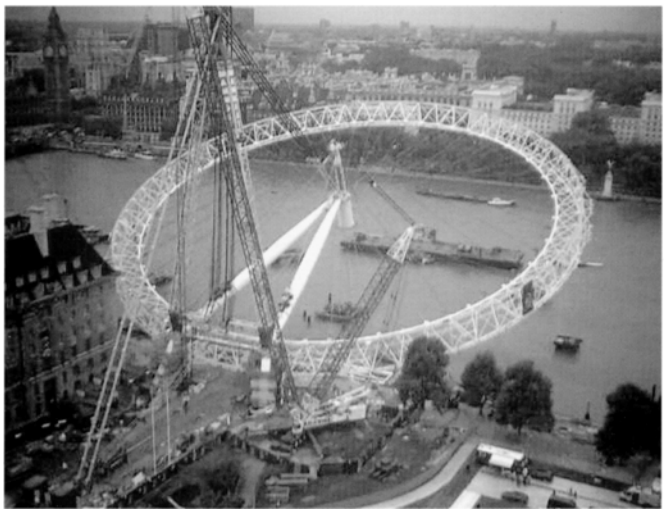


Fig. 1 — A "New Miracle" situated on the bank of the river Thames will be a new tourist attraction.

Mercon Steel Structures, located at Gorinchem in the centre of the Netherlands is one of the leading steel fabricators of bridges, offshore structures, transport equipment, storage tanks and architectural structures. Last year, Hollandia Krimpen B.V. got the order as the main contractor to manufacture the so-called British Airways London Eye. Situated on the bank of the river Thames, this huge structure of more than 1500 tonnes of steel consists of a 135-meter high observation wheel, equipped with 32 cabins for 25 persons each.

As a symbol of time, the wheel has been erected to celebrate the new Millennium and will be one of the main tourist attractions for the next decade in London. It allows the visitors to have an excellent view of almost 40 kilometers (25 miles) over London and its surroundings. The total building time was limited to 14 months, including engineering and manufacturing. Big castings for the hub and spindle were made by Skoda in Czech Republic and other parts came from France and Italy. A special heavy lifting mobile crane with a capacity up to 4000 tonnes was constructed at the same time to allow the mounting of the wheel.

Mercon Steel was contracted to manufacture the rim sections of the wheel with a total weight of around 576 tonnes of steel (Type S355J2G3 and S355J2H). Mercon has been using Elgacore DWA-55L since the early 1990s to a large extend for improved productivity in all positional welding of complicated steel structures. The stable mechanical properties and excellent weldability of the wire allows problem-free construction of a diverse range of welding structures.

The construction of the rim sections took place in 16 parts from 8.5-meter length and 6-meter width. These sections were later jointed to tour individual sections of 144 tonnes each before transport oversea. Each rim section contains more than 450 welds with stringent impact requirements. The repair rate was far below 1%. Elgacore MXA-55T was also used successfully to make root passes before filling with the submerged arc welding process.

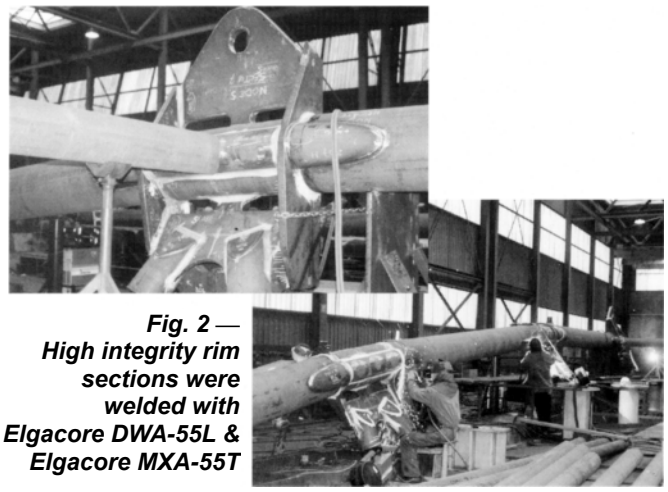


Fig. 2 — High integrity rim sections were welded with Elgacore DWA-55L & Elgacore MXA-55T

With the motto "QUALITY AND KNOW-HOW IN WELDING" the ELGA Group, with sales outlets in many European countries, has more than 13 years experience with KOBELCO welding consumables, especially flux cored wires. Thanks to Mercon Steel. ELGA and KOBELCO are really proud of being involved in this memorial project in Europe.

(Reported by Henk van Zijl,
Managing Director, Elga Benelux)

Message from the Editor

General Manager

International Operations Department

Welding Company
Kobe Steel, Ltd.

For the welding market, the year 2000 opened with indications of recovery in Asian economies. Korea surpassed Japan to become No. 1 in the world in shipbuilding, with their bigger shipyards doing brisk in business. Our flux-cored wire DW-100 (AWS E71T-1) enjoys a high major share at those shipyards where they use flux-cored wires at a high rate. In China, where there are many plans to construct new shipyards and expand existing ones, it is expected that the use of flux-cored wires will rise in the near future.

Though the ASEAN market has been rather slow to recover, it should be noted that the Thai automobile industry has seen a sharp rise in production for export, which accompanies increased sales of our CO_2 solid wire MG-51T (AWS ER70S-6). The US economy continues to be thriving. As compared with the IT industry, however, heavy industries that use a lot of welding consumables are slower in growth, and we hope that the petroleum industry will regain its steady growth as crude oil picks up in price. In Europe, the welding market is still dull, with inactive construction of ships and offshore structures. We will continue our efforts in opening up new demand with the spirit of "Hard times are full of good chances."

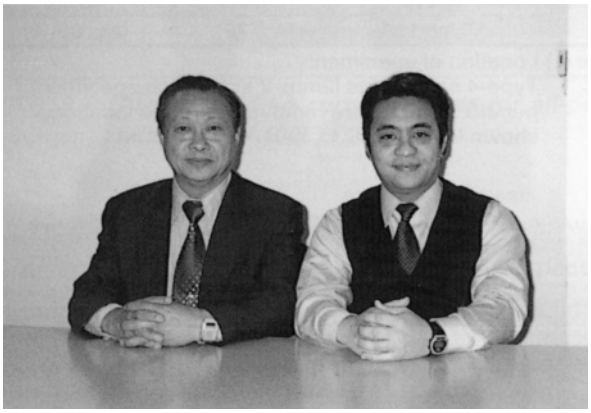
The Welding Company of Kobe Steel is now building 3-year business plans for the period beginning from 2000 and ending in 2002. They will be the action guideline to make the KOBELCO welding group grow by leaps and bounds in every market in the world in the near future. Its keynote is "fortifying marketing and sales power." Our sincere desire is to sustain long-standing business with the customers who support the KOBELCO welding group the world over. For this, you never can fortify marketing and sales power too much.

I hope the dearest readers of Kobelco Welding Today will prosper more and more.

Tetsuo (Tom) Konohira
Editorial Chairman

Contents

KOBELCO PARTNERS



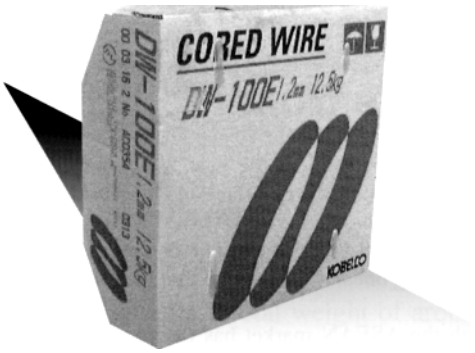
It was 1973, when I started to deal with KOBELCO welding consumables in Taiwan. We can call those days "Covered Electrodes' period." I succeeded in promotion of B-14 and Autocon-27 to TSBC (Taiwan Shipbuilding Corp., Keelung). And in 1975, I also succeeded in promotion to CSBC (China Shipbuilding Corp., Kaohsiung). It is the history of 27 years in my life with KOBELCO. During these 27 years, I found 5 processes evolve with my customers: 1. Covered Electrode, 2. Gravity, 3. SAW, 4. Solid Wire, and 5. FCW. In each phases I walked over many competitors with new technical developments by Kobe. Now I remember those days with sweet and bitter memories. In the future I would like to be with my customers and to keep on supporting them to solve their problem, under the spirit of "Never Say Die."

CENTURYCO LTD., C. C. Fu, President

Technical Report

DW-100E

(AWS A5.20 E71T-9)



DW-100E can be one of the best selections in shipbuilding and offshore construction due to excellent notch toughness at low temperatures down to minus 20 degree centigrade.

Essential Characteristics of DW-100E

DW-100E is suitable for welding mild steel and 490N/mm^2-class high strength steel. The AWS classification shown above (E71T-9) will help you understand the essential characteristics of DW-100E as follows:

E: designates an electrode.
7: indicates the minimum tensile strength of the weld metal (70 ksi = 490N/mm^2).
I: indicates all-position welding.
T: designates a (lux-cored wire.
9: refers to the wire being classified as with CO_2 shielding gas, suitable for single- and multi-pass welding, and improved in impact properties.

Ship-Class Approvals Certify the Quality of DW-100E for Higher Grade Steels

DW-100E is approved as a Grade-3 welding consumable by the following classification societies worldwide:

NK: Nippon Kaiji Kyoukai (Japan)
AB: American Bureau of Shipping (USA)
LR: Lloyd's Register of Shipping (UK)
NV: Det Norske Veritas (Norway)
BV: Bureau Veritas (France)
CCS: China Classification Society (China)

Grade-3 welding consumables are required to satisfy high notch toughness as shown in Table 1. This is because Grade-3 welding consumables are intended to be used for the extra-high notch toughness steels classified as E- and EH-grade of mild steel and high-strength steel respectively, in addition to other lower grades (A-, B-, D-, AH-, and DH-grade), in accordance with the ship-class rules. E- and EH-grade steels are designed as crack arresters in hull construction.

In case a crack accidentally occurs in the hull construction during a voyage, the crack arrester is expected to prevent the crack from propagation in order to prevent the ship from brittle fractures. How to use E- and EH-grade steels in hull construction is specified by the ship-class rules.

Table 1 — Mechanical properties of all-deposited metal required for Grade-3 gas-shielded arc welding wires for mild and high-strength steels by the LR ship-class rule

Type of steel	Tensile properties			Charpy impact absorbed energy (J) at -20°C
	YS (N/mm^2)	TS (N/mm^2)	EL (%)	
Mild steel	≥305	400-560	≥22	≥47
YP32HT	≥375	490-660	≥22	≥47
YP36HT	≥375	490-660	≥22	≥47

DW-100E Ensures High Notch Toughness in All-Position Welding

DW-100E offers stable notch toughness of the weld metal with a little scattering of impact value in all-position welding, as shown in Table 2.

Table 2 — Charpy impact absorbed energy (J) of DW-100E weld metal at –20°C in all-position welding

Location of specimen (1)	Welding position		
	Flat	Horizontal	Vertical
Face side	137	103	114
	120	96	131
	107	97	140
	(Av. 121)	(Av. 99)	(Av. 128)
Root side	97	70	75
	113	82	84
	116	64	99
	(Av. 109)	(Av. 72)	(Av. 86)

Note (1) Location of specimen: Type-4 specimens (2 mm-V side notch specimen) per JIS Z 3111 were removed from the locations shown in Fig. 1.

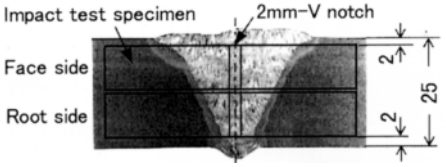


Fig. 1 — Location of impact test specimens removed from DW-100E welds (One-side welding with FBB-3)

Fig. 2 — Notch toughness is an important factor in the construction of Ships

Proper Welding Conditions in Use of DW-100E

DW-100E offers very little spatter and easy slag removal in uses over a wide range of welding currents as shown in Fig. 3 in all positions including vertical-down position.

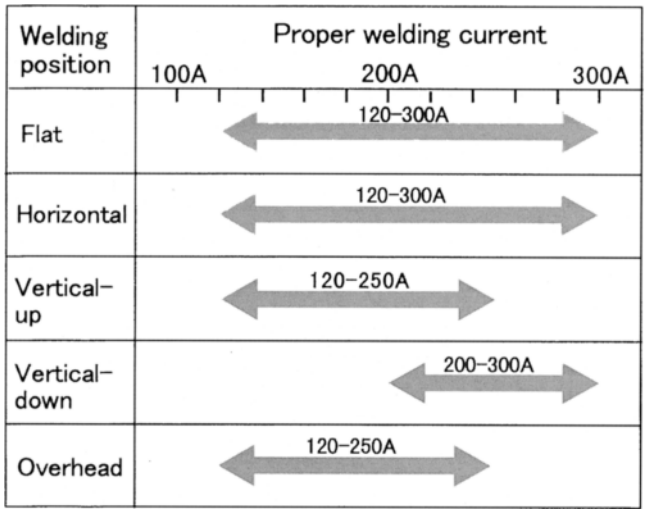


Fig. 3 — Proper welding current ranges for all-position welding (DW-100E, 1.2 mmØ)

Heat input (HI = A x V x 60/S where A: welding current, V: arc voltage, and S: carriage speed) is a predominant factor in arc welding in common, affecting quality of welds. Table 3 shows recommended heat input for DW-100E. The minimum heat input is to control hardness of the welds (Hv < 280), while the maximum heat input is to ensure notch toughness.

Table 3 — Recommended heat input ranges

Welding position (1)	Heat input (kJ/cm)
1F, 1G	10-30
2F	10-20
2G	10-15
3F, 3G, 4F	15-30

Note (1) Welding position: 1F: Flat fillet, 1G: Flat groove, 2F: Horizontal fillet, 2G: Horizontal groove, 3F: Vertical fillet, 3G: Vertical groove, 4F: Overhead fillet

In horizontal fillet welding, control of leg length is essential. Welding speed is the governing factor that determines the leg length of a single-pass fillet weld. Fig. 4 shows data of leg length as a function of welding speed in use of DW-100E.

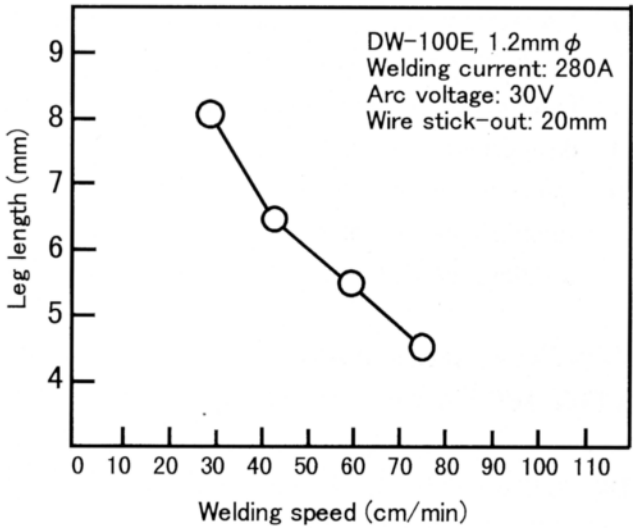
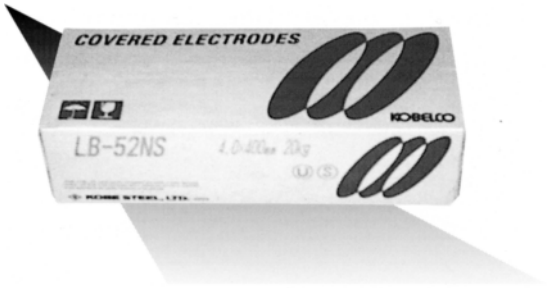


Fig. 4 — Leg length vs. welding speed in use of DW-100E in single pass horizontal fillet welding

Weldability of mild steel and 490N/mm^2-class high strength steel is quite good. However, cold cracking can occur in the welds when the base metal is a thick section with high carbon equivalent, the weld contains a high amount of diffusible hydrogen, and welding is carried out in a low ambient temperature. Diffusible hydrogen content of DW-100E weld metal is as low as the ship-class requirement of Grade H10 (Diffusible hydrogen: ≤ 0.10 ml/g), however, 30-150°C of preheating is needed depending on atmospheric temperature and plate thickness.

LB-52NS

(AWS A5.5 E7016-G)



LB-52NS is a highly reputed, dependable electrode for various low temperature applications such as LPG carrier and storage tank, offshore structure, and heat exchanger for the service temperature is down to minus 60°C.

What Characteristics of LB-52NS Do the Users Count On?

The most important quality of the electrodes used in low-temperature applications is weld notch toughness sufficient enough to prevent brittle fractures in the component materials under severe service conditions. Notch toughness, however, is commonly affected by such variables in welding as heat input, plate thickness, cooling speed, welding position, and postweld heat treatment.

LB-52NS ensures adequate notch toughness over a wide range of these variables. In addition, specific technical data such as Crack Tip Opening Displacement (CTOD) and Sulfide Stress Corrosion Cracking (SSCC) are available, which are sometimes required for special applications. Such dependable performance and technical data helps users control the welding quality.

LB-52NS Accommodates Higher Heat Input

Heat input is electric energy applied to a weld, which is determined by welding current, arc voltage, and carriage speed. Higher heat input commonly causes coarse microstructure. thereby decreasing notch toughness. LB-52NS, however, can maintain fine microstructure with higher heat input compared with conventional electrodes, due to the specific chemical composition (Si-Mn-0.5Ni-Ti-B). Fig. 1 shows the notch toughness of LB-52NS weld metals as a function of heat input. The lowest line of the absorbed energies at minus 45°C in the figure suggests that heat input can be up to 45 kJ/cm to ensure adequate notch toughness. As to those at minus 60°C, the maximum heat input can be 35 kJ/cm to ensure adequate notch toughness. In addition, this figure shows that notch toughness of LB-52NS weld metal is not deteriorated by SR.

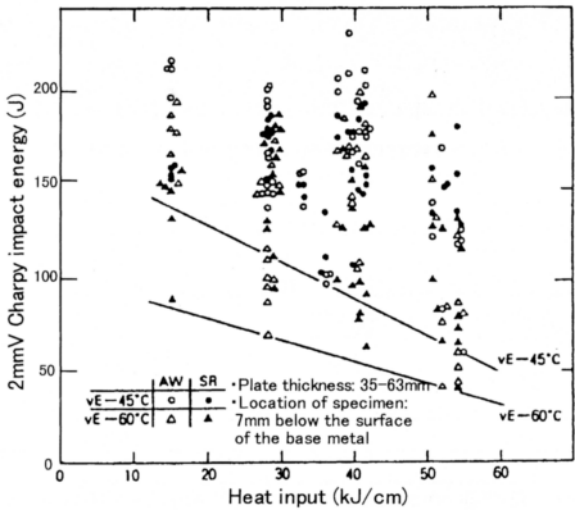


Fig. 1 — Charpy impact absorbed energy of LB-52NS weld metals as a function of heat input in welding thick-section butt joints

LB-52NS Ensures Adequate Notch Toughness Even in Thinner Plates

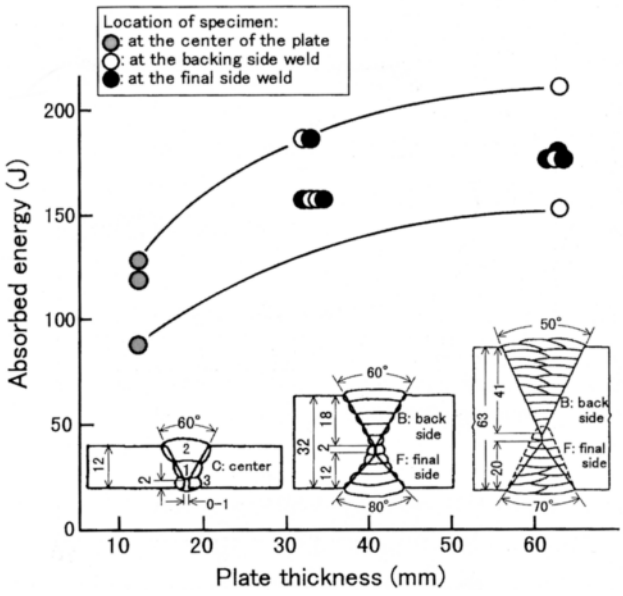


Fig. 2 — Charpy impact test results of LB-52NS (4 mmØ) weld metals in vertical-up AC welding (interpass temperature: 100-150°C, test temp: –45°C).

In welding thinner plates, the microstructure of the weld commonly tends to be coarse because of slower cooling speeds and fewer required weld passes. Fig. 2 shows Charpy impact test results of LB-52NS weld metals with three different plate thicknesses using the groove preparation and weld pass sequence shown in the figure.

It is obvious that LB-52NS provides adequate notch toughness, even in the severe condition of vertical-up welding, over a range of plate thicknesses, although with thinner base metal, notch toughness is lower with almost the same heat input. This is because the thinner the base metal, as shown in Table 1. the slower the cooling speed. Slower cooling speeds can cause more or less coarse microstructure; thereby decreasing notch toughness.

Table 1 — Plate thickness, heat input and cooling speed in Charpy impact test of LB-52NS weld metals

Plate thickness (mm) (1)	Average heat input (kJ/cm)	Average cooling speed at 540°C (°C/sec) (2)
12	38	1.2
32	40	7.6
63	40	9.6

Note (1) For pass sequence, refer to Fig. 2.
(2) Cooling speed was calculated by using Rosenthal's formula.

LB-52NS Maintains Adequate Tensile Strength over Extended PWHT

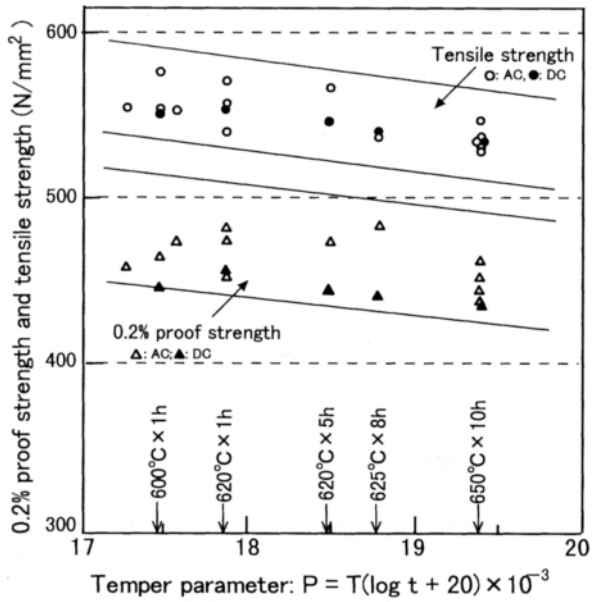


Fig. 3 — Effect of PWHT conditions on tensile properties of LB-52NS deposited metal

In welding fabrication of thick-section pressure vessels, postweld heat treatment (PWHT) is indispensable to relieve residual stresses raised by welding. As with typical ferritic weld metal, the tensile and yield strengths of LB-52NS deposited metal decreases as PWHT temperature or soaking time increases, reducing residual stresses. However, LB-52NS maintains adequate tensile strength and yield strength even after extended PWHT as shown in Fig. 3. This preferable characteristic is derived from fine-microstructure weld metal provided by the sophisticated design of chemical composition as previously mentioned.

LPG Storage Tank is Typical Application of LB-52NS

Fig. 4 — Cylindrical LPG storage tank is a typical application of LB-52NS

Liquefied petroleum gas (LPG) is stored at a low temperature of minus 45°C in thermal-insulated LPG storage tanks. Therefore, materials including weld metal of the tank must have adequate notch toughness at that temperature. In construction of a cylindrical LPG tank, in addition to automatic processes (SAW. GTAW), LB-52NS is an indispensable electrode featuring unsurpassed quality including usability in out-of-position welding and resistance to cold cracking and moisture pick-up.

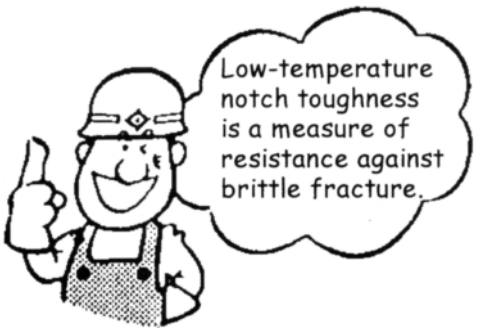
What Is Low-Temperature Notch Toughness and How Is It Determined?

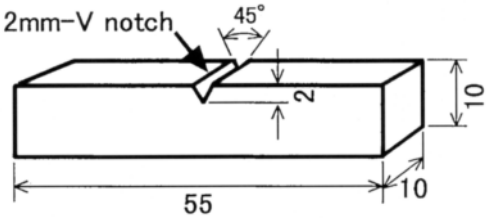
A ductile metal as judged by ordinary tensile or bend tests may tail in the "brittle fracture" mode with little or no plastic deformation when subjected to critical testing or service conditions. The critical conditions depend on "fracture toughness" of the metal. The brittle fracture is considered more dangerous than the ductile fractures exhibited in ordinary tensile or bend tests, because high-velocity failures take place in steel structures. The following three factors markedly influence the behavior of a metal in terms of brittle fracture:

(1) presence of a notch in the metal
(2) temperature of the metal
(3) residual and applied stresses in the metal

"Fracture toughness" is a generic term for measures of resistance to extension of a crack. The common methods of measuring the fracture toughness of welded joints are the Charpy V-notch impact test, the Crack Tip Opening Displacement (CTOD) test. Drop Weight test, and Compact Tension test. Of these testing methods, the Charpy V-notch impact test is most commonly used to determine fracture toughness (also known as "low-temperature notch toughness") of welds.

The Charpy V-notch impact test uses the standard specimen shown in Fig. 1. When the thickness of the weld is not large enough for removing this size of specimen, a thinner specimen (sub-size specimen) may be used. The specimen is positioned with the ends of the notched surface straddling two supports and is struck opposite the notch by a wedge-shaped hammer at the end of a pendulum. The energy absorbed in breaking the specimen is calculated from the mass and length of the pendulum, the initial height of the hammer and the height of the hammer after the fracture. For carbon and low alloy metals that exhibit a change in failure mode (from shear fracture to brittle fracture) with decreasing temperature, the test is performed at several temperatures.





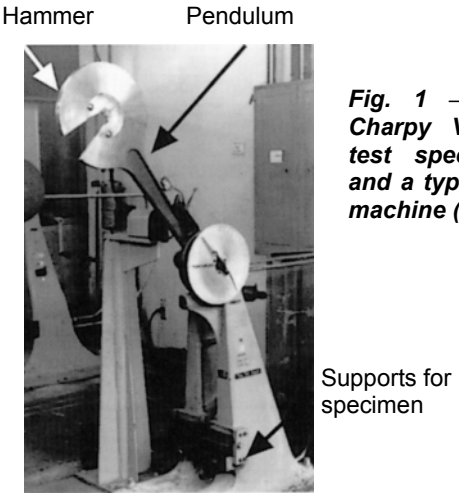


Fig. 1 — A Standard Charpy V-notch impact test specimen (Above) and a typical impact test machine (Left)

The most commonly reported result is the absorbed energy, but the percent shear fracture and the lateral expansion may also be reported. Typical transition temperature curves of carbon or low alloy weld metal are shown in Fig. 2.

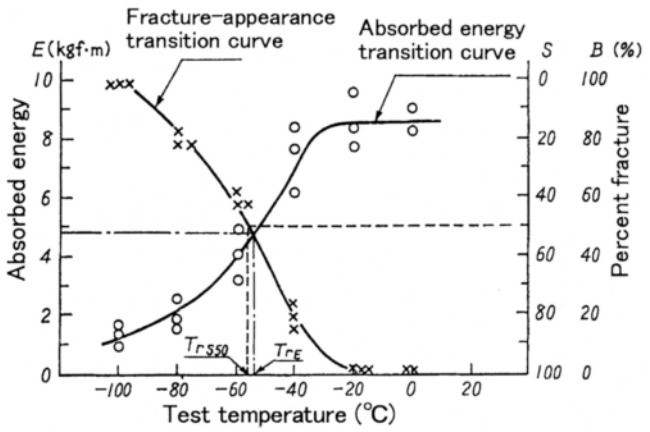


Fig. 2 — Typical transition temperature curves of a carbon or low alloy weld metal IS: shear, B: brittle)

A Celebration of the Century in the Year 2000

The 22nd of January 2000 was a special, memorial date for us: the 20th birthday of KWS, celebrated as we head into the new millennium. This special-occasion anniversary encouraged KWS to accomplish a great stride for the future. Since its establishment in January 1980, KWS has weathered through 20 years of commercial ridges and valleys including three economic crises in the country. We must say that the company has grown today fully deserve praise with a grand 20th anniversary.

The grand event was organized in one of the Singapore's best hotels, the Shangri-La Hotel, located in the Orchard Road shopping district. With the theme "Yesterday, Today, and the Future 2000," we had a real treat from the organizers.

Our guests included shareholders, agents and distributors, employees and their families, valuable suppliers, and (who could forget!) the infamous "Shark Brothers." The "Shark Brothers" are from the Golf World: Peter Chua, George Sim, and Richard Baey. If you play golf with them, you will know why they are called sharks.

Fig. 2 — Guests sitting at dinner tables for the evening programme during the KWS foundation's 20th anniversary celebrated on the 22nd of January 2000

Fig. 1 — KWS's Chairman (T. Konohira), Managing Director (S. Kanehira), and employees who are awarded for 20-years' service to the company

The programme for the night took off with the "Flight Captain" (T. Konohira) addressing the crews (Guests), followed by the in-flight meal (Dinner). After that the battle began with lots of fun and laughter coming from participants on the floor. The programme also included the presentation of long service awards, games, a karaoke session and a lucky draw, where one could walk away with a top prize of a Pioneer audiovisual hi-fi unit. No one at this time wanted the party to end. but as with every event, we had to call it a day when dawn approached. All we could have said then was to work hard and look forward to another 10 good years for KWS. Onwards with KWS!

(Reported by Alex Ong, KWS)

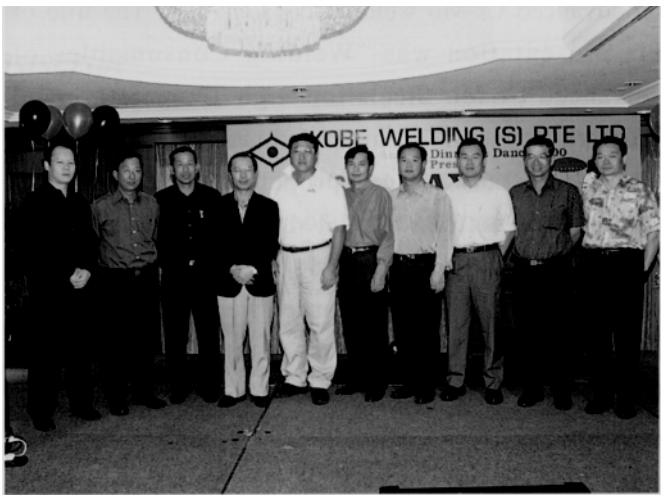


Fig. 3 — VIP guests celebrating "the History" of KWS

Feature Article

Indian International Welding Event Joins People Together

A Symposium On the Joining of Materials, SOJOM 2000, was held in Tiruchirappalli City on January 20-23. The city is located in the delta of the Cauvery River, to which a short-hour flight takes us from the largest commercial city of Chennai in the southern part of India. Tiruchirappalli is an ancient town built during the Chola Dynasty (BC 3 - AD 1). The city has many temples including a famous one called the "Rock Fort," which sits on an 83-m rocky mountain.

The city is also known as the "Temple of Welding." This is derived from the energetic activities of two organizations: the Welding Research Institute (WRI) of Bharat Heavy Electrical Ltd. (BHEL) who promoted SOJOM 2000 and provided the venue, and the Tiruchirappalli Branch of the Indian Institute of Welding (IIW), which founded the Indian welding industry.

SOJOM 2000 was held in commemoration of the 25th anniversary of the WRI and the 30th anniversary of the IIW. Therefore, in addition to many delegates from leading Indian companies and institutes, those from foreign countries including the USA, Germany, Sweden, and Japan participated, too. During the three-day symposium, a variety of technical presentations were provided. Kobe Steel was sole participant from the Asian countries including Japan.

Mr. A. Goto, Sr. Researcher, attended the symposium from Kobe Steel and provided a technical presentation on advanced Cr-Mo welding consumables. The title of his presentation was "Welding Consumables of Advanced Cr-Mo Steels for High Temperature and Pressure Services." In his presentation, he introduced the features and various properties of the welding consumables for 2.25%Cr-1%Mo-V steel (ASME Code Case 2098) and 3%Cr-l%Mo-V steel (ASME Code Case 1961/2151). These advanced welding consumables are suitable for high-strength Cr-Mo steels used for high-temperature high-pressure chemical engineering equipment such as oil refinery reactors and power generation boilers. Nowadays, the reputation of these high-strength Cr-Mo steels is gaining around the world.

Many in the audience leaned forward in their chairs and listened intently to his presentation because of the state-of-the-art welding technology in this field.

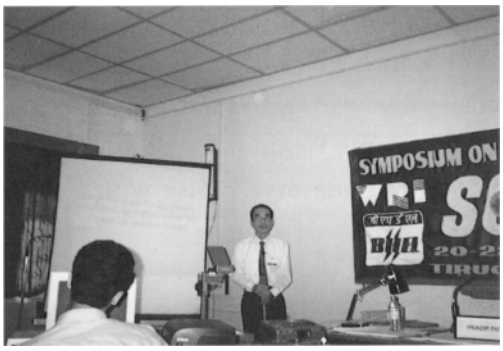


Fig. 1 — The technical presentation by Mr. Goto is very much noticed by the audience

As to the exhibition, a large number of exhibitors attended from the inside and outside of India. Nikko Boeki Kaisha, Weldwell Speciality Pve. Ltd., and Kobe Steel took part in the exhibition jointly with their booth, in which a variety of welding consumables focusing on the Cr-Mo and stainless steel types were exhibited and introduced.

Fig. 2 — The staff of the corporate exhibitors strengthen the partnership.

With many visitors to the booth, we had a chance to discuss solving routine problems and future visions in welding technology. As in any country and market, the discussion of welding technology was always brisk, which gave us courage and expectation for the future. I always look forward to future days when I might meet the readers of this magazine.

(Reported by D. Hino, KSL)

KWAI Seeks Its Place in the Duplex Stainless Steel FCW Market in the U.S.

The First North American Conference & Expo on Duplex Stainless Steels, Duplex America 2000, was held in Houston, Texas from February 28th to March 1st, 2000.

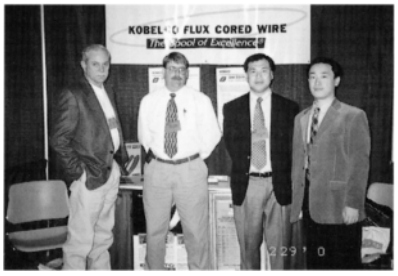


Fig. 1 — KWAI staff posing at KOBELCO booth with DW-2209 & DW-329AP (Mr. Kawaue, President of KWAI, second from right)

Duplex stainless steels are finding increased applications in the chemical, oil and gas industries including petrochemical process plants: the pulp & paper industry and the general engineering due to their outstanding corrosion resistance and mechanical properties.

KWAI attended the Conference & Expo to promote the sales of KOBELCO DW-2209 and DW-329AP flux cored wires (FCW) for duplex stainless steels. Kobe Steel dispatched a researcher. Mr. Hirohisa Watanabe. to this event for technical discussion on the FCWs with end users of fabricators and institutes. KWAI has been introducing the FCWs for duplex stainless steels for several years. This event was a good opportunity for KWAI to expand their business in duplex stainless steel FCWs in the U.S. market.

(Reported by Y. Nakai, KSL)

30 Welders Have One-Month Training on How to Prevent Weld Imperfections, through OJT and Lecture

At the request of Unithai Shipyard and Engineering Ltd., a welding training course was held at the Laem Chabang factory in Thailand from September 1st trough the 30th last year. This training course was planned and implemented by me. as per the Asian Local Training Program of the Association for Overseas Technical Scholarship (AOTS) of Japan.

On-the-job training (OJT) and supplemental lectures are significant features of this course. The curriculum, therefore, consisted of 85% OJT and 15% lecture.

Fig. 1 — 30 participants concentrate on the lecture on how to prevent weld imperfections that can cause an increase of welding costs.

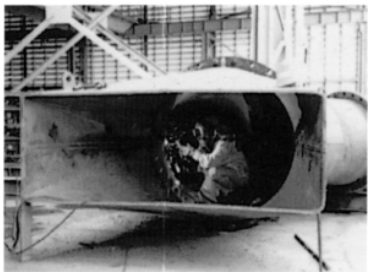


Fig. 2 — OJT is a very feature of this training course, during which all participants tried what they learnt in the lecture

(Reported by S. Yamamoto, KWT editorial staff)

Editorial Postscript

The Japan International Welding Show is going to be held at INTEX Osaka on April 12-15 this year. You will find key technologies to open the door to the 21st century. The details will be reported in the next issue.

The 2000 AWS International Welding and Fabricating Exposition is going to be held at Chicago's McCormick Place from April 26 through 28 this year. You will see some information of this event in the next issue.

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