

5-9 TEST RESULTS OF NK-EH-500A

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(1) Chemical Composition

Table 56 Chemical Composition (Heat analysis, %)

C	Si	Mn	P	S	Cr	Mo	V	Ti	B	Ceq
0.30	0.31	0.64	0.014	0.001	0.91	0.22	0.044	0.012	0.001	0.66

$$Ceq = C + Mn/6 + Si/24 + Cr/5 + Mo/4 + V/15$$

(2) Tensile and Charpy Impact Tests

Table 57 Mechanical Properties

Thickness mm	Direction	Tensile Test ¹⁾			Charpy Impact Test ²⁾		
		Yield point N/mm ² (kgf/mm ²)	Tensile strength N/mm ² (kgf/mm ²)	Elongation %	Absorbed energy 0 °C J (kgf-m)	Absorbed energy -50 °C J (kgf-m)	vT ₁₅ °C
20	L	1332 (135.8)	1593 (162.4)	24.6	65 (6.6)	33 (3.4)	< -80
	C	1321 (134.7)	1516 (154.6)	22.9	57 (5.8)	34 (3.5)	-80
40	L	1247 (127.2)	1607 (163.9)	15.3	36 (3.7)	24 (2.4)	-56
	C	1183 (120.7)	1599 (163.1)	13.7	34 (3.5)	30 (3.1)	-50
100	L	1230 (125.4)	1580 (161.1)	14.9	—	—	—
	C	1205 (122.9)	1577 (160.8)	15.0	—	—	—

1) Test specimen

$t \leq 20$ mm : JIS No. 5 (GL = 50 mm, W = 25 mm, Total thickness)

$t > 20$ mm : JIS No. 4 (GL = 50 mm, d = 14 mm, 1/4 of thickness)

2) Test specimen

JIS No. 4 (2 mm V notch)

$t \leq 20$ mm : 1/2 of thickness

$t > 20$ mm : 1/4 of thickness

vT₁₅ : 15ft-lb Transition temperature

(3) Hardness Test

(3.1) Surface hardness test

Table 58 Surface Hardness Test Results (Brinnell Hardness 10/3000)

Thickness mm	Individual hardness	Mean hardness
20	534, 543, 530, 551, 551	542
40	510, 538, 534, 518, 522	524
100	495, 518, 488, 510, 518	506

(3.2) Hardness distribution in thickness direction

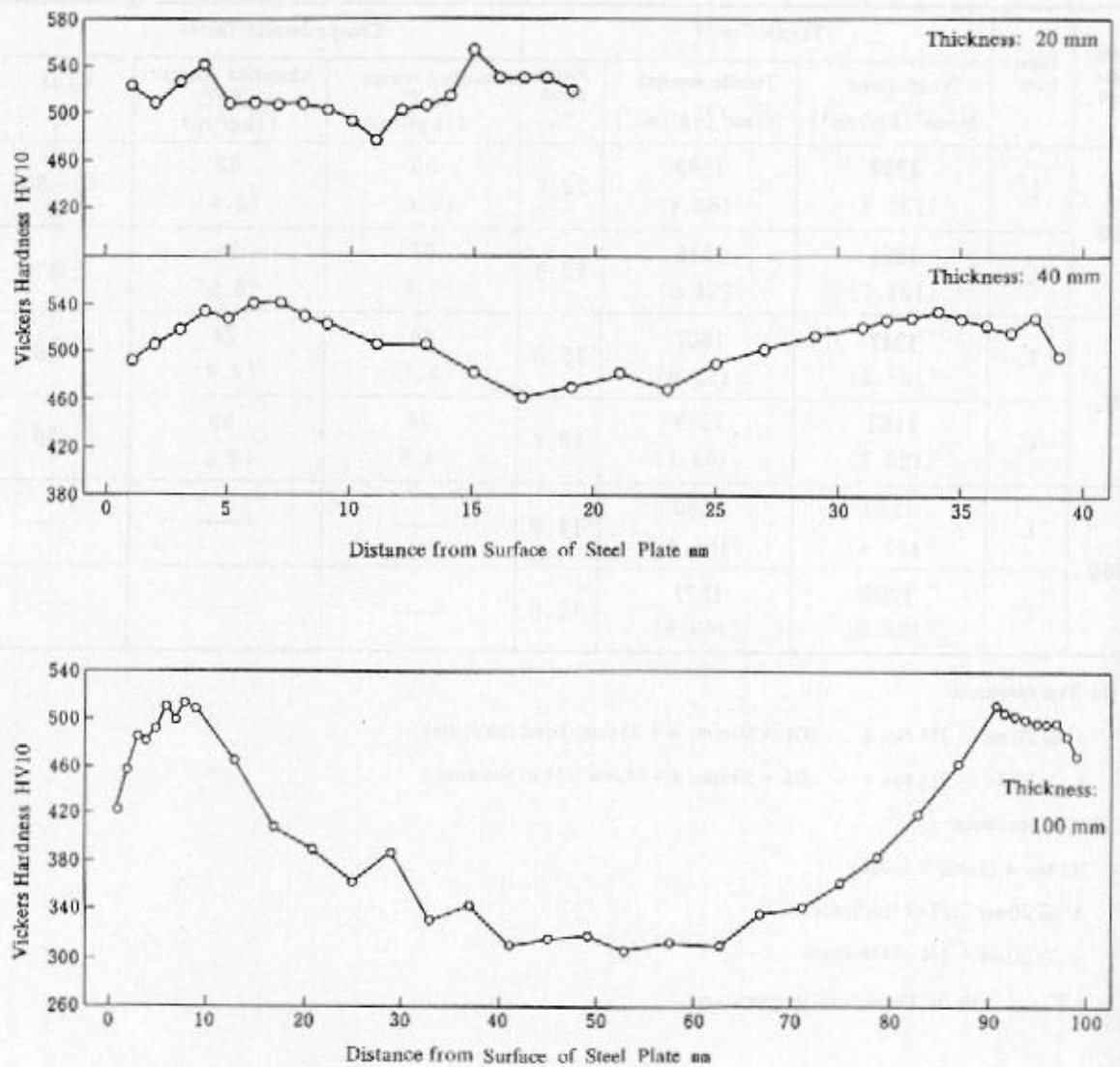


Fig. 31 Hardness Distribution in Thickness Direction

(4) Bending Test

(4.1) Standard JIS bending test

Table 59. JIS Bending Test Results

Thick- ness mm	Direc- tion	Test specimen		Bending radius (t: Thickness) ³⁾				
		No.	Width mm	4.0t	3.0t	2.0t	1.5t	1.0t
20 ¹⁾	L	JIS No. 1	50	○	○	○	—	—
	C	JIS No. 1	50	○	○	○	—	—
40 ²⁾	L	JIS No. 1	50	—	○	○	○	×
	C	JIS No. 1	50	—	○	○	○	×

○ : No cracks △ : Slight cracks × : Cracks

1) Test specimen: Total thickness

2) Test specimen: $t=35\text{mm}$

3) Bending angle: 180°

(4.2) Wide specimen bending test

Table 60 Wide Specimen Bending Test Results

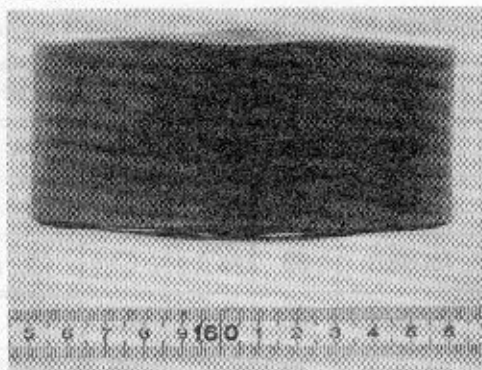
Thick- ness mm	Direc- tion	Width of test specimen 1) mm	Bending radius (t: Thickness) ²⁾			
			4.0t	3.5t	3.0t	2.5t
20	L	150	○	○	○	×
	C	150	○	○	○	×

○ : No cracks △ : Slight cracks × : Cracks

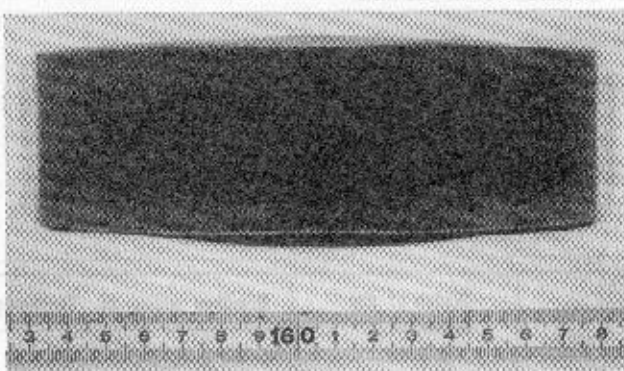
1) Test specimen: Total thickness

2) Bending angle: 180°

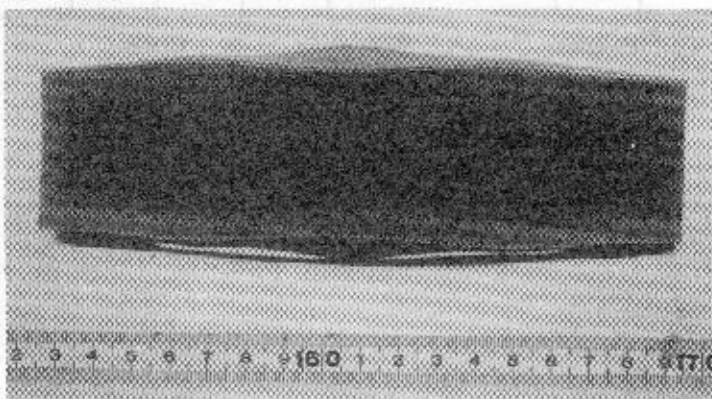
R=2.0t



R=3.0t



R=4.0t

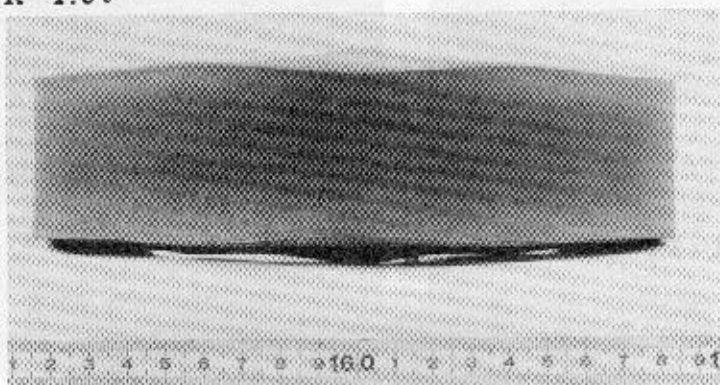


1) Test specimen: JIS No. 1 (20 mm thick x 50 mm wide)

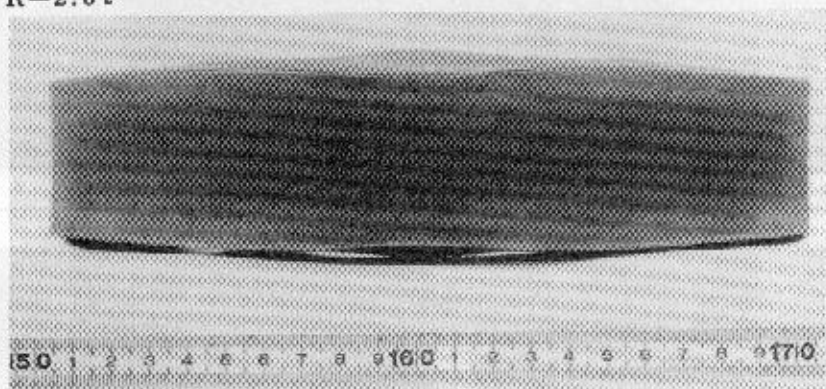
2) Sampling direction of test specimen: Rolling direction

Photo 28 Bending Test Results (Thickness: 40 mm)

R=1.5t



R=2.0t

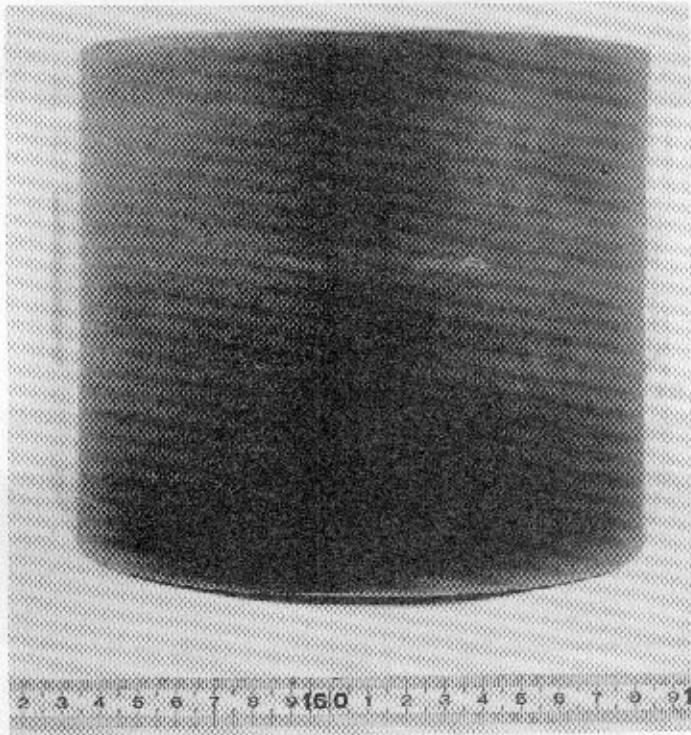


1) Test specimen: JIS No. 1 (35 mm thick x 50 mm wide)

2) Sampling direction of test specimen: Rolling direction

Photo 29 Bending Test Results (Thickness: 40 mm)

R=3.0t



1) Test specimen: 20 mm thick x 150 mm wide

2) Sampling direction of test specimen: Rolling direction

Photo 30 Wide Specimen Bending Test Results (Thickness: 20 mm)

(5) Microstructure

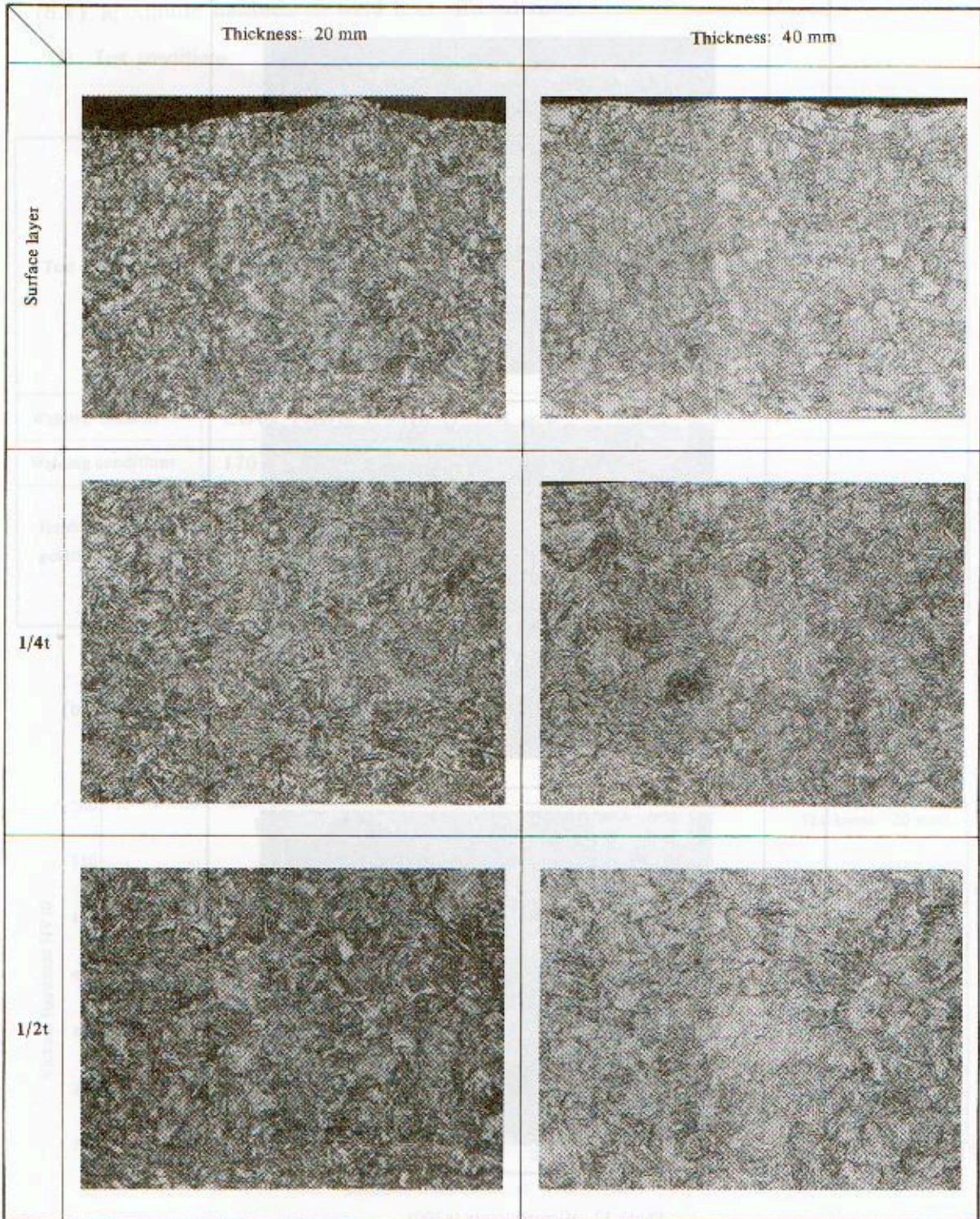


Photo 31 Microstructure (x200)

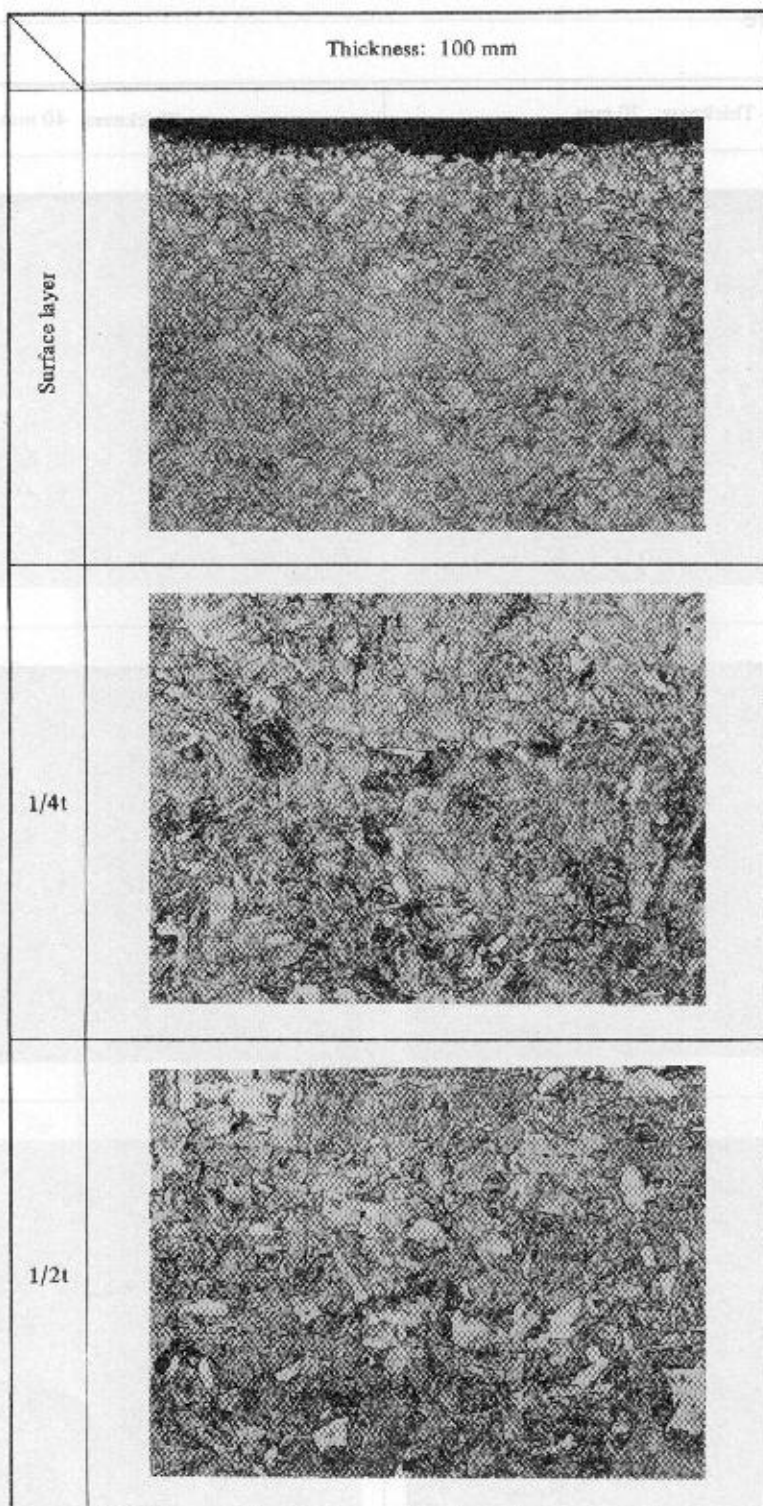


Photo 32 Microstructure (x200)

(6) Weldability

(6.1) Maximum hardness in weld heat affected zone

(a) Test conditions

Table 61 Test Conditions

Test specimen	
Welding material	LB 62 (AWS E 9016-G), 4 mm ϕ
Welding conditions	170 A - 25 V - 15cm/min (17kJ/cm)
Hardness measuring position	

(b) Test results

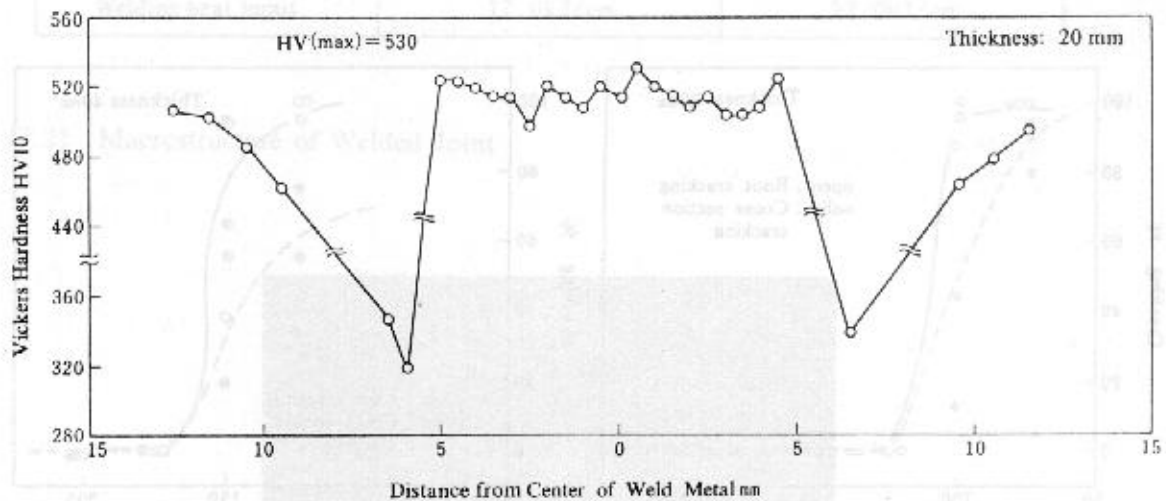
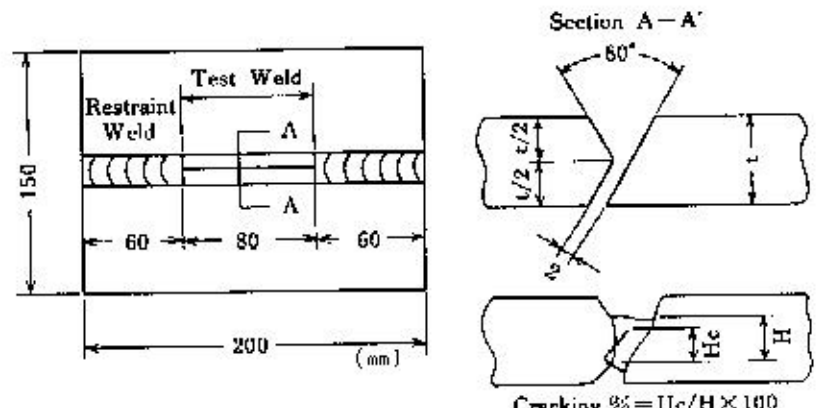


Fig. 32 Maximum Hardness in Weld Heat Affected Zone

(6.2) y-groove weld cracking test

(a) Test conditions

Table 62 Test Conditions

Test specimen	
Welding material	LB 62 (AWS E 9016-G)
Welding conditions	170 A - 24 V - 15 cm/min (17kJ/cm)

(b) Test results

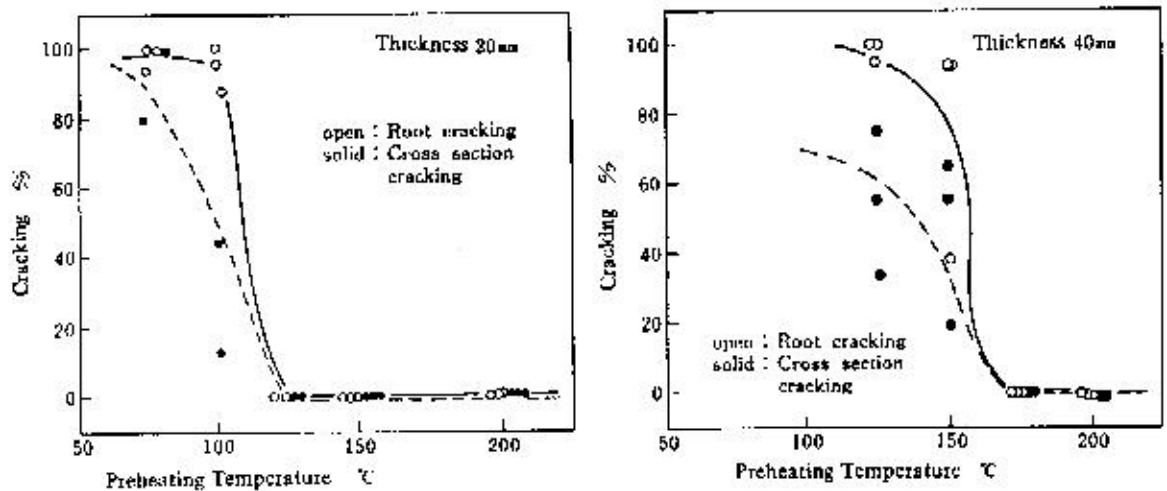


Fig. 33 Y-Groove Weld Cracking Test Results

(7) Shielded Metal Arc Welded Joint Test

Thickness of sample steel plate: 20 mm

(7.1) Welding conditions

Table 63 Welding Conditions

Groove shape mm		
Electrode	LB62 (AWS E9016-G)	
Preheating temperature	150°C	
Interpass temperature	≤ 250°C	
Pass	1 pass	Other passes
Welding current	170 A	220 A
Arc voltage	25 V	25 V
Welding speed	15cm/min	15cm/min
Welding heat input	17.0kJ/cm	22.0kJ/cm

(7.2) Macrostructure of Welded Joint

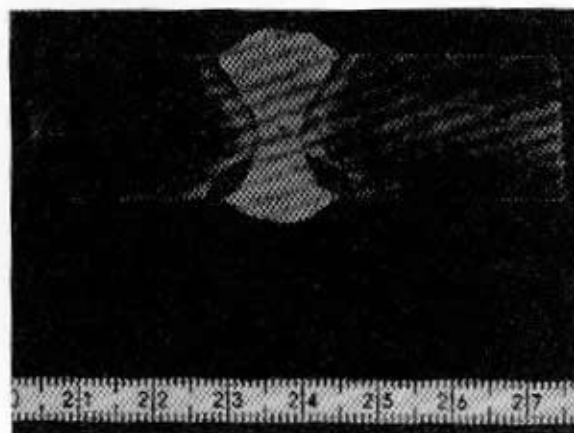


Photo 33 Macrostructure of Welded Joint

EH500A

(7.3) Welded joint hardness distribution test

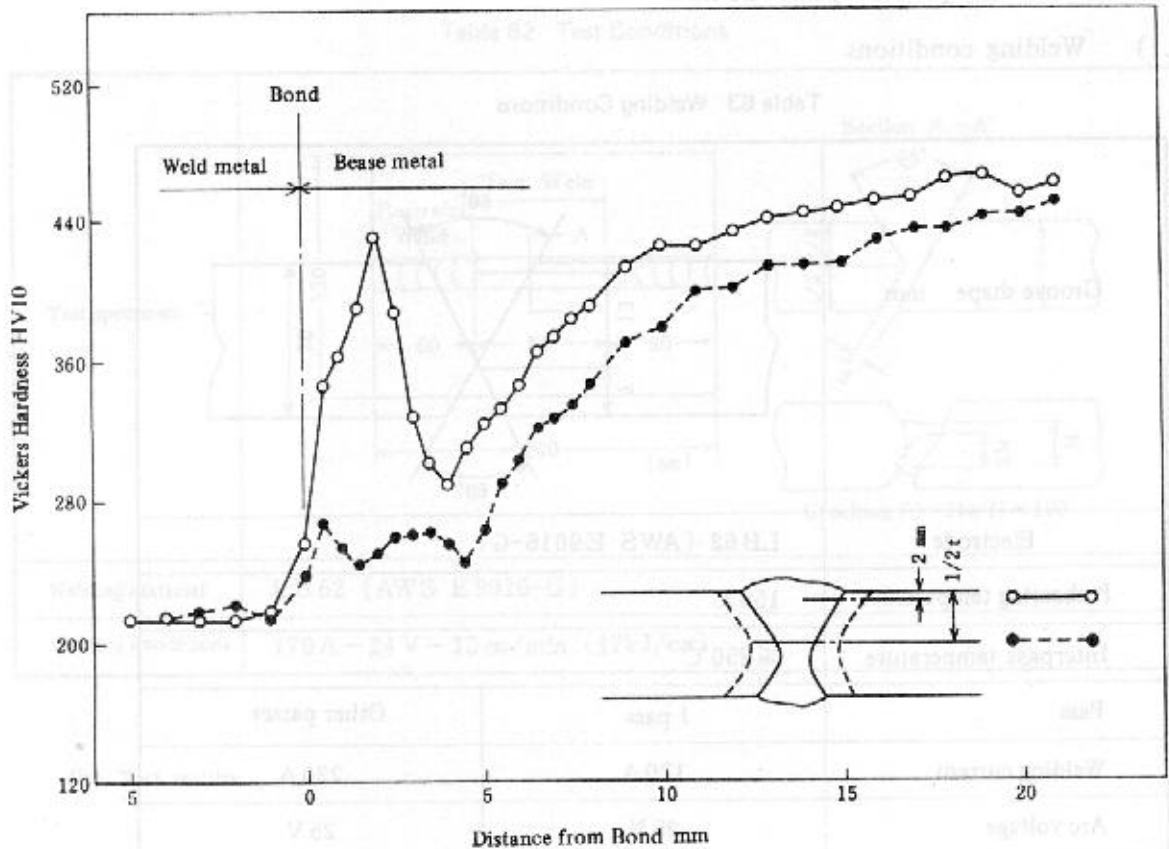


Fig. 34 Welded Joint Hardness Distribution

(7.4) Welded joint impact test

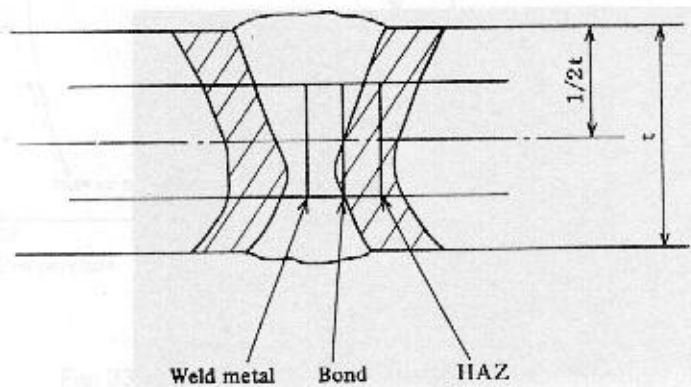


Fig. 35 Sampling Point of Test Specimen

Table 64 Welded Joint Impact Test

Notch position	Absorbed energy J (kgf-m)		vT_{1s} °C
	0 °C	-50°C	
Weld metal	112 (11.4)	31 (3.2)	- 70
Bond	115 (11.7)	52 (5.3)	- 85
HAZ	183 (18.7)	100 (10.2)	-100