5-4 TEST RESULTS OF NK-EH-400

5.4 Test Results of NK-EH-400

(1) Chemical Composition

Table 23 Chemical Composition (Heat analysis, %)

Thickness mm	C	Si	Mn	P	S	Cr	Ti	B	Ceq
19	0.21	0.34	1.56	0.025	0.004	0.23	0.008	0.002	0.53
40	0.21	0.36	1.52	0.020	0.001	0.17	0.007	0.001	0.51

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

(2) Tensile and Charpy Impact Tests

Table 24 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 ℃ J (kgf-m)
19	L	1179 (120.2)	1361 (138.8)	19.2	48 (4.9)
	C	1163 (118.6)	1316 (134.2)	19.8	40 (4.1)
40	L	1039 (105.9)	1329 (135.5)	16.6	34 (3.5)
	C	1042 (106.3)	1319 (134.5)	14.4	33 (3.4)

1) Test specimen

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

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

2) Test specimen

JIS No. 4 (2 mm V notch)

t ≦ 20mm : 1/2 of thickness

t > 20mm : 1/4 of thickness

EH400

(3) Hardness Test

(3.1) Surface hardness test

Table 25 Surface Hardness Test Results (Brinell Hardness 10/3000)

Thickness	Individual hardness	Mean hardness
19	438, 444, 451, 441, 438	442
40	451, 451, 444, 448, 451	449

(3.2) Hardness distribution in thickness direction

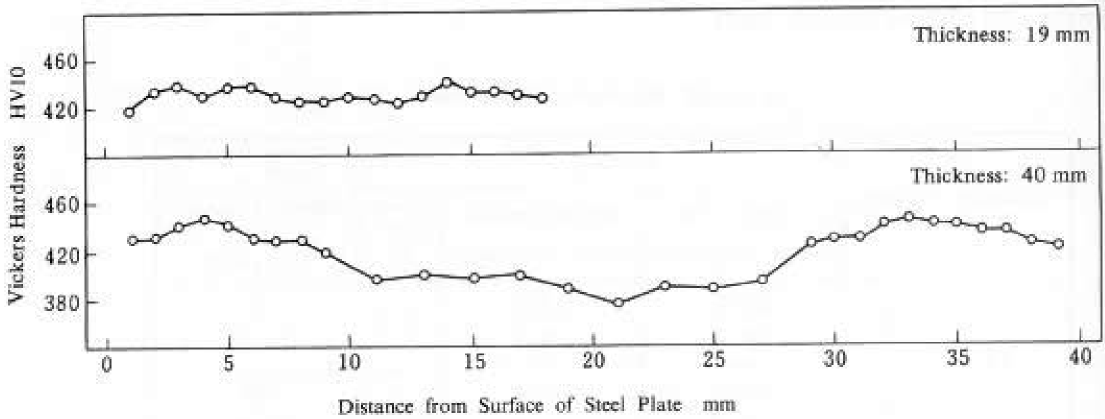


Fig. 15 Hardness Distribution in Thickness Direction

(4) Bending Test

(4.1) Standard JIS bending test

Table 26 JIS Bending Test Results

Thickness mm	Direction	Test specimen		Bending radius (t; Thickness)[3]					
		No.	Width mm	4.0t	3.0t	2.0t	1.5t	1.0t	0.5t
19 [1]	L	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 = 35mm

3) Bending angle: 180°

(4.2) Wide specimen bending test

Table 27 Wide Specimen Bending Test Results

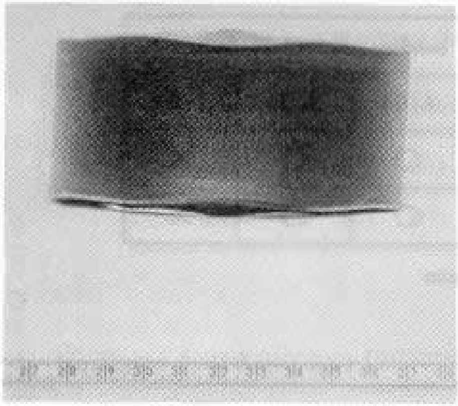
Thickness mm	Direction	Width of test specimen[1) mm]	Bending radius (t: Thickness)[2)]		
			4.0t	3.0t	2.0t
19	L	150	○	○	×
	C	150	○	○	×

○ : No cracks △ : Slight cracks × : Cracks

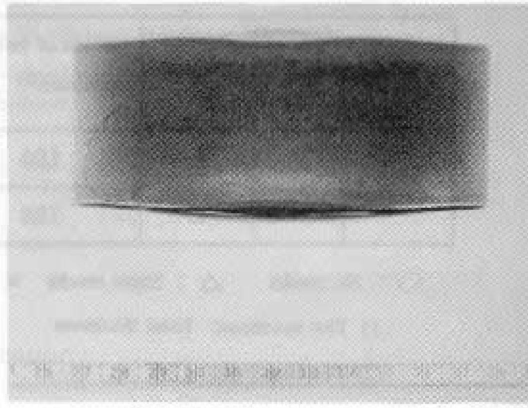
1) Test specimen: Total thickness

2) Bending angle: 180°

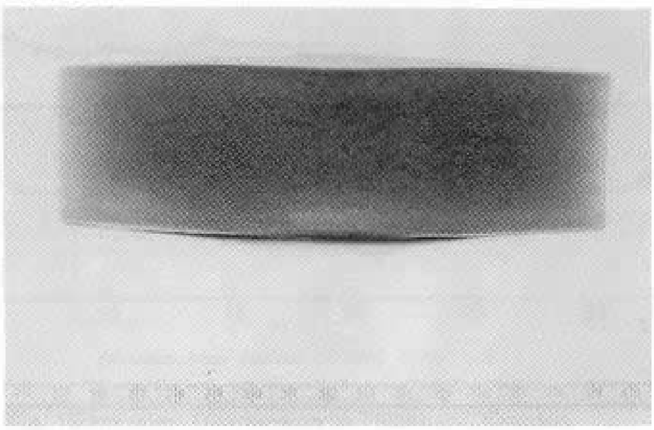
R=1.5t



R=2.0t



R=3.0t



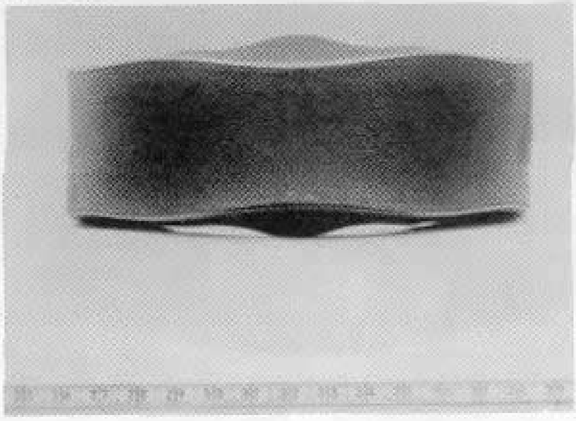
R=4.0t

1) Test specimen: JIS No. 1 (19 mm thick × 50 mm wide)

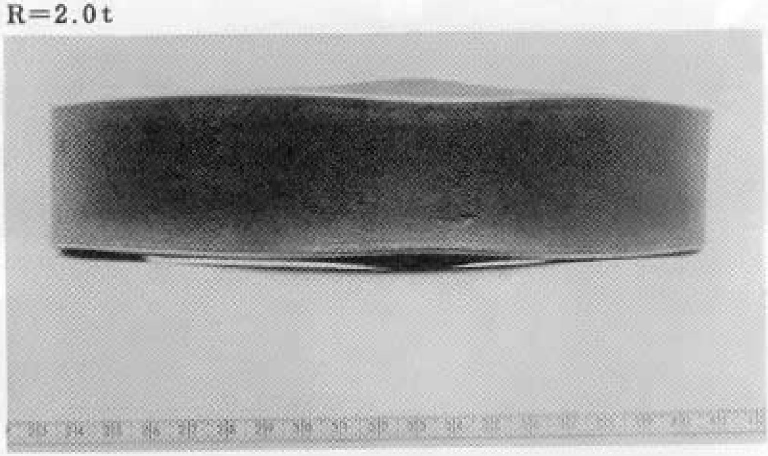
2) Sampling direction of test specimen: Rolling direction

Photo 8 Bending Test Results (Thickness: 19 mm)

R=1.0t



R=2.0t

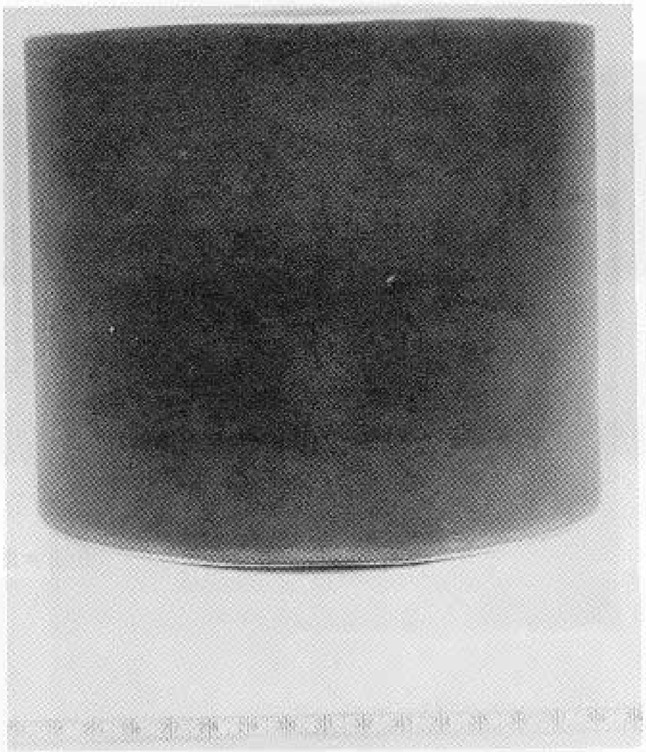


1) Test specimen: JIS No. 1 (35 mm thick × 50 mm wide)

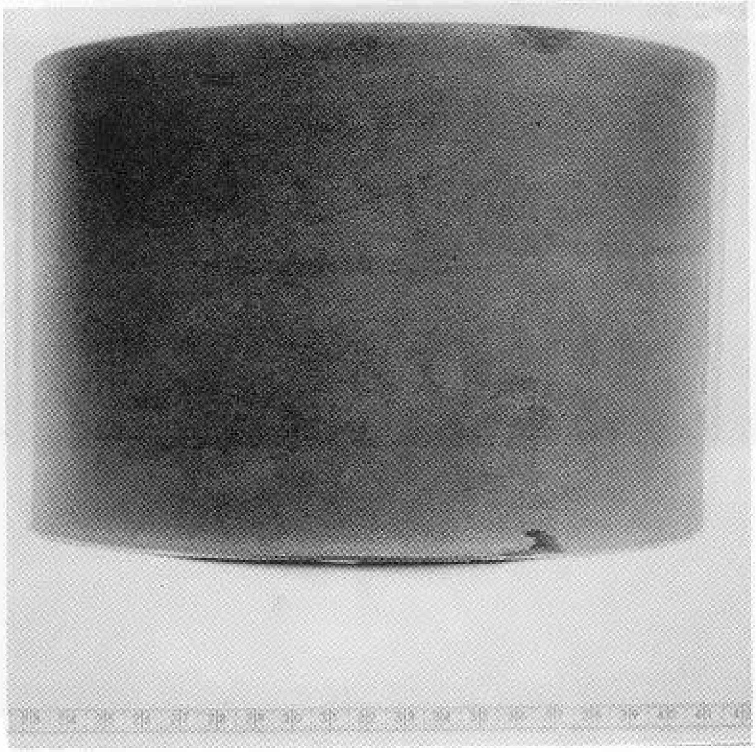
2) Sampling direction of test specimen: Rolling direction

Photo 9 Bending Test Results (Thickness: 40 mm)

R=3.0t



R=4.0t



1) Test specimen: 19 mm thick x 150 mm wide

2) Sampling direction of test specimen: Rolling direction

Photo 10 Wide Specimen Bending Test Results (Thickness: 19 mm)

(5) Microstructure

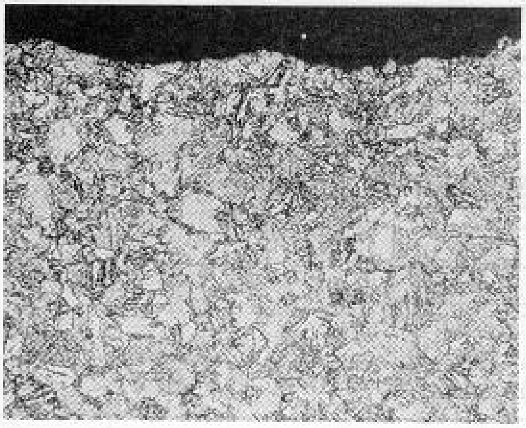
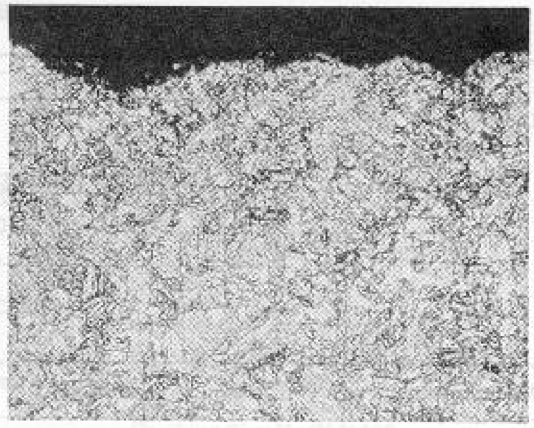
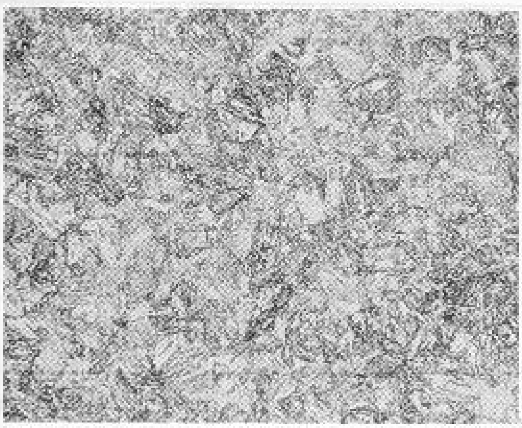
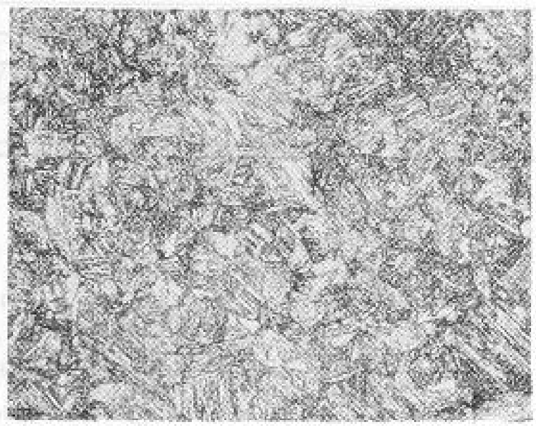
	Thickness: 19 mm	Thickness: 40 mm
Surface layer		
1/4t		
1/2t		

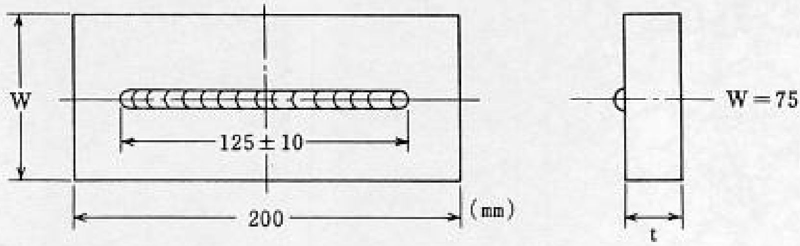
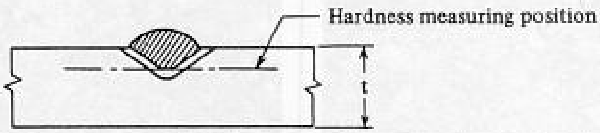
Photo 11 Microstructure (x200)

(6) Weldability

(6.1) Maximum hardness in weld heat affected zone

(a) Welding condition

Table 28 Test Conditions

Test specimen	
Welding material	LB62 (AWS E9016−G), 4 mm ϕ
Welding conditions	170A − 25V − 15cm/min (17kJ/cm)
Hardness measuring position	

(b) Test results

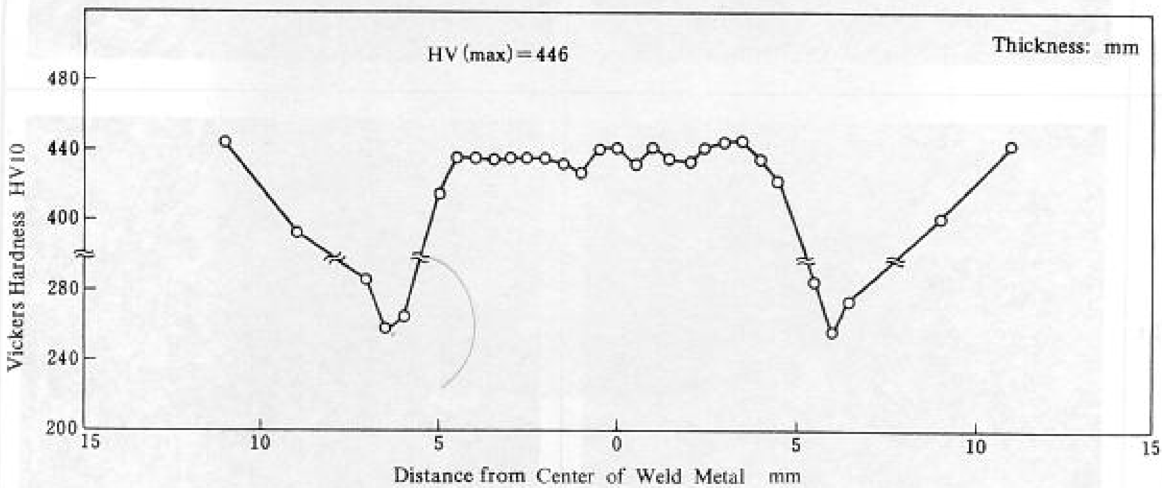
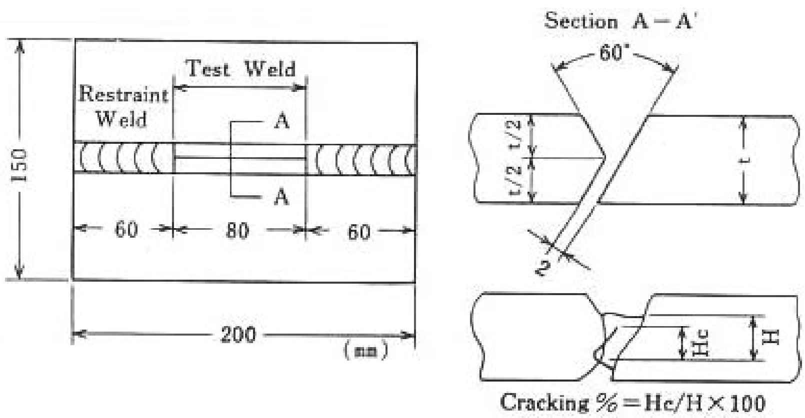


Fig. 16 Maximum Hardness in Weld Heat Affected Zone

(6.2) y-groove weld cracking test

(a) Test Conditions

Table 29 Test Conditions

Test specimen	
Welding material	LB62 (AWS E9016－G)
Welding conditions	170A－24V－15cm/min (17kJ/cm)

(b) Test Results

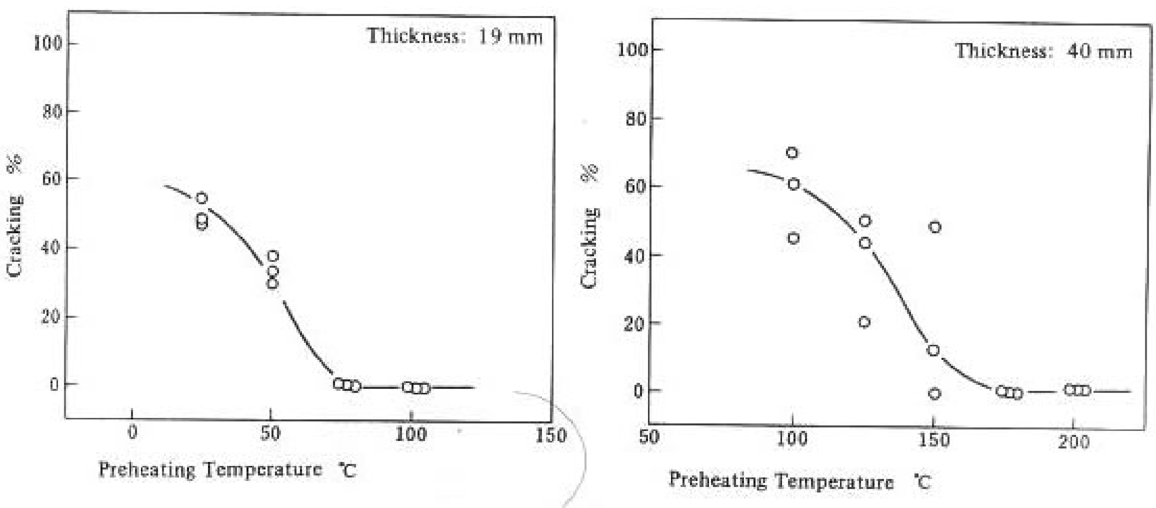


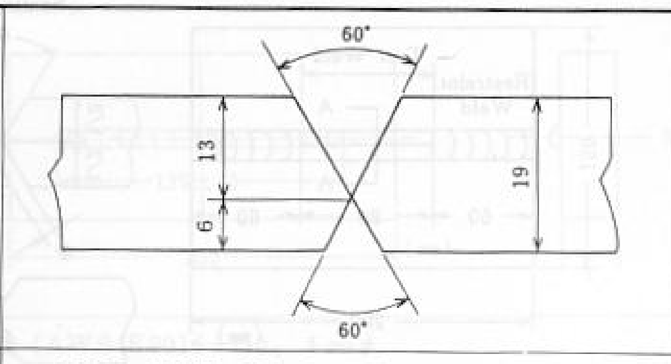
Fig. 17 γ-Groove Weld Cracking Test Results

(7) Shielded Metal Arc Welded Joint Test

Sample steel plate thickness: 19 mm

(7.1) Welding conditions

Table 30 Welding Conditions

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

(7.2) Macrostructure of welded joint

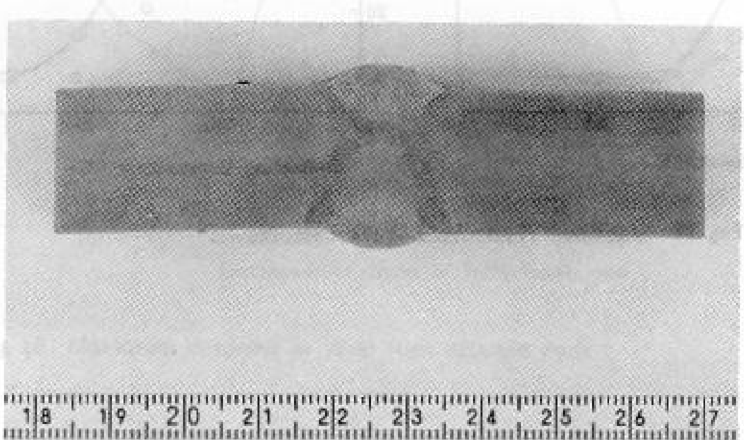


Photo 12 Macrostructure of Welded Joint

(7.3) Welded joint hardness distribution test

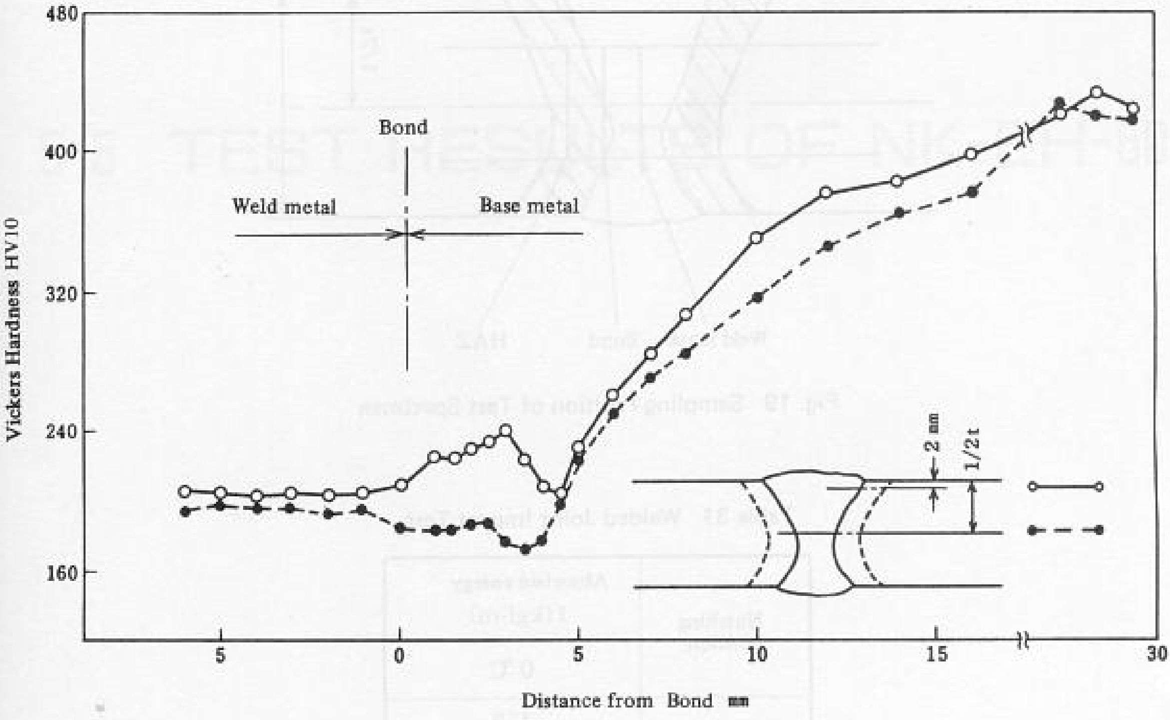
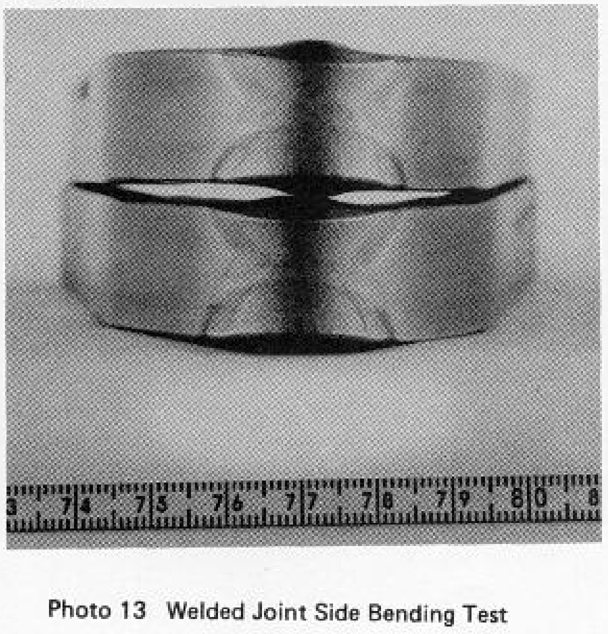


Fig. 18 Welded Joint Hardness Distribution

(7.4) Welded joint side bending test

R=38mm



Bending test results: Good

Photo 13 Welded Joint Side Bending Test

(7.5) Welded joint impact test

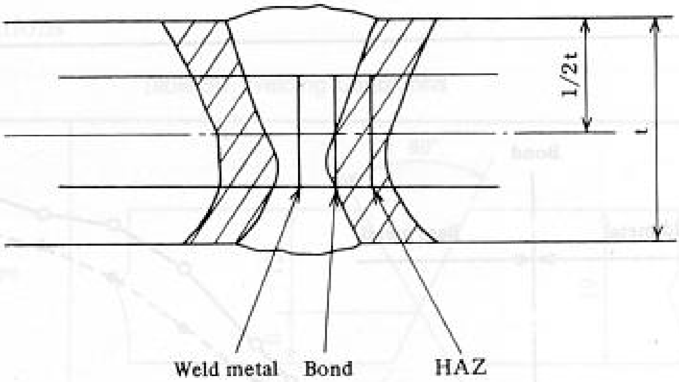


Fig. 19 Sampling Position of Test Specimen

Table 31 Welded Joint Impact Test

Notching position	Absorbed energy J(kgf-m) 0 °C
Weld metal	179 (18.3)
Bond	220 (22.4)
HAZ	228 (23.3)