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Mechanical Behavior in Buttering Weld Zone between Low Alloy Steel and Austenitic Stainless Steel

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Key Words: Buttering(), Dissimilar materials(), Interface(), Mechanical behavior (), Weld zone()

Abstract

It is important to evaluate strength of dissimilar weld zone to use dissimilar materials safely. This study examines mechanical characteristics of dissimilar weld zone between low alloy steel and austenitic stainless steel that satisfies welding related requirements of ASME Code, experimentally reviews metallurgical and mechanical properties at and adjacent to weld interface. It is confirmed that hardness singularity occurs at the weld interface, and that optimum buttering thickness is more than 5mm from view points of tensile & yield strength. From a macroscopic view, brittle fracture characteristics is observed in buttering weld zone by tensile test.

1.

가

(Cladding)

(Brazing)

(Dissimilar materials)

가

가

†

()

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#150 ~ #2400
(Emery paper) , 0.1 μm

(HClO₄:(CH₃CO)₂O=1:10)

(4)

5%

2.

(SA387 Gr.22)

(HNO₃:HCl:CH₂(OH)CH(OH)-CH₂OH=1:2:2)

(SA240 TP304)

5,6

Micro Vickers

200 μm

Table 1 Table 2

300gf,

20

600mm×100mm×9mm

Instron

39° V-groove 가

10ton

가 GTAW(Gas Metal Arc Welding)

, Cross head 2mm/min

(ER

NiCr-3) ,

Table 2 Mechanical properties

(ER 309L)

Materials	Tensile strength (MPa)	Modulus of elasticity (GPa)	Poison's ratio
Low alloy steel	415	195	0.3
Stainless steel	515	186	0.3
ER NiCr-3	550	185	0.3
ER 309L	515	180	0.3

Table 3

가 2.4mm, 4.8

mm, 7.2mm가

가

PWHT()

PWHT

PWHT

PWHT

Table 3 Welding procedure

Filler metal	Method	Wire size(mm)	Current (A)	Voltage (V)	Speed (cm/min)	Interpass temp.()
ER NiCr-3	GTAW	3.175	150	9 ~ 12	10 ~ 15	max.260
ER 309L	GTAW	3.175	150	9 ~ 12	10 ~ 15	max.177

PWHT

PWHT

ASTM A370⁽³⁾

Fig. 1

가 (Wire cutting)

Table 1 Chemical composition(weight %)

Composition Materials	C	Si	Mn	P	S	Cr	Ni	N	Fe	Co	Al	Mo	Cu	Ti	Cb	Ta
Low alloy steel	0.14	0.195	0.433	0.013	0.01	2.10	0.047		95.99	0.009	0.433	0.95				
Stainless steel	0.043	0.61	1.1	0.024	0.003	18.3	8.18	0.05								
ER NiCr-3	0.05	0.08	3.87	0.003	0.002	20.18	71.48		2.6	0.1			0.01	0.31	2.32	0.01
ER 309L	0.013	0.4	1.84	0.015	0.008	23.4	13.75					0.06	0.1			

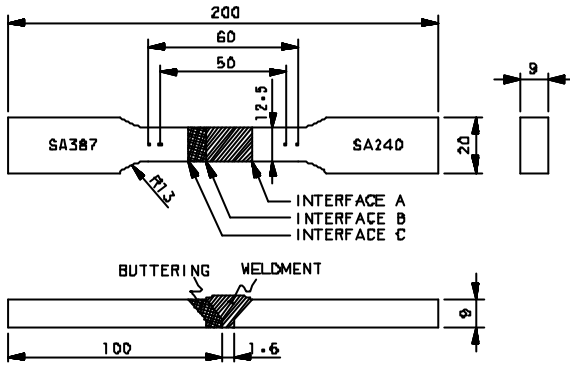


Fig. 1 Geometry of specimen

3.

3.1

가

3

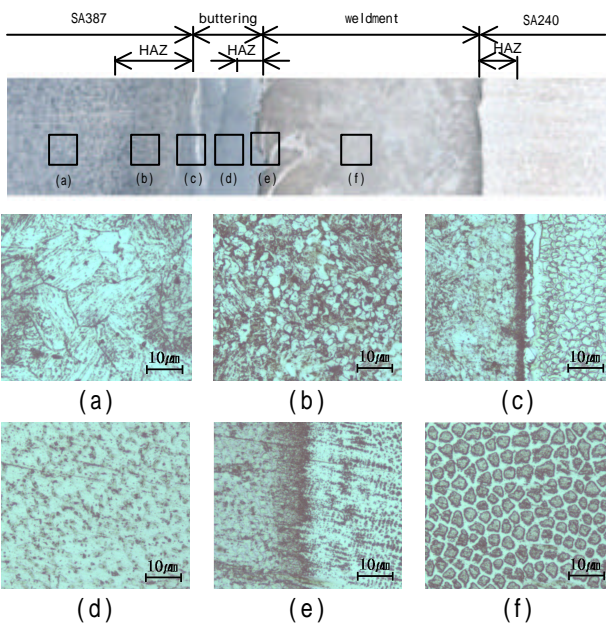


Fig. 2 Microstructure of welded specimen

Fig. 2
SEM

. Fig. 2 (a)

Fig. 2 (b)

291Hv
285Hv가

1mm

가

, GTAW

(Grain size)가

. Fig. 2 (c)

2 ~ 3µm

(band)

(5),(6)

가

가

1.9 ~ 2.3mm

1.9 ~ 2.1mm, 1.8 ~ 2.5mm

3.2

289Hv 223Hv

(NB)

. Fig. 3

가
 (1.9mm ~ 2.1mm)
 가 가
 가 (BW)
) 3
 Fig. 4 ~ Fig. 6

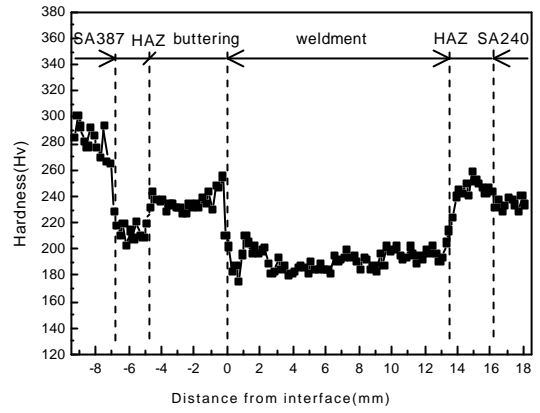


Fig. 5 Hardness distribution around welded interface (4.8mm buttering specimen)

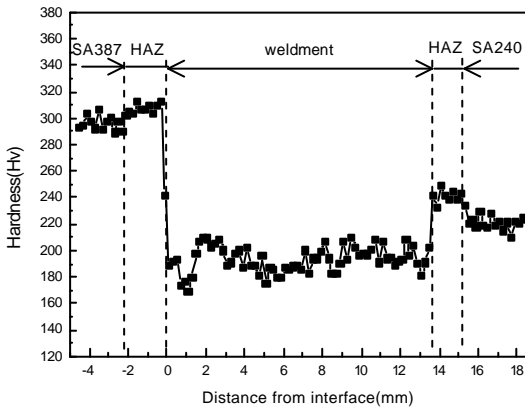


Fig. 3 Hardness distribution around welded interface (no buttering specimen)

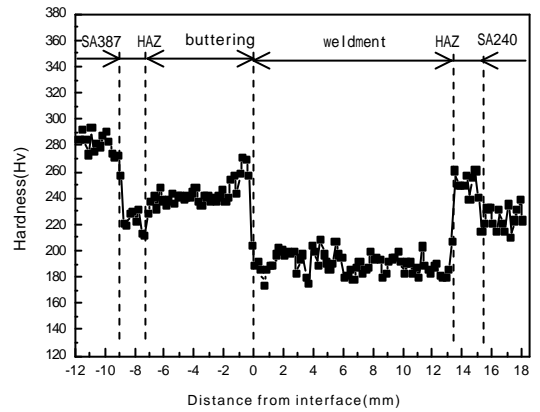


Fig. 6 Hardness distribution around welded interface (7.2mm buttering specimen)

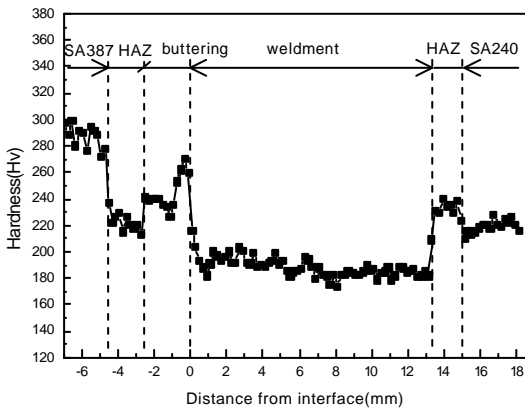


Fig. 4 Hardness distribution around welded interface (2.4mm buttering specimen)

Fig. 7

가
 가 (Interface C)
 가 (Interface B)
 가

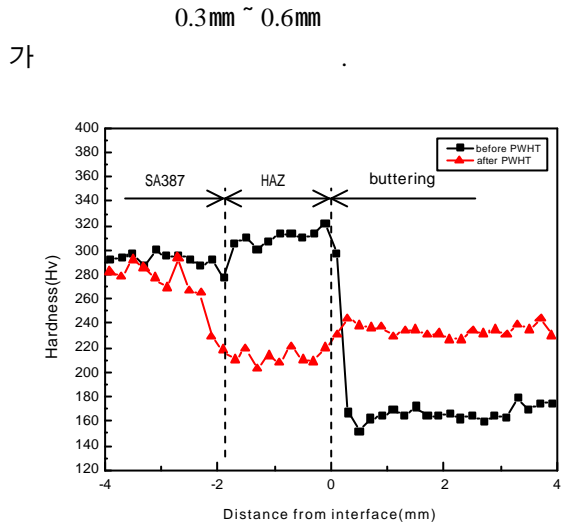


Fig. 7 Hardness distribution around welded interface before & after PWHT

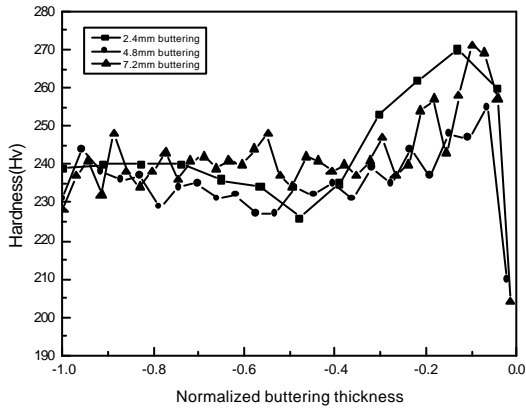


Fig. 8 Hardness distribution in buttering weld zone by buttering thickness

1/3 , 7.2mm
1/5
가 가
가
가
4.8mm , 7.2mm
3.3

Table 4 Mechanical properties of dissimilar welding materials

Materials	Yield strength (MPa)	Tensile strength (MPa)	Remarks
NB - ER 309L	351	708	SA387+SA240 ER 309L
NB - ER NiCr - 3	275	611	SA387+SA240 ER NiCr - 3
BW24	287	529	SA387+SA240 2.4mm buttering
BW48	266	542	SA387+SA240 4.8mm buttering
BW72	271	543	SA387+SA240 7.2mm buttering

가 2.4mm 가
, 4.8mm 2.4mm
가
U
가
7.2mm

3-4
2.4mm, 4.8mm, 7.2mm
가
Table 4

Fig. 8
가 2.4mm
1/2 , 4.8mm

Fig. 9

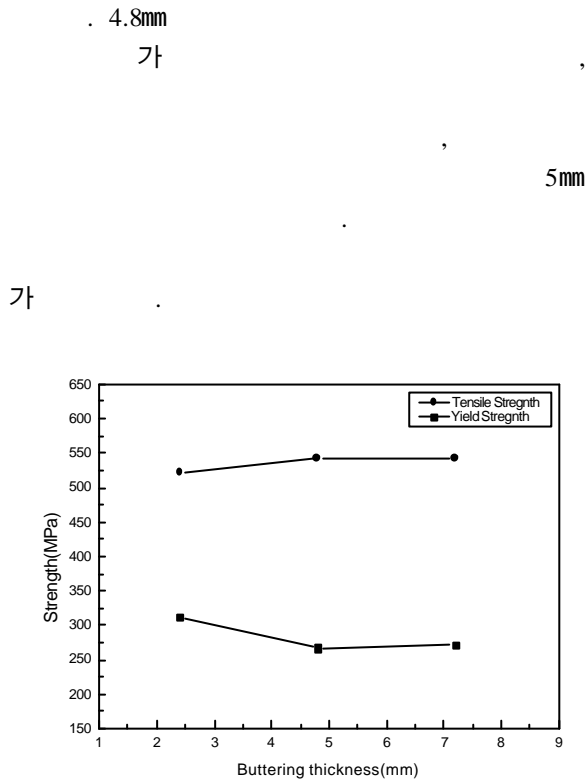


Fig. 9 Relations between buttering thickness and strength

4.

ASME B&PV Code

1)

0.3mm ~ 0.6mm

2)

5mm

3)

가

4)

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