■ 2 types of installation

Fig : installation of "Batten-Bar"

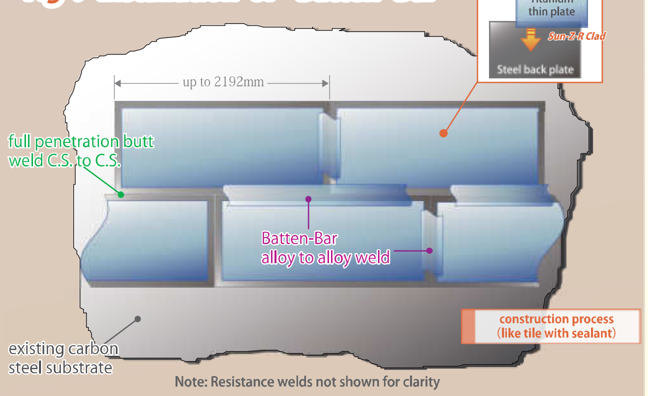
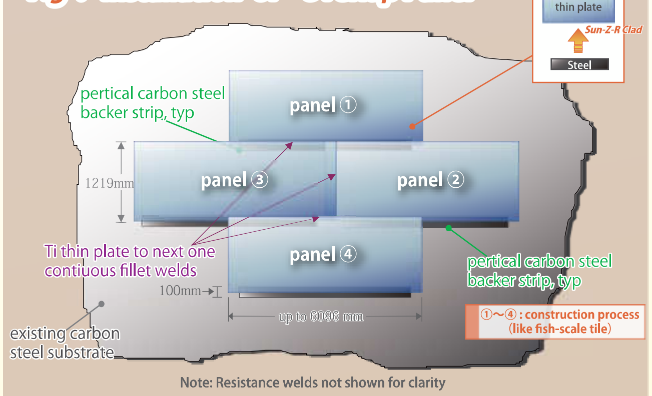


Fig : installation of "Overlap Panel"



“Batten Bar” design is new construction for FGD. Fabricated plate sizes range from 48” to 144” wide x (up to) 480” long. It can be fabricated in flat or rolled plates and can be sheared or bent to fit any particular design application. Typically, resistance welds are spaced at 6” on centers across the width of the plate for the entire length of the plate to clad the alloy sheet to the full carbon steel backer plate.

In retro-fit construction for FGD, Resista-Clad Plate is fabricated in what is called an “Overlap” design. Fabricated sheet sizes range from 48” wide x (up to) 240” long. It can be fabricated in flat sheets or rolled sheets and can be sheared or bent to fit any particular design application. Typically, two (2) resistance welds would be made on one long side of the alloy sheet to clad the alloy sheet to the 4” wide partial carbon steel backer plate.

■ Resista-Clad Plate users list

Utility / End user	Component	Alloy	Install date	Plant	Location	Design	Area
Formosa Plastics Corporation	Chimney Liners	Ti Gr. 2	June, 2009	Hua Yang Electric Power Plant	Luoyang, China	Overlap Panel	99,600 s.f. (9,250 ㎡)
Formosa Plastics Corporation	Chimney Liners	Ti Gr. 2	July, 2005	Hua Yang Electric Power Plant	Xiamen, China	Overlap Panel	47,900 s.f. (4,450 ㎡)
Formosa Plastics Corporation	(6) Chimney Liners	Ti Gr. 2	December, 1998	Hua Yang Electric Power Plant	Xiamen, China	Overlap Panel	300,000 s.f. (27,900 ㎡)
Paiton Private Power Project (Phase I)	(2) Chimney Liners	C-276	September, 1997	Paiton Generating Station	East Java, Indonesia	Batten Bar	125,000 s.f. (11,600 ㎡)
KOA Oil Company, IPP Project	Absorber Tower	254 SMO	July, 1997	Oil Plant	Osaka, Japan	Batten Bar	3,100 s.f. (288 ㎡)
Formosa Plastics Corporation FGD Plant	(7) Chimney Liners	Ti Gr.2	June, 1997	Taiwan 6th Naphtha Complex	North of Kaohsiung, Taiwan	Overlap Panel	450,000 s.f. (41,800 ㎡)
Big Rivers Electric Corporation	Bypass Duct Floor	Ti Gr.2	April, 1996	Green Station	Sebree, Kentucky	Overlap Panel	1,200 s.f. (112 ㎡)
Old Dominion Electric Corporation	(1) Chimney Liner	Ti Gr.2	July, 1995	Clover Unit No.2	Clover, Virginia	Batten Bar	26,000 s.f. (2,415 ㎡)
Old Dominion Electric Corporation	(1) Chimney Liner	Ti Gr.2	August, 1994	Clover Unit No.1	Clover, Virginia	Batten Bar	26,000 s.f. (2,415 ㎡)
Big Rivers Electric Corporation	Outlet Duct	Ti Gr.2	April, 1994	D.B. Wilson Station	Centertown, Kentucky	Overlap Panel	6,000 s.f. (558 ㎡)
Kentucky Utilities Corporation	Breeching Duct	C-276	October, 1993	E.W. Brown Station	Begin, Kentucky	Batten Bar	700 s.f. (65 ㎡)
Big Rivers Electric Corporation	Outlet Duct	Ti Gr.2	April, 1993	D.B. Wilson Station	Centertown, Kentucky	Overlap Panel	6,200 s.f. (576 ㎡)
Big Rivers Electric Corporation	Outlet Duct	Ti Gr.2	October, 1992	D.B. Wilson Station	Centertown, Kentucky	Overlap Panel	9,000 s.f. (836 ㎡)
Big Rivers Electric Corporation	(1) Chimney Liner	Ti Gr.2	March, 1989	Green Station Unit No.2	Sebree, Kentucky	Overlap Panel	16,000 s.f. (1,487 ㎡)
Big Rivers Electric Corporation	Outlet Duct	Ti Gr.2	October, 1988	D.B. Wilson Station	Centertown, Kentucky	Overlap Panel	3,500 s.f. (325 ㎡)
Cooperative Power Association	Outlet Mixing Zone	Ti Gr.2	April, 1988	Coal Creek Unit No.2	Underwood, North Dakota	Overlap Panel	4,000 s.f. (372 ㎡)
Big Rivers Electric Corporation	(1) Chimney Liner	Ti Gr.2	November, 1987	Green Station Unit No.1	Sebree, Kentucky	Overlap Panel	16,000 s.f. (1,487 ㎡)
Cooperative Power Association	Outlet Mixing Zone	Ti Gr.2	October, 1987	Coal Creek Unit No.1	Underwood, North Dakota	Overlap Panel	4,000 s.f. (372 ㎡)
Potomac Electric Power Company	Outlet Duct Floor	Ti Gr.2	September, 1987	Dickerson Station Units 1-3	Washington, D.C.	Overlap Panel	1,500 s.f. (140 ㎡)
Potomac Electric Power Company	Outlet Duct Floor	Ti Gr.2	October, 1986	Dickerson Station Units 1-3	Washington, D.C.	Overlap Panel	1,750 s.f. (163 ㎡)
Potomac Electric Power Company	Outlet Duct Floor	Ti Gr.2	October, 1986	Dickerson Station Units 1-3	Washington, D.C.	Overlap Panel	67 s.f. (6 ㎡)
Louisville Gas & Electric Company	Inlet Quench (test)	Ti Gr.2	March, 1986	Millcreek, Unit No.4	Louisville, Kentucky	Overlap Panel	850 s.f. (80 ㎡)
Allegheny Power Company	Chimney Liner (test)	Ti Gr.2	September, 1985	Pleasants Station, Unit No.2	Willow Island, W. Virginia	Overlap Panel	280 s.f. (26 ㎡)
Texas Utilities Power Company	Inlet Quench (test)	Ti Gr.2	December, 1984	Martin Lake, Unit No.1	Martin Lake, Texas	Overlap Panel	300 s.f. (28 ㎡)

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SPF Showa Premium Fabricator

A durable and long lasting technology

Resista-Clad Plate

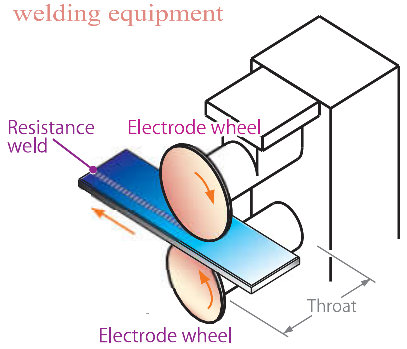
Ta • Nb • Zr • Ti • Ni alloy etc.

Corrosion Resistant solutions for FGD units

(patented)

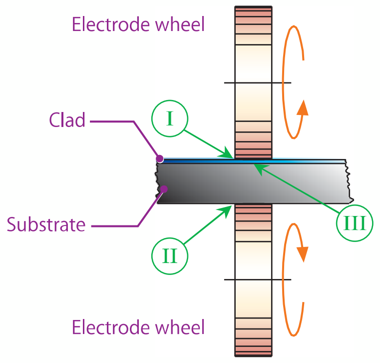
Circuler resistance seam welder

Schematic diagram of resistance welding equipment



Cross-section

I ~ III show heat locations



■ Manufacturing

Surface preparation of the substrate and cladding is the first step in production of the clad plate. Next, a proprietary binder is placed between the cladding and substrate. Finally, the cladding is positioned and is bonded to the substrate using specialized resistance welding procedures and equipment (Upper fig). The composite work piece is then positioned and moved between counter rotating electrode wheels. Pulses of electrical energy are applied in coordination with the rotational speed of the electrode wheels. Thus, a series of overlapping bonds is made between the cladding and the substrate.

Viewed in cross section (Lower fig), heat is generated in the composite work piece at locations I and II, the contact points between the electrode wheels and the

cladding substrate surfaces respectively. The heat is caused by contact resistance. Heat is also generated at location III, the cladding substrate interface. This heat melts the proprietary binder which, in turn, bonds the cladding to the substrate. Since neither the cladding nor the substrate melts, the bond properly is characterized as a braze, not a weld. Proper control of the resistance welding parameters assures that the heat necessary to obtain the required cladding/substrate bond can be obtained on a consistent basis.

Superior characterization of composites

■ Tensile tests

Tensile tests were performed in accordance with ASTM E-8. The width of the reduced section of the tensile specimen was adjusted so that it included the complete width of the bond joint between cladding and substrate. Four kinds of tests were run in this series.

① as rolled substrate
  * to measure the initial mechanical properties for comparison
② as composite, "Resista-Clad".
③ as composite, with cyclic thermal pre-treatment.
  * 300°F for 20 min. → air quenching to room temperature (x100 times)
④ as substrate, with cladding removed by machining.

Properties of the as-received substrate are typical of those for a low-carbon steel. As expected, increases in the yield and tensile strength are observed after cladding, along with a slight decrease in elongation. These changes in mechanical properties do not present problems or limitations either during clad plate fabrication or during subsequent service life of the clad plate. Thermal cycling has very little influence on the mechanical properties. Tests of those clad specimens from which the cladding had been removed also showed very little change.

■ Bend tests

A strap-type specimen is placed on a female die. The loading ram deforms the test sample, forcing it into the shaped female die. The cladding can be located in either the "down" or "up" position, thus placing the cladding surface in tension or compression, respectively, during the bend test. Bend tests did not result in either cracking or tearing in the cladding or substrate. This bend test is a demanding test whose results characterize the composite as being able to withstand sever conditions.

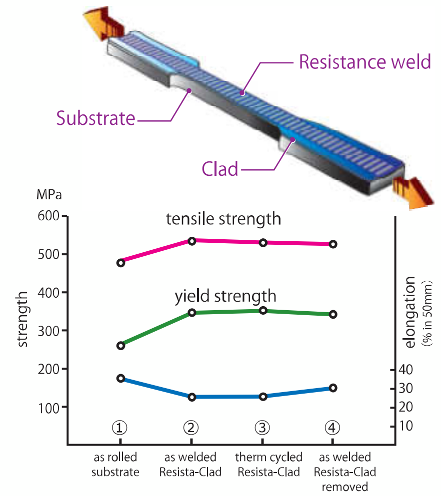
■ Peel tests

While holding the substrate fixed, the cladding is "peeled away" from the substrate. By measuring the pull force, and by knowing the length of the line-contact between clad and substrate, the peel strength can be calculated.

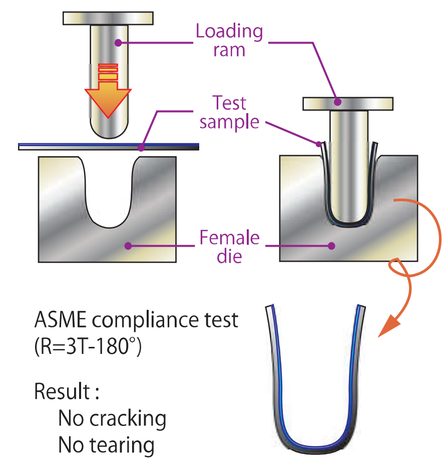
Peel tests provide a rough simulation of the type of loading which the cladding would undergo during vacuum service.

It should be noted that peel tests impose a much more severe loading on the clad than does vacuum service because of the difference in angle of loading on the cladding.

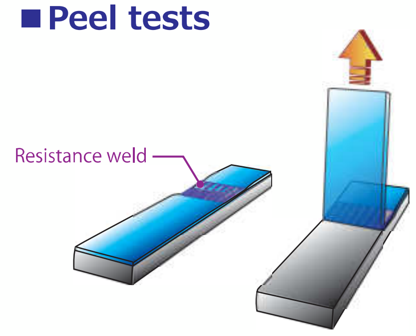
■ Tensile tests



■ Bend tests



■ Peel tests



Clad	kg/mm	1b/in
Titanium	16.1~19.6	900~1100
Zirconium	>12.5	>700
Niobium	>12.5	>700
Tantalum	16.1~17.9	900~1000