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Specifications & Fabrication Guidelines

Table of Contents

Table of Contents

ALLOY STEEL INTERNATIONAL:

Arcoplate's home office and manufacturing facility are located in Perth, Western Australia. Operating for over 25 years, ASI is accredited to the latest ISO standards for production and design service. Satellite offices, outlets, and distributors across Australia, USA, Canada, Mexico, Brazil, India, Africa, Chile and Indonesia.

Our American office is located in Mooresville, NC and is managed by Andrew Kostecki, President and Brand Development Manager of Alloy Steel North America

LOCATIONS:

*Contact ASNA for detailed list of locations

WHAT IS ARCOPLATE?

A wear resistant fused alloy steel plate manufactured by Alloy Steel International.

- Smooth dense, chromium carbide rich overlay plate manufactured by a patented production process to maximize abrasion resistance and reduce hang up and carry back no matter what the operating conditions
- no weld beads
- Has 39% less co-efficient of friction than stainless steel
- Maintains a uniform microstructure down to the fusion line
- A very low residual stress and controlled relief fractures
- Is a single pass alloy deposition from 1/4 to 3/4 inch
- No plate distortion
- Computer controlled metal dilution

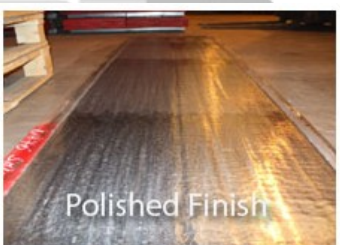
WHAT IS ARCOPLATE?

Why was it developed?

- Arcoplate was developed as a reaction to the unpredictable wear rates associated with both quenched and tempered steel plates and the old technology used to manufacture traditional bulk weld overlay plates.
- The costs associated with unscheduled maintenance or repair are obvious. Hidden costs such as productivity losses needed to be eliminated.
- **Inappropriate wear packages significantly affect mobile plants:**
  - These include drag and friction, energy consumption, stress & transference of the wear problem onto another mechanical component and machine weight.
  - Alloy Steel International's full engineering and design service enables Arcoplate to be supplied as a complete wear and anti hang up/ carry back kit fully designed to suit a specific application thereby dramatically reducing maintenance and production costs.

AVAILABLE FINISHES

- **Mill Finish**
- **Pre-polished**
- **Ultra- polished**



ARCOPLATE ADVANTAGE

Alloy Steel guarantees that Arcoplate will outperform conventional wearplates.

- **Laboratory & field tests reveal that Arcoplate will outperform:**
  - Quenched and Tempered Steel plate by a factor greater than 6:1
  - Substandard budget weld overlay by a factor of up to 4:1
  - Conventional weld overlay by a factor of up to 2:1

FREQUENTLY ASKED QUESTIONS:

Q: How would you select a steel for a specific application? E.g. crusher wear parts of haul truck liners? What process would you go through and what factors need to be considered?

A: Arcoplate wear solution engineers have proven kits for most applications for fixed plant and mobile plant applications. Arcoplate is continuously field testing with partners in the global mining industry and with several engineering companies. This allows ASI to gather information on proven applications and techniques to add to our technical library. ASI is prepared to find the best possible wear solution for any application

Q: Is Arcoplate available in my area?

A: Arcoplate is available world wide and has representatives on every major continent .

FREQUENTLY ASKED QUESTIONS:

Q: Is there a warranty on Arcoplate?

A: ASI/ASNA stands behind their product, and guarantees to outlast conventional wear plate.

Q: Will Arcoplate outlast conventional wear plate?

A: Arcoplate has been proven to outlast conventional wear plate a minimum of 2:1. Certain applications have outlasted 6:1.

Q: What size does Arcoplate come in?

A: Arcoplate is available in 2ft or 4ft by 10ft sheets. Thicknesses vary from 6mm to 20mm.

Q: We have a very unique and specific issue, can you help?

A: Our expert staff of wear plate specialists and engineers are ready to assist.

FREQUENTLY ASKED QUESTIONS:

Q: Are there any alternative s to steel wear parts eg. Different metals/ rubber, and how would these compare in terms of performance and cost?

A:Many products are available such as rubber, urethane and ceramic. Each has applications in the correct conditions. Rubber and urethane products are more resistible to impact although the life cycle is not comparable to the Arcoplate 1600, when you look at cost per pound of material produced. Ceramic certainly has application in the high sliding abrasion areas and ASI makes Arco Ceramic, which is manufactured in a new revolutionary way, and is ideal for sliding abrasion.

Q:How are these manufactured? Are any special processes such as quenching used and how do these types of techniques affect steel performance?

A: Arcoplates patented fused alloy process, created by the late Gene Kostecki in 1991, uses atomic nano-technology. This process allows Arcoplate to be tailor made to suit customer's recommendation on the metallurgical make up.

FREQUENTLY ASKED QUESTIONS:

Q:How do you ensure a good balance between weight and durability with your steels?
A: Arcoplate engineering constantly use CFD to simulate the conditions of service with in the field. ASI is able to change plate thickness to reduce mass weight and concentrate on the high abrasion and impact areas of the specific application. Arcoplate mobile plant kits are produced and installed in strips. This method has been proven for its ease of maintenance for over a decade. Arcoplate strips are lasting a minimum of 2 times the life of welded overlay plate and six time over the regular quench and tempered (QT) plate and are a major cost savings to the end user.

Q: What are the benefits of operating your own foundries as opposed to buying in raw steel for wear part production (quality control, guaranteed supply etc)?
A:The Arcoplate process is unique and patented. ASI builds the entire manufacturing machine that produces the Arcoplate finished product. The entire process has been developed in house and is a trade secret.

TECHNICAL ADVANTAGES OF ARCOPLATE

- Severe uneven alloy dilution with the base metal.
- Uneven through hardness due to variable base metal dilution.
- Very rough uneven surface resulting in high friction and poor flow.

TECHNICAL ADVANTAGES OF ARCOPLATE

ARCOPLATE WITH ITS UNIQUE PATENTED PROCESS HAS BEEN ABLE TO RESOLVE THE FIVE (5) MAJOR OBJECTIONS FACING WELD CLAD WEAR PLATE OVER THE PAST HALF CENTURY

- Severe base metal distortion and high residual locked in stress.
- Post weld straightening seriously compounds the high weld stresses

SUPERIOR ABRASION RESISTANCE:

National Research Council Canada – ASTM G65 testing From Table 1: Volume Loss mm3				
	Bottom Figure	Top Figure	Mean Figure	Extreme Low Arcoplate v Extreme High Comp
ARCOPLATE	15.20	15.99	15.60	15.20
Q&T	127.00	183.00	155.00	183.00
Volumetric loss variance	111.80	167.01	139.41	167.80
Arcoplate saving	636%	944%	794%	1004%
WELD OVERLAY	20.50	25.80	23.15	25.80
Volumetric loss variance	5.30	9.81	7.56	10.60
Arcoplate saving	26%	38%	33%	41%
WHITE IRONS	18.00	28.90	23.45	28.90
Arcoplate saving	2.80	12.91	7.86	13.70
Arcoplate saving	16%	45%	33%	47%

SUPERIOR ABRASION RESISTANCE:

Laboratory and Field Tests reveal that Arcoplate will outperform:

- Quench and tempered (QT) steel by a factor greater than 6:1
- Substandard budget weld overlay by a factor of up to 4:1
- Conventional weld overlay by a factor of up to 2:1

ARCOPLATE GRADES:

Arcoplate Alloy Grade	High Temp		Abrasion			Impact	
						Med	High
	Yes/No	°C	Low	Med	High	Med	High
1600	No	350			X		X
8668	Yes	700 - Cyclic Tempera-tures			X	X	X

VARIABLE LOAD TESTING:

Hardness Test	HV30	HV10	HV5	HV1	HV0.5
Number of impressions	12	12	12	12	12
Average (HV)	745	798	792	855	862
Standard deviation (HV)	23	48	63	186	268
Average impression size (mm)	0.27	0.15	0.11	0.05	0.03
Typical wear particle (mm)	0.40	0.22	0.16	0.07	0.05

ARCOPLATE TESTING:

SURFACE HARDNESS:

Vickers Method:

Identification	Results HV30	Average HV30	Hardness Converted (1)	
064/14/1	715, 741, 733, 702	723	659 HBW	59.3 HRC
064/14/2	631, 652, 639, 659	645	591 HBW	55.6 HRC

Notes: (1) Converted in accordance with ASTM E140, Table 8 (calculated).

Rockwell Method:

Identification	Results HRC	Average HRC
064/14/1	58.4, 58.7, 59.0, 60.0, 59.3, 60.7, 59.6, 59.0, 59.5	59.4
064/14/2	53.1, 54.6, 58.3, 55.5, 56.0, 56.1, 58.8, 49.8	55.3

Notes: (1) Converted in accordance with ASTM E140, Table 8 (calculated).

ARCOPLATE TESTING: Cross Section Hardness

Vickers Method, 30 kgf load, 3 mm below top surface:

Identification	Results HV30	Average HV30	Hardness Converted (1)	
064/14/1	652, 702, 720, 705	695	635 HBW	58.0 HRC
064/14/2	585, 581, 631, 707	626	574 HBW	54.7 HRC

Notes: (1) Converted in accordance with ASTM E140, Table 8 (calculated).

Vickers Method, 5 kgf load, approximate centre of overlay:

Identification	Results HV30	Average HV30	Hardness Converted (1)	
064/14/1	874, 736, 739, 795	786	715 HBW	61.8 HRC
064/14/2	683, 753, 701, 672	702	641 HBW	58.3 HRC

Notes: (1) Converted in accordance with ASTM E140, Table 8 (calculated).

ARCOPLATE THICKNESSES:

Alloy Thickness	Base Metal Thickness
6 mm/ *1/4 inches*	7 mm, 9 mm, 11 mm / 1/4, 3/8, 7/16 *inches*
8 mm/ *5/16 inches*	7 mm, 9 mm, 11 mm/ *1/4, 3/8, 7/16 inches*
10 mm/ *3/8 inches*	9 mm, *3/8 inches*
12 mm/ *1/2 inches*	11 mm/ *7/16 inches*
16 mm / *5/8 inches*	11 mm/ *7/16 inches*
20mm/ *3/4 inches*	11 mm/ *7/16 inches*
Standard Plate Size:	**1220 mm x 3080 mm (4t x 10 ft)**
Other thicknesses are available upon request	

ARCOPLATE APPLICATIONS:

Equipment protected by *ARCOPLATE*

Feed Bins	*Trommel Screens*	*Dredging Pump Parts*
Bucket Liners	*Truck Body Liners*	*Dredging Pipes*
Dozer Blade Liners	*Load Out Bins*	*Dipper Bucket Liners*
Sizing Screens	*Ore Dump Hoppers*	*Reclaimer Liners*
Transfer Chutes	*Hopper Doors*	*Rock Bin Liners*
Underground Skip	*Crusher Liners*	*Pan feeders*

ARCOPLATE - WEAR LINERS: PRODUCTIVE RESULTS FOR FIXED PLANT

Carbon vibratory feed chutes - High Temperature – High Wear – Acidic Environment
Arcoplate 1600 grade wear liners were used in a Carbon plant vibratory feed discharge and was able to out- perform all previous material. To date Arcoplate has returned 7 times the wear rate and is expected to obtain far greater results. An added bonus is that it is competitive to purchase and easier to install and maintain than any previously used liner.

Q&T liners will not withstand heat or acid. 304 Stainless steel liners which again will not withstand an acidic environment. Conventional clad plates are not smooth enough to maintain feed rates; they allow acidic cooling water to leach through the stress fractures into the mild steel eating out the plate. 53ma Stainless Steel had a mild success; chosen because of its ability to resist an acidic environment. 253ma lasts 3 months before replacement is necessary, due to loss of material through abrasion and the heat buckling the worn liner at the feed discharge.

The Arcoplate 1600 was in service for a period of 18 months. Arcoplate 1600 is also being installed in high wear areas of the fixed plant.

Arcoplate's patented method of manufacture produces unequalled wear characteristics in materials handling

Arcoplate 1600 grade is high impact resistant and high wear resistant.

Arcoplate is Australian made & is used the world over supplying to more than 15 countries.

Hoppers & Tub Liners

ARCOPLATE\-is being chosen as the preferred wear liner for large scale Hard Rock mining operations. Independent lab test results show that the impact resistance, abrasion & low co-efficient of friction, unique to Arcoplate, make it possible to attain optimum results in abrasion resistance in all areas of mining.

Dozer Blades

The use of ARCOPLATE Wear Kits on Dozers can enable 50,000 hours wear life. The installation is very quick, very price competitive and virtually maintenance free. That equates to a “fit and forget” strategy in most mining environments.

Dump Truck Wear Liners

In most instances an ARCOPLATE wear kit can increase the wear life on dump bodies by 200% to 300%. Not bad for a lighter kit with less down time.

Underground Trays

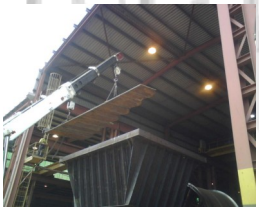
Upon completion of a very successful 12 month trial in Hard Rock, the underground operation has opted to line the entire fleet with Arcoplate.

CARRY-BACK SOLUTIONS:

	Without Arcoplate	With Arcoplate
Truck Trays	20% Carry- Back	0% Carry-Back
Dipper Buckets	60% Carry- Back	3% Carry - Back
Dozer Blades	30% Carry- Back	0% Carry-Back

ARCOPLATE THICKNESS SOLUTIONS

- 6mm on 7mm (1/4” on 1/4”)
- 6mm on 9mm (1/4” on 3/8”)



- Deflector Chutes
- Dipper Buckets
- Truck Trays
- Dozer Kits
- Grader Blades
- Underground

ARCOPLATE THICKNESS SOLUTIONS:

8mm on 7mm (5/16” on 1/4”)
8mm on 9mm (5/16” on 3/8”)
8mm on 11mm (5/16” on 7/16”)

-Coal deflector chute at impact point

-Truck Tray

-Dozer Kit

-Dipper Buckets

ARCOPLATE THICKNESS SOLUTIONS:

10mm on 9mm (3/8” on 3/8”)
10mm on 11mm (3/8” on 7/16”)

- Coal Chain Feeder Application:
- Dipper Bucket
- Dump Trucks

ARCOPLATE THICKNESS SOLUTIONS:

12mm on 11mm (1/2” on 7/16”)

- Hoppers
- Truck Liners

ARCOPLATE THICKNESS SOLUTIONS:

16mm on 11mm (5/8” on 7/16”)

- Truck Trays

20mm on 11mm (3/4” on 7/16”)

- Cyclone
- Dozer Blade

KITS AVAILABLE: CAT

Model	Type	Model	Type
320	Bucket	495	Dipper
980	Bucket	D10 SU	Dozer
988	Bucket	D10 T	Dozer
992	Bucket	D10R SU	Dozer
980F	Bucket	D10T SU	Dozer
988H	Bucket	D10T U	Dozer
992G	Bucket	D11 U	Dozer
992K	Bucket	D11R CD	Dozer
994F	Bucket	D11R SU	Dozer

KITS AVAILABLE: CAT

Model	Type	Model	Type
D11T U	Dozer	AD55	Dual Slope
D8 SU	Dozer	740E	Flat Floor
D9R SU	Dozer	775F	Flat Floor
789	Dual Slope	793F	Flat Floor
793	Dual Slope	AD45	Flat/Dual Slope
775F	Dual Slope	16H	Grader
777F	Dual Slope	D10R	Rock Bucket
785	Dual Slope		

KITS AVAILABLE: HITACHI

Model	Type	Model	Type
EX3600	Backhoe	RH170	Bucket
EX1100	Bucket	EX1200	Coal Bucket
EX1900	Bucket	EX2500	Coal Bucket
EX2500	Bucket	EX5500	Coal Bucket
EX3500	Bucket	EX1200	Dipper
EX3600	Bucket	EH3500	Flat Floor
EX5500	Bucket	EH4500	Flat Floor
RH 340	Bucket	EX1200	Rock Bucket
RH120	Bucket	EX2500	Rock Bucket

KITS AVAILABLE:

KOMATSU

Model	Type	Model	Type
465-7	Dual Slope	PC3000	Bucket
830E	Flat Floor	PC4000	Bucket
930E	Flat Floor	PC750	Bucket
D375-5	Dozer	PC800	Bucket
D375A	Dozer	PC850	Bucket
HD605	Flat Floor	WA 500	Bucket
PC1250	Bucket	WA1200	Bucket
PC2000	Bucket	WA900-3	Bucket

KITS AVAILABLE:

Make	Model	Type	Make	Model	Type
Elphinstone	1700	Bucket	Elphinstone	2900	Bucket
Le Tourneau	1850	Bucket	Le Tourneau	L2350	Bucket
Liebher	994B	Bucket	Liebher	996	Bucket
Liebher	996B	Bucket	Liebher	T282	
O&K	RH340	Bucket	O&K	RH120E	Bucket
O&K	RH170	Bucket	Terex	MT5020	


ARCOPLATE

SURFACE ROUGHNESS COMPARISON

Surface Roughness Test:

The friction developed between a bulk material sliding on a wall lining material is a function of various parameters. This includes the bulk material/ wall lining material combination, particle size distribution, and wall lining material surface roughness. Given the importance of the surface roughness on the wall lining material in determining the subsequent storage facility design parameters, the average centerline (Ra), the surface roughness of each wall lining material is tested.

SURFACE ROUGHNESS COMPARISON

The surface roughness of each of the wall lining samples is determined and the roughness of lining sample shall be given by the centerline average roughness Ra and noted by:

Table 2 – Wall Lining Materials

Wall Material	Surface Roughness 'R_a' (μm)
Arcoplate Smooth	6.0
Arcoplate Polished	2.1
Bulk Welded Clad Plate	9.5
Q & T late	7.6
White Cast Iron	17.0

$$R_a = \frac{1}{L}\int_0^L |y(x)|dx$$

where y(x) is the coordinate height measured from the mean centerline shown in Figure 5.

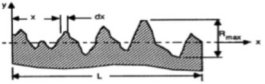


Figure 5 – Surface Roughness

MOBILE PLANT APPLICATION

- **In Batu Hijau, ASI Was invited to conduct thickness checks on the fleet of 116, 793 C truck bodies.**
- This was undertaken in conjunction with the mining company and the OEM. After 12 months service it was determined that **the average wear for 6000 hours service on the Arcoplate 10/9 floor was a loss of 1mm (0.042")**
- **Predicted wear life for the Arcoplate at the current rate of 1.22 mm per annum (worst case) would achieve a life expectancy of approx 8 years or 48,00 hours**.
- ASI doesn't suggest we can attain these results without some periodic maintenance to the floors in the is environment, however the new design Arcoplate kits will be far less to maintain and cost far less per cycle to run than any other wear kit on the market.

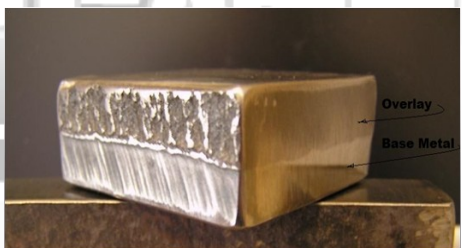
MOBILE PLANT APPLICATION CASE HISTORY

- Truck 58 is one of about 9 trucks at Batu Hijau fitted with a full Rock Box wear kit liner (not recommended by ASI) in the high velocity tail section. It was noted when these trucks are tipping that the **tipping cycles is approx. 30% slower than the Arcoplate kits.** Video taken of both wear kit applications revealed that the **Arcoplate kits are constantly empty at 70% lift and tipping time is 22 to 23 seconds.** The Rock Box kits are all still ejecting at 100% lift every time and take 30-32 seconds to fully eject.

FABRICATION:

The unique & patented Arcoplate Fused Alloy process gives:

- Smooth Deposit– no weld beads
- Very low residual stress
- Single pass alloy deposition
- Consistent microstructure
- Minimal base metal dilution
- No plate distortion
- Mill finish, pre-polished, ultra-polished finish.

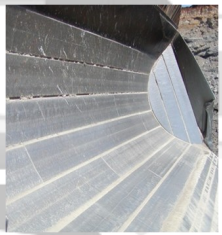


FABRICATION EQUIPMENT:

Arcoplate can be cut, formed, or rolled into virtually any shape, then easily attached.

Equipment needed:

- **2MIG welders, one for hard facing, one for mild steel**
- **Profile cutter with 400 AMP plasmas**
- **Sub Arc machine for joining plates**
- **200 Ton Press**
- **Plate roles**
- **Hand-held plasma machine**
- **9 inch grinders**
- **Stud welding machine**



FABRICATION: FORMING ARCOPLATE

Forming Arcoplate: Can be formed into pipes, cones, square-to-round transitions by rolling or pressing. Because of high hardness of Arcoplates alloy layer, there are some restriction on what radius the plate can be pressed which are determined by the alloy thickness.

Arcoplate thickness	Minimum Bend Radius (mm)
6/7	150
6/9	150
8/9	200
10/9	300
12/11	600

- **Rolling:** 6/9 and 6/7 can be pressed/rolled to a minimum diameter of 300mm (12 inches)
- For pyramid or pinch rolls it is recommended that top roll be protected with sleeve.
- Can be 12 mm thick carbon steel, and sized 50 mm (2") over roll diameter
- If hardfacing surface on the outside, low carbon steel plate should be used to sandwich the hardfacing before rolling commences.

FABRICATION: FORMING ARCOPLATE

- **Rolling:** Low Carbon Steel (LCS) plate should be same thickness as carbon steel backing of Arcoplate so stress is distributed evenly across the section of material being formed. LCS also protects the surface outside roll
- **Weld Joins:** alignment of weld joins to direction of rolling is critical. The plate should always be fed into rolls such that weld joins are perpendicular to the rollers (parallel to the direction of feed.)
- **Pressing:** press brake used for small diameter pipes, cones, square-to-round transitions
    - Forming can be done with male-and-female die combination or with a male die over air
    - Hydraulic presses provide best results
    - Use radius nosed blade to avoid stress cracking that knife edge blade produces

FABRICATION: FORMING ARCOPLATE

- **Pressing (cont.)**Most forming is done without preheat, or with just enough to take the chill off a plate ~300-450 F.
    - When brake pressing localized head can be applied with Rosebud torch to assist with pressing.
    - Applying heat will not have adverse affect on hardfacing abrasion resistance
- Square to round transitions are the hardest to form because of the 90 degree corners on the square or rectangular end.
    - General or localized preheat in these areas is needed to get good results.
    - Areas being formed usually headed to 950 F, but entire plates can be pre-heated to
- **Weld Joins:** Should be perpendicular to the press blade to avoid breaking the joins.

FABRICATION: FORMING ARCOPLATE

Cutting: Arcoplate contains a high percentage of chromium and acts like stainless steel when cutting. Normal methods, such as shearing or oxyfuel flame cutting will not be effective. **Arcoplate must be cut by carbon arc, plasma arc, or abrasive saw.**

- Can be cut with hardface side up or down, however works better with harfaced side up as layout errors are minimized.
  - Leaves slag on the mild steel side of cut edge which needs removed prior to welding.
- Conventional constant current DC welding power supplied recommended for carbon arc cutting and gouging of Arcoplate Arco Alloy.
- Keep open circuit voltage sufficiently higher than arc voltage to allow for a voltage drop in circuit.
  - Arc voltage will be in range of 35-56- open circuit voltage of at least 60 volts required.

FABRICATION: FORMING ARCOPLATE

Cutting:

- Use a hand or machine plasma system of 150 amps (30kw) or large (80 kw). The larger power supply the higher its amperage, the faster the cutting speed will be. Travel speed should be adjusted to produce a slag-free cut on the plates bottom side.

Cutting with a Carbon Arc

- Conventional constant current DC Welding power supplies are recommended for carbon arc cutting and gouging of the Arcoplate. Keep open circuit voltage sufficiently higher than the arc voltage to allow for voltage drop in circuit.
- Arc voltage will be in the range of 35 to 56 volts. Open Circuit Voltage of at least 60 volts will be required.
- If Arc cutting is done manually, layout the cut lines on carbon side of Arcoplate and center punch it for visibility.
    - Cut plate from carbon steel side and clean all slag from cut surface

FABRICATION: ATTACHING ARCOPLATE

Cutting with an Abrasive Saw

- An abrasive saw can also be sued for cutting Arcoplate. Either cutoff saw or portable concrete saw on wheels will work. Silicon Carbide wheel is recommended.

- Arcoplates steel backing plate allows it to be easily attached to other mild steel surfaces.
- **Most common methods of attachment:**
    - Perimeter and plug welds, Studs, Counterpunch bolts
- **Perimeter Welds:** simplest way of getting Arcoplate into service is to weld its carbon steel base to existing structure. Use any of the common welding processes:
    - Shield Metal Arc Welding (SMAW)
        - Gas Metal Arc Welding (GMAW
        - Flux Cored Arc Welding (FCAW)

FABRICATION: ATTACHING ARCOPLATE

- **Because the base metal is carbon steel any of the following electrodes can be used:**
  - E70 18 for SMAW
  - E70S-X for GMAW
  - Either E70T or E71T for RCAW
- For SMAW welding minimum size power supply should be 200 AMP AC/DC unit
- For GMAW welding, a 250 amp 100% duty cycle, it should be a constant voltage machine
- **Fillet Weld Size**- Most common way to weld Arcoplate is with fillet weld. The most important factor to consider when attaching with fillet weld is the size of the fillet weld.
- As a rule there should be a minimum of 2 mm between the top of the fillet weld and the hardface. Max fillet weld size can be calculated using the formula:Max Fillet Weld=Base metal Thickness minus 2 mm (1/10")
- If fillet weld is too large, weld pool will pick up carbon from hardface, making weld brittle and leading to cracking

FABRICATION: ATTACHING ARCOPLATE

If Carbon Steel base of Arcoplate Arco Alloy is joined to dissimilar metal such as 305 or 410 stainless manganese steel or Arcoplate, a 309 stainless- type electrodes should be used.

- When welding AR plate, normal mild steel welding procedures can be used if AR plate is pre-headed
    - **NOTE:** It is not necessary to pre-heat the Arcoplate
    - Pre-heating is recommended where a large amount of welding is required as the use of stainless electrodes can be quite expensive.
    - **Contact the Arcoplate manufactures for their recommended pre-heat temperatures.**

FABRICATION: ATTACHING ARCOPLATE

Sheet Spacing:

Recommended spacing of approximately 20 mm between adjacent Arcoplate sheets.

- Necessary to allow room for welding between sheets to obtain max fillet weld size.
- In some application, it is possible to reduce gaps by combining plug welds, butting up narrow edges or use of alternative attachment methods.
- **Consult ASI for design assistance**

Dogging Down: Dogging down sheets of Arcoplate during welding is critical.

- Particularly important in mobile equipment to prevent dirt getting in under and lifting the sheets
- ASI recommends using dogs tacked to the surface being lined. Slender wedges are simply banged in between the hardface and dog, to hold the sheet hard against the surface while it is tacked in place

FABRICATION: ATTACHING ARCOPLATE

- When installing horizontal strips on a vertical surface, such as on a bulldoze blade, additional spacers can be used to obtain the correct 20 mm gap, and prevent the bottom of the sheet from slipping out.

- 50x 60 mm spacers can also be employed when installing sheets on a horizontal surface to simplify installation

FABRICATION: ATTACHING ARCOPLATE

Welding Templates

- Welding spatter on hardface is detrimental to anti-hang-up properties of Arcoplate.
  - When Arcoplate is being used to reduce material carry back/hang-up, all weld spatter should be completely removed from hardface, use sheet metal welding
- When installing Arcoplate strips, it is essential that two sheet metal covers be fabricated.
- Covers are Fabricated to suit the width of the strips you are installing so the entire hard surface is protected.
- Useful to fabricate the length of the lip on the inside to match the thickness of your hardface
  - Can then be used as a guide to ensure fillet welds do not exceed max size
- When welding rolled or joins the template is positioned on the plate such that weld runs can be made along the slot with the template protecting the majority of the hardface in the region of the weld from spatter. When welding curved surface, the template will need to be flexible.

FABRICATION: ATTACHING ARCOPLATE

Plug Welds

- Arcoplate can be attached to another plate or structure by plug welding
- Minimum hole size of 25mm size hole is suggested on 300-450 mm centers.
- Plug welds holes should be cut using plasma cutter
- After cutting holes, remove slag from surface of cut, preferably with a die grinder to ensure no hardface in your weld, using Arco Alloy 880 Hardfaced wire
- Make first weld run around the outside diameter of the hole through a complete 360 degrees.
    - Plug weld should be at lease 2mm (3/32”) from base of hardface.
- The balance for the plug weld should be filled up so that it is 2 mm below the hard-faced layer.
- To protect the weld from abrasion and to reduce turbulent material flow during service, hole should be back filled with harfacing.

FABRICATION: ATTACHING ARCOPLATE

Stud Welds

- Nelson studs can be easily welded to the mild steel base of Arcoplate.
- Best results achieved when specialist stud gun in used
    - Produces full penetration weld between the stud and the backing plate
- Studs should be no smaller than M10 (3/8”) and the number of studs require will depend
- upon the size and shape of the wear plate.
- Generally, a stud spacing of 300 mm is recommended.
- Prior to welding all mill scale should be removed from the area to be welded
- If conditions are wet or cold, it is recommended that the plate be pre-heated to remove
- any Moisture
- 2 test studs should be fired prior to commencing production welding.

FABRICATION: ATTACHING ARCOPLATE

- Studs should be torque tested in accordance with ASI1554 with torque figures as shown:
- **30' bend test on the test studs is highly recommended.**
  - Involves hitting the studs with a hammer until they are 30' of until studs break.
  - If stud welding settings are correct, stud will snap and not the weld.
- Larger studs over 12 mm (1/2") in diameter can also be attached with a fillet weld using normal welding procedures such as SMAW using E7018 electrode.
- Important to note studs attached with fillet weld rather than full penetration stud weld are not as strong and a greater number of studs will be needed to support the plate.

Stud Size	Torque
M12	45Nm
M16	110Nm
M20	215Nm
M24	370Nm

FABRICATION: ATTACHING ARCOPLATE

- **ASI recommends using bolts as a last resort in attaching Arcoplate, when use of studs is not possible**.
    - Bolt heads and holes disrupt the laminar flow of material across the normally smooth alloy surface
    - Turbulence created in and around bolt holes accelerates wear rates and will significantly reduce the life expectancy of your wear liners
- Countersunk head socket screws and cap head socket screws are the most commonly used bolts, which require countersunk and or counter bored holes to accommodate the bolt heads.
- High hardness of the alloy overlay makes it impossible to machine or drill such holes in Arcoplate using conventional methods.

FABRICATION: ATTACHING ARCOPLATE

- **Spark Erosion or Electrical Discharge Machining (EDM) is an alternative method for countersinking or counter boring holes in Arcoplate**
- ASI recommends using mild steel inserts, welded into Arcoplate, where countersunk/ counter bored hole is necessary.
- Inserts are cylindrical mild steel plugs which are machine to match the shape of the desired hole.
- Holes are then cut in Arcoplate with diameter 1-2 mm larger than that of the inserts and the inserts welded in from the mild steel side of Arcoplate.
- Inserts can be machined to match most bolt head shape.

Contact ASI for more information

FABRICATION: JOINING ARCOPLATE

- **Can be joined to itself or other structural steels to form larger panels and/ or in the fabrication of bins and chutes.**
- Fabrication techniques differ slightly from standard structural steels due to the differing properties of the mild steel and alloy sides of Arcoplate
- Welds on the mild steel side **only** are considered structural, and parts are not to be
- joined to the hardface
- Any welding on the hardface is a matter of wear protection only

ASNA TAYLOR DESIGNS TO SUIT YOUR JOINING REQUIREMENTS

- **Joining Flat Sheets of Arcoplate**
  - Can be joined to form larger panels with a partial penetration butt weld on the mils steel-side.

FABRICATION: JOINING ARCOPLATE

Joining Mild Steel Side

- Start with mild steel side of Arcoplate, which provides structural strength of the join
- Turn Arcoplate sheets so they are mild steel up and bevel the edges to be joined

Bevel Size= Base Metal Thickness minus 2 mm (3/32")

- Construct a joining bench, strong enough to dog the plates down.
  - **CONSULT ASI FOR MORE INFORMATION ON JOINING BENCHES**
- After beveled, butt eh sheets up against one another on the joining bench.
- Leave 2 mm gap between each of the sheets to assist in welding the alloy side.
- All sheets need to be dogged down hard against the bench.

FABRICATION: JOINING ARCOPLATE

- **The root pass must not melt through the "land' into the hardfaced layer.**
  - This can cause hardfacing carbon to be picked up by the weld metal, resulting in a weld
  - hat is hard and brittle. For the fill passes, us 4 mm (1/8") or 5 mm (3/16") dia E7018 electrode for SMAW welding, depending upon the plate thickness or a standard E70SS MIG
  - wire for GMAW
  - Use manufacturer's recommended amperage range for the electrode chosen.
  - **NOTE:** The aforementioned recommendations are general guidelines for joining the Arcoplate Alloy range. Any welding procedures, process or combination of processes that is normally used at your plant will work in welding together mild steel base metals.
  - Essential that welds runs be kept to 150 mm and staggered over the plate to prevent excessive localized heat build- up and warping of the plates.
  - Once all weld joins have been completed, turn plate over and prepare to weld the gap on alloy side.

FABRICATION: JOINING ARCOPLATE

Structural Arcoplate Fabrication

- Arcoplate is designed for use as a liner, but can be used structurally in the fabrication of chutes, hoppers and bins.
- Extra care required when using as a structural steel
- This guide can be used as a preliminary design guide.

Contact ASI during design process.

- **Corner Joints**
  - **The weld on the mild steel side only forms the structural component of a corner join.**
  - A sealing weld on the inside corner of all joins is recommended, but unlike flat sheets

FABRICATION: JOINING ARCOPLATE

Joining Arcoplate to an Existing Structure

- If only part of the chute or bin is subject to wear, it may be necessary to join the Arcoplate to part of the existing structure.
- The weld able mild steel backing plate means this is no issues, however when welding to Q&T Plate, the Q&T manufacturers fabrication guidelines should be consulted
- When extra strength is required, flat bar can be welded

FABRICATION: SHEAR FORCE PROTECTION

Shear Force Protection

- In many applications, the edges of Arcoplate will be exposed to shear forces, such as inclined surfaces and the cutting edge on buckets and dippers. In most kits, the edges of Arcoplate liners are protected by adjacent liners.
- **Exposed edges where kit starts and stop may need additional protection**
- Most applications it is sufficient to protect the edges with a square strip of Q&T Plate, slightly thicker than Arcoplate.
  - Strip is welding in front of Arcoplate with a gap big enough to get a full weld in between the Arcoplate and Q&T strip (15-20 mm)
  - In extreme applications ASI recommends using 50 mm wide strips of ArcoSuper Bar will deliver maximum protection as both materials assist in both abrasion & impact.

FABRICATION: POLISHING

When polished, Arcoplate is second to none at reducing hang-up and material carry-back.

- Arcoplate will polish to a near mirror finish as it wears, but it is necessary to pre-polish Arcoplate in most sticky material applications, to accelerate the 'in-service' polish.
- Level of polish required depends largely on material properties and flow conditions.
- Bulldozer blades, dipper buckets and truck tray tail liners only require a light polish as they have a continual flow of material over the surface which assists in the 'in-service' polish
- Excavator buckets and front section of Arcoplate truck kits are continually carrying a 'dead' load and require higher level of initial polish to improve material flow.
- Final Post installation polish is necessary to remove any traces of weld spatter from hardface, or if product has been allowed to rust before installation.
- Use a ZD38050 or similar Zircon Disc as the initial polish, followed by a final polish using a FL38350 or similar Flap Disc.

FABRICATION: KIT DESIGN/ INSTALLATION

Kit Design/Installation

- Correct design and installation of your Arcoplate kit is essential in obtaining maximum performance out of your liners. Wear rates and patterns, material properties and flow characteristics as well as plant design will all influence the life of your wear liners and need to be considered when designing your Arcoplate liner kit.

ASI offers a full design service and should be consulted for Assistance.

FABRICATION: REPAIRING ARCOPLATE

Repairing Arcoplate

- Due to the brittle nature of Arcoplates hardface it can be hard to work with at time and it is possible to damage during fabrication.
- Because it is designed as a sacrificial liner, cracks and chips can generally be repaired without compromising the integrity or wear performance of the liner.
- Repair is not always necessary and any queries should be referred to ASI engineering department.

FABRICATION: CRACKS

Cracks

- Arcoplate comes with small pre-existing stress cracks in the hardface, which are un-avoidable result of heat used in manufacturing process.
- Varying properties of mild steel and alloy layers means they cool at different rates, which can induce small stress cracks in the alloy layer.
- These cracks **DO NOT** affect the structural integrity or the performance of the Arcoplate and should be left alone.
- Fabrication processes such as rolling and forming can sometimes induce cracks in the plate and/ or chip thehardface.
- Cracks smaller than 1mm are generally left alone
- Large cracks or chips may be repaired.
- CONSULT ASI FOR REPAIR INSTRUCTIONS

TECHNICAL REPORT:

Technical letter: Measurement of Bulk Coal Sliding Friction on various Wear plate products
Distribution: Alloy steel International Pty Ltd **Report No: R080404.1 Prepared by:** PF Britton
Reviewed by: SI Anderson **Approved by: JG Loughran**

Limitation Statement

The sole purpose of this technical report and the services performed by Rockfield Technologies Australia Pty Ltd (RTA) was to experimentally measure the frictional forces acting between lightly consolidated bulk coal samples and wear plate samples. No warranty, or guarantee, whether expressed or implied is made with respect to data not directly measured during this investigation, or to the observations and conclusions expressed as a result of that data. The report has been prepared on behalf of and for the exclusive use of Alloy Steel International Pty Ltd RTA accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report by any third party.

EXECUTIVE SUMMARY:

- Rockfield Technologies was contracted by ASI Pty Ltd to experimentally measure the effective coefficient of sliding friction between bulk coal and four wear plate samples. The primary purpose of the experimentation was to determine the frictional performance of the ARCOPLATE 1600, in both as supplied and worn conditions. The worn ARCOPLATE 1600 sample was taken from an excavator bucket post-excavation of 61 Billion BCM of overburden and coal. Two alternative commercially available wear plate products (ASTM A240 UNS S41003 & 400HB Q&T) were also tested for comparison and benchmarking of the ARCOPLATE 1600 results.
- A purpose designed test cell was designed & commissioned for operation with a conventional Jenike Shear cell test bed, located at James Cook University, Queensland, Australia.
- A medium-volatile, bituminous cooking coal from a mine in Queensland's Bowen basin was used for the testing. The moisture content of the coal samples used in each test was determined in accordance with Australian Standards. Coal moisture content was consistent throughout the testing program and ranged between 7% and 7.5% by mass

EXECUTIVE SUMMARY:

The ARCOPATE 1600 performed very well with respect to the alternative products tested. In the as-supplied, pre-polished condition**, the ARCOPLATE 1600 exhibited 23% less frictional resistance than the Utility Stainless Steel**- ASTM A 240 UNS S41003. In the worn condition, **the 1600 exhibited 39% less frictional resistance than the Utility Stainless Steel**- ASTM A240 UNS S41003.

There was little discernible difference between the measured frictional resistance of the Utility Stainless Steel- ASTMA@40 UNS S41003 & the 400HB Q&T Steel Plate because of the similar surface finish of the two products in their as-supplied condition

EXECUTIVE SUMMARY

- ARCOPLATE has developed an industry reputation for reducing 'hang up' or 'carry back' of low flow ability mate als, due most likely to low frictional resistance properties of the high Chromium ARCO ALLOY 1600. Observations have been widely made that this anti-hang up performance is further enhanced as the ARCOPLATE wears during service.
- To quantify the frictional performance of the ARCOP:ATE 1600, ASI contacted Rock field Technologies to conduct sliding friction experiments to determine the frictional performance of the ARCOPLATE 1600 in as supplied & worn conditions, & compare this performance with measurements taken using two alternative commercially available wear plate products (Utility Stainless Steel- ASTM A240 UNS S41003 & 400 HB Q&T)
- With Australian Coal exports tipping $25 billion, the potential for adoption of ARCOPLATE advanced wear & anti- hang up lining material within this sector of the mining industry is large. As such, ASI requested that coal be used as the candidate bulk solid for the testing program

EXECUTIVE SUMMARY:

Experimental Apparatus

A purpose- built test cell was designed & commissioned for the testing program. Both the test cell & measurement system was developed for use with an existing Jenike test bed located at the at James Cook University. The apparatus allows for coal sample volume of 1.7 liters to be consolidated to an appropriate level against the wear plate surface being tested for frictional performance. The carriage is subsequently driven at constant speed by the geared motor on the Jenike test bed and the frictional resistance at the wear surface is directly measured & recorded via load cells. The carriage displacement and sample consolidation are also recorded during each experiment.

Coal Type: A medium volatile, bituminous coking coal from a mine in Queensland's Bowen basin was made available by James Cook University for the testing program. Due to the size of the test cell, the coal earmarked for testing was sieved at 3/8 inch to removed the larger particles before preparing samples of the coal for testing

EXPERIMENTAL PROCEDURES:

The key procedures were developed and adopted for the sliding friction experiments and have been based on Australian Standards methods for soils testing :

Preparation of coal samples, Sliding friction test procedure, Measuring coal sample moisture content

Experimental Program: Tests were conducted for each of the 4 wear plate samples, at two different levels of consolidating load, providing a core set of 8 experiments. 4 experiments were conducted as replicates to ensure repeatability in the test results.

Results: From the bulk coal sliding friction test, the observations are made regarding the validity of the testing procedures:

- The testing apparatus was successful in measuring the frictional resistance to bulk coal sliding on various wear plate surfaces.
- A high level of repeatability of the test results was also shown for 3 test conditions
- The moisture content results for the coal test samples showed a satisfactory level of consistency throughout the testing program.

CONCLUSIONS:

The following conclusions are made regarding the measured bulk coal frictional performance of the various wear plate products tested:

- In the as-supplied, pre-polished condition, **the ARCO ALLOY 1600 exhibited 23% less frictional resistance than the Utility Stainless Steel**- ASTM A 240 UNS S41003
- In the worn condition, the ARCO ALLOY 1600 exhibited even greater performance, exhibiting **39% less frictional resistance** than the Utility Stainless Steel- ASTM A 240 UNS S41003.
- In the as-supplied, mill finish condition, there was little discernible difference between the frictional performance of the Utility Stainless Steel- ASTM A 240 UNS S41003 and the 400 HBB Q &T plate

ARCOPLATE MSDS

Identification of the Material and Supplier : Alloy Steel International Pty Ltd. +618 9248 3188
93 Mulgul Rd & 42 Mercantile Way Fax: + 618 9248 3166
Malga, WA 6944 info@alloysteel.net

Chemical Nature: Alloy of iron, chromium, molybdenum, nickel and other minor additives

Trade Name: Arcoplate

Product Use: Clad wear plate (overlay of wear resistant, chromium iron) standard 1018 steel.

Creation Date: March 2013

This Version issued: March 2013 and is valid for 5 years from this date

Hazards Identification

Statement of Hazardous Nature: Not classified as hazardous according to the criteria of SWA.

Risk Phrases: Not Hazardous

Safety Phrases: S22, S25, S36. Do not breathe dust. Avoid contact with eyes. Wear suitable protective clothing

SUSMP Classification: None allocated
ADG Classification: None allocated. Not a dangerous good under ADG Code
UN Number: Non allocated **GHS Signal word:** NONE. Not Hazardous

ARCOPLATE MSDS

Prevention: P260: Do not breathe dusts *

Response :P301+P330+P331: IF SWALLOWED: Rinse Mouth. Do NOT induce vomiting

Response:

P332+P313: If skin irritation occurs: Get medical advice

P337+P313: If eye irritation persists: Get medical advice

P370+P378: Not combustible. Use extinguishing media suited to burning material.

Storage:P401+P404: Store in a dry place. Store in a closed container

Disposal

P501: Dispose of waste material to reclaim

thicknesses.

For Full MSDS please see company website and use distributor log in information at www.alloysteel.net

ARCOWELD 880 MSDS

Identification of the Material and Supplier : +618 9248 3188
Alloy Steel International Pty Ltd. 42 Mercantile Way Malga, WA 6944
Chemical Nature: Tubular wire containing alloys and minerals. Principally iron and chromium metals.
Trade Name: Arcoweld 880 P**roduct Use:** Hardfacing welding wire for open arc use
Creation Date: September 2010
This version issues: September 2010 and is valid for 5 years from this date
Hazards identification: Statement of Hazardous Nature
This product is classified as : Not classified as hazardous according to the criteria of SWA. Not a dangerous good according to the Australian Dangerous Goods Code
Risk Phrases: Not Hazardous- No criteria found
Safety Phrases: S23, S36. Do not breathe welding fumes. Wear suitable protective clothing
SUSMP Classification: None allocated
ADG Classification: None allocated.
Emergency Overview: Physical Description & Color: Tubular wire

Major Health Hazards: no Significant risk factors have been found for this product.
Odor: No odor

CUTTING ARCOPLATE

The hardface of Arcoplate Arco Alloy 800/820/1600 contains a high percentage of chromium and acts like stainless steel when cutting. Thus, normal methods, such as shearing or oxyfuel flame cutting, will not be effective. Instead, Arcoplate Arco Alloy 800/820/1600 should be cut by carbon arc, plasma arc, or abrasive saw.

Cutting with a Carbon Arc

Conventional constant current DC welding power supplies are recommended for carbon arc cutting and gouging of the Arcoplate Arco Alloy 800/820/1600. Keep the open circuit voltage sufficiently higher than the arc voltage to allow for a voltage drop in the circuit. The arc voltage will be in the range of 35 to 56 volts, so an open circuit voltage of at least 60 volts will be required. If the arc cutting is done manually, first layout the cut lines on the carbon steel side of Arcoplate Arco Alloy 800/820/1600 and center punch it for visibility. Cut the plate from the carbon steel side and clean all slag from the cut surface.

Cutting with a Plasma Arc

Arcoplate Arco Alloy 800/820/1600 can be cut easily, using either a hand or machine plasma system of 150 amps (30kw) or larger (80kw). The larger the power supply and the higher its amperage, the faster the cutting speed will be. The travel speed should be adjusted to produce a slag-free cut on the plate's bottom side. The plate can be cut with the hardfaced side either up or down. It works better with the hardfaced side up as layout errors are minimized.

Cutting with an Abrasive Saw

An abrasive saw can also be used for cutting Arcoplate Arco Alloy 800/820/1600. Either a cutoff saw or a portable concrete saw on wheels will work. A silicon carbide wheel is recommended.

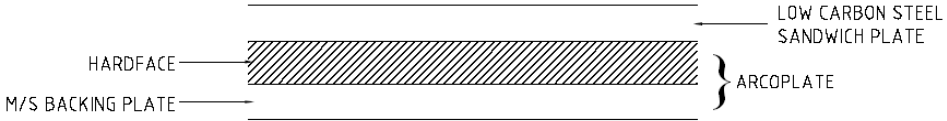
FORMING ARCOPLATE

Arcoplate Arco Alloy 800/820/1600 can be formed into pipes, cones, square-to-round transitions etc. by rolling and/or pressing. Lighter Arcoplate grades such as 6/9 and 6/7 can be safely pressed/rolled to a minimum diameter of 300 mm (12 inch), with the hardfacing on the inside surface, up to a minimum internal diameter of 1000mm for 12/11.

Rolling Arcoplate

For pyramid or pinch rolls it is recommended that the top roll be protected with a sleeve. It can be 12mm thick carbon steel, and sized 50 mm (2") over the roll diameter. This facilitates installation and removal of the sleeve, and prevents the sleeve from binding the top roll. When rolling Arcoplate with the hardfacing on the outside, a low carbon steel plate should be used to sandwich the hardfacing before rolling commences (See Figure 3.0).

Figure 3.0: Mild steel sandwich plate on alloy side of Arcoplate



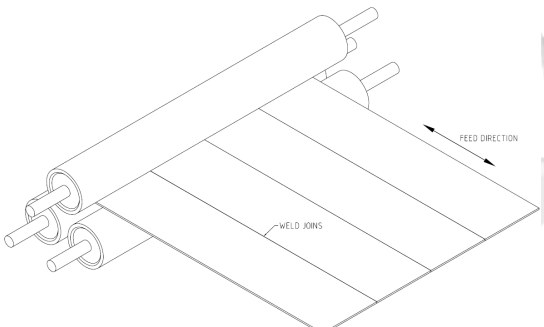
The low carbon steel (LCS) plate should be the same thickness as the carbon steel backing of the Arcoplate, so that stress is distributed evenly across the section of material being formed. The LCS plate also protects the surface of the outside rolls.

Weld Joins

When rolling Arcoplate sheets that contain weld joins, the alignment of weld joins to the direction of rolling is critical. So as to not put any undue stress or strain on the weld joins, the plate should always be feed into the rolls such that weld joins are perpendicular to the rollers (parallel to the direction of feed). Alignment of the weld joins in the opposite direction will likely snap the plates at the weld joins.

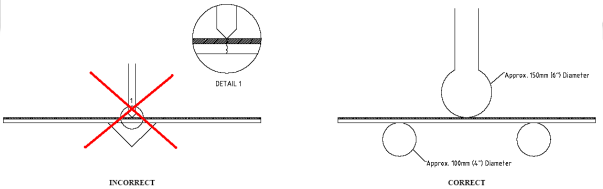
Weld Joins

Figure 3.1: Correct alignment of weld joins when rolling Arcoplate



Pressing Arcoplate

A press brake is used for small diameter pipes, cones and square- to-round transitions. Hydraulic presses provide the best results. Forming can be done with a male-and-female die combination, or with a male die over air. It is important when pressing Arcoplate, to use a radius nosed blade rather than a knife edge blade. The reason being, is that a knife edge blade produces a point load which induces stress cracking in localized areas and, in extreme cases, may lead to the plate cracking right through (See Figure 3.1).



Press

Most forming is done without preheat, or with just enough heat to take the chill off a plate: about 150-230 degrees centigrade (300-450 F). When press braking, localized heat can be applied with a Rosebud torch to assist with pressing. Applying heat will not have an adverse affect on the hardfacing's abrasion resistance. Square-to-round transitions are the hardest to form because of the 90-degree corners on the square or rectangular end. Either a general or localized preheat in these areas is needed to get good results. The area being formed is usually heated to red-hot: about 500 degrees centigrade (950 F) but entire plates can be pre-heated to 500 degrees centigrade (950 F) or more. Talk to ASI before you attempt this type of forming.

Weld Joins

As with rolling, the alignment of weld joins when pressing is critical. Weld joins should be perpendicular to the press blade to avoid breaking at the joins. It is important that this is addressed when cutting the Arcoplate, so that the weld joins are aligned correctly in the part with respect to the way it is to be pressed.

ATTACHING ARCOPLATE

Arcoplates mild steel backing plate allows it to be easily attached to other mild steel surfaces. The most common methods of attachment include perimeter and plug welds, studs and countersunk bolts. This section will outline the correct procedures that should be used for attaching Arcoplate to ensure you receive maximum performance.

Perimeter Welds

The simplest way of getting Arcoplate into service is to weld its carbon steel base to the existing structure. You can use any of the common welding processes: Shield Metal Arc Welding (SMAW), Gas Metal Arc welding (GMAW), or Flux Cored Arc Welding (FCAW). Since the base metal is carbon steel, any of the following electrodes can be used: E70 18 for SMAW, E70S-X for GMAW, and either E70T or E71T for FCAW. For SMAW welding the minimum size power supply should be a 200 amp AC/DC unit; for GMAW welding, a 250 amp 100% duty cycle, constant voltage machine is recommended.

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Fillet Weld Size

The most common way of welding Arcoplate is with a fillet weld. The most important factor to consider when attaching Arcoplate with a fillet weld is the size of the fillet weld. As a rule, there should be a minimum of 2mm between the top of the fillet weld and the hardface. The maximum fillet weld size can be calculated using the formula:

Max. Fillet Weld Size = Base Metal Thickness minus 2 mm (3/32")

It is important that this is adhered to because if the fillet weld is too large, the weld pool will pick up carbon from the hardface, making the weld brittle and leading to cracking (see Figure 4.0).

Fillet Weld Size

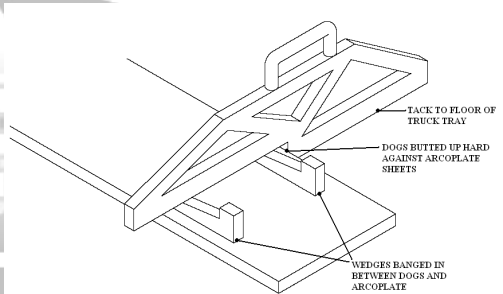
Whenever the carbon steel base of Arcoplate Arco Alloy 800/820/1600 is joined to a dissimilar metal such as 304 or 410 stainless manganese steel or AR plate, a 309 stainless-type electrodes should be used. Alternatively, when welding AR plate, normal mild steel welding procedures can be used if the AR plate is pre-heated (It is not necessary to pre-heat the Arcoplate). This is recommended where a large amount of welding is required as the use of stainless electrodes can be quite expensive. Please contact the AR plate manufacturers for their recommended pre-heat temperatures.

Sheet Spacing

ASI recommends a spacing of approximately 20mm between adjacent Arcoplate sheets. This is necessary to allow room for welding between sheets and to obtain maximum fillet weld size. In some applications, it is possible to reduce gaps by combining plug welds, butting up narrow edges or use of alternative attachment methods. Please consult ASI for design assistance.

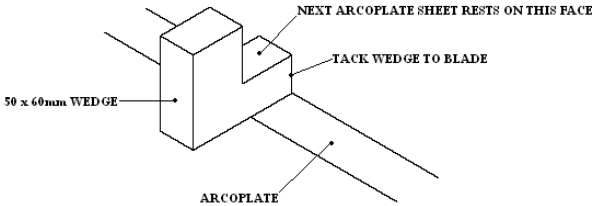
Dogging Down

Dogging down sheets of Arcoplate during welding is critical. This is particularly important in mobile equipment, to prevent dirt getting in under and lifting the sheets. ASI recommends using dogs, of a similar design to that illustrated in Figure 4.1, tacked to the surface being lined. Slender wedges are simply banged in between the hardface and dog, to hold the sheet hard against the surface while it is tacked in place. Please contact ASI for recommended dimensions.

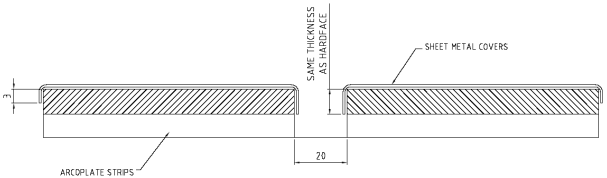


Dogging Down

When installing horizontal strips on a vertical surface, such as on a bulldozer blade, additional spacers can be used to obtain the correct 20mm gap, and prevent the bottom of the sheet from slipping out. The 50 x 60mm spacers, shown below, can also be employed when installing sheets on a horizontal surface to simplify installation.

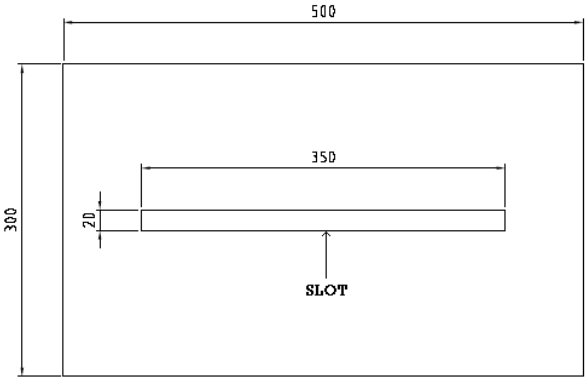


Welding templates



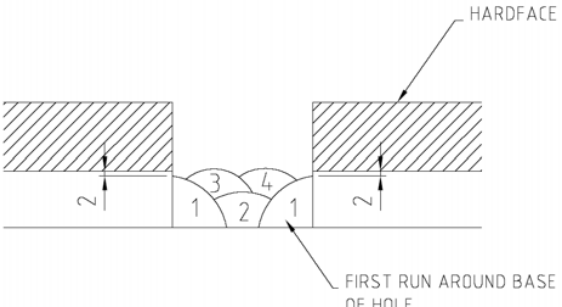
Welding spatter on the hardface is detrimental to the anti-hang-up properties of Arcoplate. In applications where Arcoplate is being used to reduce material carry back/hang-up, all weld spatter should be completely removed from the hardface. To minimise spatter during welding, ASI recommends using sheet metal welding templates. When installing Arcoplate strips, it is recommended that two sheet metal covers be fabricated as illustrated below. The covers are fabricated to suit the width of the strips you are installing (305 or 610mm wide) so that the entire hardface is protected. It may also be useful to fabricate the length of the lip on the inside to match the thickness of your hardface. This can be then used as a guide to ensure your fillet welds do not exceed maximum size

This figure shows an alternative welding template that is recommended when welding rolled Arcoplate sections or welding joins between flat Arcoplate sheets. The template is positioned on the plate such that weld runs can be made along the slot, with the template protecting the majority of the hardface in the region of the weld from spatter. When welding a curved surface, the template will need to be flexible (<1mm thick).



Plug Welds

Arcoplate can be attached to another plate or structure by plug welding. A minimum hole size of 25mm (1") size hole is suggested on 300-450mm (12"-18") centers. Plug weld holes should be cut using a plasma cutter or oxy torch. After cutting the holes, remove all slag from the cut. Next, make your first weld run around the outside diameter of the hole through a complete 360 degrees. The plug weld should be at least 2mm (1/10") from the base of the hardface. Next, the balance of the plug weld should be filled up, again so that it is 2 mm below the hardfaced layer. To protect the weld from abrasion and to reduce turbulent material flow during service, the hole should be back filled with hardfacing.



Stud Welds

Nelson Studs can be easily welded to the mild steel base of Arcoplate. Best results are achieved when a specialist stud gun is used, which produces a full penetration weld between the stud and the backing plate. Studs should be no smaller than M10 (3/8") and the number of studs required will depend upon the size and shape of the wear plate. Generally, a stud spacing of 300mm is recommended

Nelson Stud after welding

Stud Welds

Prior to welding, all mill scale should be removed from the area to be welded & if conditions are wet or cold, it is recommended that the plate be preheated to remove any moisture. 2 test studs should be fired, prior to starting welding, on a piece of scrap material. These studs should be torque tested in accordance with AS1554, with torque figures as shown in Table 4.7. A 30° bend test on the test studs is also highly recommended. This simply involves hitting the studs with a hammer until they are at 30° or until the studs break. If the stud welding settings are correct, the stud will snap & not the weld. Larger studs, over 12 mm in diameter, can be attached with a fillet weld using normal welding procedures such as SMAW using an E7018 electrode. It is important to note that studs attached with a fillet weld rather than a full penetration stud weld are not as strong, and a greater number of studs will be needed to support the plate.

Table 4.7: Torque Test Figures.

Stud Size	Torque
M12	45Nm
M16	110Nm
M20	215Nm
M24	370Nm

Bolts

Another method of attaching Arcoplate to fixed or mobile plant is with bolts. ASI only recommends
using bolts where the use of studs is not possible, as bolt heads and holes disrupt the laminar flow of material across the normally smooth alloy surface. Turbulence created in and around bolt holes accelerates wear rates and will significantly reduce the life expectancy of your wear liners

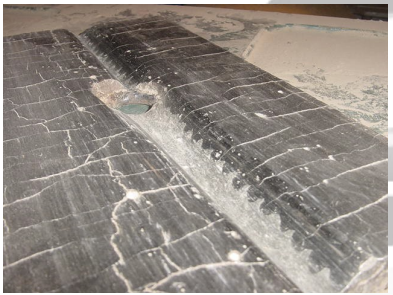


Figure 4.8: 'Comet tail' resulting from turbulence introduced by a bolt hole.

Bolts

Countersunk head socket screws and cap head socket screws are the most commonly used bolts, which require countersunk and/or counterbored holes to accommodate the bolt heads. However, the high hardness of the alloy overlay makes it impossible to machine or drill such holes in Arcoplate using conventional methods. Spark Erosion or Electrical Discharge Machining (EDM) is an alternative method for countersinking or counterboring holes in Arcoplate, however this type of machining is not readily available in many areas. ASI recommends using mild steel inserts, welded into the Arcoplate, where a countersunk/counterbored hole is necessary. The Inserts are cylindrical mild steel plugs which are machined to match the shape of the desired hole Holes are then cut in the Arcoplate, with a diameter 1-2mm larger than that of the inserts, and the inserts welded in from the mild steel side of the Arcoplate.

Machined mild steel insert for a countersunk head socket screw.

JOINING ARCOPLATE

Arcoplate can be joined to itself or other structural steels to form larger panels and/or in the fabrication of bins and chutes. Because of the differing properties of the mild steel and alloy sides of Arcoplate, fabrication techniques differ slightly from standard structural steels. The main point to consider is that welds on the mild steel side **only** are considered structural, and parts are not to be joined to the hardface. Any welding on the hardface is a matter of wear protection only. The following section details the most common methods used in joining Arcoplate, however, ASI can tailor designs to suit your requirements.

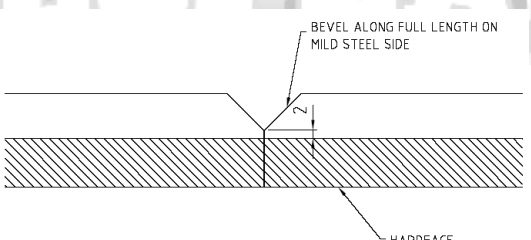
Joining Flat Sheets of Arcoplate

Arcoplate sheets can be joined to form larger panels with a partial penetration butt weld on the mild steel side. Alloy Steel International can cater for your plate joining needs with our expertise and workshop setup; however, should you wish to undertake this work yourself, the following section can be used as a guide.

Joining Mild Steel Side

The process starts with mild steel side of the Arcoplate, which provides the structural strength of the join. Turn the Arcoplate sheets so they are mild steel up and bevel the edges to be joined.

Bevel Size = Base Metal Thickness minus 2 mm (3/32")



Joining Mild Steel Side

Once all joining edges have been beveled, butt the sheets up against one another on a suitably flat bench. It is best to leave about a 2mm gap between each of the sheets to assist in welding the alloy side. All sheets then need to be dogged down hard against the bench. Figure 5.1 below shows Arcoplate sheets that have been 'dogged' down at one end. The correct procedure for dogging down Arcoplate sheets over their full length during welding is illustrated in Figure 5.3

5.1 Dogged down Edge

5.3 Correct Dogging Down

Joining Mild Steel Side

Next the sheets/joins must be cleaned to remove any foreign material from the weld zone. This can be done easily using a jet of air from an air compressor. After the job is cleaned you can make your first or root pass. We recommend using either:

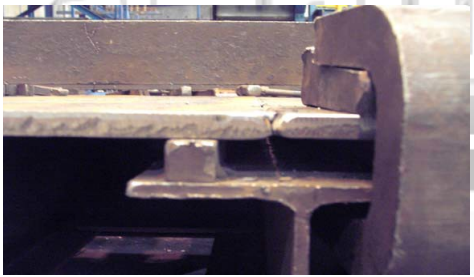
1) 3 mm dia E7018 @90-11OA for SMAW.

2) 0.89 mm to 1.14 mm dia E7OS-X @ 100-110A for GMAW.

The root pass must not melt through the "land" into the hardfaced layer. This can cause hardfacing carbon to be picked up by the weld metal, resulting in a weld that is hard and brittle. For the fill passes, use 4 mm (1 /8") or 5 mm (3/16") dia E7018 electrode for SMAW welding, depending upon the plate thickness, or a standard E70S MIG wire for GMAW. Use the manufacturer's recommended amperage range for the electrode chosen.

Joining Mild Steel Side

NOTE: The aforementioned recommendations are general guidelines for joining the Arcoplate Alloy range. Any welding procedures, process, or combination of processes that is normally used at your plant will work in welding together mild steel base metals. Figure 5.2 below shows the end view of two plates to be joined together. It is recommended that welds runs be kept to 300mm and staggered over the plate, to prevent excessive localized heat build up. Once all weld joins have been completed, turn plate over and prepare to weld the gap on the alloy side with Arco Alloy 880.



Arco Alloy 880

Arco Alloy 880 is a complementary weld overlay for the Arcoplate range of alloys. It is a 1.6mm diameter flux core wire that has a chemical composition that closely matches that of Arcoplate. It can be used in a standard MIG welder and being a flux core wire, does not require gas. Arco 880 welding should be completed by a competent welder, complete with personal respirator (MSDS is available from Alloy Steel International).

Welding the Alloy Side

Before welding the alloy side, it is important to note that hardface welds are **not** structural. They are simply a sealing weld for the joins to limit any potential channel wear. For this reason it is not necessary to bevel the edges on the alloy side. The Arco 880 is simply forced into the gaps between the sheets as a filler. If the gap between the sheets is less than 2mm, it maybe necessary to run a thin grinding disc along the join to open it up enough to fit the Arco 880 wire. Before welding, it is again important to dog the Arcoplate panel hard against a flat surface, to limit any deformation from the heat input.

Welding the Alloy Side

As with the mild steel side, weld runs should be kept to 300mm long and staggered over the plate. This is particularly important with the hardface as localised heat build up will encourage excessive cracking. It is normal for the hardface weld to crack when welding with Arco 880. This is not detrimental to the liners structural integrity nor its wear performance. Do not attempt to repair these cracks as it will only induce more cracking When all weld joins are complete, it is necessary to grind all weld on the hardface flush so as to maintain the smooth surface of the Arcoplate. This step is very important from a wear perspective, as raised weld beads (like those on Duaplate, Vidaplate, AOA etc.) ccelerates wear rates. When welding the hardface of polished Arcoplate, extra care should be taken to protect the polished finish, as weld spatter leads to pitting. We recommend using a spatter template. A final polish maybe necessary along the weld joins after completion.

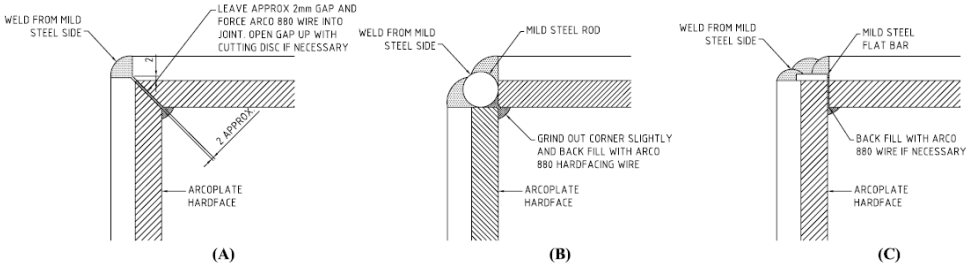
Structural Arcoplate Fabrication

Although Arcoplate is designed for use as a liner, it can be used structurally in the fabrication of chutes, hoppers and bins. The fact that its primary use is not as a structural steel means a little extra care has to be taken when using Arcoplate in this way. ASI should be consulted during the design process; however, this section can be used as a preliminary design guide.

Corner Joints

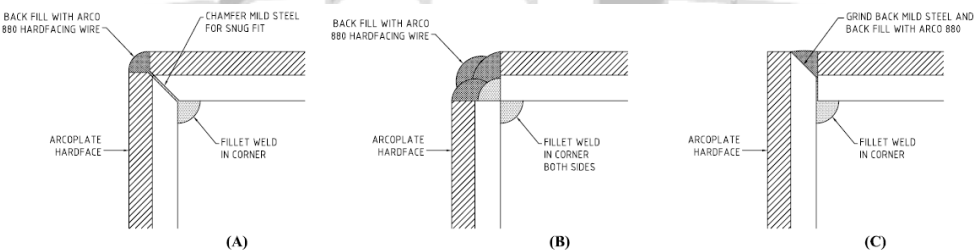
As with joining flat sheets of Arcoplate, the weld on the mild steel side only forms the structural component of a corner join. From a wear perspective, A and C offer the best protection as they give you the full depth of alloy in the corner. Option A requires chamfering of the hardface, which, whilst giving a neater finish, can be time consuming and costly. It is important with options B and C that the structural weld is kept at least 2mm from the alloy fusion line.

Arcoplate corner joints (hardface is on the inside).



Corner Joints

A sealing weld on the inside corner of all joins is recommended, but unlike flat sheets, can be left proud.



Arcoplate corner joints (hardface is on the outside).

Corner Joints

Below illustrates the more common methods used to join Arcoplate when the hardface is on the outside of the corner. Option B has a second fillet weld on the outside. A and B offer better wear protection on the corner, although option B requires more welding (which generally leads to more cracking). It is necessary with option C to grind back some of the mild steel and back fill it with Arco 880 for extra protection.