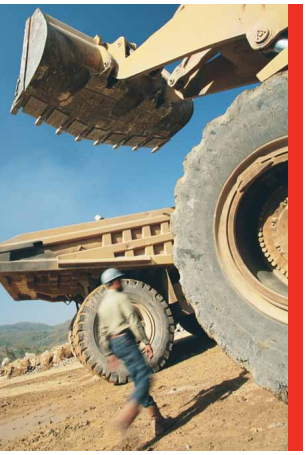
BISPLATE® 450

Shaping Australia's Future

Bisalloy Steels®

BISPLATE® 450

BISPLATE® 450 is a through hardened, abrasion resistant steel plate, with guaranteed high impact toughness.



Applications

Long life expectancy in high impact abrasion applications makes BISPLATE® 450 the ideal choice for a variety of applications, including:

- Dump Truck Bodies
- Mining Buckets
- Tipper Bodies
- Cutting Edges
- Dump Truck Wear Liners
- Construction Waste Bins
- Liner Plates/Chutes

Available Sizes

Thickness (mm)	Size (Width mm x Length m)
6, 8	2485 x 8
10, 12, 16, 20, 25	2485 x 8 and 3100 x 8
32, 40, 50	2485 x 8

(Other widths/lengths available on enquiry)

Chemical Composition, Weight % (Max)

Thickness (mm)	C	P	Mn	Si	S	Ni	Cr	Mo	B	CE (IIW) Typ Avg	CET Typ Avg
6-20	0.23	0.025	1.00	0.60	0.008	0.25	1.00	0.25	0.002	0.46	0.30
25-50	0.25	0.025	1.20	0.60	0.008	0.25	1.20	0.35	0.002	0.58	0.36

Mechanical Properties*

0.2% Proof Strength	Tensile Strength	Elongation in 50 mm GL
1150 MPa	1400 MPa	12%

*Typical 20mm thickness

Charpy Impact Properties, GUARANTEED

Charpy Impact (Longitudinal Test), -40°C Test Temperature		
Plate Thickness (mm)	**Test Piece Size** (mm x mm)	**Energy** (J) min
6-8	10 x 5	17
10	10 x 7.5	21
12-20	10 x 10	25
>20-40	10 x 10	20
>40-50	10 x 10	15

Hardness	Specification 425–475 HB, guaranteed.
Testing	Each plate is Brinell hardness tested to AS/NZS 1816, Charpy impact tested to AS/NZS 1544 on a per heat, per thickness basis.
Manufacturing Tolerances	In accordance with AS/NZS 1365. Tighter tolerances may be available on negotiation.
Surface Finish	Shotblasted
Plate Colour Code	Yellow

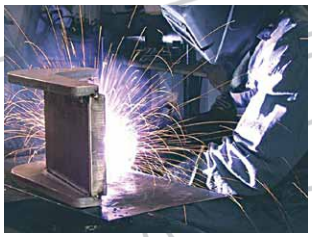
BISPLATE® 450

Manufacturing Recommendations

General Information

Unique chemical compositions and steelmaking processes for BISPLATE® 450 have been developed, incorporating low carbon/low manganese contents. This is designed to improve transverse mechanical properties and produce low levels of segregation and ensures the newly developed BISPLATE® 450 not only has superior mechanical properties but also good formability and weldability.

BISPLATE® 450 can be readily cut, welded, bent, drilled and machined using conventional tools and methods. See additional details provided below.



1. Welding

BISPLATE® 450 can be readily welded using all conventional low hydrogen welding consumables and processes including MMAW, GMAW and FCAW. It can be welded to other weldable steels.

HYDROGEN CONTROL

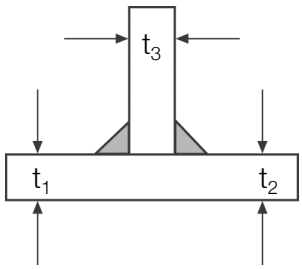
To ensure adequate welding of BISPLATE® 450 plates it is necessary to be more mindful of the levels of hydrogen introduced during welding to minimise the risk of weld and HAZ cold cracking. Weld hydrogen contents can be minimised with careful attention to the cleanliness and dryness of cold joint preparations, and the use of hydrogen controlled welding consumables. Please consult consumable manufacturers for further guidance in the correct care and handling of low hydrogen consumables.

PREHEAT AND HEAT INPUT

BISPLATE® 450 was designed to be a preheat-free steel grade (up to 40mm joint combined thickness) which have been tested and verified by BSL*. Butt welds up to 20mm plate do not need preheat under normal restraint conditions. However, if ambient humidity is high and/or the temperature is below 5°C, slight preheating to remove chill from the plate is necessary. For fillet welding, if the joint combined thickness is less than 40mm, no preheat is required. To weld plates with joint combined thickness greater than 40mm, preheat is required as shown in Table 1. BISPLATE® 450 should be welded in the working temperature range of 25–200°C, but this is dependant on plate thickness and restraint conditions. The temperature should be maintained throughout the entire welding operation, in particular tack welding and root passes. The preheat/heat input recommendations are outlined in Table 1. Do not preheat plates above 200°C.

Table 1 *Preheat/heat input recommendations for BISPLATE® 450*

BISPLATE® 450	Joint Combined Thickness ($t_1+t_2+t_3$)		
	≤40mm	>40≤60mm	>60≤100mm
Minimum Pre-heat °C	nil	100	125
Max Interpass Temp °C	150	175	200
Max Heat Input* kJ/mm MMAW, GMAW	2.0	2.5	2.5



** Heat input (kJ/mm) = Volts x Amps x 0.06 / Travel Speed (mm/minute)*

Note: *Preheating temperatures in Table 1 are for welding under normal restraint conditions. If under rigid restraint conditions, preheating temperature should be increased by 25°C. For joint combined thicknesses >100mm please refer to the manufacturer.*

SELECTION OF CONSUMABLES

When selecting consumables consideration should be given to maximum allowable strength and toughness and levels of restraint encountered within the weldment. To obtain optimum weld joint properties of adequate design strength and good toughness, it is necessary to select a consumable with the lowest strength allowable and high inherent toughness. Weld joints located in low stress areas should be carefully considered by designers.

**Refer BlueScope Steel® Technology Laboratories Report, PK/TIC/05/005.*

Lower strength consumables are undermatching for BISPLATE® 450 grades and offer better ductility and toughness and reduce the susceptibility to cracking in the weld joints. The recommended consumables are listed in Table 2, shown below.

Table 2 *Recommended AS and AWS classified consumables for welding of BISPLATE® 450*

Welding Process	Strength Level	AS Classification	AWS Classification
MMAW	Lower	E55XX, E48XX	E80XX, E70XX
GMAW	Lower	W55XX, W50XX	ER80S-X, ER70S-X
FCAW	Lower	E70XX, E71XX	E71XX, E81XX

Note: *1. Consumables listed in Table 2 are ferritic. Austenitic consumables may be used under high restraint welding conditions that require higher levels of ductility and toughness in the weldment or when the structure is subject to high levels of fatigue loading.*
2. Table 2 only shows the classification of consumable. Fabricators/end users should consult with consumable manufacturers to choose the most suitable consumable for their application.

2. Cutting

BISPLATE® 450 can be cut by all available cutting technologies such as Water Jet cutting, Laser cutting, Plasma cutting and Oxy-flame cutting. No preheating is required for thermal cutting of plates up to 20mm thick, unless the ambient temperature is below 5°C. In high humidity and cold environments, slight preheating (20-50°C) is recommended for all thicknesses. For plates greater than 20mm, minimum preheat of 50ºC is recommended.
Like other types of Q&T steel, BISPLATE® 450 gains its hardness and strength through heat treatment. Effects of heat input during thermal cutting using Laser, Plasma and Oxy cutting methods on size of heat affected zone (HAZ) should be considered.

The sizes of kerf and HAZ for different cutting methods are listed in Table 3.

Table 3 *Sizes of Kerf and HAZ for different methods of cutting BISPLATE® 450*

6–50mm Plate	Kerf Width	HAZ Width
Water Jet Cutting	1-3mm	nil
Laser Cutting	<1mm	0.2–0.5mm
Plasma Cutting	2-4mm	2-4mm
Flame Cutting	2-5mm	2-8mm

3. Bending

BISPLATE® 450 can be cold bent by the brake press-bending method as shown in Fig 1. Plate rolling techniques can also be employed. However, BISPLATE® 450 has higher hardness and strength levels compared to plain carbon steels and therefore suitable consideration of sufficient machine power, plate bending direction and former radii (R) must be made. BISPLATE® 450 should be bent at room temperature or below 200°C to avoid reduction of mechanical properties.

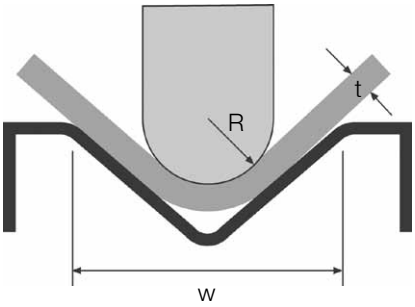


Figure 1 *Schematic diagram of bending.*

BISPLATE® 450, like all hot rolled plate, displays slightly different mechanical properties in the direction of rolling compared to the transverse direction. It is recommended that where possible the bend axis be at right angles to the plate rolling direction (transverse bending) as shown in Figure 2.

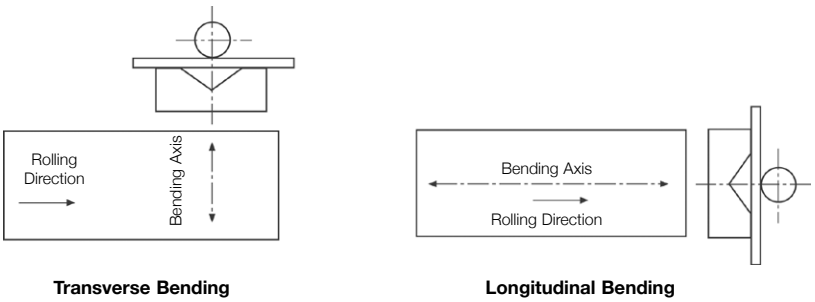


Figure 2 *Schematic diagrams of transverse and longitudinal bend directions*

Former

The minimum former radius (R) related to plate thickness (t) is listed in Table 4.

Table 4 *Minimum former radius for bending of BISPLATE® 450*

Plate Thickness (mm)	Minimum Former Radius, R (mm)	
	Trans.	Long.
6	25	30
8	32	40
10	40	50
12	48	60
16	64	80
20	80	100
25	100	130
32	130	160
40	160	200
50	200	250

Note:
1. *Bending should be conducted at room temperature or below 200°C. Bending BISPLATE® 450 at low temperatures (<10°C), requires an increase in former radii of 50% minimum.*
2. *When bending using these minimum former radii, the flame cut hardened edge (heat affected zone 1-2mm) should be removed before bending. Welded components are not recommended to be bent using the values in the table. Cut and sheared edges should be ground and rounded with grinder.*
3. *For best bending results ensure adequate lubrication between the plate, die and former. Proper lubrication can reduce bending forces by 10–25%.*
4. *For single pass pressing, a former radii increase of 50% (min.) is required.*

Die

The die edges must be clean and undamaged. The bending force and the risk of cracking can be reduced by using round edge die and by lubricating the die edges. The relationship between die opening (W) and plate thickness (t) for bending BISPLATE® 450 is listed in Table 5.

Table 5 *Die opening, minimum*

Transverse Bend (W/t)	Longitudinal Bend (W/t)
10	12

Spring Back

Spring back after bending is expected due to the high hardness of BISPLATE® 450. It has been estimated that about 10-15° spring back can be expected. Therefore, the opening angle of the die must allow a sufficient amount of over bending to overcome spring back.

4. Machining

BISPLATE® 450 is able to be machined (drilling, countersinking, tapping, turning and milling) with tools equipped with replaceable carbide inserts.

DRILLING

BISPLATE® 450 is able to be drilled either by cobalt type high speed steel (HSS-Co), solid carbide or replaceable carbide inserts. In all cases, suitable high powered and rigid drilling equipment should be used to minimise vibrations.

Recommendations for improved results:

- The supporting bars under the plate should be placed as close to the hole as possible
- If possible, use a plain carbon steel backing plate under the BISPLATE® 450
- The drilling head should be placed as close as possible to the main support
- Short length drills are preferred
- Usage of adequate and abundant coolant

Approximate feeds and speeds using different drills are listed in the following tables 6–8

Table 6 *Cutting speed and feed rate when using HSS-Co type drill (8% cobalt with small helix angle and a robust core that can withstand high torques)*

Diameter (mm)	Speed n (rpm)	Feed Rate (mm/rev)	Cutting Speed (m/min)
5	440	0.05	~7*
10	220	0.09	~7*
15	150	0.15	~7*
20	110	0.20	~7*
25	90	0.25	~7*
30	75	0.30	~7*

** This table applies when cobalt type HSS drills are used with a cutting coolant, if no fluid is used the speed should be reduced.*

Table 7 *Cutting speed and feed rate when using solid carbide drills*

Diameter (mm)	Cutting Speed (m/min)	Feed Rate (mm/rev)
>3mm	30–40	0.10–0.15

Table 8 *Cutting speed and feed rate when using replaceable insert drills*

Diameter (mm)	Cutting Speed (m/min)	Feed Rate (mm/rev)
>12mm	70–90	0.06–0.14

COUNTERSINKING AND COUNTERBORING

Countersinking and counterboring of holes are possible on BISPLATE® 450 with best performance obtained using tools with a revolving pilot. The pilot increases the stability and allows tools with replaceable carbide inserts to be used. Always use coolant.

Table 9 *Cutting speed and feed rate when using replaceable insert tools**

Diameter (mm)	Speed n (rpm)	Feed Rate (mm/rev)	Cutting Speed (m/min)
20	450	0.15–0.20	25–30
25	360	0.15–0.20	25–30
32	250	0.10–0.15	25–30
40	200	0.10–0.15	25–30
60	150	0.10–0.15	25-30

** If the machine power is low, reduce cutting speed.*

BISPLATE® 450

TAPPING

With the correct tools and cutting speeds, tapping can be performed on BISPLATE® 450 plates. High alloyed taps with higher hardness than BISPLATE® 450 have to be used.

Difficulties that commonly arise when thread cutting higher hardness steels include tap sticking, torn threads and the short life of taps. The prototype brand tools have been specifically developed for tapping in the BISPLATE® grades of steel. For through-holes of up to 2 times diameter in thread depth, the following tool and tapping speed are recommended.

The introduction of stress concentration (as a result of tapping) is an important consideration in fatigue applications.

Table 10 *Tool and tapping speeds for BISPLATE® 450*

Tap Type	Tap Speed (m/min)	Size Range	Lubrication
Prototex Ni 202602	3	M1.6–M24	Cutting Oil

With all tapping it is recommended that the cutting speed is accurately controlled and cutting oil or grease should be used.

MILLING AND TURNING

Milling and turning can be performed satisfactorily on BISPLATE® 450 using cemented carbide tools.

Table 11 *Milling and turning recommendations*

	Cemented Carbide Tooling Grade	Surface Speed v_c (m/min)	Feed Rate per Tooth
Milling	GC4030	100	0.25mm
Turning	GC4025	100	–

Other milling requirements:

- When milling flame cut edges, the cutting depth should be at least 2mm to cope with the unevenness of the edge
- Firm clamping of the workpiece
- Use cutters with the smallest possible gap between the teeth
- Avoid, if possible, the use of a universal cutter head which generally causes weakening of the power transmission and the tool mounting
- Machine stability permitting, unidirectional milling is preferable

Requirements for turning operation:

- Firm clamping of the workpiece
- Avoid long overhangs for both workpiece and tool holder
- Use correct tip radius: too large a tip radius, with insufficient clamping, causes vibrations
- Small setting angles also can cause vibrations

Formulas:

Cutting Speed (Surface Speed)	$v_C = \pi Dn/1000$ Speed $n = 1000\ v_C/\pi D$	D – Cutter diameter (mm) n – Speed (rpm)

Wear Performance

Wear testing performance has been independantly evaluated and reported by AMTC*. This was conducted under low-stress sliding abrasion (Dry Sand Rubber Wheel) and impact sliding abrasion (Paddle Wear) tests. These test methods are designed to simulate typical mining industry wear environments.

In general, results indicate BISPLATE® 450 demonstrates similar wear performance compared to European sourced 450 Brinell steels. In thicknesses <12mm BISPLATE® 450 demonstrated superior wear performance.

*Advanced Manufacturing and Technologies Centre, Central TAFE, WA.
(Summarised report available on request to Bisalloy Steels®.)

Shaping Australia's Future

For over 30 years, Bisalloy has proved it's in its element as Australia's manufacturer of quenched and tempered steel plate. Plate that not only meets standards, but has become the standard, in Australia and overseas.

Bisalloy Steels®

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