

## SUMMARY TABLES

### Structural Steel Grades

Steel Grade	Plate Thickness (mm)	Carbon Equivalent (IIW)	Brinell Hardness (HB3000/10)	Mechanical Properties									
				Tensile				Charpy V-Notch Impact					
				Plate Thickness (mm) (Min)	0.2% Proof Stress	Tensile Strength (MPa) (Min)	Elongation In 50mm GL	Plate Thickness (mm)	Energy (J) (Min)	Test Temp (°C)	Test Direction		
<b>Bisplate 60</b> (AS 3597 Grade 500)	5-12	0.40	210	5-100	500	590-730	20%	5	By Agreement	-20	L		
	>12-80	0.50						6-9.5		45		-20	
	>80-100	0.58						9.5-12		60		-20	
								13-100		80		-20	
<b>Bisplate 70</b> (AS 3597 Grade 600)	5-12	0.40	230	5-100	600	690-830	20%	5	By Agreement	-20	L		
	>12-80	0.50						6-9.5		40		-20	
	>80-100	0.58						9.5-12		60		-20	
								13-100		75		-20	
<b>Bisplate 80</b> (AS 3597 Grade 700)	5-12	0.40	255	5	650	750-900	18%	5	By Agreement	-20	L		
	>12-80	0.50		6-65		690	790-930	18%		6-9.5		20	-20
	>80-100	0.58		70-100		620	720-900	16%		9.5-12		40	-20
										13-100		40	-20
<b>Bisplate 80PV</b> (AS 3597 Grade 700PV)	6-100	0.58	255	6-65 70-100	690 620	790-930 720-900	18% 16%	6-100	Lateral Expansion 0.38mm min	By Agreement max 0°C	T		

### High Hardness Steel Grades

Steel Grade	Plate Thickness (mm)	Carbon Equivalent (IIW)	Brinell Hardness (HB300/10)	Mechanical Properties					
				Tensile			Charpy V-Notch Impact		
				0.2% Proof (MPa)	Tensile Strength	Elongation In 50mm	Energy (J)	Test Temp (°C)	Test Direction
<b>Bisplate 320</b>	5-12 >12-80 >80-100	0.40 0.50 0.58	320-360	990	1070	16%	55	+20	L
<b>Bisplate 400</b>	5-12 >12-80 >80-100	0.40 0.50 0.58	360-440	1275	1350	12%	42	+20	L
<b>Bisplate 425</b>	6-100	0.62	400-460	1400	1480	11%	38	+20	L
<b>Bisplate 500</b>	6-100	0.62	477-534	1580	1640	10%	31	+20	L

#### LEGEND

L Longitudinal

T Transverse



Guaranteed Values



Typical Values (provided for reference information only)

IIW Carbon Equivalent Formula:

$$C.E. = C + \frac{Mn}{6} + \frac{Cr+Mo+V}{5} + \frac{Ni+Cu}{15}$$



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# bulletin

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## Bisplate Wear Resistance – Low Stress Sliding Abrasion

### Introduction

Bisalloy Steels, based in Unanderra, south of Wollongong in New South Wales, Australia, manufactures the Bisplate® range of high-tensile and abrasion resistant quenched and tempered (Q&T) steel plates.

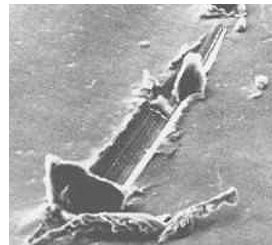
The Bisplate® range of wear grades are the most popular brand of wear plate in Australasia and are sold widely around the world. Continual product improvement has resulted in Bisplate® being widely regarded as possibly the highest quality Q&T steel plate in the world, valued for its superior flatness, through hardness, ease of welding and formability as well as its legendary wear characteristics.

Continual improvements in steel chemistries and processing have resulted in Bisplate® wear grades ongoing incremental improvement in wear characteristics over many years whilst also improving the fabrication characteristics of the plate. With a view to demonstrating these improved wear characteristics, Bisalloy, in conjunction with the University of Wollongong, has undertaken an extensive range of wear tests comparing the Bisplate range of wear grades against its competitors. Two leading European brands of Q&T steel (one water quenched and one oil quenched) and two leading brands of Japanese Q&T steel plate were tested alongside Bisplate® in a series of controlled experiments. The results of these tests, conducted in accordance with American Standards for Testing Materials (ASTM G65), are detailed below.

### Theory Of Abrasive Wear

Abrasive wear is wear by displacement of material caused by hard particles or protuberances. Abrasive wear occurs when particles slide or roll under pressure across the surface of a material and may be classified generally as a) gouging abrasion, b) high stress grinding abrasion and c) low stress scratching

abrasion or erosion. A similar action is involved in all three types of abrasive wear; i.e. a hard particle is dragged across a softer surface and material removal takes place by the formation of chips, leaving a scratch in the surface as shown in Fig. 1.



**Fig.1**  
*Material removal takes place by formation of chips*

Abrasive wear is determined by:

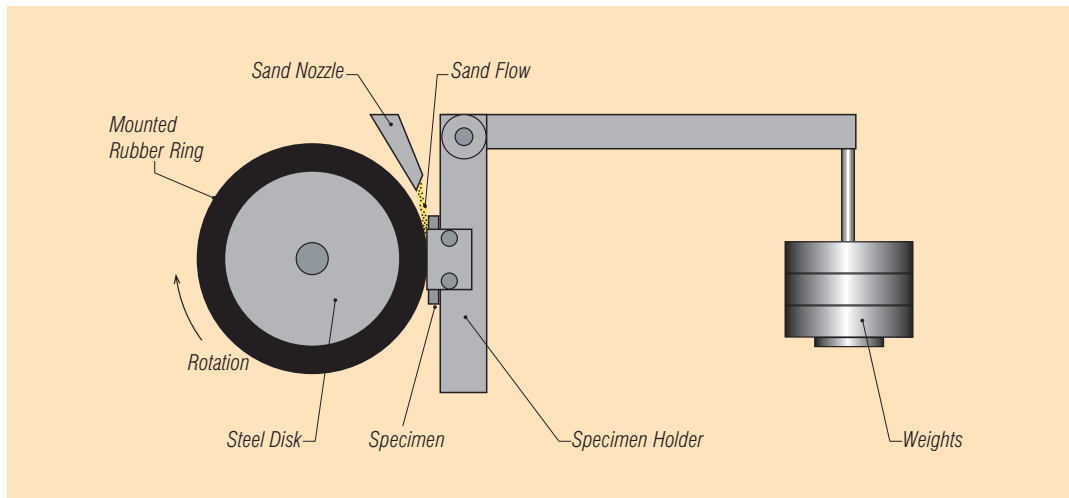
- Properties of wear material.
- Properties of abrasive material.
- Nature and severity of the interaction between abrasive and wear materials.

They are related to the hardness of the material, hardness of the particles and the pressure between the particle and the material surface. According to the simplified abrasion wear theory, volume loss (Q) is proportional to the applied load (N) and inversely proportional to the hardness (H) of the abraded surface for a certain abrasive material applied

$$Q = N/H$$

It can be seen that in a specific working environment, the wear loss of a material is dependent on hardness of the material. In general, as the hardness of the material increases, the wear rate decreases.

To assess the wear properties of Bisplate®, three grades, Bisplate 80®, Bisplate 400® and Bisplate 500® have been tested against mild steel and overseas manufactured Q&T steels under a sliding abrasive wear environment complying to ASTM standard G65-86.



**Fig.2** Schematic diagram of test apparatus (Dry Sand/Rubber Wheel Abrasion Wear)

**Parameters Set Up for Wear Testing** (ASTM Standard G65-86)

Specimen		Abrasive		Rubber Wheel			Time of Test	Load
Dimension (mm)	Surface Condition	Sand Grade	Sand Flow (g/min)	Diameter & Width	Rubber Hardness	Revolution (r.p.m)		
25x10x76	Finely Ground	60	360-380	228 & 12.7mm	A-60	200	30min	130N

**Dry Sand Rubber Wheel Wear Test (DSRW) ASTM G65-86**

DSRW is a standardised low stress sliding abrasion wear test designed to simulate the wear experienced in applications such as chutes or bins and dump truck liners for post crushed ore.

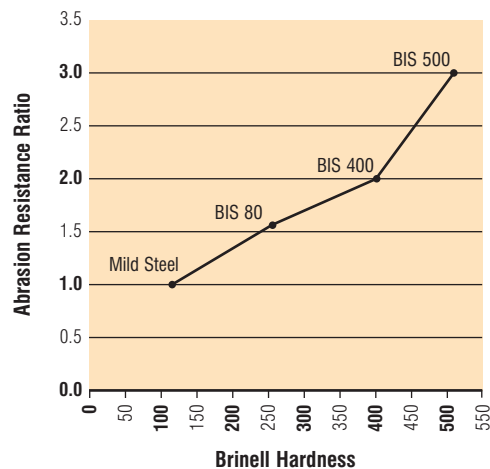
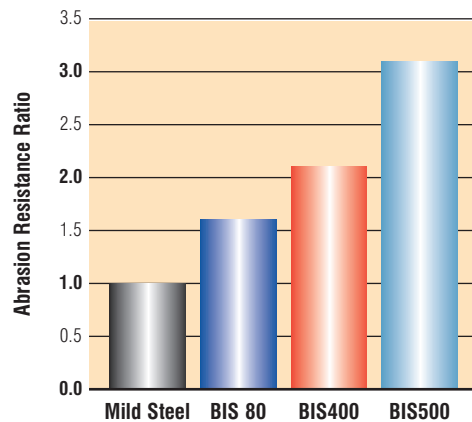
The setup of test apparatus and parameters are shown in Fig. 2 and table above.

**Results**

**1. Relationship between Wear Resistance and Hardness of the Materials**

In general, as the hardness of a wear resistant material increases, the wear resistance ratio increases (Abrasion Resistance Ratio = mass loss of mild steel/mass loss of tested steel). That is, steel with a hardness of 250 Brinell, i.e. Bisplate 80®, has relatively higher wear resistance than mild steel, which has a hardness of 120 Brinell. Bisplate 500® has a hardness twice that of Bisplate 80®.

Therefore it is expected that Bisplate 500® has a much higher wear resistance than Bisplate 80® (see Fig. 3a and b, right).



**Fig. 3** Wear resistance comparison between Bisplate® and mild steel

## 2. Wear Rate Comparison between BISPLATE® and Overseas manufactured Q&T Plates

### Bisplate 80® Structural Type

Bisplate 80® wear was slightly better than one Japanese brand and slightly worse than another. All grades were however very similar in wear resistance.

Bisplate 80® wear resistance was 60% better than mild steel.

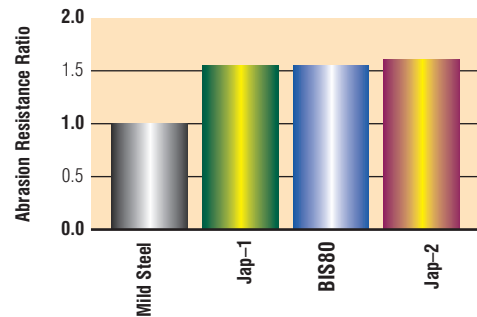


Fig.4 Comparison of wear resistance between Bisplate 80® and Japanese products

### Bisplate 400® Wear Grade

Bisplate 400® was the second best performer of the 400 grades tested. The European grade that was water quenched with a leaner chemistry was slightly worse than Bisplate 400®.

The Oil quenched 400 type steel was about 5% worse than Bisplate 400® in the wear resistance rate.

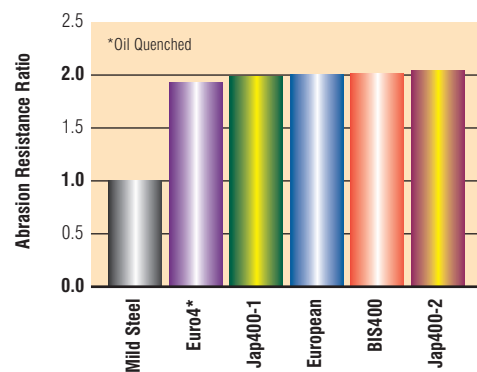


Fig.5 Comparison of wear resistance between Bisplate 400® and overseas manufactured Q&T plate

### Bisplate 500® Wear Type

Bisplate 500® performed very well compared to all Japanese 500 grade plates, 10% better than European water quenched and 30% better than European oil quenched plate.

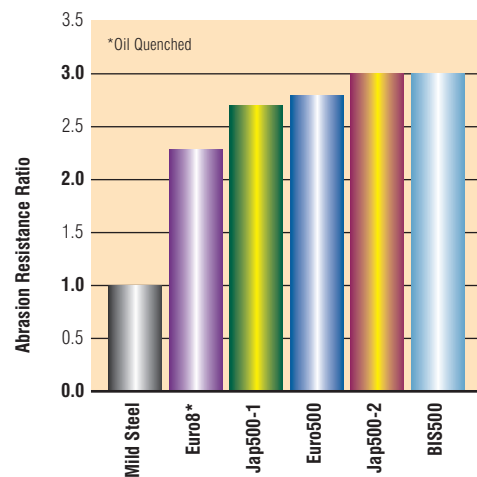


Fig.6 Wear resistance comparison between Bisplate 500® and overseas manufactured Q&T plates

## Conclusions

- In general, the material with higher hardness exhibits a higher wear resistance under abrasion sliding conditions.
- Bisplate performed very well compared to most Japanese plates and always out performed European products in each grade group.
- Water quenched steels performed much better than oil quenched products in every grade group in low stress sliding abrasive environments.