BISPLATE® Wear Comparisons

Bisalloy Steels

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 a surface of the 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.

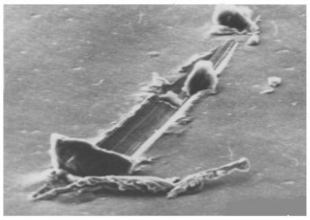

Fig 1 Material removal takes place by formation of chips

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 of BISPLATE® (BIS80, 360/400 and 500) have been tested against mild steel, overseas Q&T steels and clad plates under sliding abrasive wear environment complying ASTM standard G65-86.

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 bin and dump truck liners for post crushed ore.

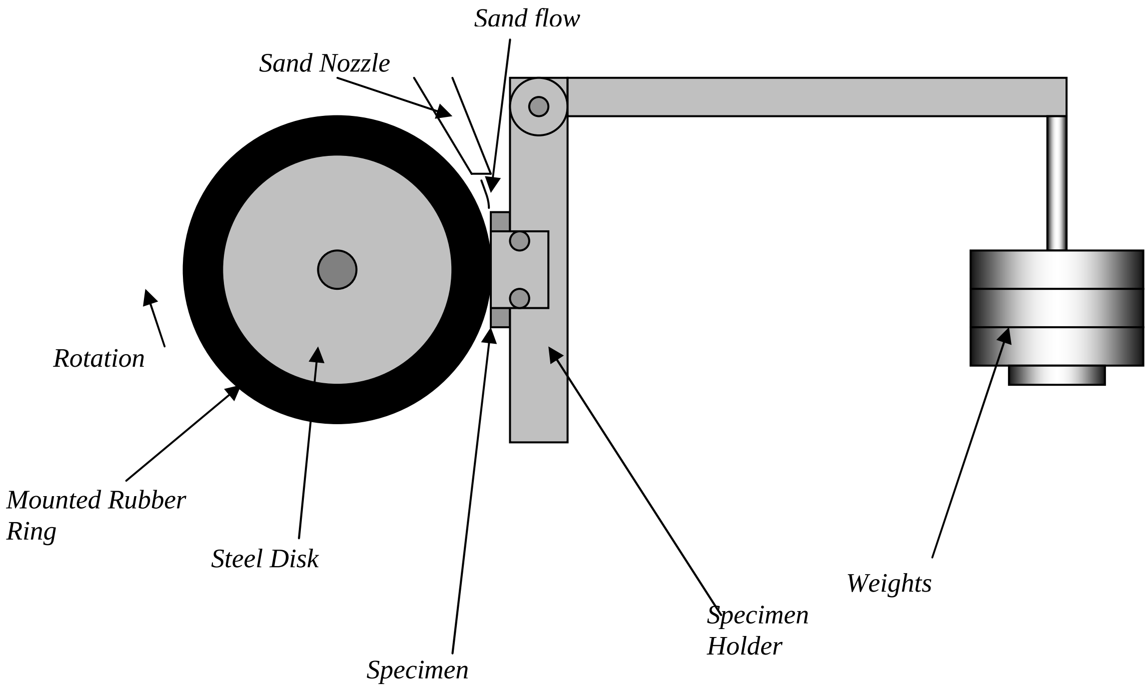

Fig. 2 Schematic diagram of test apparatus (Dry Sand / Rubber Wheel abrasion wear)

Parameters set up for wear testing (ASTM Standard G65-86)

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

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. BIS80, has relatively higher wear resistance than mild steel, which has a hardness of 120 Brinell. BIS500 has a hardness twice high as that of BIS80. Therefore it is expected that BIS500 has a resistance one time higher than BIS80 (see Fig. 3a and b).

BISPLATE® WEAR COMPARISONS

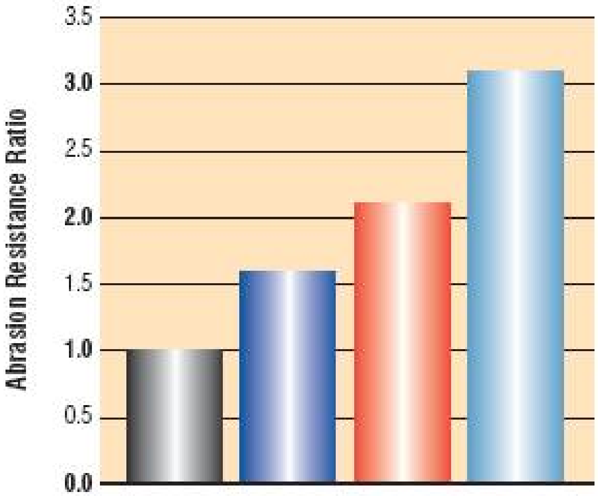

Fig 3A Mild Steel BIS® 80 BIS® 400 BIS®500

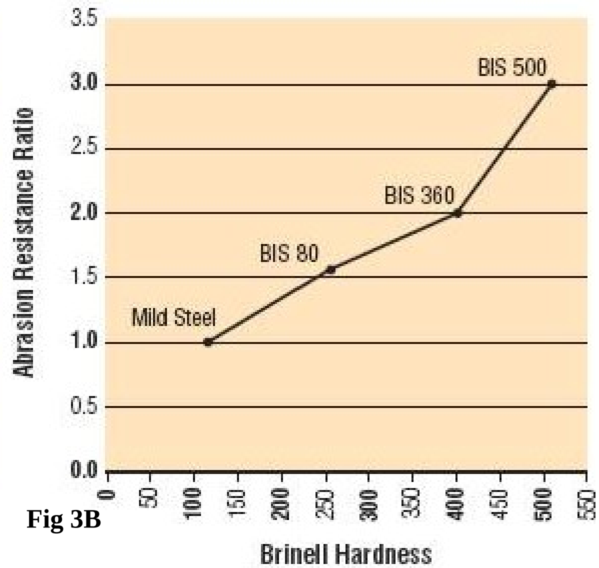

Fig 3B

Fig. 3 Wear resistance comparison between BISPLATE® and mild steel

1. Wear Rate Comparison between BISPLATE® and Other Q&T Products

BIS® 80 Structural Type

BIS® 80 wear was slightly better than one Japanese brand and slightly worse than another. All grades were however very similar in wear resistance. BIS® 80 wear resistance was 60% better than mild steel.

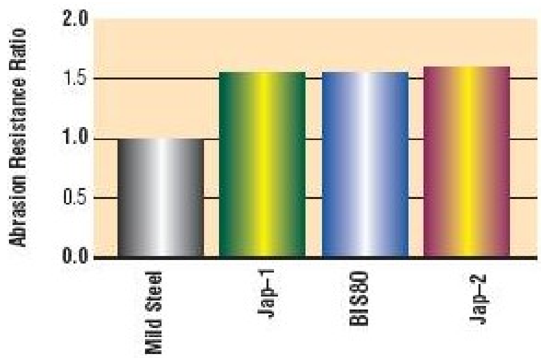

Fig.4 Comparison of wear resistance between BIS80 and Japanese products

BIS® 400 Wear Grade

BIS® 400 performed best from all the 400 grades tested. European grades, which were water quenched with leaner chemistry, were slightly worse than BIS® 400. Oil quenched 400 type was about 5% worse than BIS® 400 in the wear resistance rate.

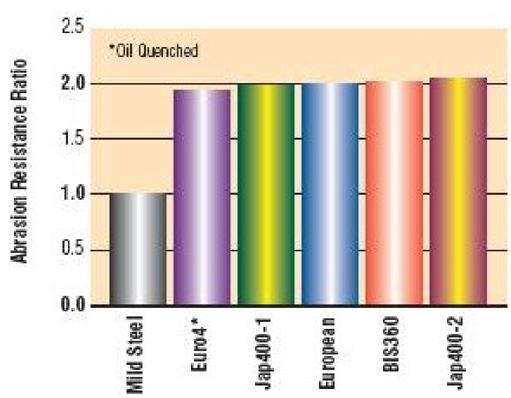

Fig. 5 Comparison of wear resistance between BIS® 400 and other products

BIS® 500 Wear Type

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

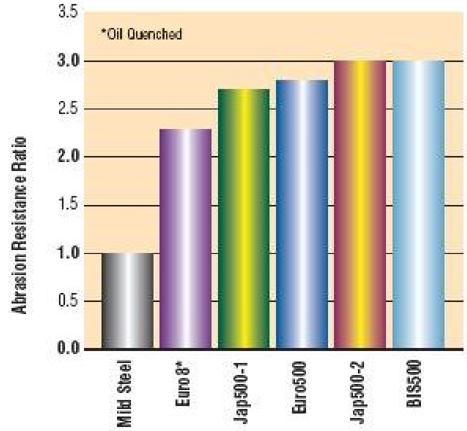

Fig. 6 Wear resistance comparison between BIS® 500 and other products

PADDLE IMPACT ABRASION TEST

The Paddle Wear Testing was conducted at the Advanced Manufacturing Technologies Centre (AMTC), a Division of Central TAFE, Subiaco WA. The testing offers a medium stress impact & sliding abrasion wear normally experienced by such components as chute liners, grizzly bars, and other impact plate liners in mining industries.

The testing is performed by placing two specimens (test material and reference material) to be compared against each other at either end of the Paddle Arm located in a Drum. Both the arm and the drum rotate in the same direction with their speeds being 270 rpm and 45 rpm respectively as shown in Figure 1. Blue metal ore sized between 5.5 and 14.0 mm was used as the abrasion medium. Each test lasts 15 minutes. Three materials were chosen as reference specimens, BIS80, BIS400 and BIS500. The testing materials are listed in Table 1 below, including three Japanese products, four European plates and tow clad (overlaid) products.

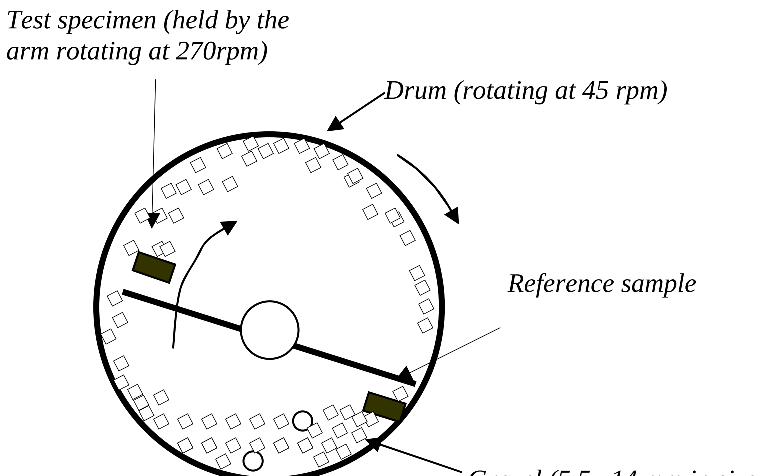

Fig. 1 Schematic set-up of Paddle Wear Tester

Table 1
Test and reference materials

Test Material	Mild steel	Jap400-1	Jap400-2	Euro400	EurO4*
Reference	BIS80	BIS400	BIS400	BIS400	BIS400

Test Material	Jap500	Euro500	EurO8*	DClad	D60
Reference	BIS500	BIS500	BIS500	BIS500	BIS500

* European oil quenched 400 and 500 grade products

RESULTS
Two samples from each material were tested against two same reference samples. The relative wear rate (RWR) of the test material was recorded as:

$$RWR = (ML_t \times \rho_t) / (ML_r \times \rho_r),$$

Where: ML_t and ML_r – mass loss (g) of test specimen and reference specimen respectively, and ρ_t, ρ_r are specific densities (g/cm^3) of test and reference materials respectively.

Table 5
Lists average relative wear rates for the Paddle tested specimens.

Test Material (HB)	Reference Material (HB)	Relative Wear Rate
Mild Steel (121)	BIS80 (255)	1.518
Jap400-1 (425)	BIS400 (424)	1.115
Euro400 (401)	BIS400 (424)	1.015
EurO4 (391)	BIS400 (424)	1.064
Jap400-2 (398)	BIS400 (424)	1.044
Euro500 (495)	BIS500 (503)	0.984
Jap500 (514)	BIS500 (503)	1.036
EurO8 (465)	BIS500 (503)	1.223
D60 (664)	BIS500 (503)	1.462
Dclad (573)	BIS500 (503)	1.164

It can be seen that BIS80 performed 50% better than mild steel under impact abrasion condition. 400 and 500 grade Q&T plates did not show major differences between manufacturers although BISPLATE®s did perform slightly better than most overseas products. Clad plates performed poorly under impact abrasion wear conditions compared to Q&T steel, especially high hardness D60 which experienced almost 50% more wear compared to Q&T plate. Higher mass loss from clad materials compared to quenched plates are caused by chipping off due to impact. Clad layer contains high volume of CrC and this layer is hard but can be very brittle. Under impact, brittle material tends to be fractured and chipped off easily compared to quenched plate.