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FATIGUE TESTING OF HARDBAND PRODUCTS ON HWDP CENTER WEAR PADS

Testing reveals that tungsten carbide in a mild steel matrix is one of the worst choices. Duraband®NC and Tuffband®NC exhibit outstanding fatigue life.

The oilfield industry has long adopted a Tungsten Carbide-Mild Steel hardbanding deposit on Heavy Weight Drill Pipe Center Wear Pads. The claim of its superiority over other types and brands of hardbanding has been that tungsten carbide is imbedded into a mild steel matrix and therefore has superior ductility and performance under fatigue stress cycling. Postle's observations, after a number of fatigue tests with various hardbanding products, suggests otherwise.

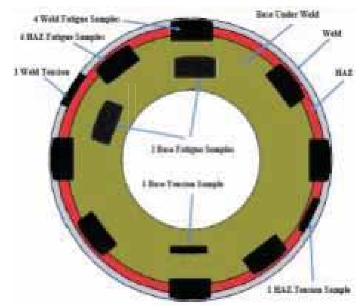

Fig.1 Center Wear Pad cross section schematic showing various sample locations in the hardbanding, HAZ and base material.

Fatigue Testing:
The center wear pad of a heavy weight drill pipe was hardbanded with one layer and included the following products:

- Tuffband®NC
- Duraband®NC
- Tungsten Carbide & Mild Steel
- Titanium

All hardband products were sectioned and EDM machined to yield a test coupon of 3.5" x .375" x .375" in dimension (see Fig.1). The edge under tensile loading was chamfered to ensure fracture on the desired surface. Test coupons were obtained from the base material, HAZ and the hardbanding deposit (see Fig.1).

Various loads were applied to arrive at a level that would yield repeatable data. The ideal load was determined to be 2400 lbs. to 240 lbs. at a frequency of 30Hz (see Fig.2).

Fig.2 A fatigue test sample mounted in the special designed fixture (4 point loading).

Results & Conclusions:

Duraband & Tuffband: All Tuffband and Duraband samples were clean of any blemishes or flaws prior to testing and achieved 1,000,000 cycles when the testing frequency and load were terminated (see Fig.3A and 3B).

Tungsten Carbide & Mild Steel: All samples contained visible tungsten carbide particles on the tested surface, which resulted in fractures at less than 45,000 cycles (see Fig.4). While the carbide particles themselves act as flaws, many times the application of tungsten carbide into a mild steel puddle drags impurities, including porosity, with it and they also lead to premature fatigue failure.

Titanium Bearing: Samples contained flaws in the form of porosity or entrapped slag, which resulted in frequencies from 5,000 to 129,000 cycles to failure. Many of the flaws occurred below the as welded surface and could not be detected by the naked eye (see Fig.5).

Fig.3A **Duraband**. The sample was brought to failure after 1,000,000 cycles. The upper photo shows the cross-section of the fractured surface. Note that there are no flaws in the weld deposit, which produces desirable fatigue failure results. The lower photo shows no flaws in the weld deposit that could produce premature fatigue failures.

Fig.3B **Tuffband**. The upper photo shows the cross-section of the fractured surface. Note There are no flaws on the hardbanding surface. The lower photo shows the sample which exhibited no flaws. **Tuffband** was cycled beyond 1,000,000 cycles to fatigue failure.

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Summary: It is clear from this testing program that hardbandings with surface flaws are highly prone to premature failure by fatigue. This appears to contradict the long held position that Tungsten Carbide and mild steel hardbandings are superior for Center Wear Pad applications over other types of hardbanding. It was also demonstrated that Tuffband and Duraband outperformed all other products tested. This does not come as a surprise because the formulations of both products are carefully monitored to ensure clean and defect free weld deposits. Competitive hardbandings may also outperform Tungsten Carbide and mild steel, provided that they are free of surface defects such as porosity, entrapped slag and cracking.

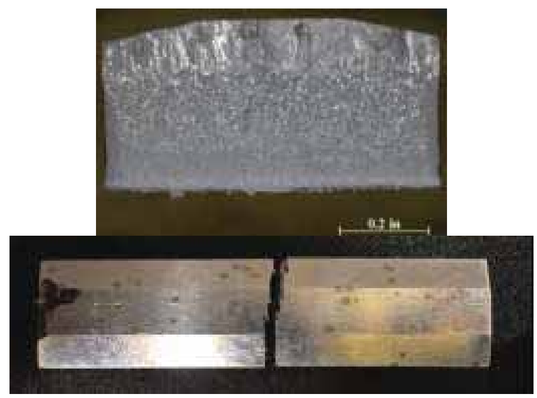

Fig.4 Tungsten Carbide and Mild Steel. The upper photo shows the cross-section of the fractured surface. Note WC particles as the source of the fatigue failure. The lower photo shows numerous WC particles with act as nucleation sites for fatigue failure.

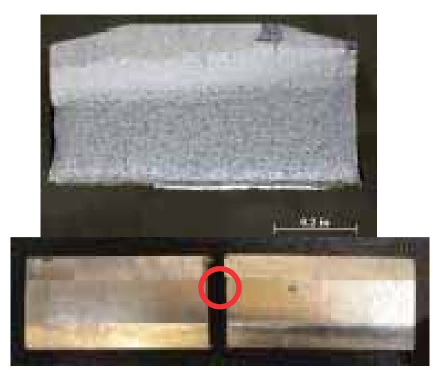

Fig. 5 Titanium Bearing. The upper photo shows the cross-section of the fractured surface. Note the major slag entrapment flaw on the test surface. It was identified as the fatigue failure source. The lower photo shows another slag entrapment flaw that did not cause a fatigue failure.