INDUSTRIAL MAINTENANCE ENGINEERING

Comprehensive Engineering Guide to Hensley Bimetallic Wear Products: Optimization, Metallurgy, and Installation

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In the heavy industrial sectors of mining, construction, and aggregate processing, the degradation of equipment due to abrasive forces represents one of the most significant overhead costs. Ground Engaging Tools (GET) and structural components of earthmoving machinery are subjected to extreme stress, leading to material loss through various mechanisms of wear. To combat these challenges, **Hensley Industries** has developed a sophisticated line of **bimetallic wear products**, including chocky bars, wear buttons, and runners. This guide provides an in-depth technical analysis of these components, their metallurgical properties, and best practices for field implementation.

The Fundamental Challenge of Wear in Heavy Industry

Industrial wear is rarely a singular event but rather a continuous process of surface degradation. In the context of excavation and material handling, wear typically manifests in three primary forms: **abrasion**, **impact**, and **erosion**. High-abrasion environments, characterized by the presence of silica, quartz, or other hard minerals, demand materials with exceptional hardness. However, extreme hardness often comes at the cost of brittleness. The engineering challenge is to create a component that offers the surface hardness of a ceramic-like metal while maintaining the structural integrity and weldability of structural steel.

The Bimetallic Solution

Hensley's bimetallic wear products solve this paradox by bonding two distinct materials. The working surface is composed of **High Chromium White Iron (HCWI)**, typically conforming to ASTM A532 standards. This layer provides the hardness necessary to resist abrasive wear. This wear-resistant layer is metallurgically bonded to a **mild steel backing plate**(S235 or equivalent). This secondary layer acts as a buffer, absorbing impact energy and providing a surface that can be easily welded onto equipment without the risk of cracking the brittle white iron.

Metallurgical Composition and Theoretical Framework

The efficacy of Hensley bimetallic products is rooted in the microstructure of the white iron layer. Unlike standard hardened steels, which rely on martensitic transformations, HCWI utilizes primary and eutectic chromium carbides. These carbides are significantly harder than the surrounding matrix, acting as micro-scale barriers against abrasive particles.

Chemical Composition Analysis

The performance of these parts is dictated by their chemical makeup. A typical analysis of the high-chromium layer reveals a high concentration of carbon and chromium, which facilitates the formation of M7C3 carbides.

Element	Concentration (%)	Function in Alloy
Chromium (Cr)	15.0 - 28.0%	Forms hard M7C3 carbides; improves corrosion resistance.
Carbon (C)	2.0 - 4.0%	Essential for carbide formation; increases matrix hardness.
Molybdenum (Mo)	0.5 - 2.5%	Improves hardenability and prevents pearlite formation.
Manganese (Mn)	0.5 - 1.5%	Deoxidizer; increases toughness of the matrix.
Iron (Fe)	Balance	Base metal.

Mechanical Properties and Hardness Scales

Hensley bimetallic products are engineered to achieve a minimum hardness of **63 HRC (Rockwell C)** or **700+ Brinell (HBW)**. To put this in perspective, standard AR400 wear plates typically have a hardness of approximately 40 HRC. The bimetallic structure allows for a hardness differential that can extend the service life of a component by 3 to 10 times compared to traditional quenched and tempered steels.

Product Taxonomy: Chocky Bars, Buttons, and Runners

Hensley offers a variety of geometries to suit different equipment profiles and wear patterns. Understanding the specific application of each geometry is critical for optimizing maintenance cycles.

1. Chocky Bars

Chocky bars are versatile, rectangular strips featuring deep V-shaped notches. These notches serve a dual purpose: they allow the bar to be bent to fit concave or convex surfaces (such as the interior of a bucket) and provide a guide for cutting the bar into smaller segments. The metallurgical bond remains intact even when the bar is formed into a radius, provided the correct procedure is followed.

2. Wear Buttons and Donuts

Wear buttons are circular bimetallic components designed for areas requiring localized protection. Their circular geometry is particularly effective in preventing "shadowing" or "washout"—phenomena where abrasive material flows around a rectangular block and erodes the base metal behind it. The rounded profile allows for a more fluid-dynamic interaction with the material flow.

3. Wear Runners and Skid Bars

These are larger, thicker components designed for the base of buckets or chutes. They act as sacrificial runners that take the brunt of the weight and friction during the loading and dumping process. By concentrating the wear on these replaceable runners, the structural integrity of the main bucket floor is preserved.

Technical Implementation: The Welding and Installation Guide

Proper installation is the most critical factor in the performance of bimetallic wear parts. Improper welding can lead to **bond failure** (delamination) or **stress cracking**in the white iron layer. Hensley emphasizes the use of specific welding processes and thermal management.

Welding Procedures (SMAW and GMAW)

The mild steel backing plate is designed for weldability, but the high-carbon content of the white iron layer nearby necessitates caution. The following guidelines should be strictly adhered to:

- Consumables: Use low-hydrogen electrodes (E7018 or equivalent) for Shielded Metal Arc Welding (SMAW) or ER70S-6 wire for Gas Metal Arc Welding (GMAW).
- Preheating: While the mild steel backing usually does not require extensive preheating, in cold environments, a preheat of 50°C to 100°C (122°F to 212°F) on the base metal is recommended to remove moisture and reduce thermal shock.
- Interpass Temperature: Monitor the temperature to ensure it does not exceed 250°C (482°F). Excessive heat can migrate to the bond line, potentially weakening the metallurgical vacuum braze.
- Weld Sequence: Avoid continuous long welds. Use a staggered or stitch-welding approach to minimize localized heat buildup. Weld from the center of the bar outwards to the ends.

Physical Preparation and Forming

When fitting chocky bars to curved surfaces, the bars should be bent along the V-grooves. If a tight radius is required, the bar may need to be cut at the grooves and welded as individual segments. **Never apply heat directly to the white iron layer** to facilitate bending, as this will cause immediate cracking and loss of hardness.

Comparative Analysis: Bimetallic vs. Alternative Wear Solutions

To justify the investment in Hensley bimetallic products, a comparison against traditional methods is necessary. The table below evaluates three common wear-protection strategies.

Feature	Hensley Bimetallic	Hardfacing (Overlay)	AR500 Wear Plates
Surface Hardness	63 - 65 HRC	55 - 60 HRC	47 - 52 HRC
Installation Speed	Medium (Welding bars)	Slow (Labor intensive)	Fast (Bolted/Welded)
Impact Resistance	High (Due to steel backing)	Low to Medium	Very High
Depth of Wear Layer	Uniform (up to 25mm+)	Variable/Thin	Full Thickness
Cost per Hour of Life	Lowest (Longest life)	Medium	High (Frequent replacement)

Engineering Case Study: Excavator Bucket Optimization

Consider an excavator operating in a granite quarry with a high silica content. The original bucket floor, made of 20mm AR450 steel, requires structural repair every 400 operating hours. By implementing a grid pattern of **Hensley Chocky Bars (CB 40)** and **Wear Buttons (WB 75)**, the maintenance cycle can be fundamentally altered.

The "Dead Bed" Effect

By spacing the chocky bars approximately 50mm to 75mm apart, engineers can create a "dead bed" effect. Abrasive material (rocks and fines) becomes trapped between the bars. Subsequent material flow then rubs against the trapped material rather than the bucket floor. This "stone-on-stone" wear significantly reduces the abrasive energy reaching the steel components.

Calculated ROI Formula

The Total Cost of Ownership (TCO) can be calculated using the following model:

TCO = (Cp + Ci + Cd) / L

- Cp: Cost of parts
- Ci: Cost of installation (labor + consumables)
- Cd: Cost of downtime (lost production revenue)
- L: Service life in hours

In most high-abrasion applications, while **Cp** is higher for bimetallic products, the significant increase in **L** and the reduction in **Cd** result in a 40% to 60% reduction in total operating costs over a 24-month period.

Troubleshooting and Failure Mode Analysis

Even the highest quality wear parts can fail if applied incorrectly. Understanding failure modes is essential for site supervisors.

1. Delamination (Bond Failure)

If the white iron layer separates cleanly from the steel backing, the cause is usually excessive heat during welding or a manufacturing defect in the vacuum braze. If the separation shows signs of blue/purple tinting on the steel, the part was likely overheated during installation.

2. Stress Cracking (Checking)

Fine hairline cracks on the surface of the white iron are normal and often expected; these are known as "relief cracks." They occur during the cooling process of the casting. However, if these cracks propagate into the steel backing or cause large chunks of iron to fall away (spalling), it indicates excessive impact or improper structural support of the wear part.

3. Accelerated Washout

If the mild steel backing wears away faster than the white iron, leaving the iron layer protruding significantly, it may lead to premature breakage of the iron due to lack of support. This is often solved by adjusting the welding pattern to provide more edge protection or using a wider bar profile.

Strategic Implications for Asset Management

The integration of Hensley bimetallic wear products is not merely a maintenance task but a strategic engineering decision. For fleet managers, the transition from reactive welding (patching holes) to proactive wear management (installing bimetallic grids) leads to more predictable maintenance scheduling. In the modern era of data-driven mining, the longevity provided by these materials allows for synchronized maintenance cycles where wear parts are replaced during scheduled engine or hydraulic overhauls, rather than causing emergency stoppages.

Furthermore, the reduction in the total volume of welding required over the life of the machine reduces the cumulative thermal stress on the bucket or chute structure. Repeatedly hardfacing or replacing thin AR plates subjects the base metal to hundreds of thermal cycles, eventually leading to structural fatigue and cracking. Bimetallic products, by lasting significantly longer, preserve the mechanical properties of the primary asset. As the industry moves toward autonomous and continuous hauling systems, the reliability of every contact surface becomes paramount, positioning Hensley's metallurgical innovations as a cornerstone of modern industrial efficiency.

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