Excerpt from:

"Castings for the Mining Industry"
-- By John Mortlock, Manager
Technical Services Division
Bradken Consolidated, Ltd.

Types of Abrasive Wear

By convention, three types of abrasive wear are recognized – gouging abrasion, high stress abrasion, and low stress abrasion. These classifications are made on the basis of the operating stresses rather than the actual abrading action.

<u>Gouging Abrasion</u>

This is wear that occurs when coarse abrasive material tears off sizeable particles from wearing surfaces. The type of service involves high imposed stresses and is most frequently encountered in handling coarse materials. The required metal toughness is high and the attainable abrasion resistance is relatively low.

<u>High Stress Abrasion</u>

This is encountered when two working surfaces rub together to crush gritty abrasives. Gross loads may be low while localized stresses are high. Moderate metal toughness is required and medium abrasion resistance is attainable.

<u>Low Stress Abrasion</u>

This type of wear usually involves moving particles, and gross operating stresses are low. Toughness requirements are very low, and the attainable abrasion resistance is high.

When moving parts are involved, it is advisable to make some deference to toughness, as in a slurry pump where low stress abrasion becomes gouging abrasion when a piece of tramp metal goes through the system.

Damascus Steel Casting Company
P.O. Box 257 · Blockhouse Road Run Extension · New Brighton, PA 15066
Call Toll Free 800-920-2210 · Tel: 724-846-2770 · Fax: 724-846-0448
info@damascussteel.com

In most cases, the expense involved in insuring against such an occurrence is offset by the larger life results from the use of more abrasion-resistant alloys.

Wear Resistant Castings

Having outlined the nature and types of abrasive wear, together with the factors influencing wear, it can be seen that the severer abrasive conditions encountered in handling many raw materials make it important that the equipment involved be constructed from materials resistant to abrasion yet compatible with other service conditions. Consequently, wear rate and part replacement make materials selection an important economic consideration in all industries which mine, process and handle ores, earthen materials and synthesized solids.

Let us now look at the various cast steels and irons available to the mining industry in these concepts.

Austenitic Manganese Steels

The present family of austenitic manganese steels evolved from an original grade first proposed by Sir Robert Hadfield in the late 19th century and is still the traditional material used for all heavy crushing applications.

The reasons for this are to be found in their high resistance to gouging wear, coupled with probably the highest toughness of any of the wear resistant steels.

It appears that austenitic manganese steel has the capacity to absorb a great deal of deformation before fracture and it is this aspect of toughness which enables it to work harden to a high hardness in service, and which confers its resistance to gouging abrasion.

Many alloying elements have been added to the original composition, and there have been variations in the base composition as well. The only significant factor controlling the wear resistance of manganese steel is the carbon content.

While it is possible that other alloying elements, such as chromium and molybdenum, contribute to wear resistance, evidence of this is not well documented.

Damascus Steel Casting Company
P.O. Box 257 · Blockhouse Road Run Extension · New Brighton, PA 15066
Call Toll Free 800-920-2210 · Tel: 724-846-2770 · Fax: 724-846-0448
info@damascussteel.com

(Although ASTM Specification A128) allows considerable latitude in the composition of austenitic manganese steel, the demands of both the foundry and the user have established practical limits for best performance in service and ease of manufacture in the foundry without excessive rejects.

For many applications 1.05% carbon may produce a poor wearing steel, while on the other hand, a combination of 1.35% carbon and 11.0% manganese could result in a steel having undissolved carbides in the grain boundaries, resulting in poor ductility.

Since carbon has an important influence on the wear resistance of manganese steel, it is normally kept as high as can be safely cast and heat treated.

Manganese-Carbon Grades

Five grades of unalloyed manganese steel castings are provided for by ASTM A128, with carbon content being the variable. This provides for the retention of toughness for particular conditions of section size, quenching capability, service stresses and welding.

Unfortunately, there is no rigorous basis for quantifying these factors and indicating the best choice.

The producer should be consulted as to grades practically obtainable for a particular design required. Final selection shall be by mutual agreement between the producer and consumer.

2% Chromium Grade

ASTM A128 Grade C allows for the addition of 1.5% - 2.5% chromium, which is a common additive to manganese steel. Chromium increases the yield strength of austenitic manganese steel, and it is normally used in castings where gross deformation will interfere with the function of a machine.

The 2% chromium grade is reputed to have better wear resistance in certain applications than plain manganese steels, although little evidence is available to substantiate this.

3.5% Nickel Grade

This grade is sometimes chosen for extremely heavy sections, large weld fabrications or to avoid stress problems associated with rapid quenching. At the low end of the carbon range (0.70% C.) castings can be heat treated by air or oil quenching rather than by the convention water quenching, although wear resistance may be sacrificed. Because of its high manufacturing cost and relatively poor abrasion resistance, the use of this alloy is somewhat limited.

Molybdenum Grades

Two grades of molybdenum bearing austenitic manganese steels are covered by ASTM A128.

Grade E-1 containing 1% carbon and 1% molybdenum has a lower critical cooling rate than plain manganese steel, which enables it to be used in a variety of applications involving heavy sections. Its higher yield strength than the .70% carbon-nickel grade provides greater resistance to wear and gross flow under heavy bearing stresses.

Grade E-2 represents a departure from other grades in that it is given a special heat treatment designed to create a carbide dispersion. The dispersion hardened grade has a higher yield strength than plain manganese steel, and it is claimed, an improved wear resistance of 10 percent to 30 percent, although this is hard to substantiate.

The molybdenum bearing grades of manganese steel have found only limited use in this country because of their high cost compared with plain manganese steel.

Damascus Steel Casting Company
P.O. Box 257 · Blockhouse Road Run Extension · New Brighton, PA 15066
Call Toll Free 800-920-2210 · Tel: 724-846-2770 · Fax: 724-846-0448
info@damascussteel.com