Improving Elbow Designs

Randy Dillard and Ken Nichols, A. J. Weller Corp., USA, report on the solution to a mitered elbow wear problem, which was recently implemented for North Texas Cement.

Introduction

North Texas Cement, Midlothian, Texas, US, operates two raw mills and two finish mills. The raw materials consists of limestone, shell and sand, and water is introduced to form slurry. This slurry material is objectively pre-crushed to approximately 4 in. dia, although it is possible for larger size aggregates to reach the elbows. The aggregate feed rate is 85% on a 300 tph scale and the actual is approximately 255 tph.

North Texas Cement had been experiencing extreme wear in the back 18° of its mitered elbows transporting raw material into the ball mill grinding chambers. Due to the high maintenance cost and production interruptions that repair was expected to cost, the company asked the A. J. Weller Corp. to find a cost effective solution.

Replacement of elbows may take anywhere from 4 - 6 hrs and requires the mill to be shutdown. Any leak in the elbow will allow water to leak and create housekeeping and safety issues and, although temporary repairs or patching allow the mill to continue to run, they require constant maintenance and last for only a short period. At this facility, replacing the raw feed inlet elbow requires a shutdown, causing a loss of 1000 - 1500 t of material due to production interruption.

Design

Elbows for this application come in several different designs with variable mitered degrees. One elbow design used chrome carbide overlay plate. This material is 600 BHN with 1/4 - 3/8 in. overlay, but it is not designed to withstand extreme impact. In some cases, chrome carbide overlay lasted approximately 3 months. Because the outer material is mild steel, it can be patched. However, since the internal carbide

Left and right. The North Texas Cement inlet elbow transporting raw feed to the ball mill.

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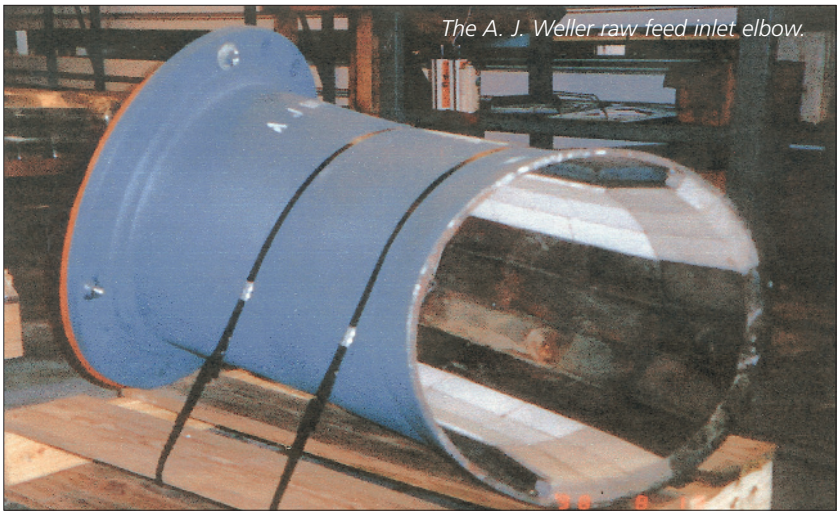
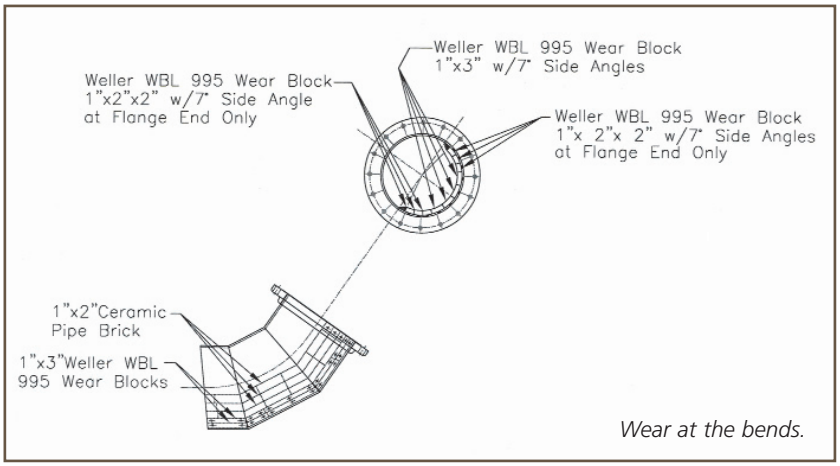


The A. J. Weller raw feed inlet elbow.



Wear at the bends.

was not repaired, the patches wear extremely quickly and require continual maintenance.

Another more common design elbow utilises Hi-alumina ceramics tiles to line the back 180°. Hi-alumina ceramics are one of the hardest known inorganic substances and can handle limestone abrasion. However, it will not handle extreme impact and breakage often occurs, allowing the aggregate to attack the elbow walls. This is the elbow design that was in use at North Texas Cement, where the ceramic lined elbows would often last 3 - 4 months, but were subject to breakage at any time. The Hi-alumina ceramics would often fail within a 2 week period. The ceramics that were used were 1 in. thick and required that the elbow have a flush internal surface. Very little wear was ever noticed on the ceramic tiles but, due to constant breakage, another solution was essential.

High chrome cast elbows are also used in this application. With a hardness ranging from 500 - 600 BHN, they perform well against extreme abrasion although, again, this material is not designed to withstand high impact. High chrome cast elbows are very brittle and subject to cracking in impact applications. In addition, high-chrome material can not be patched or welded, eliminating the possibility of any external repairs due to cracks. Any failure of a Hi-Chrome casting would require a complete replacement of the elbow.

Objective

A. J. Weller's objective was to eliminate constant repairs and replacements. This could be accomplished by designing a cost-effective raw feed inlet elbow that would meet strenuous customer requirements. Significantly extending wear life of the elbow would reduce costly repairs and downtime.

Composite technology solutions

Having inspected the wear patterns inside the elbows, the Weller engineering team observed that there was no breakage to the ceramic tiles located on the high areas of the walls. Since ceramics are cost effective in high wear areas, Weller chose to use the ceramic tiles in the specific areas where wear was high and impact minimal. The tile breakage only occurred in the lower 90 ° of the elbows and the Weller solution was to use Weller WBL-700 wear blocks to line this lower 90 ° area.

The Weller WBL-700 wear blocks are engineered to simultaneously withstand high impact and abrasion. An ultra hard grade of chrome nickel alloy (700 BHN) is cast under tight control of selected chemistry and heat treated for fine microstructure. The component is then metallurgically bonded to a mild steel backing plate. The backing plate absorbs the impact preventing the hard cast material from cracking, as this composite material is more impact resistant than any other material that is currently available.

The 1 in. thick Weller WBL-700 wear blocks were mitered on the sides and ends in the same manner as pipe brick. They were fitted into the lower 90° of the elbow along with the 1 in. thick ceramic tiles to produce the same internal flush fit. Another design consideration was to flange the lower 180° of the elbows making replacement or repairs possible without removing the elbows.

Summary

The Weller raw feed inlet elbow design has operated for 1 year without any required maintenance. This unique composite design can be rebuilt or repaired internally, without requiring the complete elbow to be replaced. This lowers future costs to North Texas Cement.

With the success of this application, the company has installed up to ten similar applications at this facility and its other plants and all applications experiencing similar cost savings.