Reprinted from

WORLD COAL®

A NEED FOR SPEED

CHRIS SCHMELZER AND DANIEL MARSHALL, MARTIN ENGINEERING INC., US, DETAIL HOW INNOVATIVE COMPONENTS ARE HELPING CONVEYOR SYSTEMS DEAL WITH THE IMPACTS OF HIGH-SPEED OPERATION.

As coal mining and processing operations continue the ongoing search for ways to increase production volumes, one area of focus has been the conveyor systems that carry massive amounts of bulk material over long distances at high speeds. One sign of this is the increasing use of wider conveyors that are able to handle larger loads, a viable approach on new material handling systems or those undergoing a retrofit.

Wider belts are typically not an option on existing conveyors; however, many companies are increasing belt speeds to raise throughput. As the trend continues to accelerate, there are a number of challenges that arise. One of the most damaging is the increased heat from friction as the conveyor travels at speeds of 210 m/min or more, placing greater stress on belts, bearings and other components.

Another is the effect of the impact from bulk material being transferred from one conveyor to another. Higher speeds deliver material to the load zone with greater force, which can cause damage to the belt and support structure. The increased impact can

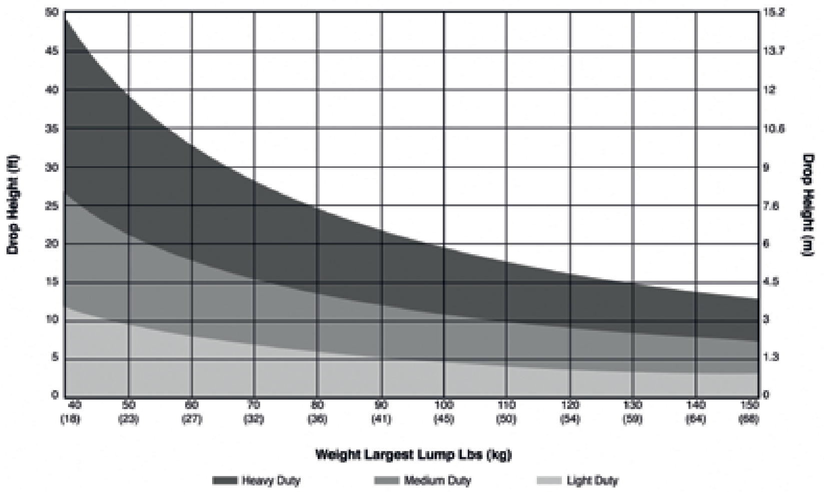

Figure 1. Impact cradle specification guide. Specifying the correct cradle for the application is a function of the drop height and the weight of the largest lump.

Figure 2. The new EVO high-speed roller cradle employs multiple heavy-duty impact rollers spaced close together in a track-mounted configuration.

also destabilise the belt path, allowing fugitive material to escape. At high speeds and volumes, this escaped material can end up as spillage on the ground, or as fugitive material on the return side of the belt, eventually getting trapped between belt and pulleys and causing considerable damage to both.

Further, the effects of higher belt speeds also complicate edge sealing systems designed to contain dust. Higher speeds can cause minor distortions in edge seals, allowing a potential escape pathway for small particles, while the greater friction from a high-speed belt also accelerates wear on elastomer sealing edges. To meet the challenges of higher-speed conveying, there is a growing range of products designed to withstand the inherent mechanical and thermal stresses.

Impact zones

Impact cradles have been in use on mechanical conveyors for some time, and they are critical components of a system that must function at high speed. Developed to absorb the force of falling material and often designed for a specific load range, impact cradles help prevent belt and structure damage, while stabilising the belt line and sealing surfaces.

Martin Engineering has developed light-, medium- and heavy-duty impact cradles to suit specific applications, including modular track-mounted designs for easy maintenance and service. The light-duty components are suitable for impacts up to 8500 lb (38 kN) of force, while the medium-duty products are rated up to 12,000 lb (53 kN). Heavy-duty cradles are engineered for impact forces from 12,000 – 17,000 lb (53.4 – 75.6 kN). All three product groups comply with CEMA Standards 502-1998 and/or 575-2000.

Specifying the correct cradle for the application is a function of the drop height and the weight of the largest lump. Figure 1 provides a selection guide to help determine which cradle is most appropriate for specific lump weights and drop heights.

These traditional cradle designs employ rugged impact bars with a top layer of low-friction ultra-high molecular weight (UHMW) plastic, moulded to a base of shock-absorbing styrene-butadiene rubber (SBR). The UHMW covering minimises drag, which can cause unnecessary belt wear and sap power from the drive motor.

For high-speed applications, the company has developed a two-part urethane formulation that delivers an even lower co-efficient of friction, resulting in less drag and greater longevity. Each impact bar is reinforced with a steel support structure. Adjustable wing supports are easily installed and matched to any standard trough angle, while eccentrics in the wings allow 5˚ of wear adjustment in the outer bars. Impact bars are replaced via four mounting bolts on each.

When properly matched to the operating conditions, these cradles deliver excellent belt support in the load zone as material is transferred from one conveyor to another. However, as belt speeds rose in excess of 210 m/min, field technicians began finding that excess heat build-up was damaging the cradles, eventually resulting in failures. Although the bar design delivers excellent support and a flat sealing surface to contain fugitive material, the friction generated at such high speeds creates too much heat to maintain normal durability. Adding a centre roller helps alleviate the problem to some extent, but the persistence of the issue led Martin Engineering to design a completely new impact cradle and load zone specifically for high-speed/high-tonnage applications.

Developed to withstand the highest speeds achievable with heavy-duty idler rolls, the new EVO high-speed roller cradle takes a different approach to softening material impact, using multiple heavy-duty impact rollers spaced close together in a track-mounted configuration. An elastomer bar suspension allows a defined vertical travel, absorbing the shock of impact and maximising the service life of the belt support structure and rolling components. Because of the track-mounted configuration, the new cradle delivers slide-in/slide-out serviceability, without the need to tip the idler for removal (Figure 2).

In another product development effort currently underway, the EVO heavy-duty load zone uses a catenary idler design to provide belt support in high-speed/high impact applications, but does so in a way that prevents belt sag and maintains edge sealing by minimising the distance between rollers at the belt edges, where sealing takes place. Centre idlers swing freely to absorb impact energy, while idlers at the edge of the belt are restricted to single-axis movement, absorbing impacts and loads yet delivering an effective belt seal (Figure 3). The cassettes raise and lower for individual, single-side removal.

Key to both designs are patent-pending upper connector brackets that link idlers throughout the load zone, allowing them to function as a unified structure. This also permits the addition of multiple sections, all bolted together to prevent them from tipping under heavy loads or impacts.

Tail pulley protection

Tail pulleys are a vital component of a belt conveyor system and, at high speeds, they can be endangered any time a piece of stray material or tramp metal falls onto the return side of the belt. When a lump ends up on the non-carrying side of a high-speed belt, the debris hits the tail pulley with great force, capable of doing significant harm to the belt, pulley and other system components.

When foreign material is trapped between the belt and the pulley, one or more failures are likely to occur. If the material fails, it will break up into smaller pieces as it is trapped between the belt and the pulley. Trapped debris can allow the belt to slip against the pulley, causing the non-carrying underside of the belt to wear prematurely. Even small particles and fines can grind away on the less durable, more easily damaged inside surface of the belt. Further, material that builds up on tail pulleys often causes the belt to wander, which in turn can damage the belt edge and/or the conveyor structure. In some cases, there may also be a risk of fire from the continuous churning and frictional heating of combustible material.

Belt failure is another possibility. Any material trapped between the pulley and the belt also has the potential to force its way out through the top cover of the belt, particularly if the material is a lump with sharp edges. This material creates an uneven belt surface and can be a starting point for longitudinal and profile rips, holes or gouges along the length of the belt.

If neither the material nor the belt fail, the face of the tail pulley is likely to be damaged. A gouged pulley will lead to belt misalignment, belt damage or pulley slippage. The most frustrating problem arising from the entrapment of material between the belt and tail pulley is the fact that it can become a repeating phenomenon. Once a piece of material reaches the pulley, it can be pinched and carried around with the pulley's rotation, then ejected back onto the return side of the belt. Once there, it will again travel

Case study

Prototypes of the EVO high-speed roller cradle were tested at an Arizona mine-for-leach copper facility, where two open pits feed a crushing facility with a capacity of 103,000 tpd. The crushed copper ore is delivered to a single leach pad by a series of overland and portable conveyors travelling at a speed of 260 m/min. At a transfer point handling <0.75 in. (<1.9 cm) agglomerated copper ore with a 20% moisture content, a 72 in. (1.8 m) belt perpendicularly feeds a 60 in. (1.5 m) belt from a straight 12 ft (3.6 m) drop.

The customer was using standard OEM impact idlers in the load zone; however, with the heavy loading conditions, maintenance personnel were forced to change an average of four to five rollers and one or more complete frames every month due to component failures. The standard idlers could not withstand the heavy load and lengthy drop, costing downtime for repairs, as well as the expense of replacement components.

The new cradles were installed and, after seven weeks of operation, approximately 2.9 million t of material were conveyed across the load zone, with zero component failures. The customer estimates that the new cradles from Martin Engineering paid for themselves in just the first week of service, due to the savings in maintenance and downtime.

Figure 3. Heavy-duty impact cradle. With its track-mounted configuration, the new cradle delivers slide-in/slide-out serviceability, without the need to tip the idler for removal.

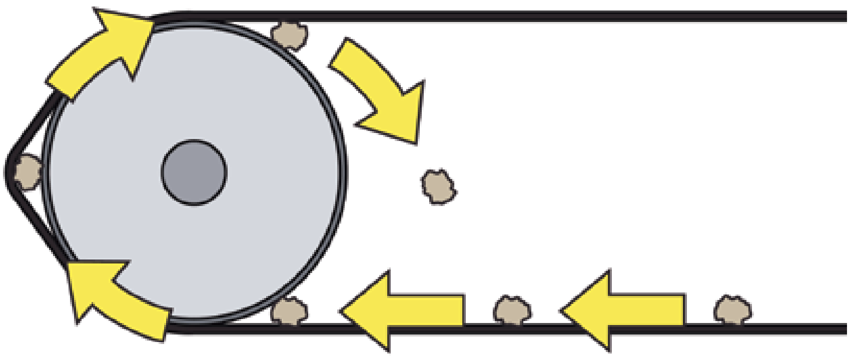

Figure 4. Repeated entrapments. Once a piece of material reaches the pulley, it can be pinched and carried around with the pulley's rotation, then ejected back onto the return side of the belt.

Figure 5. A pulley protection plough removes fugitive materials with a simple, low-pressure scraping that directs material off of the belt.

toward the pulley, where the cycle gets repeated (Figure 4).

In essence, if the lump initially fails to break something, it will repeat its behaviour until a failure occurs or the lump is removed from the belt. If the material is strong enough, it could eventually destroy the entire tail pulley section of a belt conveyor system. This potential damage can be minimised with proper transfer design, but regardless of precautions, there is still the possibility that dislodged components or conveyed material will come into contact with the tail pulley. An easily installed precaution against such danger is a pulley protection plough.

A pulley protection plough removes fugitive materials with a simple, low-pressure scraping that directs material off of the belt. The mission of a plough is to block any large lumps or stray conveyor components, such as broken idler rollers, belt cleaner blades or tramp iron from entering the tail pulley section (Figure 5).

Pulley protection devices are usually designed as a linear or v-shaped plough, using a steel frame with a rubber, urethane or plastic blade that directs fugitive material off the belt. These ploughs are typically specified in heights at least as tall as the largest lump being conveyed. At very high speeds, some suppliers recommend specifying a plough height of one-half the total height of the pulley it is protecting. Most designs include a safety cable attached at the plough's leading edge, so that, in the event of a mounting failure, the cable would prevent the plough from crashing into the pulley and actually causing the damage it was designed to prevent.

On conveyors that travel in only one direction, the pulley protection device is normally a v-shape, with the point toward the head pulley so that any loose material on the inside surface would be deflected by the wings. On reversing belts or conveyors with significant rollback, the device is typically a diagonal plough that cleans in both directions. Systems that run in either direction, where either pulley can serve as the tail pulley, should have protection installed at both ends.

The Martin® heavy-duty V-Plow is built on a 0.5 in. (12 mm) thick steel frame that delivers blade ballast even in the toughest conditions. The low-profile design features reversible mounts that can be positioned either inside or outside the stringers, with rubber bushings that isolate the frame. The heavy-duty construction fits belt widths up to 120 in. (3030 mm), with coverage of the blade width plus an additional 6 in. (150 mm). It has an operating temperature range from -20 to 160˚F (-29 to 71˚C) and is designed to accommodate belt speeds in excess of 300 m/min.

Sealing systems

Another place where the effects of high-speed belt travel can be seen is in the sealing system, where even relatively modest increases in speed can greatly accelerate physical wear and thermal stress. Existing technology delivers reliable and long-lasting sealing performance under most conditions, with some designs delivering two wear surfaces on a single elastomer sealing strip. Installed along the bottom of the skirtboard in a belt conveyor loading zone, when the bottom side of the strip against the belt is worn, the seal is inverted, providing a second service life.

Martin® Apron Seal™ skirting was the first dual-sealing system, as it incorporates a primary seal clamped to the steel skirtboard to keep lumps on the belt and an "outrigger" strip to capture any fines or dust particles that pass beneath the primary seal. The secondary seal lies gently on the belt and self-adjusts to maintain consistent strip-to-belt pressure. But even these durable systems break down more quickly at high speeds, and engineers began reviewing the designs, looking for ways to deliver the extended performance and durability customers needed for high-speed conveying.

The result is Martin® extra heavy-duty self-adjusting exterior skirting, which was introduced at MINExpo INTERNATIONAL® 2012. Designed with double-thick elastomer sealing strips, the standard 2 in. (50 mm) or massive 3 in. (75 mm) thick EHD construction features innovative swing arms that allow use on reversing belts, and a range of urethane formulas to suit specific application needs. The patented system rides gently on the belt, self-adjusting to maintain effective sealing, even as the belt path fluctuates and the sealing strip wears. The design works in conjunction with the external wear liner, installed and serviced from outside the chute. No confined space entry is needed. WC