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PREVENTING WEAR & TEAR

Dave Mueller, Martin Engineering, USA, explains how innovations such as impact cradles and belt cleaners can address the challenges of large material conveying.

Mined and quarried raw materials are extremely heavy and oddly shaped large rocks, some with jagged sharp edges. Due to the varying needs of different applications, the material can be transported as is and processed by the end customer. Therefore, beyond the needs of mines and quarries, bulk handlers

– such as ports, cement producers, and power plants – need heavy-duty conveyors to receive some raw materials before loading them onto vessels or sending them to the crusher.

Whether loaded by a hopper or transferred from another conveyor, hard rock punishes the belts and system components like idlers, enclosures, and cleaners. The demand on these systems is daunting, leading to premature equipment wear and excessive downtime. Designers at Martin Engineering's Center for Innovation (CFI) have reimagined large material conveying and devised components that focus on safety while increasing production and reducing downtime.

Figure 1. Impact cradles and support cradles are linked by transition rollers to avoid belt sag and retain the seal.

Figure 2. The tracker reacts the moment the belt drifts to make slight adjustments.

Figure 3. Offering edge-to-edge coverage, new cleaner designs are more resilient in punishing environments.

Yes, large rocks can create dust

Watching the flow of tonnes of heavy material leaves little doubt that the conveyor system components can only handle so much wear. One of the main safety culprits is dust, which is ever-present as the material impacts the belt and shifts vigorously in the transfer enclosure and beyond.

Environmental and workplace safety organisations like the US Mining Safety and Health Administration (MSHA), Safe Work Australia, and the European Occupational Safety and Health Administration (EU-OSHA) have introduced strict regulations around respirable crystalline silica (RCS) to prevent work-related chronic lung diseases.[1,2,3] Commonly found in materials like limestone, coal, and ore, RCS is present in a large percentage of the Earth's crust, making it pervasive throughout the bulk handling sector.

Pressure from the weight can create deep slumps in the belt that release fugitive spillage and dust along the belt path. Without proper belt cleaning, compacted fines remain adhered to the belt as carryback and drop along the system's return path, further reducing air quality and increasing labour hours for cleanup.

Supporting the belt

Moving millions of tonnes of raw material exponentially raises the chances of one rock landing precisely enough to damage the splice and create a highly unsafe incident. The force of loading can warp impact idler rollers and the bearings inside, but there are ways to avoid this. One is by restricting the drop height or slowing the descent of heavy bulk material from a direct impact on the conveyor belt. Operators have found that controlling material loading extends the life of the belt and the conveyor support structure. Another way to extend equipment life is to properly and completely support the belt in the loading zone using a cradle.

Martin engineers devised a heavy-duty impact cradle that supports the belt and absorbs the impact of loaded material in a consistently sealed environment (Figure 1). In contrast, impact idlers can leave unsupported gaps between idlers where dust and spillage can escape. Additionally, the bearings and rollers can misshapen over time, reducing the efficiency and safety of the conveyor system. Impact cradles are specially designed with a top layer of slick ultra-high-molecular-weight polyethylene (UHMW) moulded to a base of impact-absorbing styrene-butadiene rubber (SBR). The belt slides across them easily with little friction, while the bars give enough shock support that the belt is not damaged from precise hits on sharp edges. By eliminating the gaps between idlers, skirting creates a tight seal against bars, further reducing the amount of fugitive dust and spillage for more compliant and safer operations.

Belt speeds above 650 fpm (3.3 mps) can exceed the limits of impact cradles. For higher-speed conveyors, a specially designed heavy-duty high-speed cradle with four trac-mounted idlers closely spaced to eliminate belt sag can support material impact without excessive drag. Innovative upper connector brackets link idlers throughout the load zone, allowing them to work in tandem as a unified structure. The elastomer bar suspension is engineered to match the CEMA rating specific to the application by absorbing shocks from impact. This maximises the life of the belt support structure and rolling components. Slide-out/slide-in roller frames allow idler service without the need to raise the belt or remove adjacent idlers, drastically reducing the time and labour needed for standard impact idler maintenance and replacement.

Sealing the transfer

Wear liners are 'wear parts' that protect the skirtboard wall of the conveyor transfer enclosure from splashing, shifting, and abrasion damage caused by large chunks of raw material hitting a fast-moving conveyor belt. Commonly, wear liners are sheets of steel either welded onto the internal chute wall or the chute is raised to accommodate an external liner design. These are generally accompanied by a long rubber skirt seal extending the length of the chute designed to seal against fugitive dust and fines.

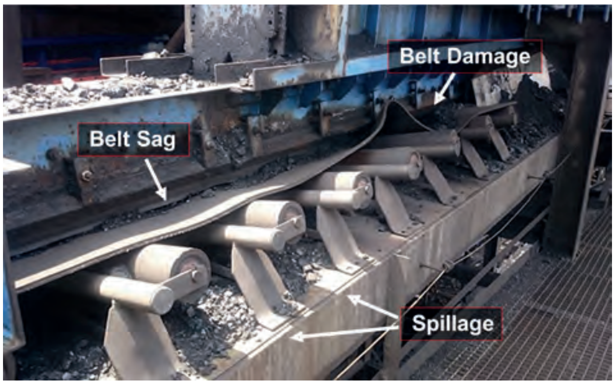

Figure 4. Broken equipment, spillage, and improper idler spacing all culminated in expensive consequences.

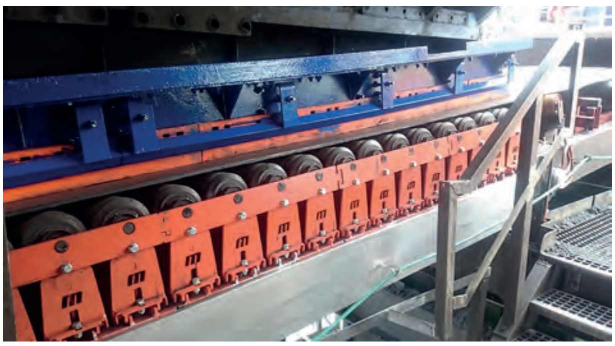

Figure 5. High-speed impact cradle has four rollers that can be interlocked for integrated performance.

For extra heavy-duty applications, wear liners can deplete quickly and may need extra protection. The canoe liner is made from durable urethane moulded around a rugged steel plate to absorb impact and abrasion. It is an engineered urethane strip moulded directly around a protective steel plate. The protective plate being integrated directly into the urethane liner is unique to Martin Engineering and prevents material from fouling the space between the urethane and the steel causing delamination. Separation tests have shown it delivers superior shielding of the skirt sealing system and skirtboard over other designs.

Replacement involves simply removing the worn units, cutting the end piece to fit and mounting each new cartridge, reducing what used to be a one or two day job to one or two hours. This unique design extends equipment life, offers longer periods of dust and spillage control, improves safety, and reduces maintenance, lowering the overall cost of operation.

Belt troughing and alignment

Retaining a tight seal and ensuring a centred load through the stilling and settling zones of the enclosure is key to a smooth, spillage-free trip to the discharge zone. Due to the weight of the material, friction of any kind can be a power issue, so a combination cradle offers sealed load support with bars on the wings and heavy-duty high-speed rollers at the centred base of the unit where the pressure is greatest.

Although the settling zone helps centre the load, it can shift on its path toward the discharge zone. This is commonly due to travelling over idlers which can create a slight bump, disrupting the material's position. When large material shifts, it can destabilise the load to one side, causing the belt to drift off centre. This is generally followed by excessive spillage, contact with the conveyor structure, belt edge damage, and inadequate cleaning at the head pulley.

Broken idlers do not just happen at the loading zone. Dust, weight, and wear affect rolling components down the entire system both on the carrying side and return side. A broken or seized idler can cause the belt to drift towards the conveyor structure. High-speed friction contact between the belt and the seized idler and/or the stringer damages the unprotected underside and edge of the belt. Worse yet, heat from friction can exceed the belt's fire-retardant threshold, potentially leading to catastrophic fires that are quickly carried by the system throughout the site.

The heavy-duty tracker uses sensing rollers that ride on either side of the belt edge and detect slight variations in the belt path. Triggered by the force of a wandering belt, the sensing rollers automatically position a pivoting idler in the opposite direction of the misalignment. The lever action requires less force to initiate the correction, so slight adjustments retain consistent contact between the belt and idlers and require less energy to realign the belt. Strategically placing units along the carrying side and return side ensures a true belt path through the entire rotation regardless of load shifts (Figure 2).

Cleaning caked-on carryback

Heavy-duty environments put demands on cleaners that cause the blade to degrade faster, need more monitoring and tensioning, and require replacement sooner than other applications. Moreover, during transfer and transport, vibration and gravity coax fines towards the centre of the belt where the greatest pressure from heavy material is applied. Scratches, cracks, and divots on the belt surface provide a convenient place for pressurised dust and fines to get packed and easily slip past primary cleaners (aka scrapers). Once on the return path, they drop, causing dust emissions, fouling return rollers and piling under the system requiring cleanup.

New designs in heavy-duty belt cleaners have reimagined the approach to cleaner technology. The innovative design incorporates a matrix of tungsten carbide scrapers installed in a three-dimensional helix angle across the face of the discharge pulley. It is tensioned lightly against the belt to prevent damage to the belt or splices and requires no re-tensioning after installation for the life of the blade. Despite extremely low contact pressure, field tests have revealed the unique blade design to have significantly superior results over standard primary cleaners (Figure 3).

The secondary cleaner is designed to clear the remaining dust and fines, resulting in a significant reduction in carryback, dust, and spillage that eludes the primary cleaner. Independent 6 in. wide blades with carbide tips are mounted on a stainless-steel assembly. Each tip is supported by spring-loaded arms at both ends that react to fluctuations in the belt. With up to four times the equipment life of conventional cleaners, the primary and secondary cleaner systems have drastically improved safety with fewer inspections and cleanup, reduced maintenance costs, and significantly lowered the cost of operation.

Coal mine in Witbank, Mpumalanga, South Africa

A coal mine in Eastern South Africa producing 3.1 million tpy of coal was experiencing heavy spillage and system damage along the length of a main conveyor due to inadequate loading zone equipment. Impact idlers allowed excessive belt sag, causing high volumes of spillage. Dust and fines fouled idlers, and rocks became lodged between the belt and the skirt, resulting in unscheduled downtime due to frequent equipment failures and chute liner replacements. Material that had built up threatened to encapsulate the belt return, so labour was diverted for cleanup, further raising operating costs (Figure 4).

Technicians from Martin Engineering South Africa were invited to offer a solution. They recommended the installation of seven high-speed impact cradles along the length of the module 3 feeder unit (Figure 5). Using elastomer bar suspension to absorb shock from impact, the specially designed idlers exceed the operating limits of typical impact bar-type belt support cradles. The rolling components minimise friction on the belt and maximise the life of the belt support structure. Low-friction polyurethane Martin® ApronSeal™ Single Skirting was also installed to contain material and retain a tight seal on the running belt, further reducing spillage.

Six months after the installation, the volume of spillage has been reduced considerably, and the sealing system remains durable because no material is entrapped beneath the seal. The lack of fugitive material has mitigated wear and tear on components and reduced the amount of labour needed for cleanup, maintenance, and replacement of broken equipment. "We're very happy with the end result", said a plant manager. "The project was so successful that we are going to convert the other feeders in the plant (up to 14 more transfer points). This has definitely decreased the cost of operation."

Conclusion

Heavy raw material is unpredictable, which can have a serious effect on conveying systems and operations if the system is not properly designed to handle and adapt to change. A lack of predictability leads to unscheduled downtime and can veer production away from forecasts. The pressure to meet demands often does not coincide with budgets for new equipment that offers a long-term solution.

Conveyor design engineers recommend taking a holistic view of the system and choosing solutions that address the causes of downtime and workplace hazards from loading to discharge. Investing in modern technology that provides a longer equipment life, better results, and a greater return on investment (ROI) over the long term leads to higher production and a lower cost of operation.

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