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ON THE COVER

Designed for a new era of bulk handling: the all-electric transshipment crane CBG 500 E combines the market demands for a reliable crane with high handling capacities. Due to the electric drives, the available energy is used efficiently and the crane operates in an environmentally friendly manner. The CBG 500 E has a boom length of up to 50 m and handles up to 2000 tph. In sheltered water the maximum load capacity in grab operation is 90 t and in open water 65 t.

For more information visit: <https://go.liebherr.com/tc4hf3>

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GET A HANDLE ON CONVEYOR HAZARDS



Bernd Küsel,
CBG Conveyor Belt Gateway,
Germany, evaluates hazards for steel
cord conveyor belts.

Steel cord conveyor belts are the lifelines of most large mines and handling facilities. Their reliability is essential, and their long-term operation is critical to the economics of mining.

Splices

All conveyor belts contain one or more splices because they are assembled from several individual lengths on site. Typically, an overland installation contains several dozen splices.

The splices are made on site under difficult conditions - i.e. conditions different from those in which the conveyor belts are manufactured. The vulnerable, unvulcanised rubber can lose the required properties at high ambient temperatures, resulting in negative degradation of the splice matrix. The deficiencies worsen during operation and can lead to the breakdown of the bond between the rubber and the steel cords, i.e. to the rupture of the splice. As in the conveyor belt itself, the steel cords have no contact with each other in the splices, the forces are transmitted exclusively via the rubber. The only thing that matters is that the rubber-steel bond holds.

Other factors, such as dirt, faulty workmanship, incorrect vulcanisation temperatures, incorrect heating time, insufficient or uneven pressing pressure, etc., also lead to weakening of the splice system.

Splice failure, i.e. loss of adhesion of the components with subsequent tearing, has disastrous consequences for production, personnel safety, and company profitability. Splice failure can occur early or take years to happen, due to progressive ageing. Joint failure can be rapid or slow, depending on where the detachment begins – it is similar to the opening of a zipper.

These very serious problems occur more frequently than is generally known.

In addition to these endogenous factors that can jeopardise the operation of steel cord conveyor belts, exogenous causes, such as damage from foreign objects or from defective equipment parts, are of great importance. Often, damage to the tension member steel cords is not visible from the outside. In contrast to the steel cords, the cover rubber is highly deformable. In the event of impact damage, this can result in the belt appearing intact even though the steel cords inside the belt have been damaged. Depending on the number and position of the affected steel cords, the breaking strength of the conveyor belt may have been unacceptably reduced. In addition, corrosion may occur as a result of such damage; the danger is continuously aggravated.

Operators often counter the numerous risks by replacing conveyor belts or their splices long (often years) before they actually reach their potential service life, which is a waste of considerable financial resources.



Increase reliability and extend service life

Replacing a belt just because it 'looks worn', 'is that old', or because it is classified not safe to operate anymore by inadequate inspection methods, is no longer appropriate.



Figure 1. A CBGuard Life Extender in an overland conveyor.



Figure 2. A CBGuard in a coal handling conveyor.

The basis for deciding whether and when a belt should be replaced or repaired should include a detailed assessment of the conveyor belt's condition and its splices during operation. Gradual changes and intelligent analysis and evaluation must be included in the decision. The goal must be to operate the belt safely until its actual end of function.

Current methods

Some systems currently available on the market can have critical shortcomings. Only radiology-based systems can detect and highlight the multitude of potential problems in high-resolution quality in real time. The common methods include:

Opto-electronic systems

At most, damage visible from the outside can be detected. No information is provided on the condition of the tension member ropes or the joints. Damage filled with conveyed material is usually overlooked.

Magnetic resonance systems

This simulates analogue wave signals or steel cord images that need to be interpreted by specially trained personnel.

Monitoring is limited to steel cables, meaning other changes in the belt are not detected. Metallic cross reinforcements or other parts, e.g. conductor loops for longitudinal slitting detection, make the data practically unusable.

Unlike X-ray based systems, magnetic systems cannot detect foreign objects, edge damage, slitting, incorrect cord pitch, wire damage, etc.

Mobile systems

Inspections provide only a snapshot in time without the ability to intervene in the event of impending belt defects that could lead to total conveyor failure. They are often inaccurate, expensive (the equipment must be laboriously positioned and calibrated), and in most cases can only be performed when the belt is at a standstill or creeping. In addition, personnel deployment can be problematic due to travel restrictions (e.g. during pandemics, etc.).

Visual inspections by personnel

By their nature, visual inspections by people can detect very few, gross violations. The belt must be inspected from both sides in creep mode.

A new idea

To help try and improve belt safety and service life, Conveyor Belt Gateway jointly designed the CBGuard Life Extender monitoring system. This enables repairs to the conveyor belt to be carried out at the best possible time. The clear X-ray images that capture every cubic millimetre of the conveyor belt allow maintenance personnel to decide whether repairs should be made in the short term, or whether it is still

possible to wait until the next scheduled maintenance stop. This way, unnecessary interruptions in conveying are avoided.

Often, only partial lengths of the conveyor belt are worn. X-ray analysis can be used to easily decide which one needs to be replaced. The remaining belt can continue to be operated. The most important criterion is regularly the condition of the tension member steel cords.

The stocking quantity of conveyor belts can be reduced because the CBGuard software indicates in good time when replacements should be procured.

Core functions

The primary functions of the CBGuard system include:

- Detailed, radiographic examination of steel cord conveyor belts in real time, during normal conveying operation.
- Continuous, artificial intelligence-assisted analysis of the condition of all conveyor belt elements and comparison with their target condition.
- Automatic warning when threshold values, which can be individually configured by the operator, are exceeded, as well as shutdown of the belt drive in the event of threatening events, for example an imminent belt break.
- Detection of any critical changes, such as: steel cord breaks, corrosion, blisters, and misalignments.
- Detection of holes, notches, foreign objects, protruding steel cords, edge breakage, uneven cover wear, excessive elongation of joints, etc.
- Automatic, immediate notification of maintenance personnel of faults via SMS. Alerts are also triggered on the computer monitor and directly on the scanner.
- Live marking of defects of any kind, whether in the tension member or cover rubber – visible on the monitor, in the video of the entire belt or in the printed report. All information is available at any time in high-resolution quality.
- Automatic identification of each splice using fingerprint technology. No manipulation of the conveyor belt is required.



Figure 3. Service entrance for a CBGuard Life Extender.

- Can be integrated with the Internet of Things.
- Virtually retrofittable into all conveyor systems.

The system generates ionising rays from electricity that penetrate the moving conveyor belt and then strike the receiver module – an image field made of amorphous silicon. It is a process similar to the way photodiodes in a digital camera work. Countless, seamless images are continuously generated and analysed in real time by the intelligent software, which is based on advanced facial and palm print recognition algorithms. Specific events (e.g. damage to the belt) are detected by analysing hundreds of grey levels of the countless X-ray images. The smart software assigns specific damage or defects to the changes based on the individual structure, size, colour, and position.

The device complies with all international safety regulations and does not contain any radioactive material. The CBGuard is operated from the user's control centre or via the Internet.

The scanner can be extended to include a laser module that measures belt thickness to within hundredths of a millimetre over the entire length and width. This function generates a topographical contour map from which abrasion weak points of the belts can be easily identified. For example, wear marks from chute seals, which can lead to longitudinal grooves and render an otherwise flawless belt unusable, are visualised. Detected at an early stage, appropriate corrections can be made to the conveyor system parts causing the damage.

The compact design and low weight of the scanner allows easy and quick installation, and it is largely wear-free because it has no moving parts or contact with the conveyor belt.

Case study

One of the latest applications, was for a loading facility at a coal mining complex in South America.

Its lifeline, a several kilometre-long conveyor with a 2200 mm wide steel cord conveyor belt, is equipped with a CBGuard Life Extender X6, with an integrated cooling system and belt thickness lasers. The capacity of the conveyor is 8000 tph.

The automatic all-in-one belt health scanning during the conveying process allows the company to focus on its core business, coal mining and conveying.

Summary

For responsible and economical operators of long steel cord conveyor belts, the use of fully automatic, self-sufficient, radiographic monitoring is indispensable as it can ensure seamless, real-time monitoring of steel cord conveyor belts and improve operational safety and economic efficiency. 