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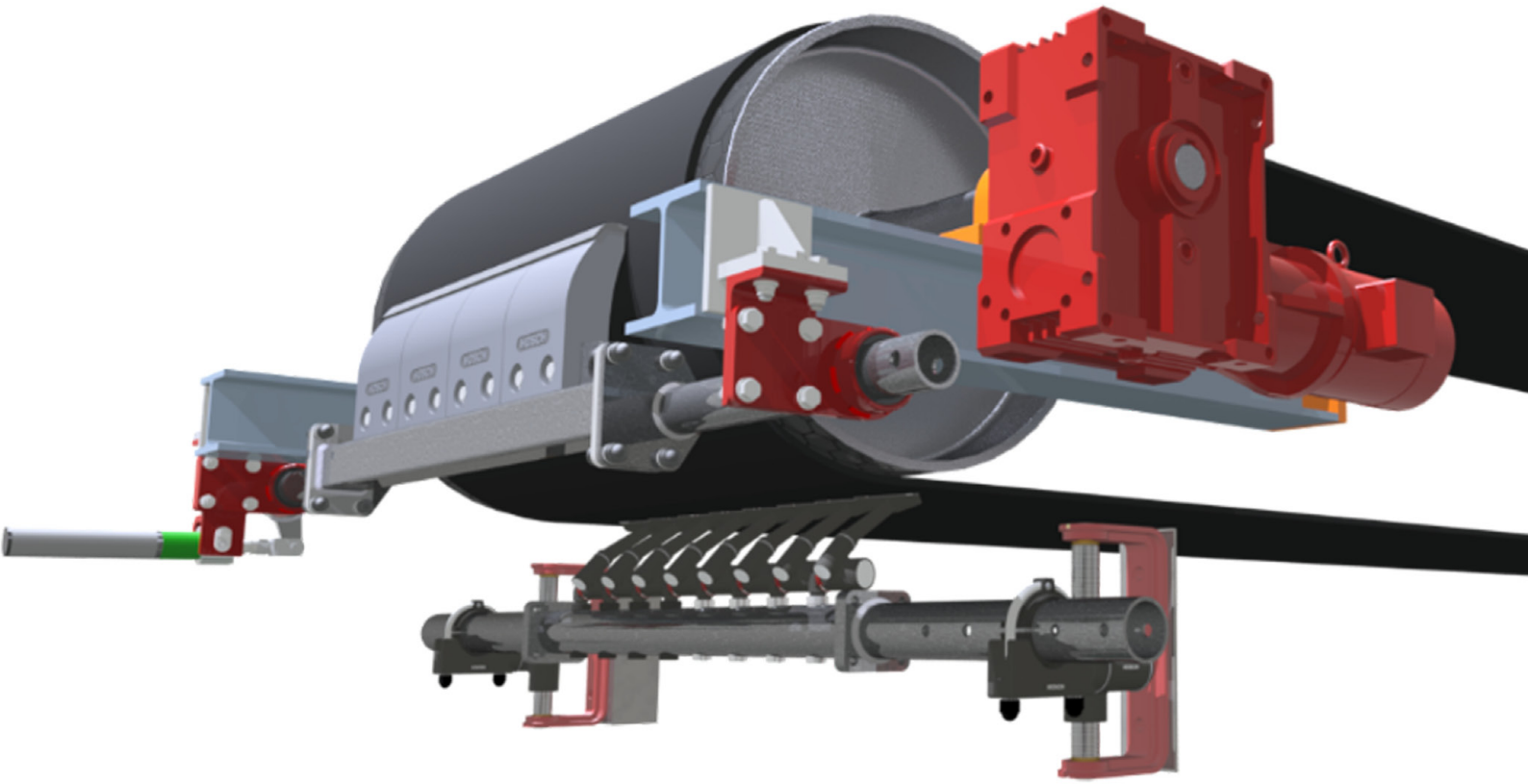

World's longest Railway Tunnel Project – supported by innovative Conveyor Digitalisation and reliable Engineering

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HOSCH

World's longest Railway Tunnel Project – supported by innovative Conveyor Digitalisation and reliable Engineering

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The consortium BTC Brennero Tunnel Construction and the Hosch Group jointly delivered on a world-class tunnelling project by combining excellent engineering with the innovative remote monitoring system Hoschiris Discover. System integration in May 2021 has effectively prevented any instances of serious belt damage. Moreover, service missions have become more efficient and can be scheduled on-demand.

Tunnelling • Conveying • Belt cleaning • IIoT • Monitoring • Digitalisation • Brenner Base Tunnel

Introduction

When completed the Brenner Base Tunnel will be the longest underground railway connection in the world. Such complex tunnelling projects and massive underground constructions are a challenge to engineers and equipment alike. But the effort will be well worthwhile. Regional cross-border transport will become much more time and cost efficient. However, the construction work has to tackle a number of logistical challenges and the 230 km of tunnel drivage calls for enormous quantities of rock to be transported over long distances. As excavation works are driven from both ends of the tunnel each side has to maintain conveyor systems that are critical to the whole operation. With only limited piling options at the tunnel face, continuous conveying is a crucial factor.

In case of the Mule 2 and 3 construction lots, BTC Brennero Tunnel Construction was able to meet this challenge by taking an interdisciplinary approach. 42 km of tunnel were excavated with three Tunnel Boring Machines (TBMs) and a further 20 km were drilled and blasted by conventional means. The 42 km of mechanised tunnel required the excavation of 6,000,000 m^3 rock. To reduce the impact on the environment and infrastructure, engineers laid 80 km of conveyor belt, the excavated material being transported inboard the system well away from the tunnelling plant (**Fig. 1**).

Mattia Corna, Plant Manager for BTC, is in charge of managing all the operational challenges in terms of electrical and mechanical engineering, as well as logistics. Having two or sometimes three TBMs working at the same time takes the importance of conveyor reliability and operating time to a new level. With tunnel progress the main focus, any material handling operation has to be reliable and with the material load varying from 800 to 1,800 t/h, depending on the performance of the TBMs and belts have to be as durable as possible.

If critical conveyor lines are stopped, the whole operation including the TBMs will be soon interrupted. Given the high operational and downtime costs of almost 200,000 € per hour for each TBM it is essential to keep any externally induced downtime to these machines into a minimum. In order to spend valuable capacities on the excavation process the conveyor system therefore has to be optimised in terms of reliability, operating time and cost efficiency. Based on their acquired operational experience the management team identified

Fig. 1: Long distance belt installations above and below ground – a pair of conveyors running inside the tunnel

a non-redundant conveyor section with 20 km of belt, as the most critical bottleneck (**Fig. 2**). This section was the first element in the conveying line where material from all three TBMs would come together. It also presented a significant challenge in terms of access for maintenance personnel.

Hardware Reliability Improvement based on state-of-the-art Belt Cleaning Technology tailored to operational Requirements

To reduce component wear, carry-back material and unscheduled downtime, a combination of Hosch scrapers HD-PU-S2 and D2 scrapers was chosen and installed

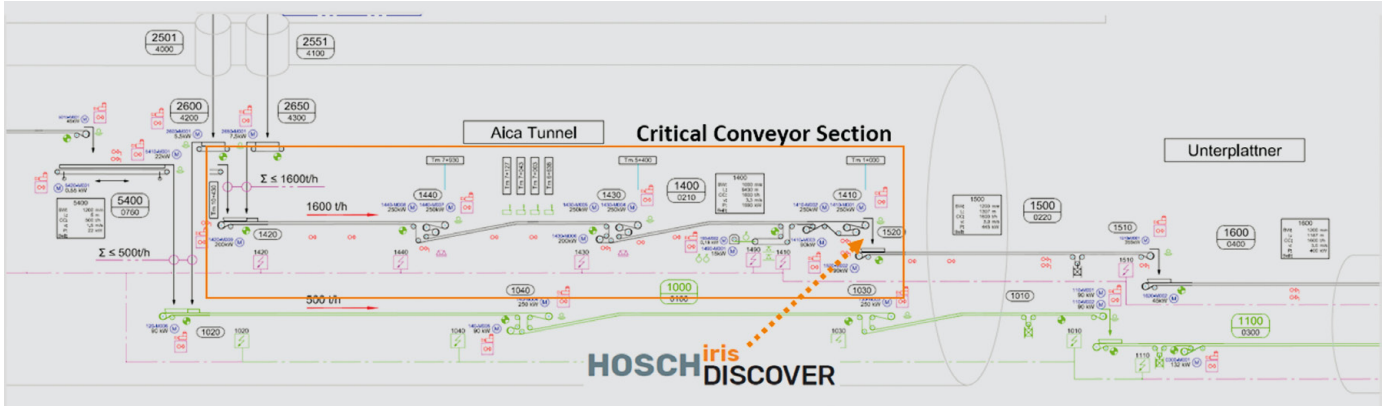

Fig. 2: Heavy-duty electrical installations on a Hosch HD-PU-S2 scraper with Hoschiris Discover Unit components

Fig. 3: Layout of the belt conveyor system showing the critical conveyor section and the position of the Hosch scrapers and Hoschiris Discover equipment

at the identified section (**Fig. 3**). This combined set-up was no coincidence, but was a result of Hosch Group experts working in close cooperation with the operating technicians. The tunnel advance rates being achieved means that the conveyed material and its physical properties are changing permanently. Predicting component wear by cohesiveness and abrasion rates was impossible and had to be solved in practice.

Partnering with the Hosch Group in this challenge produced an immediate impact. By deploying their unique experience in belt cleaning systems and ultra-resistant wear parts, the conveyor experts from Germany were able to design and integrate a reliable and low-maintenance solution. This includes the flexible adjustment and improvement of components during the first weeks of operation. To facilitate speedy implementation engineers from Hosch accompanied the service technicians at the construction site, the operation also being supported by R&D Experts from Hosch HQ, which tailored components to match the requirements.

Reducing Risks and operational Challenges with Remote Monitoring

While having a reliable belt cleaning solution is essential for improving belt lifetime and conveyor availability, several more risks occur when operating a conveyor system. Apart from rollers and drives, the most common down-time triggers are splice-failures. Furthermore, when operating a long-distance conveyor line, keeping an eye on the belt condition is usually associated with time and labour extensive service missions, or so called 'belt-walks'. Such missions are an even more challenging endeavour in a tunnel where two conveyor lines and a heavily frequented train track are running side-by-side. Repairing a belt splice can take 10 to 40 hours, depending where in the tunnel the damage occurred and how heavy the load on the belt is at the moment of incident.

In order to enable a more efficient prioritisation and timing of maintenance efforts for the belt, the Hosch HD-PU-S2 scraper was equipped with the patented Hoschiris Discover Unit for continuous belt monitoring. An important part of the operating principle of Hosch belt scrapers is continuous contact with the belt surface. Due to advanced engineering and bearing design Hosch scraper blades can maintain seamless contact with the belt surface. This unique ability was primarily taken into account when developing and installing the Hoschiris Discover. This sophisticated remote monitoring system makes use of the privileged position and ability of the scraper, while magneto-inductive position sensors are able to detect even the slightest deflection of the scraper blades (**Fig. 4**).

The remote monitoring system provides immediate feedback about changes or damage to the belt surface. A straightforward and automated data analysis system was also included to support the operator's decision making process. Three-staged alarm thresholds are defined in conjunction with the individual data signature

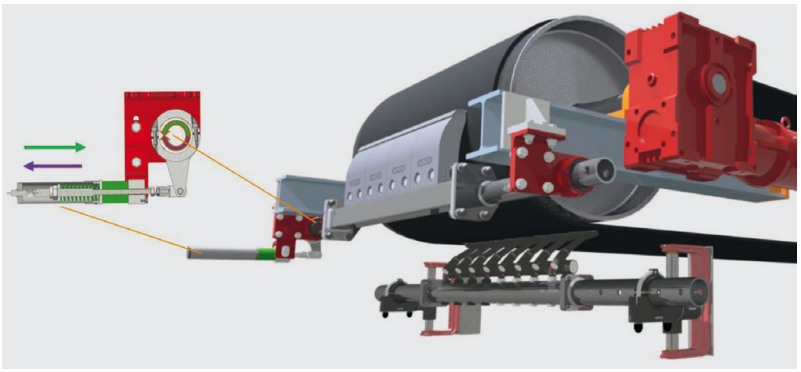

Fig. 4: Hosch scraper type HDPU-S2 and D2 installed in sequence together with the magneto-inductive sensor mechanism for high-precision belt surface remote monitoring

Fig. 5: Mattia Corna conducting a visual inspection of sensor data in the control room (left) and video stream from the belt head and transfer point (right)

of the belt. Notifications about detected anomalies and their severity can therefore be transmitted without delay. Having such a reliable notification system in place, means that capacities can be focused on more urgent operational challenges.

The system also includes a camera at the belt head, to validate registered events and perform remote visual inspection. The camera stream and the sensor data and insights are both presented in real-time on a screen in the control room. The Hoschiris Discover Web provides information on operating times, scraper wear, registered scraper deflection and triggered alarms (**Figs. 5 and 6**).

From digital Potential to operational Excellence

It is a well-known fact that a digital application is just as capable as its user. The additional insights provided by Hoschiris Discover therefore had to be taken on board by site management and maintenance technicians. Apart from being notified about irregularities on the belt surface, engineers took advantage of the detailed data visualisation capability. By comparing observations during maintenance missions with correlating data patterns, the operating team grew in confidence in its ability to identify belt splices, belt sections and general belt conditions. Over time maintenance missions were scheduled according to data signatures rather than fixed in intervals. This innovation allowed capacities to be released for investment in other critical parts of the operation.

The Discover system was further utilised to identify and remove oversized material or metal objects that could cause serious belt damage along the whole conveyor line. Technicians experienced with the Hoschiris Discover system and the conveyor installation were able to identify potential events and developments, even before alarms were triggered. Thanks to the Discover System they can now pinpoint the indicated belt damage along the 20 km conveying system to an accuracy of about 10 m.

During the course of the project over 180 million metres of conveyor belt have been scanned and monitored by fully automatic means. Every month about 150 GB of data is recovered, analysed and visualised in order to generate operational benefits and insights for the maintenance management. These figures show that the need for digital applications to monitor conveyor belts can be met by deploying small but smart and pragmatic installations. Robust technology combined with sophisticated mechanical equipment transforms a high-performing belt-cleaning product into a digital remote monitoring solution that can help to keep the whole operation running.

Efficient Operations driven by digital Solutions as the new Standard

The application described in this article highlights the obvious benefits of introducing reliable digital monitoring solutions into operational planning. With the digitised society now becoming a reality, the tunnelling sector and heavy industry in general are still struggling to close the gap. There are many reasons for this. Outmoded equipment and operating procedures, as

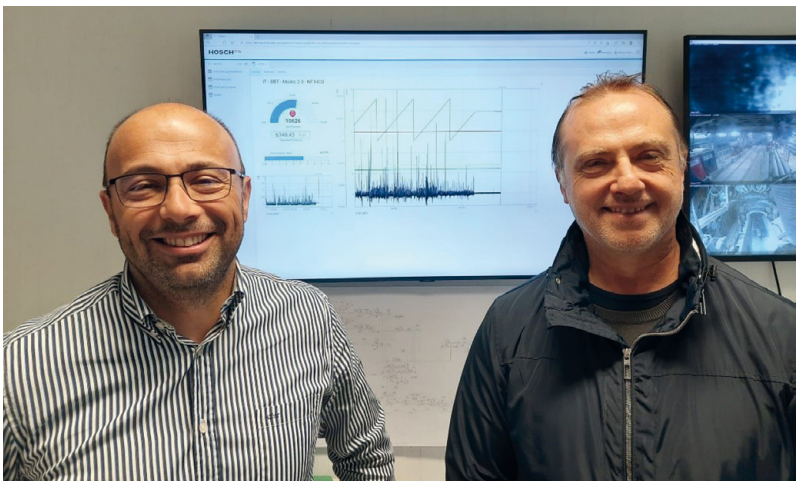

Fig. 6: Mattia Corna of Brennero Tunnel Construction and Giovanni Zingone from Hosch Italy Srl in front of the Hoschiris Discover dashboard

well as a lack of industry-ready and sufficiently rugged technology are just some obstacles. On the other hand, future generations and the workforce of tomorrow will certainly have a challenge to cope with non-digital practices and processes. What is more, the costs incurred for skilled labour and manual operations will continue to increase. So the stakes are high. Combining of engineering expertise with operational ingenuity, as demonstrated here, can deliver real benefits when it comes to digital monitoring in practice – and this is possible right now.

BTC Brenner Tunnel Construction and the Hosch Group have shown how mutual cooperation and a readyness to accept new technology can improve plant maintenance efficiency. The direct impact of this is greater plant availability and reduced safety risks. The number of tunnelling projects without digital monitoring and predictive maintenance on-demand will fade. It is now set to decline as we go forwards. The future focus must therefore be on project-based experience and future-ready equipment.

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