Large-scale designs

Bernd Küsel, Phoenix AG, Germany, describes the design processes involved in the supply of a conveyor belt system to a mine in China.

The People’s Republic of China is the biggest consumer of coal and the largest coal producing country next to the US, with approximately 1 billion t produced in 2001 (a more accurate figure for US production of 1 million t can be found from Energy Information Administration). The drop from the 1.3 billion t of Chinese coal produced in 1997 was caused by the gradual closure of tens of thousands of small mines across the country, which has been taking place since 1998. China exported around 85 million t in 2001, which is the largest amount in Chinese history.

China is interested in the modernisation of large-scale coal mines and the development of new ones. The concentration process, putting bigger mines into strategic focus, has strengthened China’s interest in slope belt conveyors, which continuously move coal from the underground mines to the surface. Such a haulage method has a long history in German mining.

The first steel-cord conveyor belt ever imported for an underground coal mine in China was made by Phoenix in 1994. Phoenix was awarded the contract based on broad experience with underground drift conveyors in Germany, such as the supply of the strongest underground conveyor belt in the world, the Phoenixcord St 7500, which has an actual breaking strength of 8200 N/mm belt width and operates at Prosper Haniel Mine in Bottrop.

Founded on experience with previous conveyor belts, Chinese design institutes based feasibility studies on an expected operational life for the conveyor belt of three to five years. Phoenix, however, predicted a service life of more than 15 years for their superior conveyor belt.

It would therefore be beneficial to have a deeper look into how well the Phoenix conveyor belt has performed in seven years of operation in this new environment.

The mining company

The Shanxi Jincheng Anthracite Coal Mining Group, a state-owned company, was reorganised on the basis of the former Jincheng Coal Mining Bureau, which was first set up in 1958. The fast-growing company operates four mines with a mining area of 904 km², employing 27,000 people.

Jincheng Coal Mining Group is located in Zezhou county in Shanxi province, approximately 600 km south-west of the Chinese capital Beijing. Approximately 30% of Chinese coal production comes from Shanxi province. The anthracite produced in the Jincheng area is of excellent metamorphic grade, which is widely used by the chemical industry, metal refineries and power-generating plants.

Jincheng Coal Mining Group produces approximately 13 million tpa. The company has won highest national awards, such as the National Excellent Management Award and the Golden Horse Award. The company is also ISO 9002 certified.

The mine

The ISO 9001 certified Chengzhuan mine has a designed coal production of 4 million tpa and employs 4100 people. Main products of the Chengzhuan mine are washed middle lump coal, washed small lump coal, washed coal fine and standard coal fine. It is Shanxi Jincheng Anthracite Coal Mining Group’s largest and most modern mine. Fully-mechanised longwall mining accounts for 100% of its production.

The conveyor system

The belt conveyor is 2830-m-long with a lift of 192 m, hoisting 1700 tph of ROM coal with a teesize of up to 300 mm. The speed can be adjusted between 0 - 4 m/s. The conveyor has got a two-pulley head drive powered by three 750 kW water-cooled squirrel-cage motors. The power distribution among the drive motors is adjustable. In an emergency, the belt conveyor can be stopped within an optimum period of time. This conveyor belt carries all mined material to the surface.

Conveyor belt design

The conveyor belt was designed and built in accordance with the strictest standards worldwide, the German DIN 22101 (belt conveyors for bulk materials - bases for...
calculation and design) and DIN 22129 (steel cord conveyor belts for underground coal mines). The DIN 22129 norm requires minimum physical data for the rubber covers, such as abrasion resistance, breaking strength, elongation at break and separation strength between the cover rubber and the core rubber, as well as steel cable pullout strengths and the tensile strength of the individual steel cables. In addition, the geometrical tolerances regarding thickness, width, tracking and steel-cord height level are strict.

Additionally, the belt had to pass fire tests according to Chinese standard MT 147. These included a high-energy test on a propane burner trestle, where a specified area of the conveyor belt sample has to remain undamaged after the flames have been extinguished, as well as the drum friction test, where the temperature must not exceed a certain limit and no flame or glow are allowed. In 1994, the Phoenocord St 3500 was the first steel-cord conveyor belt to pass this test.

The St 3500 is a DIN 22129 standard, 1400-mm-wide conveyor belt with a minimum breaking strength of 3500 N/mm belt width. With an actual total strength of 5400 kN, it is the strongest conveyor belt in use in China.

The 10 and 8-mm-thick, fire-resistant polychloroprene (CR) rubber covers are both equipped with the Phoenotec active protection system, which consists of special single polyamide cords arranged at right angles to the longitudinal axis of the belt. The spacing and diameter of the Phoenotec cords for the top and bottom covers were tailor-made for this application, ensuring optimum protection.

The Phoenotec system triples the belt’s resistance to impact and slitting by tramp material. Additionally, the dynamic splice strength is increased substantially, and the pressure of the steel cords on the bottom cover when moving over the pulleys is more evenly distributed. The number of injuries is also reduced thanks to the buffer effect of the highly-elastic high-strength synthetic cords.

CR-based conveyor belts for underground use provide the highest safety standard worldwide and were introduced to the market in 1975, when Phoenix supplied 3000 m of St 4000 conveyor belts for a drift conveyor at the Göttelborn mine, Germany.

Because of transportation limits, the 5,665-m-long conveyor belt for the Chengzhuan mine had to be supplied in 22 single lengths, weighing 21 t each. Onsite, 21 lengths had to be spliced together. One conveyor belt length is used as a spare in case an emergency occurs. For these splices, which are the weakest points of an endless conveyor belt, Phoenix guaranteed the strength to be equal to nominal conveyor belt strength.

The splices were made using new mobile curing presses and fresh vulcanising material. Phoenix supervisors and splicing engineers from Germany together with Chinese splicing experts and helpers completed the work in the shortest possible time.

All splices were carried out above-ground. Firstly, half of the single lengths were spliced and let down one by one onto the bottom strand of the conveyor. The same procedure was applied for the top strand of the conveyor. Then, the two strands were joined together, creating an endless conveyor belt.

As a special quality control measure, the mine tested a splice that was made onsite. This joint was cut out of the conveyor belt and was tested in both a Chinese laboratory and an independent German testing institute. The splice strength was found to be even more than 100% of the nominal belt strength.

Conclusion

The Chengzhuan mine has become a prominent place for visitors from all over the country because of its advanced technology and performance.

The conveyor system was put into operation in July 1995. So far, it has carried 19 million t of raw coal. Except for a few minor injuries caused by tramp material, the Phoenocord conveyor belt is in excellent condition with practically no wear of the covers and splices.

As expected from the results in German underground coal mining, where Phoenix steel-cord conveyor belts achieve operating lifetimes of more than 20 years for similar applications, this conveyor has a predicted trouble-free service life of more than 15 years.