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Tianjin Port Coal Loading Conveyor

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ABSTRACT

As part of an overall expansion of the coal transport infrastructure in China, the Port of Tianjin is working towards increasing its capacity to export coal. Due to a shortage of real estate close to the wharves, a long conveyor was required to transport coal from the stockpiles to the ship-loader, a distance of approximately 10km. This paper details the design and construction of this large system and the challenges associated with its implementation, as well as the continuing blurring of the definition of what is an "Overland" conveyor.

INTRODUCTION

Tianjin is located approximately 200km from Beijing and, along with a great deal of manufacturing industry, incorporates one of China's major port facilities. As part of a general drive to improve the infrastructure supporting China's coal industry, the Port of Tianjin has embarked on a major upgrade of its coal (and coke) export facilities. Due to a scarcity of land close to the wharves, the stockpile area for the export terminal has been located approximately 10km from the Ship Loading Facilities. To transport the coal from the stockpile area to the ship loader, a long, curved overland conveyor was required. Unlike most conveyors of this length, this conveyor actually forms part of the ship loading operation and as such requires a very high level of reliability.

Discussion on potential routes for the conveyor began in 2000, with significant difficulties presenting the designers with a number major challenges. Apart from the overall distance from the Stockpile area to the wharf, the two facilities are separated by a shipping channel that is in constant use. As well, the entire route is over a tidal flat which meant that the conveyor had to be constructed on elevated gantries for the whole of its length.

A straight line conveyor would have had a lower cost associated with the gantry structure but it was just not feasible. The exit from the Stockplie area was not in line with the required route and even the straightest route would have meant a very long crossing of the shipping channel. For this reason a curved design was settled upon, with the system incorporating two horizontal curves. These curves extend for almost the whole of the first 5000m of the conveyor but they do minimise the length of the seaway crossing. As usual these curves were design for the smallest radii practical. An overview of the facility and the conveyor route are shown in Figure 1.

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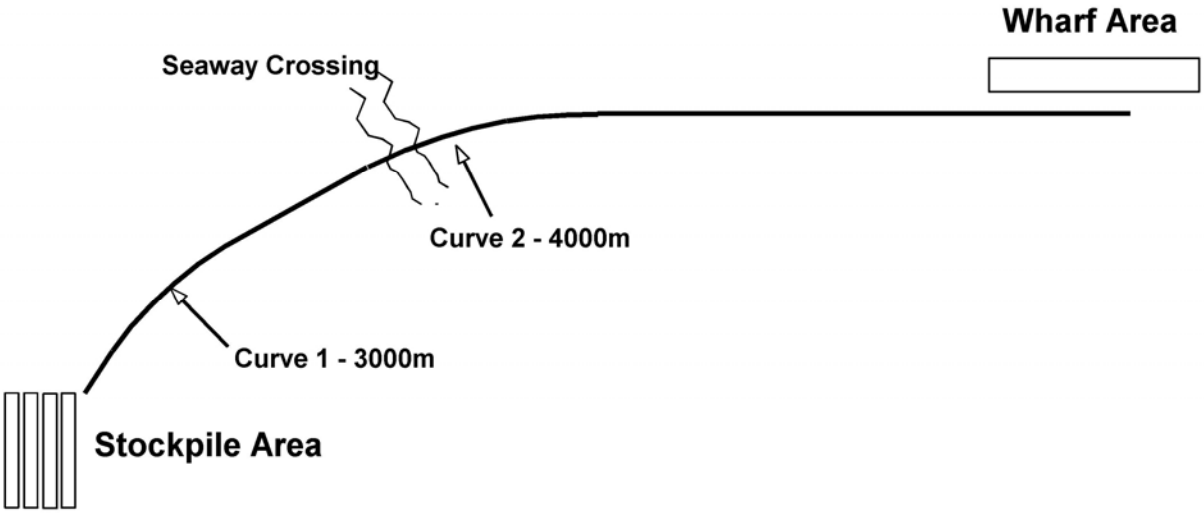

Figure 1. Route for Tianjin Coal Transport Conveyor

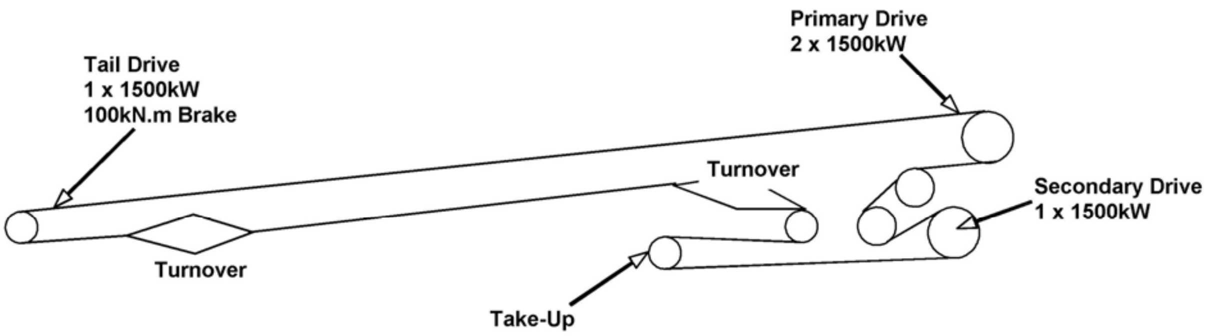

Figure 2. Layout of Tianjin Coal Transport Conveyor

CONCEPTUAL DESIGN

The design capacity for the conveyor was specified at 6000tph with the capacity to sustain "surges" of up to 10%. The actual definition of a surge was never clearly defined so the system ended up with a practical capacity of 6600tph. The general design parameters for the system are shown below.

Material	Coal
Capacity	6000tph
Width	1800mm
Speed	5.6m/s
Conveyor Length	8980m
Lift	8m
Belt Strength	ST-3150
Idler Type	3- Roll, 45 degree trough (Carry) 3-Roll, 45 degree trough (Return in curves) 2-Roll, 10deg V (in straight sections)
Idler Spacing	2m Carry/4m Return
Horizontal Curve Radii	3000m & 4000m
Installed Power	4x1500kW Variable Speed AC
Braking Capacity	100kN.m at Tail
Operating Temperature Range	-20C to +40C

The conveyor was configured with 2x1500kW drives on the head pulley, 1x1500kW on a secondary drive at the head and 1x1500kW on the tail pulley. A 100kN.m brake was also installed on the tail pulley. Turnovers were incorporated at the head and tail for cleanliness. The overall configuration of the system is shown in Figure 2.

A number of different drive arrangements were considered prior to settling on the above arrangement. Locating all the power at the head was most attractive but there was a significant cost increase in the belt if this approach was adopted. Apart from cost, the factor that finally dictated that the system incorporate a tail drive was the requirement to get the horizontal curves to work. The curves extend from the tail pulley for approximately 5000m. To engineer a workable arrangement in the curves, it was felt that low, constant belt tension was important. If all the drives were located at the head of the conveyor, then the tensions in the curves would be considerably higher and would vary with ambient temperature.

The decision to install Variable Speed AC drives was again taken after exhaustive investigation. The final decision came down to ease of installation, mechanical simplicity and of course price. The head drives were configured to operate with one drive acting as a master on speed control and the other two drives acting as torque followers.

The tail drive was configured to maintain constant tension as measured from a bend pulley supported on load cells. This technology is well established in the underground coal industry and it was felt that while the load cells add a small number of components to the system, they enable the tension at the tail pulley to be guaranteed, regardless of ambient temperature or load. Knowing precisely the tension at the tail pulley significantly simplifies the horizontal curve design. Figure 3 shows a photograph of the tail drive, with the tension measuring pulley clearly visible.

Figure 3. Tianjin Coal Conveyor Tail Dive

A sizeable brake (100kN.m) was installed on the tail pulley, at the request of the client, to reduce the system stopping time. This was the largest brake that could be accommodated without risking the belt being pulled out of the curves on an empty stop. Even with a brake of this size installed, the stopping time was only reduced from about 30s to about 25s. As with any long system the time required to establish the braking tension field around the conveyor is so long that applied braking has only a small influence on the actual stopping time.

LOW TEMPERATURE CONSIDERATIONS

The minimum ambient temperature of –20C is not extremely cold by northern hemisphere standards but for engineers with predominantly Australian experience it is significantly colder than the operating conditions to which they are accustomed. To ensure satisfactory operation of this system, every component was required to be certified to operate at the minimum temperature. For a number of components (notably the signal line communications system and the idlers) operational testing in a low temperature cool room was required.

To ensure that the belt tensions were calculated accurately, it was essential that the idler rim drag was known with significant precision over the entire range of operating temperatures. At the initial design stage, a maximum drag of 5N/roll at –20C was believed to be achievable and this number was used for design purposes. A design/testing regime was then established to ensure that the supplied rolls would have a rim drag not higher than this value.

Careful attention was paid to seal design, lubrication and assembly throughout the project and both the initial and subsequent QA testing of the rolls showed this to be worthwhile. The tests were carried out with newly assembled rolls that had never been turned. They were left in the test room at –20C overnight and then tested at this temperature. Figure 4 shows the average results from a test sample of five carry rolls. The high initial drag of 24N is not unexpected and it was pleasing to see an average drag after five hours of less than 2N/roll. No roll tested in this batch had a final rim drag of more than 3N. The ability to achieve certified, low rim drag is valuable in a project such as this and should be a standard requirement at the specification stage.

The rest of the components in the system were conventional and conservatively designed in accordance with the client's specific instructions. A high safety factor of 7:1 was stipulated for the belt and the powering calculations were to be at least in accordance with CEMA. While these requirements added somewhat to the cost of the system, they go someway to ensuring durability.

CONSTRUCTION

The full design and manufacture of major components including drive frames, pulleys, idler rolls, switchboards etc was carried out in Australia by Continental Conveyor P/L. The components were then shipped to Tianjin. The drives, motors, gearboxes etc were delivered direct to site from various parts of the world. The bulk steelworks including idler frames and gantries, and all concrete was supplied locally.

The system was erected by CHEC, a local construction company under the supervision of CCE Australia engineers, and with the assistance of Goodyear Australia to supervise the belt splicing and installation.

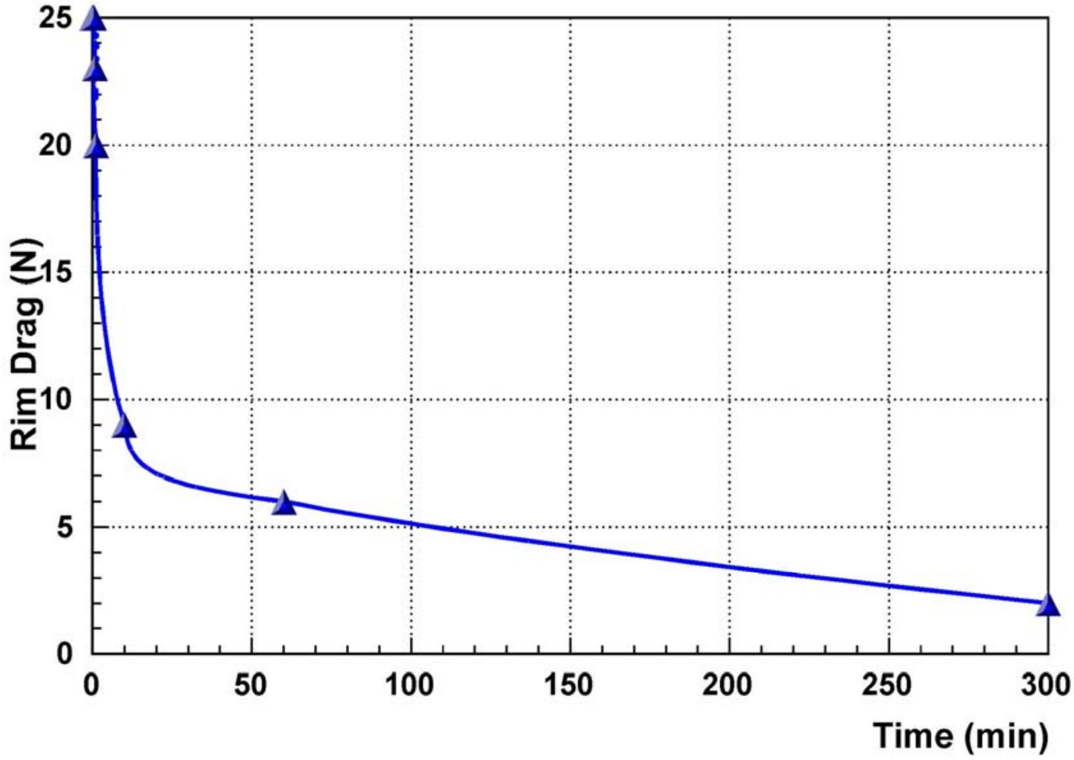

Figure 4. Tianjin Coal Conveyor – Carry Roll Rim Drag Measurements

Figure 5. Tianjin Port Coal Conveyor Under Construction

Figure 6 The Completed Tianjin Coal Conveyor

Having the system mounted on gantries made for easy access once equipment was in location, but the absence of any road along the base of the conveyor proved a significant challenge. Any rainfall made the local mud impassable and at times delayed work until the terrain had dried out. The enthusiasm of the local workforce however ensured that the project was completed on time. Figure 5 shows an aerial view of the gantry structure early in the construction phase. The coal conveyor is the larger of the two visible. (The other conveyor carries coke and was awarded under a separate contract.)

The finally completed conveyor is impressive by any measure as Figure 6 shows. It is a long, high capacity, tightly curved conveyor built in a distant location in a short time frame. Its success is a credit to all parties involved.