Conveying Coal Skillfully

Coal transportation from the port to the railway line

Adani Group's Dahej port, one of the sophisticated ports in the country, needed an apt system to transport coal from the shore to the railway line. To resolve this issue, it built a state of the art conveyor system. This system is elevated and passes through busy roads, village and industrial area. Here is an overlook at the system and its design.

Source: Conveyor Dynamics, Inc / PMC Projects Pvt Ltd

Maintenance trolley that allows maintenance personal access to the conveyor.

When Adani Group at Dahej wanted a conveying system to transport coal from its port at Dahej to the private railway line, which is around 4.75 km away, PMC Projects, a subsidiary of the Adani Group, approached Conveyor Dynamics, Inc (CDI).

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Initially, CDI was awarded a contract to produce a basic engineering design of the elevated silo conveyors and a basic engineering design for the Adani Power Conveyor system that PMC intended to build in the future to transport coal from the terminus of the second silo conveyor to a new power plant they will build around 10.85 km away.

After CDI completed the basic engineering, PMC realized that acquiring the land in the conveyor corridor posed a significant challenge. To avoid large change orders, the Adani group decided to handle all procurement, construction and project management in-house.

System overview

The silo conveyor system is comprised of three conveyors connected in series that transport up to 6,000 tph coal from the Dahej port to a rail wagon loading silo.

The first conveyor in the series is SC-1A (Silo Conveyor 1A). It is 1.6 km long and gains 6.7 m of elevation. The conveyor transports up to 6,000 tph coal on an ST1000 1,600 mm wide belt traveling at the speed of 7.5 m/s. Two horizontal curves with 1,100 m radii and nine vertical curves with various radii are included in the conveyor route. Most of the conveyor is located in an elevated gallery that is 6 m above the ground except where the conveyor crosses roads where the gallery elevation rises to 9m above the road grade. The SC-1A is powered by two 500 kW inverter driven motors, and includes two brakes. One brake is located on the tail pulley and the other is located within the take-up sheave assembly. This second brake is used to boost the take-up tension during an unpowered stop.

The SC-1A discharges onto the second conveyor in the series tagged as SC-2A. This conveyor is 1.4 km long and gain 8.7 m of elevation. It transports up to 6,000 tph on an ST1000 1,600 mm wide belt traveling at 7.5 m/s. Like SC-1A the entire conveyor is elevated at 6 m off the ground and it is powered by two 500 kW inverter driven motors.

Currently, SC-2A directs feed onto a 485 m long low speed conveyor tagged as SC-3. However, SC-2A's discharge chute includes a diverter gate that will allow SC-2A to discharge coal onto the Adani Power Conveyor system in the future. The SC-3 discharges coal into the rail wagon loading silo.

Source: Conveyor Dynamics, Inc / PMC Projects Pvt Ltd

Dust capturing hood designed to shield the coal from wind.

Route optimization

The route selected for the silo conveyors was tightly constrained by a number of existing industries occupying most of the land outside the port, Lakhigam village and a large road. The conveyors could not pass outside a 5 m wide corridor between the road and surrounding developed properties.

Engineering horizontal curves like the two in this system is an iterative process. First, a rough profile of the conveyor is selected. The tensions along the conveyor route are computed and used to determine the minimum horizontal curve radius that the conveyor can safely negotiate. The tension prediction must be accurate and requires drag prediction using rubber rheological equations (Nordell, 1996) and dynamic analysis (Nordell, 1984). After determining the belt tensions, a new route is selected with horizontal curves and tensions for the new route are computed. The process is then repeated.

Source: Conveyor Dynamics, Inc / PMC Projects Pvt Ltd

Erecting the First Bent.

High speed conveying

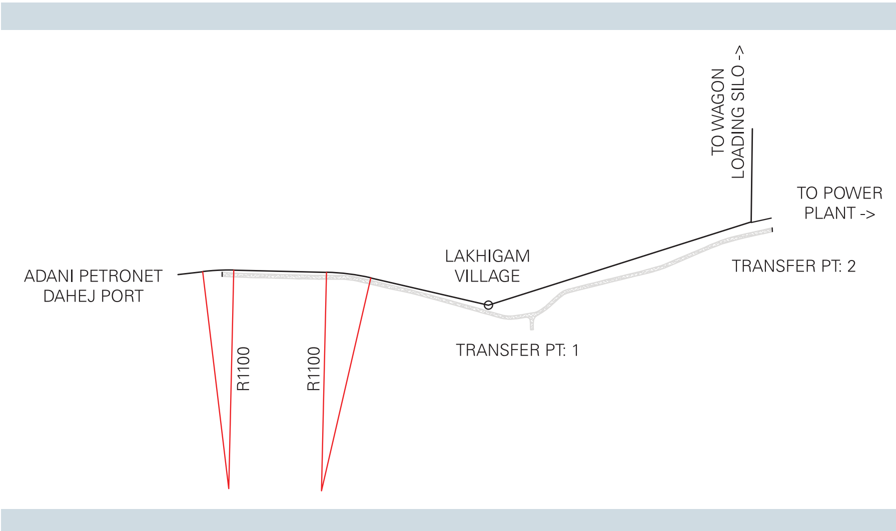
Operating SC-1A and SC-2A at 7.5 m/s reduced the capital expense of the system and also the belt tension in SC-1A allowing it to bend through tighter horizontal curves. However, operating these conveyors at high speeds reduce the life of their belts compared to identical belts running slower. This is because most belt wear occurs in the loading zone. A high speed belt sees the loading zone more often than a low speed belt. Since SC-3 is much shorter than SC-1A and SC-2A it was designed to operate at 4 m/s so that the frequency of belt replacement on this conveyor could be reduced.

Since the speed of SC-3 is 4 m/s instead of 7.5 m/s, the belt width of SC-3 is 2,200 mm – far wider than the SC-1A and SC-2A. In addition to the increased width, the weight of the SC-3 belt is 59 kg/m, almost 50 per cent more than the weight of two other belts, which weigh 42 kg/m. Also, on this third belt, the linear weight of material is 476 kg/m. On the other hand, the SC-1A and SC-2A increase the speed while reducing the linear weight of material to 264 kg/m. Reduced linear weight reduces the belt tension necessary to control sag.

Furthermore, it also reduces the indentation losses and the tension required to lift the material. This reduces overall belt tension, which improves belt tracking in the horizontal curves. The narrower belt also shortened the idler roll length from 816 to 594mm reducing the weight and cost of the idlers. Additionally, it also reduced the width of the elevated gallery, cutting the weight, strength and space requirements for the gallery. These reductions further cut the capital investment.

However, the tolerances allowed for high speed conveyor components that are substantially tighter than their equivalent low speed counterparts. In particular, to reduce vibration and noise and extend idler life, CDI recommends that idler TIR not to be exceeded 0.4 mm at 7.5 m/s.

Only a handful of companies in the world can consistently manufacture idlers with 0.4 mm TIR. The typical welded end disk



Dahej overland conveyor plan.

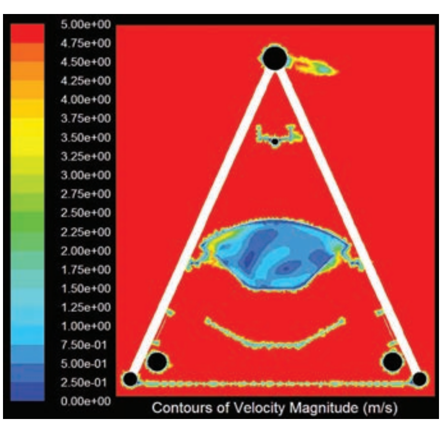
Source: Conveyor Dynamics, Inc / PMC Projects Pvt Ltd

idler assembly usually fails to meet spec because the welding process warps the shell. Several leading edge manufacturers have approached the problem by designing press fit end disks. This is the approach Elecon chose when they designed a special idler roll just for Dahej. The result was an idler with consist low TIR.

Tubular triangular gallery

Prior to working on the Dahej system, CDI designed two triangular gallery supported conveyors in Nigeria. At Dahej, CDI was responsible for all detail design drawings of the conveyor gallery. This was the first time CDI created complete detail drawing of the triangular galleries. It was also PMC's first time constructing triangular galleries. CDI's engineering teams needed to work closely to create a practical design.

Meeting the tight structural tolerances specified by CDI to minimize vibration on the high speed conveyor proved a significant challenge for PMC particularly in horizontal galleries. Precise alignment was further complicated by the introduction of camber. Each 36 m gallery was constructed from three 12 m modules. Precisely fabricated wedges were butt welded between these modules to create a single 36 m long cambered gallery. Ultimately PMC designed a jig system to control the conveyor alignment to within the straight and horizontally curved galleries. The jig controlled the belt centerline to within w+/-1 mm.



CFD Simulation of the Conveyor Gallery. Wind generates negligible airflow above the belt.

Source: Conveyor Dynamics, Inc / PMC Projects Pvt Ltd

PMC fabricated all galleries and bents in a laydown yard at the port. The gallery design could not accommodate training idlers and PMC engineers recognized that field adjustment of the idlers during commissioning would be difficult. To avoid belt training issues, the locations of the idlers were controlled to within 1mm. In the horizontal curves a custom idler jig was used to position the idlers. The work paid off as no idler adjustments were required during commissioning.

Maintenance

Walkways substantially increase the weight of conveyor galleries. To eliminate this additional weight, CDI designed and provided detail drawings for a triangular maintenance trolley that allows maintenance personnel access to the conveyor.

Dust Control

Coal dust generation was a major concern at Dahej, particularly where the conveyor passes through Lakhigam village. Instead of enclosing the entire gallery with cladding, the belt trough-stringer-hood cover was designed to form a single aerodynamic section that shields the coal from wind. The design was validated using computational flow dynamics. Installing side cladding on the gallery would have made idler inspection from the trolley very difficult. The low profile hood cover prevents personnel from viewing the top side of the belt. Alignment of the conveyor can be visualized from the underside of the belt. Heat detection systems are critical as it is not possible to see a fire on the belt outside of the transfer towers.

To further reduce dust, a Dry Fog Dust Suppression (DFDS) system was installed at each conveyor discharge point to control dust generated in the chutes.

Erection

Since the conveyor system passes through both residential and industrial areas, minimizing the inconvenience and disruptions to the local community was an important consideration. PMC created a strategic plan for each and every gallery, mapping the approach through the village to ensure fast safe erection of the galleries.

Conclusion

In India, acquiring land is challenging and conveyor systems often must allow local populations to freely pass through the conveyor corridor. Free movement is best facilitated by elevating the conveyor system, but this can become cost prohibitive. A triangular gallery with a motorized maintenance trolley is a practical structure for economically supporting elevated conveyors.

In addition to the light weight structure, high speed conveying and horizontal curves offers further reduce capital investment costs.