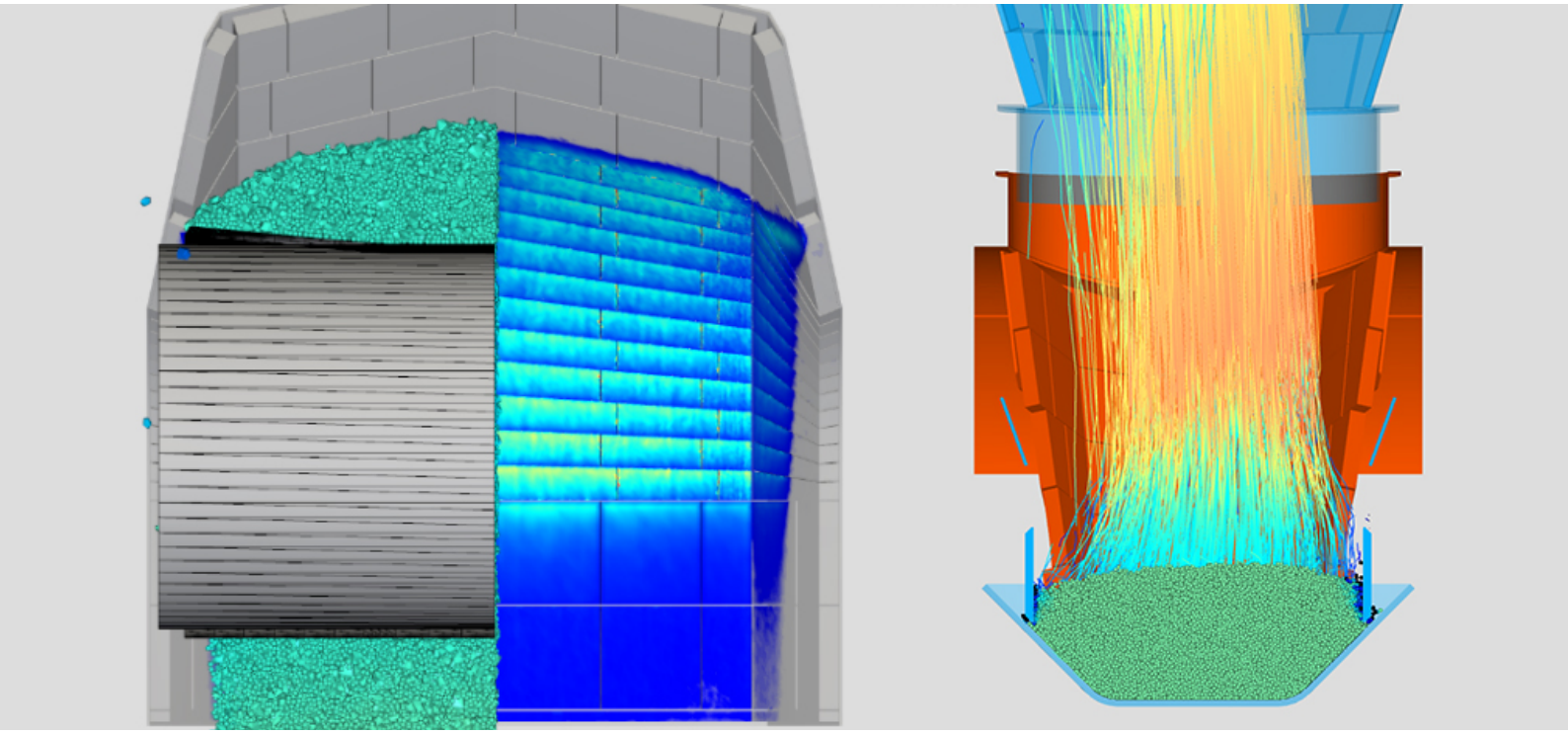
CASE STUDY

ROCKY

With Rocky DEM, Onyx Projects finds solutions for longstanding bucket wheel reclaimer blockages and port delays



> The powerful processing power and extensive customization options of Rocky continue to improve. Of particular note is the enhanced calibration suite tools that Onyx has customized in collaboration with ESSS to improve the speed and accuracy of determining material parameters to simulate the flow properties of real world materials."

Dr. Richard Elliott

Principal Mechanical Engineer, Onyx Projects

Bucket wheel reclaimers (BWRs) are a key piece of equipment in iron ore loading. Stoppages and delays in this part of a ship's loading process can cause bottlenecks and slowdowns at ports around the world. As part of a program aimed at reducing delays and improving overall port availability, Onyx Projects was tasked with investigating a BWR that was experiencing yard belt drift, blockage and buildup resulting in unscheduled delays. Several investigations over fifteen years had failed to find root causes or solutions to the problem. With Rocky DEM, Onyx applied root cause analysis techniques and used advanced DEM modeling to finally identify and resolve the BWR issues.

Iron-ore fines can cause many bulk material handling problems: blocked transfer chutes, material build-up that requires frequent hosing, non-central loading that leads to belt runoff. In this analysis, Onyx found that a site-based data analysis suggested several root causes for the BWR belt drift, including transient machine conditions. Multiple simulations were therefore needed to better understand the problem.

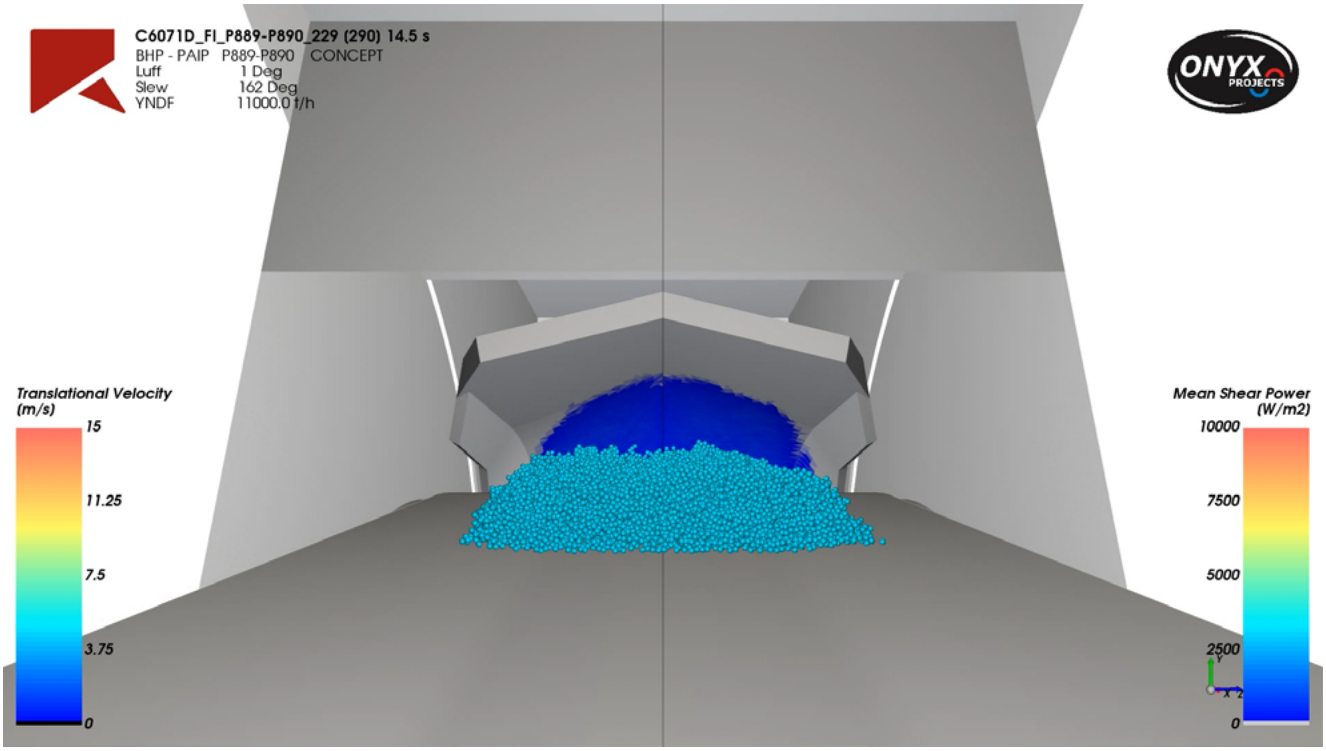


Figure 1: Section slice of ore through transfer chute.

Capturing the complex behavior of this "sticky" material in a simulation environment is a challenge. To understand and predict the flow of iron-ore fines in this BWR, Onyx Projects used simulated shear cell experiments to calibrate the flowability of 3 different iron-ore fines materials at differing moisture levels to capture the full range of flow behavior and replicate the real flow problems. The initial calibration simulated a real-life

Jenike experiment and adjusted simulation input parameters to match the results of the real-world test. The calibrated materials were then validated with detailed comparisons of the BWR chute DEM simulations to site observations of the same.

Rocky DEM's complex simulations included several components that helped provide Onyx with key insights. Included in the analysis were every quadrant of the machine's operation and the sensitivity of the belt loading forces to slew within each quadrant, plus the sensitivity of:

- **Belt loading forces caused by material surging due to the regular tipping of the bucket wheel on the boom belt.**
- **Belt forces due to the stopping and starting of material loading by the bucket wheel onto the boom belt, which occurs when the slew changes direction when cutting the pile.**
- **Belt forces due to crash stopping and re-starting the BWR's boom belt.**
- **Belt forces due to boom luff position for all three benches of operations.**
- **Belt forces due to material type—three different iron-ore fine material types were simulated.**

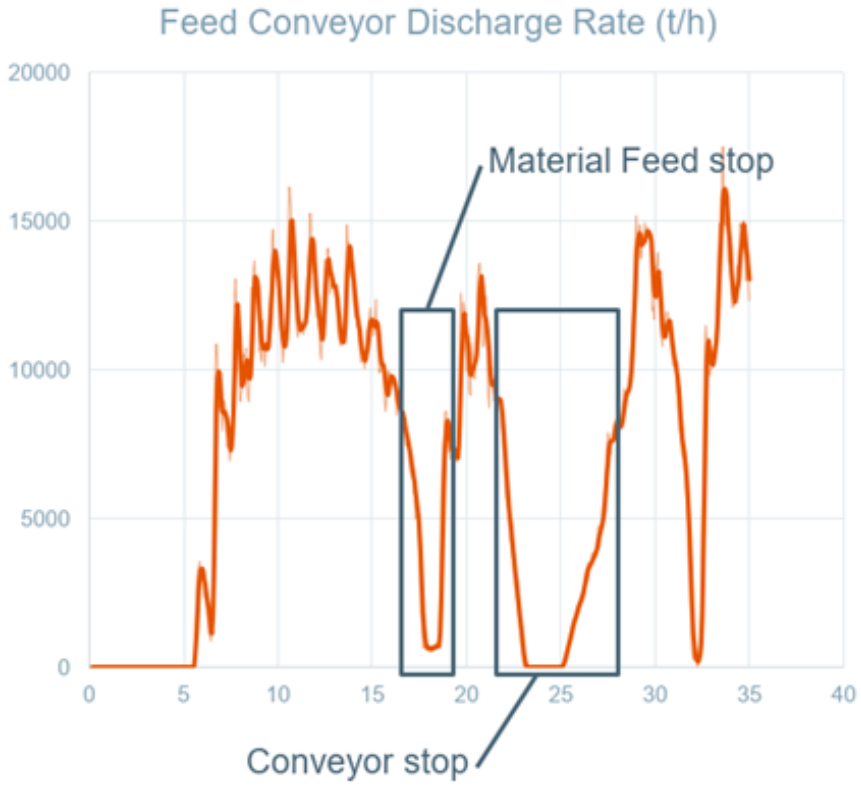


Figure 2: Transient belt loading set-up – bucket tipping and feed on/off and belt stop start events.

A review of transient conditions was essential to capturing and replicating the underlying root cause of the belt drift problems. The advanced Rocky DEM simulations showed the transient spikes in lateral belt forces that matched the site-based evidence. Previous steady-state simulations had been unable to demonstrate the underlying problems. Onyx also discovered that relatively minor changes in material flow behavior, especially adhesion, can significantly influence the belt loading forces.

To improve the BWR loading process, Onyx developed a novel impact plate with separate wings specifically to improve the central loading of the reclaimer chute during transient surge conditions across the whole operating range of the machine slew positions. The wing inserts can condense material from the impact plate into a central place.

With revised impact plate configuration and chute modifications, Onyx could demonstrate significantly reduced variability of lateral belt loading forces under the same transient operating conditions.

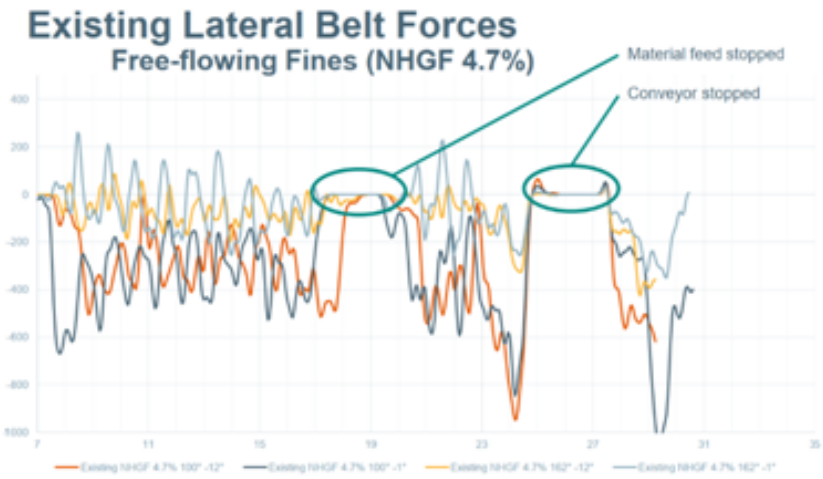


Figure 3: Before upgrade - transient lateral belt force measured in response to transient loading conditions.

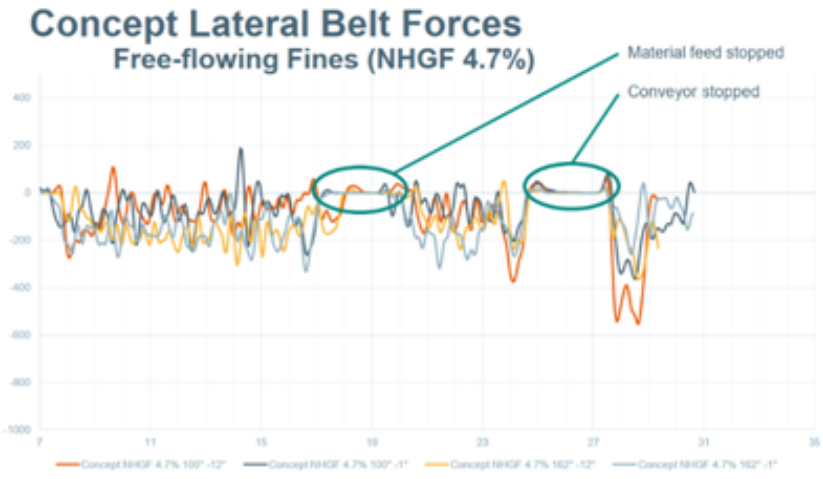


Figure 4: After upgrade - transient lateral belt force measured in response to transient loading conditions.

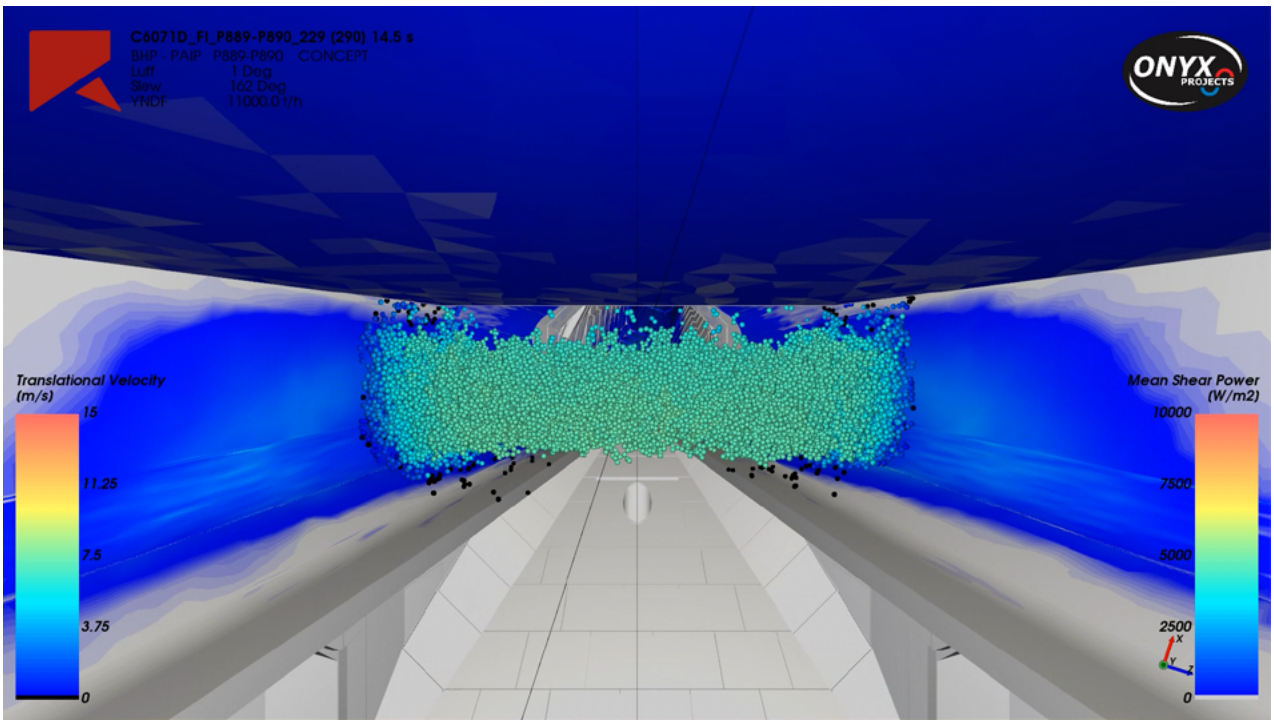


Figure 5: Section slice of material through transfer chute.

Because of insights gained during the simulation, engineers were able to design an improved BWR transfer chute, which eliminated many of the underlying root causes of the original belt drift problems. Also, the impact plate and separate wings experienced less build-up and had improved access for inspection/cleaning and maintenance.

Thanks to the re-designed impact plate and separate wings the reclaimer now centrally loads the yard belt during the transient operating conditions resulting in significantly reduced belt drift and fewer unscheduled delays associated with the BWR. The performance enhancements have de-bottlenecked the route, increasing the rates for reclaiming and ship-loading.

Figure 6: Ore discharge from wings, central feed presentation to lower chute.

Problem

Onyx Projects needed to optimize bucket wheel reclaimers (BWR) in an iron ore loading equipment. Yard belt drift, blockage and buildup in these pieces were causing unscheduled delays. Several investigations over fifteen years had failed to find root causes or solutions to the problem.

Solution

Onyx engineers turned to Rocky simulation as an engineering solution, applying root cause analysis techniques and advanced DEM modeling to finally identify and resolve the BWR issues.

Benefits

Rocky DEM's complex simulations included several components that helped provide key insights for engineers to design an improved BWR transfer chute, which eliminated many of the underlying root causes of the original belt drift problems, reducing unplanned downtime.

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Onyx Projects is supported by Leap Australia, Rocky DEM Channel Partner