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Catch and release

During cement production, the proper loading and distribution of material on a conveyor at the point where the cargo touches the belt are linked to long-term system health, as well as workplace safety and process efficiency. Referencing a plant project in Texas, USA, where dust and spillage posed a potential risk to workers, Martin Engineering highlights the importance of efficient conveyor transfer design.

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Often, cement production can involve heavy raw materials being transferred from one conveyor to the next in an unobstructed vertical drop onto an inadequately supported belt, which reduces belt life and can damage rolling components. However, this is not the only factor that degrades efficiency. Varying sizes of conveyed material – rock, aggregate, sand, ash, slurry – each present unique loading issues at stages throughout the transport cycle. Whether it is controlling spillage, containing dust, reducing carryback or avoiding belt mistracking, proper conveyor transfer design will help mitigate many of the issues that lead to downtime while accommodating future retrofits.

Proper conveyor transfer design will help mitigate many of the issues that lead to downtime, including dust spillage

Signs of improper belt loading

No two operations are alike. Failure to consider all aspects of design will result in unnecessary dust, spillage and generally shorter belt and equipment life. When designing a loading zone, engineers should account for several elements:

- how material moves through the system
- material adhesiveness
- material distribution characteristics
- material interaction with the belt
- bulk density
- safety and maintenance.

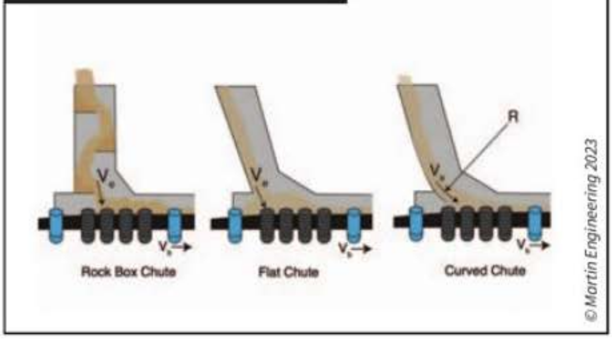
How material moves through the system

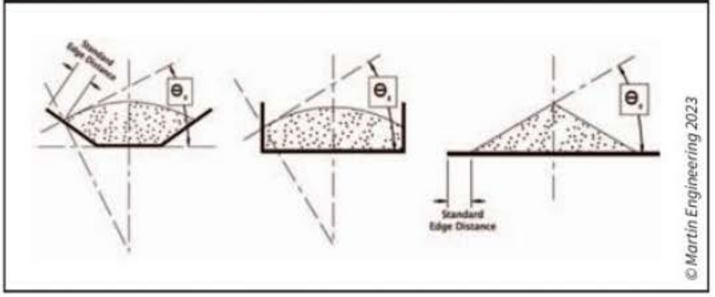
Some chute designs have rock boxes or shelves that slow the descent of cargo but can result in clogging or sudden surges when deposits of material break free. Flat chutes can produce splashing and backflow that damage components and result in spillage, dust and uncentred belt loading.

However, a curved design better controls material flow and remedies these issues by slowing the descent and centring the cargo.

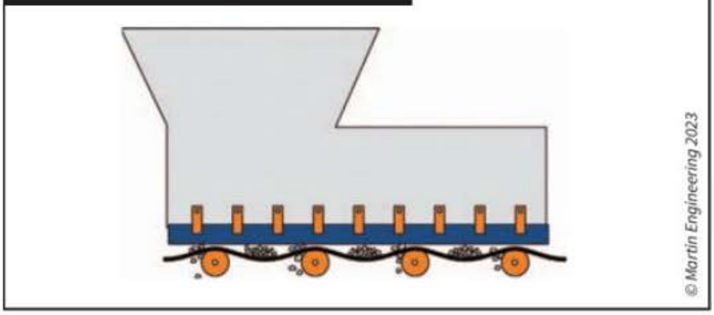
Modern loading zone design has elements that focus on safety for both personnel and equipment

Some chute designs are better for specific materials, but surges are a concern





Surcharge angle (θs) as represented in a troughed belt, for a pan or apron feeder and a flat belt



Belt sag between idlers causes separation from the skirtboard, creating an unsealed environment

Material adhesiveness

Cement producers need to take several factors into consideration such as moisture, silica content and the direction of the metal grain on the surface of the chute walls, which can all contribute to chute plugging and excessive downtime. Systems may not always clog right away – instead, the weight of build-up might cause a sudden surge that overwhelms the loading zone.

Material distribution characteristics

To establish how quickly into the chute from the tail pulley the belt should be troughed and at what angle, the surcharge angle is the angle of the pile in relation to the contact with the belt after it achieves a stable profile. This can inform chute design when mitigating spillage.

Material interaction with the belt

Improper loading of small sharp materials such as aggregate, crushed stone and gravel can produce significant dust and spillage along walkways, fouling the return side of the belt and becoming entrapped between the skirtboard and belt, resulting in belt damage. Uneven loading can cause the belt path to shift, leading to mistracking and creating spillage along the entire length of the system.

Bulk density

The loose bulk density is the weight per unit of volume of material in a non-compacted condition. Although the consolidated bulk density (total volume when compacted) of some materials can cause the troughed cargo to condense into a much smaller size, once the particulates separate in the transfer chute at the point of discharge, the volume can increase considerably. Therefore, loose bulk density should be recalculated and used to determine the geometry of each transfer point based on this change.

Safety and maintenance

Labour and safety issues for monitoring and maintaining the flow of material can be costly if overlooked. When receiving cargo from other conveyors, feeders, front loaders, rail cars, etc, the paramount concern in any design should be safety. This is achieved by controlling throughput, minimising obstructions and sealing the chute to prevent spillage and dust.

Belt support

Installed directly under the chute discharge, impact cradles alleviate belt damage by absorbing the forces from the landing of material on the belt. Many operators are moving away from impact idlers in favour of static cradles that feature a bed of steel angles lined by energy-absorbing impact bars with a top layer of low friction, ultra-high molecular weight (UHMW) polymer.

The space between impact idlers can create a small gap between the skirtboard and the belt. The impact of material on the belt can cause a splashing effect of fines and produce air turbulence that seeks exit points from the chute through these gaps, pulling dust and spillage with it. The bar design retains a consistent seal at the loading point to reduce the amount of spillage and dust emissions.

Case study – dust and spillage in Texas, USA

Safety personnel at a cement plant in Texas raised attention to a transfer point leading from the cooling process to the tripper conveyor in the clinker barn. The transfer point struggled with excessive spillage of hot material and posed a potential risk to workers.

Processing approximately 181.4tph (200stph) of raw meal, when the molten clinker rolls out of the kiln, it is loaded onto a pan conveyor consisting of high heat metal pans pulled by a chain. Cold air cools the cargo quickly, reducing it from nearly 760˚C (1400˚F) to 176-426˚C (350-800˚F).

The large hole and the warped grate indicate the extreme heat emitted by the system

Once the clinker is cooled, it is dropped through a 1.5m (5ft)-long sloped chute onto a high-heat belt attached to a tripper conveyor that is suspended 24.4m (80ft) above the massive piles along the length of the airplane hangar-sized clinker barn. With a length of 335m (1100ft) and a width of 610mm (24in) , the belt conveys material at a speed of 1.32m/s (260ft/m). Operators found that, even with the heat rating, the heat, material impact and mistracking due to uneven cargo would cause the belt to fray, erode quickly or experience splice detachment.

Several issues contributed to safety concerns. The original transfer point from the pan conveyor to the tripper had some problems with sealing. Hot fines would melt the steel of the enclosure and spill out the sides, collecting on the walkway around it. In addition, back-ups in the transfer chute often stopped production until they could be addressed. Manually clearing a clogged transfer chute carried the possibility of direct contact with the hot material, so a trained employee wearing high-heat PPE used an air lance or CO_2 blasting device to perform the cleaning, leading to longer downtime.

Even scheduled maintenance imposed both safety and cost concerns. Contractors were brought in approximately twice per month to clean the area. A crew of 4-5 workers with a vacuum truck would remove the debris. This cost the plant as much as US$15,000-20,000 per month, depending on the scope of the job and the number of times the crew needed to come in.

Martin Engineering was invited to offer solutions. The team installed a new enclosure with an impact cradle, external wear liner, apron seal skirting, track-mounted idlers, support cradles and dust curtains. These components work together as a total solution to improve belt loading, reduce spillage and dust, and minimise impact damage to the belt.

Nearly a year following installation, operators report improved efficiency and significantly less spillage. "Material piling on the walkway has been drastically reduced, and there's less dust in the immediate area, so this project made working around the transfer point much safer," said a source close to the project.

Since installation, belt damage such as holes and splice detachment have not been a problem. Because the belting is the most expensive and time-consuming component to replace, this reduced the cost of operation significantly. In addition, the enclosure has remained intact and sealed, continuing to control spillage. Removing most of the idlers from the entire transfer point reduced the chance of roller seizure and friction damage on the return side of the belt.

"We no longer need the crew with the vacuum truck, so that has definitely cut down on man hours and the significant expense for maintenance and cleaning," the source concluded. "Overall, we're happy with the results. The Martin equipment has made the area safer and more productive."

Conclusion

Loading zone design is not an exact science, and with so many considerations, some details inevitably get missed. Until the system is up and running, engineering design can only provide highly informed scientific estimates that may change. Unpredictable factors such as weather, foundation settling, and variations in the material density can have significant effects in the post-construction operations and efficiency.

Luckily, there is equipment specifically designed to mitigate these design issues and engineered to fit any system retroactively. It is only through experience, observation, and testing – and some smart engineering – that the correct retrofit can be applied. ■

REFERENCES

[1] SWINDERMAN, RT, MARTI, DE, GOLDBECK, LJ, MARSHALL, D AND STREBEL, MG (2009) in: *Foundations™: The Practical Resource For Cleaner, Safer, More Productive Dust & Material Control, Fourth Edition.* Neponsett, USA: Martin Engineering, 575p.

Integrated modular components work together for maximum performance