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Conveyor belt support: Design, efficiency and maintenance

Figure 1: A flat, sag-free belt line is essential to successfully sealing the load zone.

To mitigate dust and spillage from surface and underground mine conveyors, design engineers must do whatever is practical to keep the belt's line of travel consistently steady and straight. While there are many factors that influence the belt's running line both inside and outside the loading zone, a key ingredient is proper belt support.

Modern belt support systems are designed to retain a smooth belt path with minimal bumping or disruption of settled cargo, avoiding gaps in the loading zone and minimising "belt sag" between idlers along the length of the system. New designs reduce maintenance costs and improve safety by offering easier access to components and decreasing the amount of labor required to perform routine maintenance.

BUILDING PROPER BELT SUPPORT

Before any support components (cradles, idlers etc.) are installed, the structure on which all conveyor equipment is attached – the "stringer" – must be precisely aligned and the footings secure. Stringer alignment using laser surveying is the preferred method. The Conveyor Equipment Manufacturers Association (CEMA) publication Appendix D provides installation tolerances. Also, it is imperative that footings provide rigid support to prevent movement or deflection. Finally, engineers should account for the amount of material being loaded and the force of the impact to prevent excessive belt deflection under the load.

As noted in Martin Engineering's FoundationsTM industry reference book, the belt's line of travel must be stabilised with proper support in the loading zone to achieve an effective, minimum-spillage conveyor[1]. Ideally, the belting should be kept flat, as if it were running over a table that prevented movement in any direction except in the direction the cargo needed to travel. With a true belt line, support components can better maintain a sealed environment. According to CEMA there are a number of techniques and components that can be used, independently or in combination, to control belt sag by improving belt support in the loading zone. They include idlers, belt support cradles and impact cradles[2].

IDLERS

Idlers share the same responsibilities: to shape and support the belt and cargo, while minimising the power needed to transport the materials. Idlers are generally classified according to roller diameter, type of service, operating condition, belt load and belt speed. They are rated on their load-carrying capacity and calculated bearing life. CEMA uses a two-character code that expresses the idler classification and implied load rating, with a letter-based code followed by idler diameter in inches, resulting in classes from B4 to F8. [**Figure 2**]

Idler Classifications (Based on CEMA Standards)

CEMA Idler Classification	Roll Diameter		Belt Width		Description
	mm	in.	mm	in.	
B4	102	4	450-1200	18-48	Light Duty
B5	127	5	450-1200	18-48	
C4	102	4	450-1500	18-60	Medium Duty
C5	127	5	450-1500	18-60	
C6	152	6	600-1500	24-60	
D5	127	5	600-1800	24-72	
D6	152	6	600-1800	24-72	
E6	152	6	900-2400	36-96	Heavy Duty
E7	178	7	900-2400	36-96	
F6	152	6	1500-2400	60-96	
F7	178	7	1500-2400	60-96	
F8	203	8	1500-2400	60-96	

Metric dimensions are conversions by Martin Engineering; belt widths may not be actual metric belt sizes.

Figure 2: Idler Classifications based on CEMA standards.

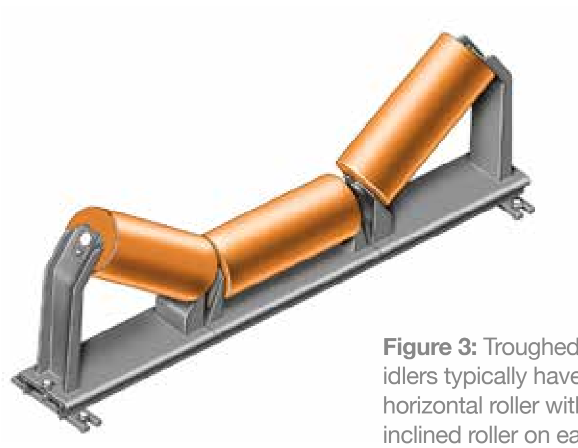

Figure 3: Troughed idlers typically have a horizontal roller with an inclined roller on each side.

Figure 4: Impact idlers.

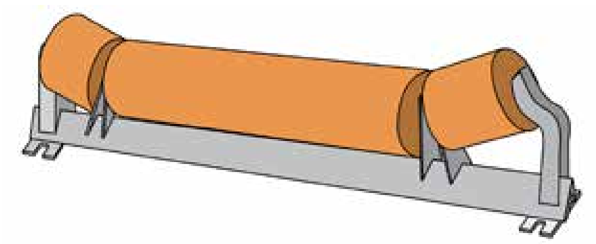

Figure 5: Picking idlers provide a low trough angle to help center large chunks of cargo.

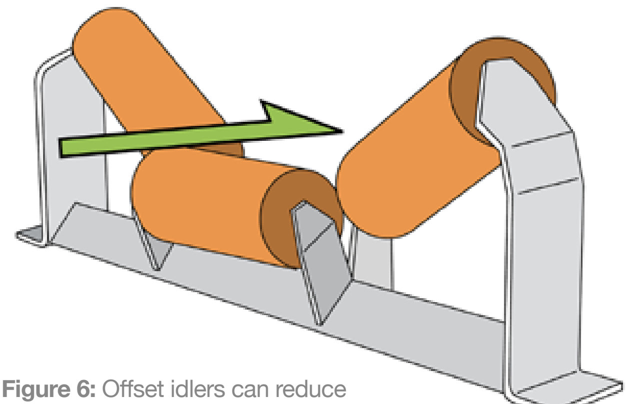

Figure 6: Offset idlers can reduce the overall height of the assembly.

Available in flat or troughed designs, *carrying idlers* provide support for the loaded belt. The flat idler usually consists of a single horizontal roll for use on flat belts, such as feeders. The troughed idler typically consists of three rolls – one horizontal roll in the center with inclined (or wing) rolls on either side. [**Figure 3**] The angle of the two inclined rollers from horizontal is called the trough angle. These are designed to support and shape the belt into a specific trough angle for the conveyance of cargo.

One solution for absorbing impact in the belt's loading zone is cushioned *impact idlers*, which typically have a similar load rating to standard idlers, with the same shafts and bearings. One disadvantage is that each idler supports the belt only at the top of the roller. No matter how closely spaced, the rounded shape and deflective rubber will allow the belt to oscillate or sag away slightly from the ideal flat profile. [**Figure 4**]

With long center rollers and smaller side rollers, the *picking idler* delivers a shallow trough with a wide base, giving larger cargo such as raw stone a wider area on which to settle. Without that wide base, large chunks would

Recommended Idler Spacing for Applications Outside the Loading Zone as Published by CEMA							
		Carrying Side Idler Spacing Outside the Loading Zone					
		Weight of Material Handled in Kilograms per Cubic Meter (lb_m/ft^3)					
Return Idler Spacing	Belt Width	480 (30)	800 (50)	1200 (75)	1600 (100)	2400 (150)	3200 (200)
m (ft)	m (in.)	m (ft)	m (ft)	m (ft)	m (ft)	m (ft)	m (ft)
3,0 (10.0)	457 (18)	1,7 (5.5)	1,5 (5.0)	1,5 (5.0)	1,5 (5.0)	1,4 (4.5)	1,4 (4.5)
3,0 (10.0)	610 (24)	1,5 (5.0)	1,4 (4.5)	1,4 (4.5)	1,2 (4.0)	1,2 (4.0)	1,2 (4.0)
3,0 (10.0)	762 (30)	1,5 (5.0)	1,4 (4.5)	1,4 (4.5)	1,2 (4.0)	1,2 (4.0)	1,2 (4.0)
3,0 (10.0)	914 (36)	1,5 (5.0)	1,4 (4.5)	1,2 (4.0)	1,2 (4.0)	1,1 (3.5)	1,1 (3.5)
3,0 (10.0)	1067 (42)	1,4 (4.5)	1,4 (4.5)	1,2 (4.0)	1,1 (3.5)	0,9 (3.0)	0,9 (3.0)
3,0 (10.0)	1219 (48)	1,4 (4.5)	1,2 (4.0)	1,2 (4.0)	1,1 (3.5)	0,9 (3.0)	0,9 (3.0)
3,0 (10.0)	1372 (54)	1,4 (4.5)	1,2 (4.0)	1,1 (3.5)	1,1 (3.5)	0,9 (3.0)	0,9 (3.0)
3,0 (10.0)	1524 (60)	1,2 (4.0)	1,2 (4.0)	1,1 (3.5)	0,9 (3.0)	0,9 (3.0)	0,9 (3.0)
2,4 (8.0)	1829 (72)	1,2 (4.0)	1,1 (3.5)	1,1 (3.5)	0,9 (3.0)	0,8 (2.5)	0,8 (2.5)
2,4 (8.0)	2134 (84)	1,1 (3.5)	1,1 (3.5)	0,9 (3.0)	0,8 (2.5)	0,8 (2.5)	0,6 (2.0)
2,4 (8.0)	2438 (96)	1,1 (3.5)	1,1 (3.5)	0,9 (3.0)	0,8 (2.5)	0,6 (2.0)	0,6 (2.0)

Metric conversions added by Martin Engineering; belt widths may not be actual metric belt sizes.

Figure 7: CEMA Idler Spacing Chart.

drift to one side of the belt or the other, which can cause misalignment. [**Figure 5**]

Most of these designs are *in-line idlers*, meaning all three rollers are positioned end to end. *Offset idlers* place the center roller slightly in front of the wing rollers, which are aligned in a V slightly below the center roll profile. By reducing the overall height of the idler set, this configuration is excellent for cramped quarters such as mines or other applications that require heavy-duty support but lack the space. [**Figure 6**]

IDLER SPACING

Typically, idlers are placed close enough together to support a fully loaded belt so it will not sag excessively between them. Sagging causes the load to shift as it is carried up and over each idler and down into the valley between, increasing belt wear and power consumption while contributing to fugitive dust and spillage. This complicated mathematical relationship has been published. CEMA has produced tables of recommended idler spacing for applications outside the loading zone. [**Figure 7**]

CRADLES

The "flat table" concept is so important to good sealing that many designers now use cradles in place of idlers under conveyor loading zones. Instead of using an idler's rolling "cans," cradles use low-friction bars to support the belt profile.

Belt support cradles perform two functions – controlling belt sag in the load zone to curtail spillage and providing

Figure 8: Impact cradles minimise belt damage and improve edge sealing.

a slick surface upon which the belt can ride. In addition, impact cradles reduce belt damage by absorbing the forces from the landing of material on the belt. Other benefits of using cradles under the transfer point include a reduction in moving parts and elimination of required lubrication. The modular design of the typical cradle system allows the belt support to be extended as far as the circumstances require.

IMPACT CRADLES IN THE LOADING ZONE

Some bulk handling operations drop material from a great height through a long chute with nothing to control the descent. Constant high magnitude impacts without proper support can damage the belt cover and weaken its carcass. An example would be an 18″ (45.7 cm) lump of sandstone dropping 7 feet (2 m, 13 cm). This lump will hit the belt with the same energy as a fully loaded refrigerator falling 10 feet (3m, 5cm). Bulk material can also “splash,” sending debris in all directions at a high trajectory and creating a “ripple” effect on the belt, de-stabilising its line of travel and increasing spillage.

To minimise these negative effects, impact cradles are installed directly under the material drop zone to bear the brunt of the shock of the material hitting the belt as it loads. [**Figure 8**] These cradles are usually constructed of a set of individual impact-absorbing bars assembled into a steel support framework. The bars are made from durable elastomeric materials that combine a slick top surface – allowing the belt to skim over it to minimise friction – and one or more sponge-like secondary layers to absorb the energy of impact.

A number of “combination cradle” designs are available, which use bars for a continuous seal at the belt edge but also incorporate rollers under the center of the belt. [**Figure 9**] These hybrid designs are popular as a way of combining the low power consumption of rollers with the flat sealing surface of impact or slider bars. The running friction is kept low by supporting the center of the belt with conventional rollers, reducing power consumption. The belt edge is continuously supported, eliminating belt sag between the idlers. Some models allow the bumpers to be flipped to double the service life.

CRADLE MAINTENANCE

Some cradles are fixed to the crossbeam and require workers to reach in or access the units from underneath. However, if there is available room in the work area, there are units engineered to slide away from the stringer during scheduled downtime when the belt is empty.

Much like pulling out a drawer to a filing cabinet, a single worker removes the locking pin in a one-tool procedure and simply slides the cradle into the open-access area to perform maintenance outside of the belt plane. This creates a safer work environment, improves access for higher quality maintenance, reduces the amount of labor needed and minimises the amount of downtime required for the procedure.

Maintenance procedures for a conveyor belt-support system should include regular inspection and reporting either by a designated internal resource or a maintenance contractor, including:

1. Identification of areas with excessive spillage and determine the cause.
2. Inspection of rolling components for wear and operation.
3. Scheduled replacement of seized, damaged or worn rollers.
4. Lubrication of bearings in rolling components as appropriate.
5. Inspection of belt-support cradles.
6. Adjustment of cradles to compensate for wear.
7. Realignment and/or replacement of bars showing abuse or wear.
8. Removal of material accumulations from rollers, frames, cradle structure and support bars as required.
9. Default to the manufacturer's instructions for the required maintenance on any specific component.

Experienced system designers recommend selecting belt support system components that prioritise ease of maintenance. The easier maintenance is to perform, the more often it will be done, resulting in longer equipment life, reduced downtime and lower cost of operation.

CONCLUSION

The use of improved belt support and sealing techniques places additional requirements on conveyor drive systems. However, these additional requirements and costs will seem minor when compared to the power consumed by operating with a single "frozen" idler, or several idlers operating with material accumulation. By implementing the proper belt support systems, a mine can prevent the many costly problems that arise from the escape of fugitive material. It's better to design a system that incorporates the slightly elevated power consumption required to prevent spillage, rather than suffer the much higher power consumption and greater consequences that arise from fugitive material. The costs for installation and operation of proper belt-support systems represent an investment in efficiency.

REFERENCES

1. Swinderman, Marti, Goldbeck & Marshall; Martin Engineering: FoundationsTM 4th Edition (2009); ISBN 978-0-9717121-1-9; Library of Congress Control Number 2007942747; Chapter 10: Belt Support; pp.130-151.
2. Conveyor Equipment Manufacturers Association (CEMA), (2005): "Conveyor Installation Standards for Belt Conveyors Handling Bulk Materials;" In Belt Conveyors for Bulk Materials, Sixth Edition, Appendix D, pp. 575–587; Naples, Florida.

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