AGENDA OF THE CEMA ENGINEERING CONFERENCE
BULK CONVEYOR ACCESSORIES COMMITTEE MEETING
Tuesday, June 26, 2018 – 1:00 pm

1. Call to order

2. Attendance and Introductions – recognize new attendees

3. Approval of Agenda

4. Review and Approval of Previous Minutes (attached)

5. Old Business
   a) Update on review of Belt Mistracking Allowance incorporated in Skirtboard Sealing Best Practices. (attached)
      Sub-Committee: Lee Williams (Leader). Members: Brett DeVries, Matt Koca, Scott Smith, Dr. Robin Steven, Todd Swinderman, Akiko Wakatsuki.
   b) Emerging Technologies Committee tasked to Accessories Committee to review Skirtboard and Skirting Pressure Calcs and Resultant Drag from the Belt Book and to revise and expand as required
   c) Consider implication of High Speed and High tonnage Belts as it pertains to CEMA 575-2013. (Attached CEMA 575-2013)
   d) Review submitted “Tracking and Training Devices” document. (Attached)
   e) From Emerging Technologies Committee: Address concerns that Accessories Manufacturers may not be keeping up with Higher Speed Belts.

6. New Business
   a) CEMA Whitepaper – Volunteers needed (Sample attached)
   b) Errata fixes and minor revisions are being incorporated into 2nd printing of 7th Edition of the Belt Book. The 2nd printing will reflect the newer methods of impact bed energy calcs discussed in CEMA 575-2013. Therefore, CEMA 575 -2013 needs to be reviewed for accuracy. Suggest we walk through this during the committee meeting. (Attachment CEMA 575-2018 Draft)
   c) CEMA No. 576 – Proposal Review for same reason as 6b above (Attached)
   d) Discrepancies in the 7th Edition Belt Book when recommending training idler spacing (Attached)

7. Next Meeting – June 25, 2019, La Playa Hotel, Naples, FL

8. Adjourn

Greg Westphall, Chair
Lee Williams, Vice Chair
1. The meeting was called to order at 1:00 pm – Greg Westphall, Flexco

2. Attendance and introductions

3. Announcement that John Barickman, Martin Engineering; resigned as Chair. Vice Chair, Greg Westphall, Flexco; assumes Chair position in John’s absence per CEMA guidelines. There were no objections.

4. Reviewed Minutes from June 21, 2016. Amendment to minutes to reflect Judd Roseberry, Richwood; agreed to contribute a section to the accessories chapter of the belt book as opposed to a chapter. The minutes were approved as amended.

5. Old Business
      Sub-Committee: Todd Swinderman, RToddS Engineering; Lee Williams (chair), ASGCO; Matt Koca & Brett DeVries, Flexco; Geoff Normanton, Fenner Dunlop; Joshua Stoll, Richwood; Dr. Robin Steven, ContiTech North America; also CEMA Staff is invited to the meeting.
      - Todd Swinderman, RToddS Engineering; presented a comparison of existing related standards and a proposal for skirtboard spacing based on them.
      - The group discussed that the current CEMA standard of 2/3 BW has drawbacks for small belt widths and very wide belt widths. Also faster belt create problems due to material piling up between skirting. Another consideration is the space left for fastening skirting near the edges of the belt. The discussion turned to the fact that the amount of allowable wander in the belt ultimately determines the space left for things like skirting, and this should be established first. We can revisit the sealing best practices after wander standard is completed. The group also noted that the pulley width recommendations may be affected.
      - A motion to pursue establishing a belt wander standard was proposed and passed by the group.
b) **Belt Tracking & Training Best Practices.** We largely covered this in the previous discussion.

c) **CEMA Standard 575-2013.** Update for high speed, high tonnage belts was not discussed. Greg Westphall, Flexco; to review with committee this omission and resolve.

6. **New Business**

a) Noted that the Accessories Committee has been tasked by the Bulk Belt Systems and Emerging Technologies Committee to investigate the *Skirtboard Friction / Drag information in the belt book 7th Ed*, and should propose updates and expansion as needed.

b) There was a topic that was brainstormed from a previous Emerging Technologies committee regarding the concern that accessories manufacturers are not keeping up with **Higher Speed Belts**. It was agreed that this topic is better reviewed at the next accessories meeting.

c) Accessories Committee to review **Skirting Pressure Calcs** in belt book at next meeting

d) It was overlooked at the Accessories Committee Meeting to call for a White Paper regarding Safety. **Greg Westphall, Flexco**; agreed to provide a White Paper on **Proper Belt Clamp Usage**.

e) It was learned in the Emerging Technologies Committee meeting that Richwood emailed a *Tracking and Training document* to be reviewed by the Accessories Committee as content for next Belt Book. Greg Westphall, Flexco; will distribute for review. (attached)

7. **Nomination and Election of Vice Chair.** **Lee Williams, ASGCO;** was elected Vice Chair

8. **Next Meeting:** June 26, 2018, La Playa Hotel, Naples, FL.

9. **Adjourn**

Respectively submitted,

Greg Westphall
CEMA Bulk Conveyor Accessories Committee
Skirtboard Sealing

Best Practices Approach

Draft 1

The primary purpose of a skirtboard is to keep the load on the conveyor, preventing material spillage over the belt edge, while the load is settling onto the belt and material has reached belt speed. Best practices in chute and skirtboard design now provide the opportunity for much cleaner and more efficient material handling system.

The skirtboard and the wear liner placed inside the skirtboard combine with an elastomer sealing system to form a multiple-layer seal. The elastomer seal should not be expected to withstand material side pressures or pieces of material larger than small fines. The skirtboard and wear liner form the first line of defense intended to contain fugitive material and prevent material head pressure from contacting the sealing system. To avoid entrapment of material between skirtboards, wear liner, and belt, skirtboards should be installed so they taper upwards providing increased clearance from the belt (vertical).

Inadequately sized skirtboard always leads to poor conveyor performance in form of material spillage, excessive dust, and higher operating cost by the end user.

**Proper Skirtboard Size:**

**Length**- Refers to additional length of steel beyond the impact zone. Skirtboard should extend past point where material fully settles onto the profile. The length needed for the bulk material to reach receiving belt speed and settle into the surcharge profile is calculated in the equation below (Eq. 12.45 p.513 Belt Book).

\[ L_a = \frac{V_b^2 - V_{ey}^2}{2g (\mu_b - \tan(\theta))} \]

\[ L_a \] = distance to accelerate bulk material to receiving belt speed

\[ V_b \] =velocity of receiving belt

\[ V_{ey} \] =vertical velocity of bulk material as it leaves discharge chute

\[ g \] =gravitational constant

\[ \mu_b \] =effective coefficient of friction between bulk solids, skirtboards and belt

\[ \theta \] =inclination angle of receiving belt
If difference between $V_b$ and $V_{ey}$ is small and receiving belt flat, $La= 2$ ft. per 100 ft./min belt speed, with minimum 3 feet past loading chute

It is good practice to terminate skirtboards above an idler rather than between idlers to prevent spillage or belt damage.

**Width**- CEMA recommends distance between skirtboards is $2/3$ width of troughed belt. May be more effective to recommend amount of free belt edge distance **minimum** required for belt edge seal and belt wander; acceptable amount of belt wander is 1.00” (25mm).

**Height**- Contributing factors effecting height of skirtboard include belt width and speed, material lumps and air speed at discharge. Skirtboard should be tall enough to contain the material load when belt is operating at normal capacity and to pass two of largest lumps stacked on top of each other without jamming. CEMA has published a table specifying minimum height for uncovered skirtboards (Table 12.47 p.515 Belt Book). For dusty materials, it is a good practice to increase height of skirted area to create an added space to reduce positive air pressure. This area serves to “still” dust laden air so particles can fall back onto the cargo of the conveyor. To control dust, the cross-sectional area of the chute should be sized to keep the exit air velocity below 200-250 feet/minute. If this maximum exit velocity cannot be achieved, then mechanical dust suppression or collection is necessary.

**Purpose of Wear Liner**

A. Provides sacrificial, easily replaceable wear surface protecting wall of the chute and skirtboard
B. Helps center the material load
C. Prevents material load from applying high side forces to sealing strips
D. Can reduce friction, impact, noise, and degradation of bulk material

**Wear Liners-4 styles: straight, spaced, deflector, tapered**

**Straight Wear Liner**- Real benefit is it provides improved life and improved sealing effectiveness without closing down the effective load area. Best for belts with multiple load points.

**Spaced Wear Liner**- Variation of straight where a space is created between the skirtboard and liner used as a negative pressure area. Fines and dust can be pulled from this space by a dust collection system.

**Deflector Wear Liner**- Bend inward at bottom half of liner- provides free area between elastomer seal and liner for collecting fines for the outer seal to handle without the outward forces of material load. Reduces effective cross-sectional area of the skirtboard area.

**Tapered Wear Liner**- Cast from Molybdenum steel for use in heavy duty applications. The cross section is trapezoidal to reduce the gap where the bottom edge meets the belt, skirtboard, and
skirting seal. They are heavy and supplied in short lengths, therefore difficult to keep bottom edges in a smooth straight line.

**Edge Sealing Systems**

Effective sealing at the edge of a belt requires a properly supported belt, wear liners, skirtboards, and an edge seal. A number of engineered sealing systems are now commercially available. These systems consist of a strip of elastomer attached to the lower portion of the skirtboard by an arrangement of clamps. Effective sealing requires an adequate amount of free belt distance. Free belt distance, amount of belt outside the skirtboard on both sides of the conveyor, provides space for the sealing system and belt wander. A good practice is to use a minimum of 3.50” (90mm) for the sealing system and 1.00” (25mm) for belt wander. The seal should start in the loading area and continue to the end of the settling zone.

There are a number of different approaches to skirtboard sealing. The best way to define these systems is to describe where each contacts the belt.

**Vertical Sealing**- This type of sealing arrangement uses a single rubber or elastomer sealing strip attached to the skirtboard with some type of clamp.

**Advantages:**
1. Low in cost
2. Minimal free belt edge required
3. Can be self-adjusting

**Disadvantages:**
1. Difficult to adjust accurately
2. Easily over adjusted causing premature wear
3. Prone to material entrapment
4. Susceptible to leakage of dust and fines

**Inward Sealing**- This type of seal contains an elastomer seal clamped to the outside of the skirtboard with the lower portion curled back under the steel.

**Advantages:**
1. Self-adjusting
2. Require limited free belt edge distance
3. Handle light fluffy and fine non-abrasive materials
4. Handle high internal chute pressure
5. Handle severely mistracking belts

**Disadvantages:**
1. Shorter seal life due to being in material flow
2. Prone to material entrapment under sealing strip-leads to premature belt wear
3. Reduced carrying capacity due to space taken up by the seal where the load could be carried

**Outward Sealing** - Type of system that seals on the outside of skirtboard. The most effective is a multi-layered seal containing a primary strip which contains most of the material escaping past wear liner and secondary seal containing fines and dust.

**Advantages:**
1. Long lasting- positioned away from material flow and protected by skirtboard and wear liner
2. Can be self-adjusting
3. Low required sealing pressure due to multiple layered sealing design
4. Adapt to existing clamp system

**Disadvantages:**
1. Require greater free belt edge distance
2. Susceptible to damage if belt mistracks underneath seal

The skirtboard seal should not be the first line of defense in preventing material spillage, but rather a last chance to contain fugitive material and prevent its release. The better job done by the belt support and wear liner systems to contain material and keep it away from the belt edge, the better the performance will be of the belt’s edge sealing system. A multi-layer flexible seal incorporating some self-adjustment will provide effective material containment for a transfer point. Maintenance and periodic inspection are also important to extend the life of the conveyor’s sealing system.

### SIX STEP METHODOLOGY FOR MATERIAL CONTAINMENT ON A CONVEYOR BELT

**I. Achieve constant and consistent belt elevation**
   A. Full idler / belt contact both empty and full loading conditions
   B. Full trough transition
   C. Belt fully troughed to final conveyor trough angle
   D. Avoid catenary curves near the load zone

**II. Provide impact protection**
   A. Absorb impact
B. Protect belt
C. Reduce material bounce

III. Provide proper belt support
A. Continuous bed under seal area
B. Belt support stands between idlers at seal location prevent belt sag between components which allow gaps

IV. Containment of bulk material
A. Proper size skirt board
   1. Length (0.02 X Belt speed or equation?)
   2. Width : Free edge distance may be problematic for walking conveyors, narrow conveyors (outward seal design may limit loading width), or different types of skirt manufacturers while 2/3 BW may be problematic for narrow conveyors (may not have enough room for sealing components)
   3. Height

V. Wear liners
A. Straight
B. Spaced
C. Deflector
D. Tapered

VI. Sealing of dust and fines
A. Edge sealing (I believe we should remove the advantages/disadvantages portion as different manufacturers may develop components to mitigate disadvantages)
   1. Vertical
   2. Inward
   3. Outward
   4. Skirt liners (similar to wear liners but on outside of skirt boards)
B. Covered conveyor sections
C. Stilling chambers
D. Dust curtains
E. Vacuum systems

CEMA Skirtboard Sealing
FLEXCO Commentary
June 10, 2016

WIDTH
- In favor of maintaining the 2/3rd belt width specification. Concern was that changing standard to reference an offset from the edge of the belt would restrict the throat of the chute too severely for material flow on the narrower belt sizes (≤36”).
• Would consider a rule stating skirt width is 2/3rd belt width or 12” of freeboard from edge of belt, whichever results in a larger chute opening.

BELT WANDER
• While 1” maximum of belt wander is a laudable goal, we feel that it does not represent general practice. Standard return idler widths assume approximately 1-1/2” of belt wander before the belt runs off the end of the idler, and frequently belts are even beyond this point.
• Transfer points should be designed conservatively so that spillage is not occurring under typically conditions. To that end, we suggest that skirting be designed to accommodate belt mistracking of 2” or 5% of belt width, whichever is greater, without spillage.

SKIRTING TYPES
• Inward – We refer to this as tangential skirt. Are there are names/descriptions for this design?
  o Excellent seal against dust
  o Dips and moves as the belt traverses idlers (Slider beds not needed)
  o Slow wearing
  o Choose durometer to be softer than belt (60A typically)
  o Excessive belt wander will disengage this skirting rendering it inoperable.
  o Lack of freeboard prevents use on belts ≤36”
• Vertical
  o “Standard” skirting predominate in the industry
  o Requires least amount of freeboard
  o Can be fixed position or self-adjusting
  o Usually suffers from uneven wear against belt rendering it less effective at containing dust and material
  o Frequently wears a shallow groove in the top cover of belt
• Outward
  o Include multiple seal skirting designs in the category?
  o Requires more freeboard than vertical skirting

WEAR LINER
• Clearly define and distinguish “skirt wall”, “skirt board”, “wear liner”, “canoe liner”, etc.
• Types & materials
• Intended to contain material (lumps), not dust?
• Application guidelines
BELT TRANSITION
- Do not load belts in the transition zone
- Effective skirting systems are very difficult to design in this zone. Subpar material containment is likely

MINIMUM HEIGHT
- If a minimum chute opening of 2/3rd belt width is maintained, we favor a minimum 8” tall wear liner and a minimum 15” skirt wall for covered skirting systems.

PERPENDICULAR SKIRTING
- The chute wall is bent outward to make 90° intersection with the troughed belt surface.
- Flat skirt rubber is used. (Not tangential or outboard)
- When multiple chutes load onto the same belt, the downstream chutes need perpendicular skirting
- The inlet is usually AR steel and flared
- This skirting is less likely to disturb already loaded material

SKIRT MATERIAL DUROMETER & ABRASION INDEX
- Conventional wisdom says the skirt material should be of a softer durometer than the belt
- We typically use 60A rubber
- Do not know what the abrasion index is or have experience with higher durometer skirt materials

SKIRT PRESSURE
- We do not have a specification or target value for skirt pressure

DIN & ISO
- I was unable to locate any DIN or ISO standards regarding conveyor skirting.
DISCUSSION ON MISTRACKING

WITH PROPOSED DEFINITIONS FOR:
MISTRACKING
MISTRACKING ALLOWANCE
SKIRTBOARD WIDTH
SKIRTBOARD TOLERANCES

R. Todd Swinderman
CEMA 2017 Engineering Conference
INCONSISTENCIES & CONFLICTING GUIDANCE

- No Common Definition of Mistracking
- Only Two Standards Mention Misalignment Allowances
- Several Different Pulley Face Standards & Guidelines
- Several Different Structural Clearance Standards & Guidelines
- Two Different Standard Edge Calculations
- No Standard Skirtboard Width but Many Different Guidelines
- No Installation Tolerances for Skirtboards
WANDER – DRIFT – SWAY - MISTRACKING

• IPSS 1-11-026-15 – Misalignment: Belt runs consistently with the pulley face. If it runs over the pulley face it is called Belt Sway

• CEMA 102 – Training: the process of adjusting idlers, pulleys, and loading conditions in a manner which will correct any tendency of the belt to run other than centrally.

• Web - Mistracking:-The off-center travel of a conveyor belt.

• Web – Tracking: (Training) is defined as the procedure required to make the conveyor belt run “True” under all operating conditions.
RANGE OF PULLEY FACE WIDTHS
RANGE OF HEAD CHUTE WIDTHS

Pulley Face + 100 to 400 mm

Pulley Face

BW + 50 to 250 mm

Chute Width
RANGE OF MISTRACKING ALLOWANCES
MISTRACKING ALLOWANCE

• Indian Interplant Standard Differentiates between
  – Mistracking Allowance  = Varies by BW from: +/- 20 to 30 mm from Conveyor Centerline
  – Belt Sway = +/- [BW - (Pulley Face Width)/2]

• DIN Mistracking Allowance
  – Varies by BW from: +/- 40 to 75 mm from Conveyor Centerline
RANGE OF STRUCTURAL CLEARANCES

Structural Clearance BW + 120 to 600 mm

Pulley Face BW + 50 to 250 mm

Mistracking Allowance ± 20 to 75 mm

Chute Width Pulley Face + 100 to 400 mm
## MISTRACKING ALLOWANCE CLASSES

<table>
<thead>
<tr>
<th>Mistracking Allowance Class</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Standard Duty**           | - 90% Fines, BW $\leq 1600$, $V_b \leq 2.5$ m/s  
- Free Flowing Bulk Materials  
- Central & Consistent Loading, Ambient Temperatures  
- Grains, Clean Coal Packaging Conveyors, Reject Conveyors  
- Good Maintenance |
| **Heavy Duty**              | - All Lumps $\leq 20$ degree surcharge, BW 800 to 1600, $V_b \leq 5$m/s  
- Sticky, Wet or Interlocking Bulk Materials  
- Central loading, variable throughput, -20 to + 40 $^\circ$C  
- Main process conveyors, Quarries, Power, Cement, Steel, Fertilizer, Wood Chips, Hog Fuel, Clay, Secondary Crushers  
- Average Maintenance |
| **Severe Duty**             | - All Lumps $\leq 30$ degree surcharge, BW $\geq 2000$, $V_b > 5$m/s  
- Difficult Materials, Run of Mine, Primary Crushers  
- Off-Center Loading, Tropical or Artic Conditions  
- Portable Conveyors, Open Cast Mining, Underground Mining, Overland Conveyors, Hard Rock Mining, Stackers/Reclaimers/Trippers  
- Poor Maintenance |
MISTRACKING ALLOWANCE, $M_{A-PULLEY}$

<table>
<thead>
<tr>
<th>Belt Width (in.)</th>
<th>Mistracking Allowance $M_{A-Pulley}$ ± (in.)</th>
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<tr>
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<table>
<thead>
<tr>
<th>Belt Width (mm)</th>
<th>Mistracking Allowance $M_{A-Pulley}$ ± (mm)</th>
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</thead>
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</table>

- **Severe Duty**: 6.0 ± (in.) for belt widths 18 to 120 in.
- **Heavy Duty**: 5.0 ± (in.) for belt widths 30 to 108 in.
- **Standard Duty**: 4.0 ± (in.) for all other belt widths.

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For further details and specific calculations, consult the full technical specification or manufacturer's guide.
RANGE OF SKIRTBOARD WIDTHS

- Skirtboard Width: BW
- Structural Clearance: BW + 120 to 600 mm
- Chute Width: ± 20 to 75 mm
- Pulley Face Width: BW + 50 to 250 mm
- Mistracking Allowance: ± 20 to 75 mm
**SKIRT BOARD WIDTHS**

\[ W_s = \frac{2}{3} \, BW \]

\[ W_s = \sin(90-\beta) \times \frac{2}{3} \times BW \]

\[ W_s = 2 \times \cos(\beta) \times (\frac{BW}{3} - 115) + \frac{BW}{3} \]

**CEMA**

**Schortt - South Africa**

**FOUNDATIONS - Martin**

**W_s Comparison**

<table>
<thead>
<tr>
<th>BW</th>
<th>( \beta )</th>
<th>CEMA</th>
<th>Schortt</th>
<th>FOUNDATIONS</th>
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<td>2000</td>
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</table>
Terms
\(\beta\) = Existing: Troughing Angle
\(b_c\) = Existing: Standard Belt Edge used for Capacity Calculations
\(b_{mt}\) = New: Mistracking Allowance
\(b_{ws}\) = New: Location of Skirtboards based on \(b_{mt}\), \(W_{st}\) & Trough Angle \(\beta\)
\(W_s\) = Redefine: Width of Skirtboards used to calculate height of material rubbing on skirtboards, \(d_{ms}\)
\(W_{st}\) = New: Width of Window that Includes all CEMA member Skirtboard Systems
\(W_{sh}\) = New: Height of Skirtboard that Includes all CEMA member Skirtboard Systems

a That Relate to Belt Tracking
POSSIBLE DEFINITION OF SKIRTBOARD WIDTH, $W_S$

Skirtboard Width, $W_S$, is the inner-most dimension between the skirtboards and wearliners, if any.

$$W_S = BW - 2 \times [(B_{WE} + M_{A-Pulley}) \times \cos(\beta) + W_{SS}]$$

*CEMA Standard Belt Edge: $B_{WE} = 0.055 \times BW + 22.9$ (mm)  
DIN Standard Belt Edge: $B_{WE} = BW - [(0.9 \times BW - 50 \text{ mm})/2]$ (BW ≤ 2000)  
$B_{WE} = 125 \text{ mm}$ (BW > 2000)
POSSIBLE DEFINITION OF MISTRACKING ALLOWANCE

Mistracking Allowance:
The allowable movement of the belt from its centered position without
the belt over-running any one of the; driven, tail, takeup or bend pulley faces
or; contacting the structure, idler brackets or obstructions to the belt path.

\[
M_{A}\text{-Pulley} = \frac{(Pf - BW)}{2} \quad M_{A}\text{-Structure} = \frac{(St - BW)}{2}
\]

\[
BW = \text{Belt Width}, \quad Pf = \text{Pulley Face}, \quad St = \text{Structural Clearance}
\]
SUMMARY

• Mistracking: The amount that the belt deviates laterally from the centerline of the conveyor.

• Mistracking Allowance: The allowable movement of the belt from it’s centered position without the belt over-running any one of the; driven, tail, takeup or bend pulley faces or; contacting the structure or return idler brackets.

• Skirtboard Width: The inside dimension of the loading chute between the skirtboards and wear liners, if any.
CONF. CALL ‘minutes’ (19 April, 2018)

Attendees:
- Todd Swinderman (RToddS Engineering)
- Lee Williams (ASGCO)
- Bruce Antonioli (ASGCO)
- Akiko Wakatsuki (Fenner)
- Naylu Garces (Cema)
- Matt Koca (Flexco)
- Greg Westphall (Flexco)
- Scott Smith (Richwood)

**Topic:** Belt Mistracking Allowance

- Todd prepared a PowerPoint presentation titled “Discussion on Mistracking”. The information within was collected from several sources. The PP was used as a starting point for group discussion.

- **LABEL?**
  - Suggestions were tossed around for “Labeling” this new Standard such as *Lateral Drift, Mistracking, Wander, Sway, etc.* The group settled on Belt ‘Mistracking’.

- **CLASSIFICATIONS?**
  - The group discussed breaking *Mistracking Allowance* down into ‘classes’. Initial thoughts were 3 basic categories (Standard, Heavy, and Severe Duty). Descriptions of each would include criteria such as Material Size, BW, Belt Speed, etc.
  - Categories for classification are still open for discussion....
    - There were some concerns whether there is a correlation between *mistracking* and *duty*.
    - Should the allowance be based more on the conveyor structure??
    - Are we making *recommendations* for allowable mistracking for *new design* (greenfield) or are we *creating* mistracking criteria for *existing conveyors*??
      - Since the BELT BOOK was written to assist with new construction we should probably approach things from that direction.

      ...In other words, the conveyor designer needs to size the Pulleys, Idlers, and Structure to allow for a certain amount of acceptable belt mistracking. This may currently vary from Design Firm to Design Firm (eg. when we see narrow belts running on wide pulleys.)

      - A question came up.... For our purposes, should we simply specify that the belt can never mistrack off the edge of the pulley? If this occurs, corrective action needs to be taken such as installing a belt tracker or inspecting alignment of the system. This makes sense at the Head & Tail but not so
much for parts of the conveyor in-between and is excessive for narrow belts on extra wide pulleys.

- The above is not written in stone at this time and needs further deliberation.

- **DEFINING CRITERIA…**
  - Should the amount of ‘allowable’ mistracking be a design condition and pre-determined?
  - Pulley face width *(ref: Ch.7_table 7.32)*
  - Head chute width
  - Structural clearances
  - Skirtboard widths
  - Belt material (fabric, steel)

- **OTHER CONSIDERATIONS**
  - As mentioned earlier, aside from a belt mistracking at the Head and Tail pulleys it can wander anywhere in between. Do we limit this particular standard to just Head and Tail areas?
  - Mistracking allowance should be looked at as a stated [design criterion](#). Once this is established we can make other recommendations for things like skirtboards.
  - According to the BELT BOOK, for standard pulleys, pulley width is +2” for belt widths up to 40”.
  - Consult Pulley committee to inquire if they currently have something in place regarding pulley face mistracking for **ALL** classes of pulleys. If so…
    - what criteria do they use?
    - Do they have any issues with defining mistracking as “belt travel beyond the edge of the face”?
  - Looking to have something solid to present at the June meeting.

- Next conf. call with this group slated for mid May-early June.
CEMA STANDARD NO. 575-2013

Bulk Material Belt Conveyor
Impact Bed/Cradle
Selection and Dimensions

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

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Revision of CEMA Standard 575-2000
Approved: September 10, 2013

CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION (CEMA)

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END
List of Changes and Explanations

1. Pg. 1 – Definitions: Changed N (length of impact zone) to L_n to maintain consistency with the belt book.

2. Pg. 1, 8 – Definitions: Changed T_e(IB) to \( \Delta T_{IB} \), T_em(IB) to \( \Delta T_{IB} \) to maintain consistency with universal method in belt book.

3. Pg. 1, 8 – Changed f (coefficient if friction value – dimensionless) to C_b to maintain consistency with the belt book.

4. Pg. 1, 8 – Removed T_e(TI), T_em(TI) from power loss calculations. Calculating the effects of the small amount of idlers removed and replaced with impact beds can be very time consuming under the universal method as detailed in belt book. Equations for \( \Delta T_{i_{IS}} \) (change in tension from idler seal friction), \( \Delta T_{i_{LM}} \) (Change in tension from idler load friction), \( \Delta T_{i_{MN}} \) (tension loss from idler misalignment), and \( \Delta T_{M_{ZN}} \) (tension change due to bulk material moving between idlers) would need to be added. Removing the tension effects of the small amount of idlers results in a power loss calculation typically 10% to 15% higher than when the idlers are accounted for. This difference errs on the side of caution and greatly simplifies the calculations.

5. Pg. 8 – Changed table 2 to match belt book (table 6.67) coefficient of friction values for various materials.

6. Pg. 1, 8 – Added R_b (friction modifying factor) to power loss calculation to maintain consistency with the belt book.

7. Adjusted calculations to maintain 2 significant digits.

8. Updated table of contents
Foreword

Impact Beds/Cradles are used to reduce premature idler failure and reduce belt damage in the load zone of bulk material handling conveyor systems. This standard has been established to provide a uniform method of rating and dimensioning among the various manufacturers of conveyor belt Impact Beds/Cradles.

This standard assures the users of conveyor Impact Beds/Cradles that an Impact Bed/Cradle is dimensionally compatible with conveyor idlers manufactured to the CEMA Standard No. 502, most current revision. The 575 standard establishes impact energy ratings to assure the end user the Impact Bed/Cradle is structurally suitable for the application. This standard does not restrict the manufacturer, who has complete freedom to design all parts of the Impact Bed/Cradle according to its best engineering judgment based upon the information supplied by the end-user.

There are three classes of Impact Beds/Cradles rated according to the weight and height of fall of the bulk material and conveyor idler class. Manufacturers voluntarily specify into which class their particular designs fall.

It is hoped this standard will assist the end user in receiving an Impact Bed/Cradle, which is structurally suitable for the specified conditions and reduce the misapplication of Impact Beds/Cradles.

The capacity of the conveyor belt to withstand impact varies according to belt construction. Contact the belt supplier for information regarding the ability of a specific conveyor belt to withstand impact.

Contents

Foreword ................................................................. i
Definitions .............................................................. 1
Rating and Class System ............................................. 3
Impact Bed/Cradle Dimensions ................................. 3
Location of Impact Bed/Cradle ................................. 3
Impact Bed/Cradle Selection ..................................... 4
Example: Impact Bed/Cradle Selection ....................... 4
Power Requirements ............................................... 8
Example: Imperial .................................................. 8
Example: SI ........................................................ 10
Conclusions .......................................................... 10
Comments ............................................................ 10
Special Applications ............................................... 11
Typical Specification .............................................. 11
Disclaimers .......................................................... 12
Units ...................................................................... 12
Definitions

A: Base width mounting holes center to center distance.
B: Mounting foot mounting holes center to center distance.
C: Overall width of the Bed/Cradle.
C_b: Coefficient of friction impact bed, dimensionless
D: Overall length of the mounting foot.
E: Maximum height of the outer edge of the Bed/Cradle.
H: Maximum distance from outer edge to outer edge of the Bed/Cradle sliding surface.
h: Vertical fall distance of a lump from the center of gravity of the homogeneous load or lump to the belt in feet.
h_m: Vertical fall distance of a lump from the center of gravity of the homogeneous load or lump to the belt in meters.
K: Maximum height of the center roller of the inbound/outbound idler, or distance to the bottom of the belt.
k: The spring constant of the entire Impact Bed/Cradle including the sliding surface and support structure in lbs per inch.
k_m: The spring constant of the entire Impact Bed/Cradle including the sliding surface and support structure in newtons per meter\([N/m]\).
L: Mounting bolt diameter.
L_n: Length of the impact zone in ft.
L_nm: Length of the impact zone in meters.
M: Clearance between the belt and the center sliding surface.
R_b: Coefficient of friction modifying factor.
\(\Delta T_{IB}\): Change in belt tension as a result of impact bed in lbs.
\(\Delta T_{IBm}\): Change in belt tension as a result of impact bed in N.
V: Belt speed in feet per minute.
V_m: Belt speed in meters per second.
Q: Flow rate of the bulk solid in short tons per hour.
**Q_m:** Flow rate of the bulk solid in metric tons (tonnes) per hour.

**W:** Mass of single lump in pounds.

**W_n:** Mass of single lump in kilograms.

**W_b:** Weight of belt in lbs per foot of belt length.

**W_{bm}:** Weight of belt in newtons per meter of belt length.

**W_m:** Weight of material in lbs per foot of belt length.

**W_{mm}:** Weight of material in newtons per meter of belt length.

**W_e:** Equivalent mass of flowing bulk material in lbm.

**W_{em}:** Equivalent mass of flowing bulk material in kg.

**Impact Bed:** A conveyor component that is located underneath the belt in the impact or loading zone of a bulk material handling conveyor belt transfer point designed to support the belt and help absorb the impact of falling material.

**Impact Cradle:** See Impact Bed.

**Outbound Idler:** The idler immediately after the Impact Bed/Cradle in the direction of belt travel.

**Inbound Idler:** The idler immediately preceding the Impact Bed/Cradle in the direction of belt travel.

**Transition Distance:** The distance between where the belt leaves a terminal pulley of a belt conveyor and the point where the belt is fully troughed.

**Transition Idler:** An idler with metal rollers and adjustable wing angles to help support the belt in the transition from a terminal pulley to a troughed configuration.

**Slider Bed:** A support under the carrying side of a conveyor belt that is designed to handle the sliding load of the belt and the bulk solid.

**Loading Zone:** The area where material is received on the conveyor belt.
Rating and Class System

Impact Beds/Cradles are rated according to their structural capacity to absorb the force of impact from a falling lump or stream of bulk solid. There are three simplified ratings based upon the weight of the bulk solid or equivalent mass of homogenous stream multiplied by the height of the fall \((W \times h)\).

The impact energy from a falling single lump is significantly more than that from a homogeneous stream of bulk material so in most applications the weight of the largest lump that can be expected is the critical variable. Table 1 gives the impact energy rating ranges for Impact Beds/Cradles. Contact a CEMA member for impact energies over 2000 ft-lb, as the impact may exceed the impact ratings of most fabric ply belts.

<table>
<thead>
<tr>
<th>Impact Energy</th>
<th>lb-ft (N-m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L - Light Duty</td>
<td>&lt;200 (271)</td>
</tr>
<tr>
<td>M - Medium Duty</td>
<td>200 to 1,000 (271 to 1,356)</td>
</tr>
<tr>
<td>H - Heavy Duty</td>
<td>1,000 to 2,000 (1,356 to 2710)</td>
</tr>
<tr>
<td>Consult CEMA Member</td>
<td>&gt; 2,000 lb-ft or 2,710 N-m</td>
</tr>
</tbody>
</table>

The designation for an Impact Bed/Cradle shall be the duty rating followed by the Idler class. For example a Heavy Duty Impact Bed/Cradle which is dimensionally compatible with CEMA D6 idlers in the load zone shall be designated as H-D6.

<table>
<thead>
<tr>
<th>H</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Duty Impact Rating</td>
<td>CEMA Idler Class D6 for Dimensions</td>
</tr>
</tbody>
</table>

Impact Bed/Cradle Dimensional Standard

The CEMA Idler Class for the idlers used in the load zone shall determine the dimensional class of the Impact Bed/Cradle. The dimensions A through K corresponds to the dimensions in the CEMA Standard for Bulk Material Belt Conveyor Troughing and Return Idlers No. 502, most current revision (see figure 1).

Location of Impact Beds/Cradles

Impact Beds/Cradles are placed in load zone in the area of direct impact from the falling lumps or stream of material. The Impact Bed/Cradle should be positioned so the impact is striking the impact bars or pads at the center. The belt must be fully transitioned with properly fitted metal transition idlers before the entry into the Impact Bed/Cradle. A suitable idler which is dimensionally compatible may be used as the inbound idler just preceding the first Impact Bed/Cradle. When the impact area is long or there are multiple load points, intermediate idlers which are dimensionally compatible may be used to separate Impact Bed/Cradle sections (see figure 2).
The belt must be fully troughed according to CEMA “Belt Conveyors for Bulk Materials” and the transition idlers must be constructed with metal rollers. A suitable idler which is dimensionally compatible may be used as the outbound idler just following the last Impact Bed/Cradle.

**Impact Bed/Cradle Selection**

1) **Determine the dimensional class**

The dimensional class of the Impact Bed/Cradle is the same as the CEMA class of the idlers in the load zone. All of the idlers in the load zone must be from the same manufacturer, have the same trough angle, be of the same CEMA class and be in good working condition or the Impact Bed/Cradle will not fit or function properly. Contact a CEMA member if your load zone is not fitted with idlers all from the same manufacturer, of the same trough angle or all of the same CEMA class. Example: The idlers in the impact zone are CEMA D6. The dimensional class of the Impact Bed/Cradle is therefore D6.

*Note: Some manufacturers’ designs do not use standard CEMA Dimensions for L, B, or D*

![Figure 1 – Typical Impact Bed / Cradle](image-url)
Figure 2 – Transition Distance, Inbound and Outbound Idler Positions
Figure 3- Impact Bed/Cradle - Bar Type

Figure 4- Impact Bed/Cradle - Saddle Type
2) Determine the Duty Rating

The duty rating of a CEMA Impact Bed/Cradle is determined by the maximum impact energy that will be created by the falling lump or stream of material. A simplified formula of the weight of the largest lump, W, or the rate of flow, Q, of the material and the vertical height of fall, h, is used to determine the rating. Calculate both quantities and select the larger of the two values for determining the appropriate duty rating.

For flow rates below 3000tph [2722 tonnes/hour], it is not necessary to calculate the equivalent mass of a homogeneous stream since it will be negligible.

Material containing large lumps

Determine the maximum lump size that will be conveyed. Calculate the weight, W (lbs.) or Wₙ (kg), of the lump. If slabs of material are likely to pass through the system use the maximum size slab to determine the maximum lump weight. Determine the maximum vertical fall distance, h (ft) or hₘ (meters). The impact energy is given by equation #1.

\[ \text{Equation #1} \quad \text{Impact Energy (lb-ft)} = W \times h \quad \text{(Imperial)} \]  
\[ \text{Impact Energy (N-m)} = Wₙ \times hₘ \quad \text{(SI)} \]

Consult Table 1 to determine the appropriate duty rating.

Figure 5 - Determine impact energy from a single lump

Homogeneous stream of material without large lumps-(For Q>3000 st/hr, or Qₙ>2,722 t/hr)

Determine the maximum vertical fall distance h (feet), hₘ (meters). Determine the design rate of flow, Q (short tons per hr.), Qₙ (tons/hr), of conveyed material. In order to use the lump energy equation, an equivalent mass of the flowing stream needs to be calculated.

\[ \text{Equation #2} \quad \text{Equivalent Mass (We)} = 8.03 \times 10^{-4} \times Q^2/k \quad \text{[imperial]} \]  
\[ \text{Equivalent Mass (Wₑm)} = 7.72 \times 10^{-2} \times Qₙ^2/kₙ \quad \text{[SI]} \]

The impact energy is given by equation #1. Add the equivalent mass to the largest lump mass multiplied by the drop height (h or hₘ) to determine the duty class from Table 1.
Power Requirements

Impact Beds/Cradles can have a significant effect on the power requirements of a conveyor, particularly for short conveyors. It is advisable to calculate the theoretical power requirements for an Impact Bed/Cradle and check the available power of the drive.

The power requirement is determined by the formulas:

**Imperial**
\[ \Delta T_{IB} = C_b \times (W_b + W_m) \times L_n \times R_b \]
\[ \text{Power Loss (HP)} = (\Delta T_{IB} \times V) \div 33,000 \]

**SI**
\[ \Delta T_{IBm} = C_b \times (W_{bm} + W_{mm}) \times L_{nm} \times R_b \]
\[ \text{Power Loss (KW)} = (\Delta T_{IBm} \times V_m) \div 1,000 \]

The default value for \( R_b \) is 1.00 but when starting under full load use \( R_b = 1.50 \)

<table>
<thead>
<tr>
<th>Sliding Surface</th>
<th>( C_b )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>0.64 to 0.84</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0.56</td>
</tr>
<tr>
<td>Urethane</td>
<td>0.60 to 0.67</td>
</tr>
</tbody>
</table>

**Example: Imperial**

A 60-inch conveyor traveling at 750 fpm is conveying 8 inch minus ore, which weighs 120 lb/ft\(^3\) at the rate of 2500 tph. The solid density of the ore is 180 lb/ft\(^3\). The conveyor is equipped with CEMA D6 impact rollers in the load zone. The vertical drop at the transfer point is 12 ft and the impact is confined to an area approximately 4 feet long. Determine the rating and class for an Impact Bed/Cradle for this application. Determine the horsepower requirements for the Impact Cradle.
Rating

Since the lump size is large in this application it is probably material from a primary crusher that has passed through a grizzly with 8-inch square openings. It is accepted practice to assume the largest slab that could pass through the grizzly would be 8 inch thick by 8 inch wide by 24 inch long.

To calculate the impact energy from the homogeneous stream it will be necessary to obtain a value of k from a CEMA member manufacturer. For this example use 70,000 lb/ft (5833 lb/in).

- The weight of the largest lump that could be expected to impact the receiving belt would be Volume = \((8 \times 8 \times 24)/1728 = 0.89\) ft\(^3\).
- The weight of the lump would be \(0.89\) ft\(^3 \times 180\) lb/ft\(^3 = 160.20\) lb.
- From figure 5 the impact energy is: \(W \times h = 160.20 \times 12 = 1922.40\) lb-ft
- Equivalent mass from a homogeneous stream of material is given by Equation 2. \(W_e = 8.03 \times 10^{-4} \times 2500^2/k = 0.86\) lb, Impact energy = \(0.86\) lb \(\times 12.0\) ft drop = 10.32 lb-ft.
- From Table 1 the rating for this application would be H (Heavy Duty) because the largest calculated impact energy value falls between 1,000 and 2,000 lb-ft.

Class

Since CEMA D6 idlers are used in the impact zone the dimensional class for this application is D6.

Rating and Class

The correct Impact Bed/Cradle designation for rating and class for this example is H-D6.

Power Requirements

In order to calculate the power requirements you will have to know the values of \(W_b\) and \(W_m\). These values can be obtained from the design calculations of your conveyor or from a CEMA member manufacturer. Estimates of these values can be made by referring to the latest revision of the CEMA publication “Belt Conveyors for Bulk Materials.”

For this example use the weight per foot of the belt, \(W_b\), as 22 lb/ft. The weight of material per foot of belt is 111.11 lb/ft. To estimate the dynamic power requirement use \(C_b = 0.56\) for a UHMW cover material on the Impact Bed/Cradle.

\[
\Delta T_{ib} = C_b \times (W_m + W_b) \times L_n \times R_b
\]

\[
\Delta T_{ib} = 0.56 \times (111.11 + 22.00) \times 4 \times 1 = 298.17\) lb
\]

Power loss (HP) = \((\Delta T_{ib} \times V) ÷ 33,000\)

Power loss (HP) = \([298.17 \times 750] ÷ 33,000 = 6.78\) HP
Example: SI

- Belt Size = 1500mm
- Belt Speed = 3.81 m/s
- Bulk Density = 1922 kg/m³
- Solid Density = 2883 kg/m³
- Bulk Material Flow rate \( Q_m \) = 2268 metric tons per hour
- Vertical Drop \( h_m \) = 3.66 m
- Largest lump slab size = 203 mm thick x 203 mm wide x 610 mm long
- Length of impact zone = 1.22 m
- Weight of belt, \( W_{bm} \) = 321.05 N/m
- Weight of material, \( W_{me} \) = 1621.52 N/m
- Volume of largest lump = \( (203 \times 203 \times 610) / 1 \times 10^9 = 2.51(10)^{-2} \) m³
- The weight of the largest lump would be \( 2.51(10)^{-2} \) m³ x 2883 kg/m³ = 72.36 kg
- Impact energy for single lump: \( W_m \times h_m = 72.36 \times 3.66 \times 9.81 = 2598.06 \) N-m
- Equivalent mass \( W_{em} \): \( 0.0772 \times 22682 / k_m = 0.39 \) kg (where \( k_m = 1021500 \) N/m)
- Impact energy for Equivalent mass = \( 0.39 \times 3.6 \times 9.81 = 13.8 \) N-m

Power Requirements: SI Calculation

\[
\Delta T_{ibm} = C_b \times (W_{mm} + W_{bm}) \times L_n \times R_b \\
\Delta T_{ibm} = 0.56 \times [(1621.52 + 321.05) \times 1.22] \times 1 = 1327.16 \text{ N} \\
\text{Power loss (kW)} = (\Delta T_{ibm} \times V_m) / 1000 \\
\text{Power loss (kW)} = (1327.16 \times 3.81) / 1000 = 5.06 \text{ kW}
\]

Conclusion

The proper rating and class of Impact Bed/Cradle for this example is H-D6. The running power requirement for the Impact Bed/Cradle is 6.78 HP (5.06 kW). The maximum impact energy expected to be transmitted to the conveyor structure is 1922.40 lb-ft (2598.06 N-m).

Comments

It is important to determine the maximum lump size that can be expected to pass through the transfer point as the single impact from a single lump almost always produces the greatest impact force. A round 8-inch lump in this example would weigh 27.92 lbs and create an impact energy of 335.04 lb-ft for a medium-duty rating. In this example an 8 inch × 8 inch × 24 inch slab merits a heavy-duty rating with an impact energy of 1922.40 lb-ft.

Even though 8-inch minus material does not fit the definition of a homogeneous stream of material it is good to check both impact energies. It is important to check the structure that will support the Impact Bed/Cradle to make sure it can handle the load.
Special Applications

Consult a CEMA member for applications involving explosive bulk solids or for other applications with unique requirements such as food grade construction, corrosion or chemical resistant applications, extreme temperature or belt speeds over 1,000 fpm (5 m/s).

Typical Specification: Impact Bed/Cradle

Impact Beds/Cradles shall be designed to meet CEMA Standard 575, the most current version.

The Impact Bed/Cradle shall be designed to withstand the maximum impact force as determined by the greater of the two calculations:

- **Equation #1** Impact Energy = \( W \times h \) (imperial), \( W_n \times h_m \) [SI]
- **Equation #2** Equivalent Mass \( (W_e) = 8.03 \times 10^{-4} \times Q^2/k \) [imperial]
  
  Equivalent Mass \( (W_{em}) = 7.72 \times 10^{-2} \times Q_m^2/k_m \) [SI]

The manufacturer shall use the information supplied by the end user to establish which rating and class of Impact Bed/Cradle is to be provided. The Impact Bed/Cradle shall be designed to withstand the force of a single maximum impact with a design factor of 1.5.

The manufacturer shall specify:

a. Any exceptions to the standard contained in their design.

b. The duty rating and class of the Impact Bed/Cradle using the CEMA rating and class system.

c. Any limitations resulting from the application as specified by the end user.

The end user shall specify:

a. The maximum lump or slab weight (lb-imperial, kg-SI) that will pass through the load zone.

b. The maximum bulk density (lb/ft\(^3\) [imperial], kg/m\(^3\) [SI]) of the bulk solid being handled.

c. The maximum drop height (ft, m).

d. The maximum flow rate of the bulk solid (short tons/hr [imperial], tons/hr [SI]).

  e. The CEMA class and trough angle of the idlers in the load zone and the manufacturer’s product number designation.

  f. Belt speed (feet/min [imperial], meters/sec [SI]).

  g. Certification based on product specifications supplied by the manufacturer, that the existing structure is capable of supporting the weight of and the impact force transmitted by the Impact Bed/Cradle to the structure.

  h. Whether or not the bulk solid being conveyed is flammable or explosive.

  i. Special construction requirements for corrosion resistance or process compatibility.

  j. Length of load zone.

The transition idler(s) shall be a metal idler(s) and the inbound idler(s), if present, must be from the same manufacturer, have the same trough angle, be of the same CEMA class, be in good working condition, and the belt shall be fully troughed before entering the Impact Bed/Cradle and upon leaving the Impact Bed Cradle.
If more than one load zone is used intermediate idlers of the same CEMA class will be used between Impact Beds/Cradles.

**Disclaimers**

This standard implies no representation that a particular belt is suitable to be used in combination with a particular Impact Bed/Cradle. Contact the belt supplier for information on the impact capacity of the belt.

Each manufacturer is responsible for the design of their product including the suitability for use in applications where fire retardant Impact Beds/Cradles may be required by statute or application.

The replacement of idlers with an Impact Bed/Cradle may increase the horsepower requirements of the conveyor drive. Contact a CEMA member for information.

Impact Beds/Cradles may be required to meet additional industry or government standards or requirements such as for use in underground mines, hazardous locations or for food handling that are not spelled out in this standard. Contact a CEMA member for information.

CEMA reserves the right to revise this standard at any time without notice.

**Units**

<table>
<thead>
<tr>
<th>Imperial</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (in)</td>
<td>25.4 mm</td>
</tr>
<tr>
<td>1 foot (ft)</td>
<td>.3048 meter</td>
</tr>
<tr>
<td>1 pound (lb)</td>
<td>.454 kg</td>
</tr>
<tr>
<td>1 pound force (lbf)</td>
<td>4.4482 newtons</td>
</tr>
<tr>
<td>1 foot per minute (fpm)</td>
<td>.005 meters per second</td>
</tr>
<tr>
<td>1 short ton per hour (Q)</td>
<td>907.18 kg per hour</td>
</tr>
</tbody>
</table>

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Belt Tracking and Training Devices

All conveyor belts in a conveyor system may have a nominal amount of wander during normal operation. Material spillage and/or damage to the belt, structure, and conveyor components may occur when the belt wanders beyond its design limits. Proper belt tracking is critical to maintain the safe and efficient operation of any conveyor system. Following the guidelines detailed in Chapter 5 on belt alignment and Chapter 12 on proper belt loading to determine the root cause of the belt misalignment should correct many issues with belt tracking.

In some instances, the belt may still wander beyond design limits despite any efforts at belt alignment and proper loading. In these instances, a belt tracking or training device may be used.

Definition
A belt tracking or training device is an accessory or system used to center the belt on the structure when the belt has a tendency to wander beyond its design limits.

CEMA Recommendations
- Before installing a tracking or training device or system, attempt to properly align the belt using the guidelines detailed in Chapter 5 on belt alignment and Chapter 12 on proper loading.
- Before installing a tracking or training device or system, the main rotating components of the conveyor system (idlers, pulleys) should be returned to their neutral position. That is, these components should be squared to the structure and centered within the structure within the tolerances as specified in Appendix D.
- Each one direction conveyor should have a minimum of one tracking or training device or system installed on the return belt prior to entering the tail pulley.
- Each reversing conveyor should have a minimum of two reversing tracking or training devices or systems installed on the return belt, one prior to entering the tail pulley and one after exit of the discharge pulley.
- Allowance should be made for one return belt tracker or trainer and one carry side tracker or trainer for every 50 ft of conveyor or in accordance with the manufacturer’s specific recommendations.

Types of Devices
There are many types of tracking and training devices available from CEMA member companies. They can be divided into three main types: active devices, passive tension devices, and brute force devices. Active devices detect when the belt has wandered beyond design limits and respond in some manner to correct the misalignment. These devices include Return Belt Center Pivot Trainers, Carrying Side Belt Center Pivot Trainers, and Powered Automatic Belt Training Systems. Passive devices use belt tension to maintain the belt in alignment. These devices include Hold Down Rollers, Biased Idlers, V Return Idlers, Crown Pulleys, and Inverted Arc Return Belt Trackers. Brute force devices apply pressure to the edge of the belt to force it into alignment. These devices include Edge Guide Rollers and Brute Force Tracking Systems. Devices applying direct pressure on the edge of the belt, such as Brute Force Devices and Edge Guide Rollers, should be used as a last resort as they may cause damage to the belt edges.
Final Notes
The root cause of the belt wander should be determined first and all methods of correcting the root cause should be attempted before alternate solutions are used. Skewing or “knocking” carrying and return idlers is a common practice and can be used to correct minor variations in belt tracking, however, when the belt wanders beyond design limits, skewing idlers is not an effective method of alignment. Skewing idlers creates additional tension and drag on the conveyor system and can reduce component life. Belt tracking and training devices can be used to correct belt wander when other methods have failed.

To function properly, belt tracking and training devices need to be properly maintained according to the manufactures recommendation. Active devices with unlubricated or frozen pivots cannot properly respond to belt misalignments. Active devices should never be “tied off” as they will no longer be able to respond to variations in belt wander and may create excessive drag on the conveyor system. Worn or frozen rotating components should be replaced to maintain proper function of the device.
Is Lock-Out, Tag-Out Enough?

CEMA ACCESSORY COMMITTEE
Todd Swindermann, RToddS Engineering

Lock-out, tag-out procedures are designed to bring a system to a state of zero potential and kinetic energy. The conveyor belt often stores potential energy in the form of belt stretch or bulk material on an inclined or declined section of the belt, even after the conveyor has been de-energized and theoretically can’t move. This stored potential energy can present a serious hazard to workers performing common maintenance such as splicing the belt or cleaning around pulleys. Unfortunately, serious accidents occur every year from conveyor systems that we thought to be brought to a state of zero energy.

It is common practice to lift the counter weight in an attempt to relieve the belt stretch but this may not be sufficient to solve the problem. When the belt is cut for splicing or the jam is cleared the belt may move in an unpredictable direction if it is not blocked from the potential motion. For example, a belt with 100 m centers capable of 2% elastic stretch could unexpectedly move 2 m when released. Best practice is to clamp the belt on both sides of the repair or cleaning operation. This can be considered too time consuming and is often either not done or done inadequately in the name of getting back into production as soon as possible. CEMA states:

“Brakes and backstops should never be used as the only method of holding a belt during maintenance or cleaning. If working on a belt at or near pinch points make sure the potential energy of the belt and load has been neutralized with belt clamps or other suitable means.”

“...belt Clamps or other suitable means” is often taken to mean using homemade belt clamps with come-a-longs attached to idler bases or using a wire rope choker to block the belt movement. With these approaches, there is no way to tell if the holding power is adequate for the job. Several CEMA members manufacture engineered belt clamps that have specific working ranges. Proper belt clamping requires knowledge of the possible belt tensions, selecting correctly engineered belt clamps and anchoring the belt clamps to structural members capable of resisting the belt forces.

Because of the latent energy hazard of stored energy from the elevated load or belt stretch, conveyors pose unique hazards to workers. It is recommended in addition to lock-out, tag-out that blocking belt with engineered belt clamps and then testing the conveyor by trying to start it be added to routine job procedures.

CEMA’s 7th ed. Belt Conveyors for Bulk Materials, is available in their e-commerce store, available in hard copy or pdf. For additional information on Safety, go to CEMA’s website.

www.cemanet.org

Figure 1. In addition to lock-out, tag-out, blocking the belt with engineered clamps and then confirming the conveyor cannot start is considered best practice.
Bulk Material Belt Conveyor
Impact Bed/Cradle

Selection and Dimensions
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>4</td>
</tr>
<tr>
<td>Definitions</td>
<td>5</td>
</tr>
<tr>
<td>Rating and Class System</td>
<td>7</td>
</tr>
<tr>
<td>Impact Bed/Cradle Dimensions</td>
<td>8</td>
</tr>
<tr>
<td>Location of Impact Bed/Cradle</td>
<td>9</td>
</tr>
<tr>
<td>Impact Bed/Cradle Selection</td>
<td>9</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>12</td>
</tr>
<tr>
<td>Example</td>
<td>12</td>
</tr>
<tr>
<td>- Imperial</td>
<td>12</td>
</tr>
<tr>
<td>- SI</td>
<td>13</td>
</tr>
<tr>
<td>Conclusion</td>
<td>14</td>
</tr>
<tr>
<td>Comments</td>
<td>14</td>
</tr>
<tr>
<td>Special Applications</td>
<td>14</td>
</tr>
<tr>
<td>Typical Specification: Impact Bed/Cradle</td>
<td>14</td>
</tr>
<tr>
<td>Disclaimers</td>
<td>15</td>
</tr>
<tr>
<td>Units</td>
<td>16</td>
</tr>
</tbody>
</table>
FOREWORD

Impact Beds/Cradles are used to reduce premature idler failure and reduce belt damage in the load zone of bulk material handling conveyor systems. This standard has been established to provide a uniform method of rating and dimensioning among the various manufacturers of conveyor belt Impact Beds/Cradles.

This standard assures the users of conveyor Impact Beds/Cradles that an Impact Bed/Cradle is dimensionally compatible with conveyor idlers manufactured to the CEMA Standard No. 502, most current revision. The CEMA standard 575 establishes impact energy ratings to assure the end user the Impact Bed/Cradle is structurally suitable for the application. This standard does not restrict the manufacturer, who has complete freedom to design all parts of the Impact Bed/Cradle according to its best engineering judgment based upon the information supplied by the end-user.

There are three classes of Impact Beds/Cradles rated according to the weight and height of fall of the bulk material and conveyor idler class. Manufacturers voluntarily specify into which class their particular designs fall.

It is hoped this standard will assist the end user in receiving an Impact Bed/Cradle, which is structurally suitable for the specified conditions and reduce the misapplication of Impact Beds/Cradles.

The capacity of the conveyor belt to withstand impact varies according to belt construction. Contact the belt supplier for information regarding the ability of a specific conveyor belt to withstand impact.

On the past versions of this publication:

1. Definitions and Power Requirements:

- Changed N (length of impact zone) to $L_n$ to maintain consistency with the belt book
- Changed $T_e(\text{IB})$ to $\Delta T_{sbn}$, $T_{em}(\text{IB})$ to $\Delta T_{sbn}$ to maintain consistency with universal method in belt book
- Changed $f$ (coefficient of friction value – dimensionless) to $C_{sb}$ to maintain consistency with the belt book
- Removed $T_e(\text{TI})$, $T_{em}(\text{TI})$ from power loss calculations. Calculating the effects of the small amount of idlers removed and replaced with impact beds can be very time consuming under the universal method as detailed in belt book. Equations for $\Delta T_{sbn}$ (change in tension from idler seal friction), $\Delta T_{lbn}$ (change in tension from idler load friction), $\Delta T_{mbn}$ (tension loss from idler misalignment), and $\Delta T_{mzn}$ (tension change due to bulk material moving between idlers) would need to be added. Removing the tension effects of the small amount of idlers results in a power loss calculation typically 10% to 15% higher than when the idlers are accounted for. This difference errs on the side of caution and greatly simplifies the calculations.
- Changed Table 2 to match belt book (Table 6.84) coefficient of friction values for various materials
- Added $R_{rsb}$ (friction modifying factor) to power loss calculation to maintain consistency with the belt book

On this 2018 version: ???

4 of 16
DEFINITIONS

A  Base width mounting holes center to center distance
B  Mounting foot mounting holes center to center distance
C  Overall width of the Bed/Cradle
C_{sb}  Coefficient of friction impact bed (dimensionless)
D  Overall length of the mounting foot
E  Maximum height of the outer edge of the Bed/Cradle
H  Maximum distance from outer edge to outer edge of the Bed/Cradle sliding surface
h  Vertical fall distance of a lump from the center of gravity of the homogeneous load or lump to the belt (ft)
h_{m}  Vertical fall distance of a lump from the center of gravity of the homogeneous load or lump to the belt (m)
K  Maximum height of the center roller of the inbound/outbound idler, or distance to the bottom of the belt.
k  The spring constant of the entire Impact Bed/Cradle including the sliding surface and support structure (lbs/in)
k_{m}  The spring constant of the entire Impact Bed/Cradle including the sliding surface and support structure in newton per meter (N/m).
L  Mounting bolt diameter.
L_{n}  Length of the impact zone (ft)
L_{nm}  Length of the impact zone (m)
M  Clearance between the belt and the center sliding surface.
R_{b}  Coefficient of friction modifying factor.
\Delta T_{IB}  Belt tension loss as a result of impact bed (lbs)
\Delta T_{IBm}  Belt tension loss as a result of impact bed (N)
V  Belt speed in feet per minute (fpm)
V_{m}  Belt speed in meters per second (m/s).
Q  Flow rate of the bulk solid (stph)
Q_{m}  Flow rate of the bulk solid (mtph)
W  Mass of single lump (lbs)
W_n  Mass of single lump (kg)
W_b  Weight of belt in lbs/ft of belt length
W_{bm}  Weight of belt in N/m of belt length
W_m  Weight of material in lbs/ft of belt length
W_{mm}  Weight of material in N/m of belt length
W_e  Equivalent mass of flowing bulk material (lbm)
W_{em}  Equivalent mass of flowing bulk material (kg)

**Impact Bed/Cradle**: A conveyor component that is located underneath the belt in the impact or loading zone of a bulk material handling conveyor belt transfer point designed to support the belt and help absorb the impact of falling material.

**Outbound Idler**: The idler immediately after the Impact Bed/Cradle in the direction of belt travel.

**Inbound Idler**: The idler immediately preceding the Impact Bed/Cradle in the direction of belt travel.

**Transition Distance**: The distance between where the belt leaves a terminal pulley of a belt conveyor and the point where the belt is fully troughed.

**Transition Idler**: An idler with metal rollers and adjustable wing angles to help support the belt in the transition from a terminal pulley to a troughed configuration.

**Slider Bed**: A support under the carrying side of a conveyor belt that is designed to handle the sliding load of the belt and the bulk solid.

**Loading Zone**: The area where material is received on the conveyor belt.
RATING AND CLASS SYSTEM

Impact Beds/Cradles are rated according to their structural capacity to absorb the force of impact from a falling lump or stream of bulk solid. There are three simplified ratings based upon the weight of the bulk solid or equivalent mass of homogeneous stream multiplied by the height of the fall (W × h).

The impact energy from a falling single lump is significantly more than that from a homogeneous stream of bulk material so in most applications the weight of the largest lump that can be expected is the critical variable. Table 1 gives the impact energy rating ranges for Impact Beds/Cradles. Contact a CEMA member for impact energies over 2000 lbf-ft, as the impact may exceed the impact ratings of most fabric ply belts.

Table 1. Impact Bed/Cradle Duty Rating

<table>
<thead>
<tr>
<th>Duty Rating</th>
<th>Description</th>
<th>Impact Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Light Duty</td>
<td>&lt; 200 (271)</td>
</tr>
<tr>
<td>M</td>
<td>Medium Duty</td>
<td>200 to 1,000 (272 to 1,356)</td>
</tr>
<tr>
<td>H</td>
<td>Heavy Duty</td>
<td>1,001 to 2,000 (1,357 to 2,712)</td>
</tr>
<tr>
<td></td>
<td>Consult CEMA Member Company for Impact Energies</td>
<td>&gt; 2,000 lbf-ft (2712 N-m)</td>
</tr>
</tbody>
</table>

The designation for an Impact Bed/Cradle shall be the duty rating followed by the Idler class. For example a Heavy Duty Impact Bed/Cradle which is dimensionally compatible with CEMA D6 idlers in the load zone shall be designated as H-D6.

<table>
<thead>
<tr>
<th>H</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Duty Impact Rating</td>
<td>CEMA Idler Class D6 for Dimensions</td>
</tr>
</tbody>
</table>
IMPACT BED/CRADLE DIMENSIONS

The CEMA Idler Class for the idlers used in the load zone shall determine the dimensional class of the Impact Bed/Cradle. The dimensions A through K corresponds to the dimensions in the CEMA Standard No. 502 Bulk Material Belt Conveyor Troughing and Return Idlers, the most current revision. (See Figure 1).

*Note: Some manufacturers’ designs do not use standard CEMA Dimensions for L, B, or D

![Figure 1. Typical Impact Bed / Cradle](image)
LOCATION OF IMPACT BEDS/CRADLES

Impact Beds/Cradles are placed in load zone in the area of direct impact from the falling lumps or stream of material. The Impact Bed/Cradle should be positioned so the impact is striking the impact bars or pads at the center. The belt must be fully transitioned with properly fitted metal transition idlers before the entry into the Impact Bed/Cradle. A suitable idler which is dimensionally compatible may be used as the inbound idler just preceding the first Impact Bed/Cradle. When the impact area is long or there are multiple load points, intermediate idlers which are dimensionally compatible may be used to separate Impact Bed/Cradle sections (see Figure 2).

The belt must be fully troughed according to CEMA “Belt Conveyors for Bulk Materials” 7th edition, and the transition idlers must be constructed with metal rollers. A suitable idler which is dimensionally compatible may be used as the outbound idler just following the last Impact Bed/Cradle.

IMPACT BED/CRADLE SELECTION

1) Determine the dimensional class: The dimensional class of the Impact Bed/Cradle is the same as the CEMA class of the idlers in the load zone. All of the idlers in the load zone must be from the same manufacturer, have the same trough angle, be of the same CEMA class and be in good working condition or the Impact Bed/Cradle will not fit or function properly. Contact a CEMA member if your load zone is not fitted with idlers all from the same manufacturer, of the same trough angle or all of the same CEMA class. Example: The idlers in the impact zone are CEMA D6. The dimensional class of the Impact Bed/Cradle is therefore D6.
2) Determine the Duty Rating: The duty rating of a CEMA Impact Bed/Cradle is determined by the maximum impact energy that will be created by the falling lump or stream of material. A simplified formula of the weight of the largest lump, \( W \), or the rate of flow, \( Q \), of the material and the vertical height of fall, \( h \), is used to determine the rating. Calculate both quantities and select the larger of the two values for determining the appropriate duty rating.

For flow rates below 3,000 tph [2,722 mtph], it is not necessary to calculate the equivalent mass of a
homogeneous stream since it will be negligible.

**Material containing large lumps**

Determine the maximum lump size that will be conveyed. Calculate the weight, $W$ (lbs) or $W_n$ (kg), of the lump. If slabs of material are likely to pass through the system use the maximum size slab to determine the maximum lump weight. Determine the maximum vertical fall distance, $h$ (ft) or $h_m$ (m). The impact energy is given by Equation 1.

**Equation 1**: Impact Energy (lb-ft) = $W \times h$ (Imperial), (see Figure 5).

Impact Energy (N-m) = $W_n \times h_m$ (SI), (see Figure 5)

Consult Table 1 to determine the appropriate duty rating.

![Figure 5. Impact force for material containing large lumps](image)

**Homogeneous stream of material without large lumps - (For Q> 3,000 tph, or $Q_m$ > 2,722 mtph)**

Determine the maximum vertical fall distance $h$ (ft), $h_m$ (m). Determine the design rate of flow, $Q$ (tph), $Q_m$ (mtph), of conveyed material. In order to use the lump energy equation, an equivalent mass of the flowing stream needs to be calculated.

**Equation 2**: Equivalent Mass $(W_e) = 8.03 \times 10^{-4} \times Q^2/k$ (imperial), (see Figure 6)

Equivalent Mass $(W_{em}) = 7.72 \times 10^{-2} \times Q_m^2/k_m$ (SI), (see Figure 6)

The impact energy is given by Equation 1. Add the equivalent mass to the largest lump mass multiplied by the drop height ($h$ or $h_m$) to determine the duty class from Table 1.

![Figure 6. Impact force for homogeneous material without lumps](image)
POWER REQUIREMENTS

Impact Beds/Cradles can have a significant effect on the power requirements of a conveyor, particularly for short conveyors. It is advisable to calculate the theoretical power requirements for an Impact Bed/Cradle and check the available power of the drive.

The power requirement is determined by the formulas:

**Imperial**

\[ \Delta T_{sb} = C_{sb} \times (W_b + W_m) \times L_n \times R_{rsb} \]

Horsepower (HP) = \( \frac{\Delta T_{sb} \times V}{33,000} \)

**SI**

\[ \Delta T_{sbmn} = C_b \times (W_{bm} + W_{mm}) \times L_{nm} \times R_{rsb} \]

Horsepower (kW) = \( \frac{\Delta T_{sbmn} \times V_m}{1,000} \)

The default value for \( R_{rsb} \) is 1.0 but when starting under full load use \( R_{rsb} = 1.50 \)

<table>
<thead>
<tr>
<th>Sliding Surface</th>
<th>( C_{sb} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>0.64 to 0.84</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>0.56</td>
</tr>
<tr>
<td>Urethane</td>
<td>0.60 to 0.67</td>
</tr>
</tbody>
</table>

**Example: Imperial**

A 60 in conveyor traveling at 750 fpm is conveying 8 in minus ore, which weighs 120 lb/ft³ at the rate of 2500 tph. The solid density of the ore is 180 lb/ft³. The conveyor is equipped with CEMA D6 impact rollers in the load zone. The vertical drop at the transfer point is 12 ft and the impact is confined to an area approximately 4 ft long. Determine the rating and class for an Impact Bed/Cradle for this application. Determine the horsepower requirements for the Impact Cradle.

**Rating**

Since the lump size is large in this application it is probably material from a primary crusher that has passed through a grizzly with 8 inch square openings. It is accepted practice to assume the largest slab that could pass through the grizzly would be 8 in thick by 8 in wide by 24 in long.

To calculate the impact energy from the homogeneous stream it will be necessary to obtain a value of \( k \) from a CEMA member manufacturer. For this example use 70,000 lbf/ft (5,833 lbf/in).

- The weight of the largest lump that could be expected to impact the receiving belt would be:
  \[ \text{Volume} = (8 \text{ in} \times 8 \text{ in} \times 24 \text{ in}) / 1728 \text{ in}^3/\text{ft}^3 = 0.89 \text{ ft}^3 \]
- The weight (W) of the lump would be: \( 0.89 \text{ ft}^3 \times 180 \text{ lbf/ft}^3 = 160.20 \text{ lbf} \)
- From Equation 1, the impact energy (IE) is: \( W \times h = 160.20 \times 12 = 1922.40 \text{ lbf-ft} \)
- Equivalent mass from a homogeneous stream of material is given by Equation 2.
  \[ W_e = 8.03 \times 10^{-4} \times 2500^2/k = 0.86 \text{ lbf}, \text{IE} = 0.86 \text{ lbf} \times 12 \text{ ft} = 10.32 \text{ lbf-ft} \]
- From Table 1 the rating for this application would be H (Heavy Duty) because the largest calculated
impact energy value falls between 1,000 and 2,000 lbf-ft.

Class

Since CEMA D6 idlers are used in the impact zone the dimensional class for this application is D6.

Rating and Class

The correct Impact Bed/Cradle designation for rating and class for this example is H-D6.

Power Requirements

In order to calculate the power requirements you will have to know the values of $W_b$ and $W_m$. These values can be obtained from the design calculations of your conveyor or from a CEMA member manufacturer. Estimates of these values can be made by referring to the latest revision of the CEMA publication “Belt Conveyors for Bulk Materials”.

For this example use the weight per foot of the belt, $W_b$, as 22 lbf/ft. The weight of material per foot of belt is 111.11 lbf/ft. To estimate the dynamic power requirement use $C_{sb} = 0.56$ for a UHMW cover material on the Impact Bed/Cradle.

\[
\Delta T_{sb} = C_{sb} \times (W_m + W_b) \times L_n \times R_{rsb}
\]

\[
\Delta T_{sb} = 0.56 \times (111.11 \text{ lbf/ft} + 22 \text{ lbf/ft}) \times 4 \times 1 = 298.17 \text{ lbf}
\]

Horsepower (HP) = \(\frac{\Delta T_{sb} \times V}{33,000}\)

Horsepower (HP) = \([298.17 \times 750]\) ÷ 33,000 = 6.78 HP

Example: SI

- Belt Size = 1,524 mm
- Belt Speed = 3.81 m/s
- Bulk Density = 1,922 kg/m$^3$
- Solid Density = 2883 kg/m$^3$
- Bulk Material Flow Rate ($Q_m$) = 2,268 mtph
- Vertical Drop ($h_m$) = 3.66 m
- Largest lump slab size = 203 mm thick x 203 mm wide x 610 mm long
- Length of impact zone ($L_n$) = 1.22 m
- Weight of belt, $W_{bm}$ = 321.05 N/m
- Weight of material, $W_{me}$ = 1,621.52 N/m
- Volume of largest lump = \((203 \times 203 \times 610)/1 \times 10^9 = 2.51(10)^2\) m$^3$
- The weight of the largest lump would be \(2.51(10)^2\) m$^3 \times 2,883\) kg/m$^3 = 72.36 kg
- Impact energy (IE) for single lump: $W_m \times h_m = 72.36 \times 3.66 \times 9.81 = 2,598.06$ N-m
• Equivalent mass \( W_{em} = 0.0772 \times 22,682/k_m = 0.39 \text{ kg} \) (where \( k_m = 1,021,500 \text{ N/m} \))

• Impact energy for Equivalent mass = \( 0.39 \times 3.6 \times 9.81 = 13.8 \text{ N-m} \)

**Power Requirements: SI Calculation**

\[
\Delta T_{sbnm} = C_b \times (W_{mm} + W_{bm}) \times L_n \times R_b
\]

\[
\Delta T_{sbnm} = 0.56 \times [(1,621.52 + 321.05)] \times 1.22 \times 1 = 1,327.16 \text{ N}
\]

Horsepower (kW) = \( \left( \Delta T_{sbnm} \times V_m \right) \div 1,000 \) = 5.06 kW

**Conclusion**

The proper rating and class of Impact Bed/Cradle for this example is H-D6. The running power requirement for the Impact Bed/Cradle is 6.78 HP (5.06 kW). The maximum impact energy expected to be transmitted to the conveyor structure is 1,922.40 lb-ft (2,598.06 N-m).

**Comments**

It is important to determine the maximum lump size that can be expected to pass through the transfer point as the single impact from a single lump almost always produces the greatest impact force. A round 8 in lump in this example would weigh 27.92 lbs and create an impact energy of 335.04 lbf-ft for a medium-duty rating. In this example an 8 in × 8 in × 24 in slab merits a heavy-duty rating with an impact energy of 1,922.40 lbf-ft.

Even though 8 in minus material does not fit the definition of a homogeneous stream of material it is good to check both impact energies. It is important to check the structure that will support the Impact Bed/Cradle to make sure it can handle the load.

**Special Applications**

Consult a CEMA member for applications involving explosive bulk solids or for other applications with unique requirements such as food grade construction, corrosion or chemical resistant applications, extreme temperature or belt speeds over 1,000 fpm (5 m/s).

**Typical Specification: Impact Bed/Cradle**

Impact Beds/Cradles shall be designed to meet CEMA Standard 575, the most current version.

The Impact Bed/Cradle shall be designed to withstand the maximum impact force as determined by the greater of the two calculations:

• Equation #1 Impact Energy = \( W \times h \) (imperial), \( W_m \times h_m \) (SI)

• Equation #2 Equivalent Mass (\( W_{eq} \)) = \( 8.03 \times 10^{-4} \times \left( \frac{Q^2}{k} \right) \) (imperial)

  Equivalent Mass (\( W_{em} \)) = \( 7.72 \times 10^{-2} \times \left( \frac{Q_m^2}{k_m} \right) \) (SI)
The manufacturer shall use the information supplied by the end user to establish which rating and class of Impact Bed/Cradle is to be provided. The Impact Bed/Cradle shall be designed to withstand the force of a single maximum impact with a design factor of 1.5.

The manufacturer shall specify:

a. Any exceptions to the standard contained in their design.

b. The duty rating and class of the Impact Bed/Cradle using the CEMA rating and class system.

c. Any limitations resulting from the application as specified by the end user.

The end user shall specify:

a. The maximum lump or slab weight [lb (kg)] that will pass through the load zone.

b. The maximum bulk density [lb/ft³ (kg/m³)] of the bulk solid being handled.

c. The maximum drop height [ft (m)].

d. The maximum flow rate of the bulk solid [stph (tph)].

e. The CEMA class and trough angle of the idlers in the load zone and the manufacturer’s product number designation.

f. Belt speed [ft/min (m/s)].

g. Certification based on product specifications supplied by the manufacturer, that the existing structure is capable of supporting the weight of and the impact force transmitted by the Impact Bed/Cradle to the structure.

h. Whether or not the bulk solid being conveyed is flammable or explosive.

i. Special construction requirements for corrosion resistance or process compatibility.

j. Length of load zone.

The transition idler(s) shall be a metal idler(s) and the inbound idler(s), if present, must be from the same manufacturer, have the same trough angle, be of the same CEMA class, be in good working condition, and the belt shall be fully troughed before entering the Impact Bed/Cradle and upon leaving the Impact Bed Cradle.

If more than one load zone is used intermediate idlers of the same CEMA class will be used between Impact Beds/Cradles.

Disclaimers

This standard implies no representation that a particular belt is suitable to be used in combination with a particular Impact Bed/Cradle. Contact the belt supplier for information on the impact capacity of the belt.

Each manufacturer is responsible for the design of their product including the suitability for use in applications where fire retardant Impact Beds/Cradles may be required by statute or application.

The replacement of idlers with an Impact Bed/Cradle may increase the horsepower requirements of the conveyor drive. Contact a CEMA member for information.

Impact Beds/Cradles may be required to meet additional industry or government standards or requirements such as for use in underground mines, hazardous locations or for food handling that are not spelled out in this standard. Contact a CEMA member for information.
<table>
<thead>
<tr>
<th>Units</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch (in)</td>
<td>25.4 millimeters (mm)</td>
</tr>
<tr>
<td>1 foot (ft)</td>
<td>0.3048 meters (m)</td>
</tr>
<tr>
<td>1 pound (lb)</td>
<td>0.454 kilograms (kg)</td>
</tr>
<tr>
<td>1 pound force (lbf)</td>
<td>4.4482 Newton (N)</td>
</tr>
<tr>
<td>1 foot per minute (fpm)</td>
<td>0.005 meters per second (m/s)</td>
</tr>
<tr>
<td>1 short ton per hour (stph)</td>
<td>907.18 kilogram per hour (kg/hr)</td>
</tr>
<tr>
<td>1 cubic feet (ft³)</td>
<td>1,728 cubic inches (in³)</td>
</tr>
</tbody>
</table>
Example (Imperial)

A 60 in conveyor traveling at 750 fpm is conveying 8 in minus ore, which weighs 120 lbf/ft³ at the rate of 2500 tph. The solid density of the ore is 180 lbf/ft³. The conveyor is equipped with CEMA D6 impact rollers in the load zone. The vertical drop at the transfer point is 12 ft and the impact is confined to an area approximately 4 ft long. Determine the rating and class for an Impact Bed/Cradle for this application. Determine the horsepower requirements for the Impact Cradle.

Data
Belt size = 60 in
Belt speed (V) = 750 fpm
Bulk density ($\gamma_m$) = 120 lbf/ft³
Bulk material flow rate / Design capacity (Q) = 2500 tph
Vertical drop (h) = 12 ft
Largest lump slab size = 8 in thick x 8 in wide x 24 in long
Length of impact zone ($L_n$) = 4 ft
Lump size = 8 in minus ore
k = 70000 lb/ft or 5833 lb/in as in the BBK page 456

- **Rating**: Since the lump size is large in this application it is probably material from a primary crusher that has passed through a grizzly with 8 in² openings. It is accepted practice to assume the largest slab that could pass through the grizzly would be 8 inch thick by 8 inch wide by 24 inch long.

To calculate the impact energy from the homogeneous stream it will be necessary to obtain a value of k from a CEMA member manufacturer. For this example use 70,000 lb/ft (or 5833 lb/in).

The weight of the largest lump that could be expected to impact the receiving belt would be:

$$\text{Volume} = \frac{8\text{in} \times 8\text{in} \times 24\text{in}}{1728 \text{in}^3/\text{ft}^3} = 0.89\text{ft}^3$$

The weight of the largest lump (W) would be:

$$W = 0.89\text{ft}^3 \times 120 \text{ lbf/ft}^3 = 106.8\text{lbf}$$

From equation for the impact force for material containing large lumps (Equation 2):

$$F = W + \sqrt{2 \times k \times W \times h}$$

$$F = 106.8\text{lbf} + \sqrt{2 \times (70000\text{lb/ft}) \times (106.8\text{lbf}) \times (12\text{ft})}$$

$$F = 13501.7\text{lbf}$$

From equation for the impact force for homogeneous material without lumps (Equation 3)

$$F = (0.1389) \times Q \times \sqrt{h}$$

$$F = (0.1389) \times 2500\text{tph} \times \sqrt{12\text{ft}} = 1202.9\text{lbf}$$
The equivalent weight from homogeneous stream of material without large lumps \( W_e \):

\[
W_e = 8.03 \times 10^{-4} \times \frac{Q^2}{k}
\]

\[
W_e = 8.03 \times 10^{-4} \times \left( \frac{2500 \text{ tph}}{70000 \text{ lbf/ft}} \right)^2 = 0.072 \text{ lbf}
\]

From Equation 1, the impact energy from the single lump is:

\[
IE = W \times h = 106.8 \text{ lbf} \times 12 \text{ ft} = 1282 \text{ lbf-ft}
\]

The impact energy from the homogeneous stream is:

\[
IE = W_e \times h = 0.072 \text{ lbf} \times 12 \text{ ft} = 0.864 \text{ lbf-ft}
\]

From Table 1 the rating for this application would be \( H \) (Heavy Duty) because the largest calculated impact energy value falls between 1,000 and 2,000 lbf-ft.

- **Rating and Class**: Since CEMA D6 idlers are used in the impact zone the dimensional class for this application is D6. The correct Impact Bed/Cradle designation for rating and class for this example is \( H-D6 \).

**Power Requirements**

In order to calculate the power requirements you will have to know the values of \( W_b \) and \( W_m \). These values can be obtained from the design calculations of your conveyor or from a CEMA member manufacturer. Estimates of these values can be made by referring to the latest revision of the CEMA publication “Belt Conveyors for Bulk Materials.”

For this example use the weight per foot of the belt, \( W_b \), as 22 lbf/ft. The weight of material per foot of belt, \( W_m \), is 111.11 lbf/ft. To estimate the dynamic power requirement use \( C_b = 0.56 \) for a UHMW cover material on the Impact Bed/Cradle. The length of impact zone, \( L_n \), is 4 ft. \( R_{rsb} = 1 \) (default value).

\[
\Delta T_{sbn} = C_b \times (W_m + W_b) \times L_n \times R_{rsb}
\]

\[
\Delta T_{sbn} = 0.56 \times (111.11 \text{ lbf/ft} + 22 \text{ lbf/ft}) \times 4 \text{ ft} \times 1 = 298.17 \text{ lbf}
\]

\[
\text{Horsepower (HP)} = \frac{\Delta T_{sbn} \times V}{33000} = \frac{298.17 \text{ lbf} \times 750 \text{ fpm}}{33000} = 6.78 \text{ hp}
\]
CEMA Guide 576 – Draft 1

Classification of Applications for Bulk Material Conveyor Belt Cleaning

Provided by the Members of the Bulk Conveyor Accessories Committee of the Conveyor Equipment Manufacturers Association (CEMA)

www.cemanet.org
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FOREWORD

Conveyor belt cleaners are used to remove fugitive material, otherwise known as carryback, from the return side of the conveyor belt after the bulk material has been discharged. Ideally, this will be accomplished from within the chute works so that the removed carryback will pass onto the next system element. However, other locations may also be suitable. It is understood that the methods and designs for cleaning belts are numerous.

This guide has been established to provide a uniform method for determining the application class of any individual belt conveyor. This application class will assist in the selection of an appropriate conveyor belt cleaner or conveyor belt cleaner system for the application. By ranking the application, guidance concerning the needed ruggedness and durability of the applicable conveyor belt cleaner will be available. Manufacturers voluntarily specify into which class their particular designs fall.

Belt cleaner designs vary significantly, and it is each manufacturer’s responsibility to provide equipment that is suitable for the application as rated and the intended use.

The degree of cleanliness resulting from a properly specified installed and maintained belt cleaner or multiple belt cleaner system is not covered by this guide. It is the end user’s responsibility to define the desired level of cleaning that is required for their application. It is the responsibility of the belt cleaner supplier to provide a system and maintenance requirements that can meet the end user’s expectation of cleaning results.

This guide assumes the application class ranking will consider the conveyor belt to be in “new” or “as new” condition.

This guide makes no statement regarding the cleaning performance or life of any particular conveyor belt cleaner. Contact a CEMA member for information.

On 2014, it was added ANSI/CEMA Standard No. 550 Material Classification Code Chart as an Appendix for reference. Added Material Description from CEMA 550 for the two materials used as examples.

Additionally, a material was changed – Coal, Mined. As opposed to Coal, Bituminous, Mined, 50 Mesh & Under to better match the Metric Example.

In this revision, .....
INTRODUCTION

The proper selection of a belt cleaner must consider the environment in which the belt cleaner must operate. Several factors will play significant roles in deciding the appropriate selection.

This guide provides a method to condense a complex operating environment into a single classification number to be used when selecting belt cleaners.

RANKING AND CLASS SYSTEM

The application class is determined using the following factors.

1. Belt width
2. Belt speed
3. Quantity and type of belt splices
4. Abrasiveness of the material
5. Stickiness/moisture content of the material

For the purposes of this classification, conveyor belts must be new or in “as new” condition.

METHOD

The environment in which the conveyor belt cleaner must operate is divided into two main categories, the conveyor belt itself and the material carried. There are three factors describing the conveyor belt (belt width, belt speed, quantity and type of belt slices) and two factors describing the material (abrasiveness of the material, stickiness/moisture content of the material) for a sum of five. Each of the five factors is rated individually. The final application score is the sum of all five factors.

The final score is divided into five application class levels and should be specified when conveyor belt cleaners are being selected. The selected conveyor belt cleaner should have a rating that meets or exceeds the calculated application class score. (Note: ANSI/CEMA standard 550 is a valuable tool for assigning values to the material categories. A copy of its Material Classification Chart is included here as an appendix.) An explanation of the factors appears below.

CONVEYOR BELT CHARACTERISTICS CATEGORIES???

Belt Width

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&lt;24 in (&lt;610 mm) width</td>
</tr>
<tr>
<td>1</td>
<td>24 in – 42 in (610 mm – 1067 mm) width</td>
</tr>
<tr>
<td>2</td>
<td>&gt;42 in – 60 in (1067 mm – 1524 mm) width</td>
</tr>
<tr>
<td>4</td>
<td>&gt;60 in – 96 in (1524 mm – 2438 mm) width</td>
</tr>
<tr>
<td>8</td>
<td>&gt;96 in (&gt;2438 mm) width</td>
</tr>
</tbody>
</table>
CEMA Guide 576 - Classification of Applications for Bulk Material Conveyor Belt Cleaning

### Belt Speed

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;300 fpm (&lt;1.5 m/s)</td>
</tr>
<tr>
<td>2</td>
<td>300 – 600 fpm (1.5 – 3 m/s)</td>
</tr>
<tr>
<td>4</td>
<td>601 – 1000 fpm (3.1 – 5 m/s)</td>
</tr>
<tr>
<td>8</td>
<td>&gt;1000 fpm (&gt;5 m/s)</td>
</tr>
</tbody>
</table>

### Splice Type (Consider that the splice condition may change with time. Use a higher score when in doubt.)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Vulcanized (for the entire life of the belt)</td>
</tr>
<tr>
<td>2</td>
<td>Mechanical splices with belt speed below 500 fpm (2.5 m/s)</td>
</tr>
<tr>
<td>4</td>
<td>Mechanical splices with belt speed 500 fpm (2.5 m/s) or greater</td>
</tr>
</tbody>
</table>

### MATERIAL CHARACTERISTICS CATEGORIES? According to the paragraph above

#### Abrasiveness (Choose the worst case expected conditions in situations where the conditions will vary)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mildly Abrasive (ANSI/CEMA Standard 550 code designation 5, Abrasive index 1-17)</td>
</tr>
<tr>
<td>2</td>
<td>Moderately Abrasive (ANSI/CEMA Standard 550 code designation 6, Abrasive index 18-67)</td>
</tr>
<tr>
<td>3</td>
<td>Extremely Abrasive (ANSI/CEMA Standard 550 code designation 7, Abrasive index 68-416)</td>
</tr>
</tbody>
</table>

#### Stickiness/Moisture Content (Choose the worst case expected conditions in situations where the conditions will vary)

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mild/Dry (&lt;2% moisture by weight)</td>
</tr>
<tr>
<td>2</td>
<td>Medium/Moist (2-8% moisture by weight)</td>
</tr>
<tr>
<td>4</td>
<td>Heavy/Wet (&gt;8% moisture by weight)</td>
</tr>
<tr>
<td>8</td>
<td>Severe/Wet slurry with fines (ANSI/CEMA standard 550 codes F, O, V) different names there</td>
</tr>
</tbody>
</table>

The sum of the individual scores is broken down into the following ratings.

### APPLICATION SEVERITY RANKING RATINGS?

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 6</td>
<td>Class 1</td>
</tr>
<tr>
<td>7-10</td>
<td>Class 2</td>
</tr>
<tr>
<td>11-15</td>
<td>Class 3</td>
</tr>
<tr>
<td>16-23</td>
<td>Class 4</td>
</tr>
<tr>
<td>≥24</td>
<td>Class 5</td>
</tr>
</tbody>
</table>
EXAMPLES — This need to be updated due revision of std 550

7. Material Tables

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Loose Bulk Density Lb/Cu Ft</th>
<th>CEMA Material Code</th>
<th>Angle of Repose (Loose)</th>
<th>Recommended Angle of Max. Inclination (Conveyor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limestone</td>
<td>55-95</td>
<td>75A_{w}46MY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coal, Bituminous, Mined</td>
<td>40-60</td>
<td>50D_{s}35LNXY</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

IMPERIAL

A conveyor designer needs to choose belt cleaners for a conveyor carrying limestone from the quarry pit. The conveyor width is 36 in and the belt speed is 420 fpm. The belt will be installed with a vulcanized splice but will be spliced mechanically during its life.

Referring to the Belt Width chart, a score of 1 for the 36” width is assigned.

From the Belt Speed chart, a score of 2 is assigned.

From the Splice Type chart, a score of 2 is assigned since this belt will typically have mechanical splices in it even though it is vulcanized at commissioning.

Referring to ANSI/CEMA Standard 550, the CEMA material code is 75A_{w}46MY which contains code? 6 as the abrasiveness rating index for limestone. From this, a score of 2 is assigned.

From the Stickiness/Moisture Content table, a score of 4 is assigned because is coming from a quarry pit?. Even though the majority of the time this material will run fairly dry, groundwater or heavy rain can make the pit very wet. A conservative ranking would assume wet conditions.

The total score would be 1+2+2+2+4=11. From the Application Severity Ranking Chart, the designer would select conveyor belt cleaners rated for at least Class 3 applications.
A designer needs to choose belt cleaners for a new conveyor in a terminal expansion. The material conveyed will be clean bituminous coal on an 1800 mm wide belt at 4.1 m/s. The site specified a vulcanized splice for all belts.

Referring to the **Belt Width chart**, a score of 4 for the 1800 mm width is assigned.

From the **Belt Speed chart**, a score of 4 is assigned.

From the **Splice Type chart**, a score of 0 is assigned since this belt will be vulcanized throughout its life.

Referring to ANSI/CEMA Standard 550, the CEMA material code is **50D35LNXY** which contains 5 as the abrasiveness rating for bituminous coal. From this, a score of 1 is assigned.

From the **Stickiness/Moisture Content table**, a score of 2 is assigned. Rain and anti-dust measures could result in extra moisture in the coal. A conservative ranking would assume moist conditions.

The total score would be 4+4+0+1+2=11. From the Application Severity Ranking Chart, the designer would select conveyor belt cleaners that rated for at least Class 3 applications.
### APPENDIX. ANSI/CEMA STANDARD 550 – MATERIAL CLASSIFICATION CODE CHART

This need to be updated due revision of std 550

<table>
<thead>
<tr>
<th>MAJOR CLASS</th>
<th>MATERIAL CHARACTERISTICS INCLUDED</th>
<th>DEFINITION &amp; TEST REFERENCE</th>
<th>CODE DESIGNATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Bulk Density, Loose</td>
<td>A-8</td>
<td>Actual Lbs/Cu Ft</td>
</tr>
<tr>
<td></td>
<td>No. 200 Sieve (0029&quot;) And Under</td>
<td></td>
<td>A_{200}</td>
</tr>
<tr>
<td></td>
<td>Very Fine</td>
<td></td>
<td>A_{very}</td>
</tr>
<tr>
<td></td>
<td>No. 100 Sieve (0059&quot;) And Under</td>
<td></td>
<td>A_{100}</td>
</tr>
<tr>
<td></td>
<td>No. 40 Sieve (016&quot;) And Under</td>
<td></td>
<td>A_{40}</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td></td>
<td>B_{x}</td>
</tr>
<tr>
<td></td>
<td>No. 6 Sieve (132&quot;) And Under</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1/2&quot; And Under</td>
<td></td>
<td>C_{1/2}</td>
</tr>
<tr>
<td></td>
<td>Granular</td>
<td></td>
<td>D_{x}</td>
</tr>
<tr>
<td></td>
<td>3&quot; And Under</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7&quot; And Under</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>16&quot; And Under</td>
<td></td>
<td>D_{16}</td>
</tr>
<tr>
<td></td>
<td>Lumpy</td>
<td></td>
<td>D_{X}</td>
</tr>
<tr>
<td></td>
<td>Over 16&quot; To Be Specified</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X=Actual Maximum Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Irregular</td>
<td></td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Stringy, Fibrous, Cylindrical, Slabs, Etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowability</td>
<td>Very Free Flowing - Flow Function &gt;10</td>
<td>A-12</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Free Flowing - Flow Function &gt;4 But &lt;10</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Average Flowability - Flow Function &gt;2 But &lt;4</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Sluggish - Flow Function &lt;2</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Abrasiveness</td>
<td>Mildly Abrasive - Index 1 - 17</td>
<td>A-1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Moderately Abrasive - Index 18 - 67</td>
<td></td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Extremely Abrasive - Index 68 - 416</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>Builds Up and Hardens</td>
<td>B-3</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Generates Static Electricity</td>
<td>B-5</td>
<td>G</td>
</tr>
<tr>
<td></td>
<td>Decomposes - Deteriorates in Storage</td>
<td>B-7</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td>Flammability</td>
<td>B-11</td>
<td>J</td>
</tr>
<tr>
<td></td>
<td>Becomes Plastic or Tends to Soften</td>
<td>B-2</td>
<td>K</td>
</tr>
<tr>
<td></td>
<td>Very Dusty</td>
<td>B-8</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>Aerates and Becomes Fluid</td>
<td>B-1</td>
<td>M</td>
</tr>
<tr>
<td>Properties</td>
<td>Explosiveness</td>
<td>B-10</td>
<td>N</td>
</tr>
<tr>
<td>or</td>
<td>Stickiness-Adhesion</td>
<td>B-18</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>Contaminable, Affecting Use</td>
<td>B-19</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>Degradable, Affecting Use</td>
<td>B-6</td>
<td>Q</td>
</tr>
<tr>
<td>Hazards</td>
<td>Gives Off Harmful or Toxic Gas or Fumes</td>
<td>B-12</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Highly Corrosive</td>
<td>B-4</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>Mildly Corrosive</td>
<td>B-13</td>
<td>T</td>
</tr>
<tr>
<td></td>
<td>Hygroscopic</td>
<td>B-14</td>
<td>U</td>
</tr>
<tr>
<td></td>
<td>Interlocks, Mats or Agglomerates</td>
<td>B-15</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Oils Present</td>
<td>B-16</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>Packs Under Pressure</td>
<td>B-20</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Very Light and Fluffy - May Be Windswept</td>
<td>B-20</td>
<td>Y</td>
</tr>
<tr>
<td></td>
<td>Elevated Temperature</td>
<td>A-11</td>
<td>Z</td>
</tr>
<tr>
<td>Angle of Repose</td>
<td>Loose</td>
<td>A-5</td>
<td></td>
</tr>
<tr>
<td>Maximum Angle of Inclination</td>
<td>Conveyor</td>
<td>A-4</td>
<td></td>
</tr>
</tbody>
</table>
and are not covered by a CEMA standard, but are available from CEMA Members on an application-by-application basis. Even though an impact idler provides for some cushioning under the belt to help soften the force and reduce the possibility of damage, the impacting force has to be dissipated. The magnitude of these impact loads and their dissipation is not covered in CEMA load ratings.

Impact idlers with removable end stands, reinforced frames, and other special features to aid skirtboard and belt sealing systems are available from your CEMA Member idler manufacturer.

Using an impact style troughing idler as a transition idler is not recommended. Although not classified as idlers, there are numerous designs and configurations of fixed impact bars, impact saddles, impact cradles, and impact/slider beds available and described in CEMA Standard 575, latest version. These can solve some specific impact or sealing system application problems, but are not a “cure all”. These are available from CEMA Members on an application-by-application basis. Refer to Chapter 11.

Belt Training Idlers, Carrying
Normal carrying idlers are the primary devices that control the belt alignment. No self-alignment idlers are needed under well designed, precisely assembled, and maintained belt conveyors. There are transient conditions, however, that may cause conveyor belts to become misaligned despite all efforts to assure proper installation and maintenance. For this reason, conveyor manufacturers can furnish belt training idlers to help control belt alignment in difficult situations.

The training idlers pivot about an axis vertically perpendicular to the center line of the belt, and when the belt becomes off-center, they swing about so that the axes of the rolls themselves become canted in a corrective direction. This swinging about the center pivot is accomplished in various ways usually associated with the pressure of the off-center belt against a fixed arm attached to the pivoting idler frame. See Figure 5.10.

![Figure 5.10](image)

Carrying 35° troughed belt training idler

If the belt is to be reversed, the self-aligning idlers must be of a type that will swing about their pivot in a corrective direction regardless of belt direction. Those types that depend on friction of the off-center belt to shift the idler will work in both directions of belt movement. Even with properly designed self-aligning idlers, the training of a reversing belt requires very careful alignment of all idlers and pulleys as well as leveling and alignment of the conveyor structure itself. If belt training idlers are required, they should be spaced from 100 to 150 feet (31 to 46 m) apart, and at least one training idler should be used on conveyors less than 100 feet (31 m) long. Belt training idlers should not be used in areas of belt transitions or other areas of high belt tension.
BELT ALIGNMENT

A belt conveyor must be designed, constructed and maintained so that the belt consistently runs centrally on its mechanical system of idlers and pulleys. To accomplish this, the following conditions must prevail:

- Square the tail and head pulleys with the conveyor frame.
- Square all idlers and returns with the conveyor frame; be sure they are in line and lie in the same horizontal plane; and tighten the attachment belts.
- Level all frames to ensure a cross-section parallel to the ground plane. If one side of the conveyor frame is lower than the other, gravity will force the belt off-center.
- The belt must be straight and the belt splice square.
- If side creep occurs only in the vicinity of the belt splice, the splice may not be square with the belt. In general, if the creep follows the belt, there is a problem with the belt. If it remains in one general area, there is a problem with the system.
- The belt should have good contact with all troughing rolls.
- Load material centrally on the belt.

Refer to Appendix D for information on CEMA Conveyor Installation Standards. There may be times when the above procedure is not sufficient and the belt persistently runs to one side. The following corrective measures may be initiated to prevent side creep:

- While running the belt at the lowest speed possible, find the point of maximum side creep. The idler preceding this point along the direction of belt travel can be adjusted to minimize side creep. Facing the conveyor from the tail end, the idler must be pivoted clockwise to correct side creep on the left, and counterclockwise to correct side creep on the right. Once the belt is centered, change to a higher speed (if possible) and load the belt with material. Continue adjusting until normal operating conditions do not cause the belt to misalign.
- If creep persists, insure that the head and tail pulleys are perfectly aligned. Steer the belt with the carrying or return idlers. See Figures 5.10 and 5.15.
- Training idlers can be installed to replace troughing or return idlers. They should only be used in problem systems and should be at least 50 feet (15 m) from any terminal or bend pulleys. Do not use a training idler in a vertical curve. Reversible belt training idlers are available for reversible belt conveyors. Free rotation of the training idler’s vertical bearing is essential for satisfactory tracking results.
- If creep still persists, some or all of the troughing idlers may be tilted not more than 2 degrees from the vertical, in the direction of belt travel.
- If none of the above steps solve a belt misalignment condition, the conveyor should be laser aligned and corrective action taken based upon the survey data.

Note:
Maximum tracking effect occurs when the distance between the corrective components and the following components is maximized.
Definition
A belt training device is an accessory or system that helps maintain the desired alignment of the conveyor belt.

CEMA Recommendation
- The main rotating components of a conveyor system that are in contact with the belt are to be aligned so that they are aligned horizontally and vertically as well as to the center line of the desired belt travel within the tolerances specified in Appendix D.
- Mark the fixed locations of rotating components that have been purposely misaligned to aid in belt tracking.
- Each one-direction conveyor will have a minimum of one belt training device installed on the return run of the belt prior to the belt entering the tail pulley.
- Each reversing conveyor will have at least one reversing belt training device installed on the return run approximately mid-point between the terminal pulleys.
- Allowance will be made for one return belt trainer for every 50 ft (15 m) of conveyor and one carrying side belt training device for every 50 ft (15 m) of conveyor thereafter or in accordance with the manufacturer's recommended spacing.

There are numerous belt training devices available from CEMA member companies, each one designed for specific applications. They include: Guide Rollers, Hold Down Rollers, Return Belt Center Pivot Trainers, Carrying Side Belt Center Pivot Trainers, Biased Idlers, Powered Automatic Belt Training Systems, Inverted V Return Idlers, Crowned Pulleys, Rubber covered rollers and Brute Force Tracking Systems. All of the designs that react to the belt wandering off center utilize the effects of gravity and the friction between the tracking device and the belt to create a correcting force. The stationary or brute force devices that do not react to the belt wander are typically installed as safety devices to force the belt to travel within a fixed window to avoid contact with the structure. Brute force devices should not be used as a substitute for an interactive belt training system.

The technique of “knocking” or purposely miss-aligning idlers to track the belt is common and a certain amount of it is necessary to track any belt due to slight variations in the belt and accumulated tolerances in the conveyor components. However, this practice is often over used and can create an unmanageable situation. Miss-aligned components increase the tension on the belt and therefore the power requirements. A permanent misalignment is a permanent power drain. Secondly if there is no control over which idlers are knocked then there is no way to get the system back in alignment without a complete re-alignment of all components. It is not uncommon to have idlers knocked one direction by one crew and back the other direction by the next crew. It is also common to see belt training devices tied off so that they cannot function. Another common problem is lack of maintenance of the belt training devices. Since most devices work on gravity and friction it is critical that they be free to react to the smallest unbalances if they are to track the belt. These two issues; the over knocking of idlers, the tying off of belt tracking devices are not effective management methods for belt tracking. To track a belt you need to determine the root cause problems and correct them, treating the symptoms does not have a high probability of success and only increases operating costs.