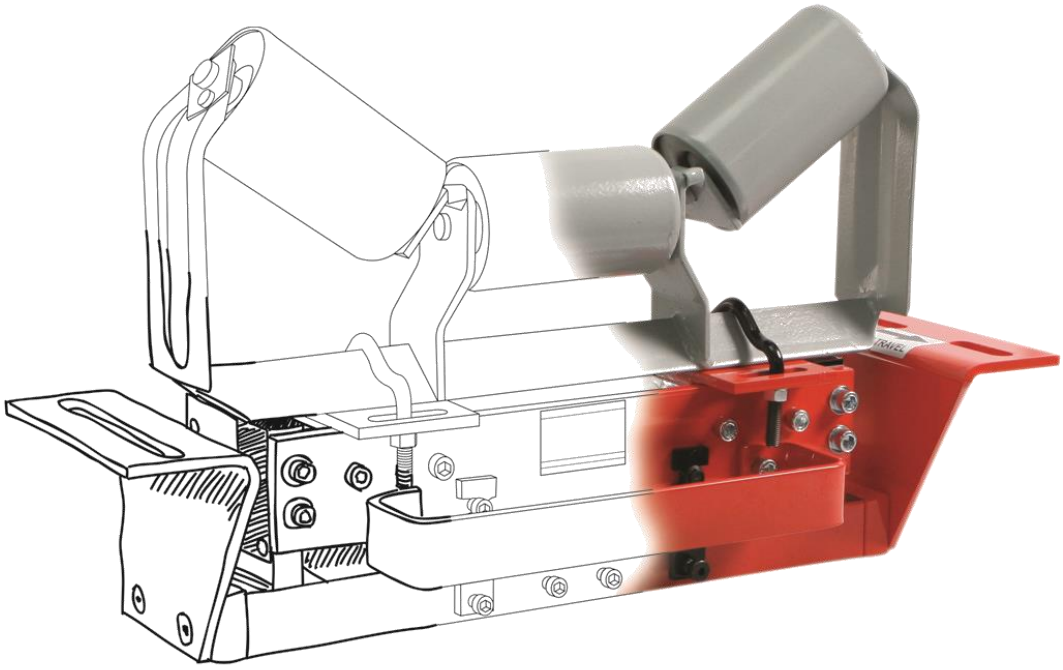
Product Application Guidelines

Belt Scales



SIEMENS

Table of Contents

Preface

The contents of this guide are intended to be used for pre-sales activities when a belt scale solution is being considered. The information required to properly size a belt scale does not take into consideration many of the other factors that are part of either the environment or the conveyor, which can lead to adverse performance if not properly managed or eliminated.

Please refer to the appropriate belt scale operating instructions for full specifications, as well as installation and calibration procedures. Manuals can be downloaded from the Siemens website at www.siemens.com/weighing When installed and applied according to the guidelines,. belt scale design and manufacture results in greater accuracy. To help the user maintain the accuracy and performance of the belt scale, this guideline provides recommendations for the proper application of belt scales under specific conveyor and environmental conditions.

The guide is meant to be read chronologically to both teach and build on the knowledge of how certain aspects of the application can compound with others to create poor performance from the scale.

Note: All diagrams are specific to the Milltronics MSI belt scale. When applying this guideline to other belt scale models, use diagrams as examples only.

Other belt weighing solutions are available including Microwave, Ultrasonic, Laser, Optical, and Gamma ray. These technologies are non-contacting, and therefore do not have the same point of reference as a gravimetric based belt scale which is the basis for this application guideline.

Introduction

Belt conveyor weighing can:

- Indicate flow rate of material during processing
- Totalize material for inventory monitoring
- Assist in loading of truck, ship, or rail car
- Assist in custody transfer
- Provide quality control for material batching
- Help monitor production

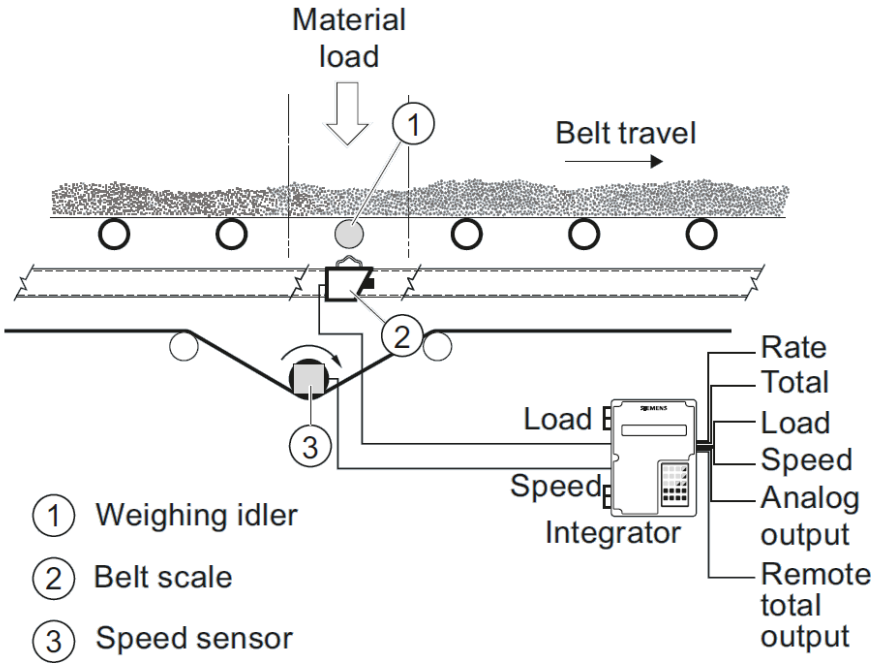
A belt scale is a weighing solution that combines three components:

1. **Scale**
   Belt scales monitor the flow rate of material on a conveyor belt.

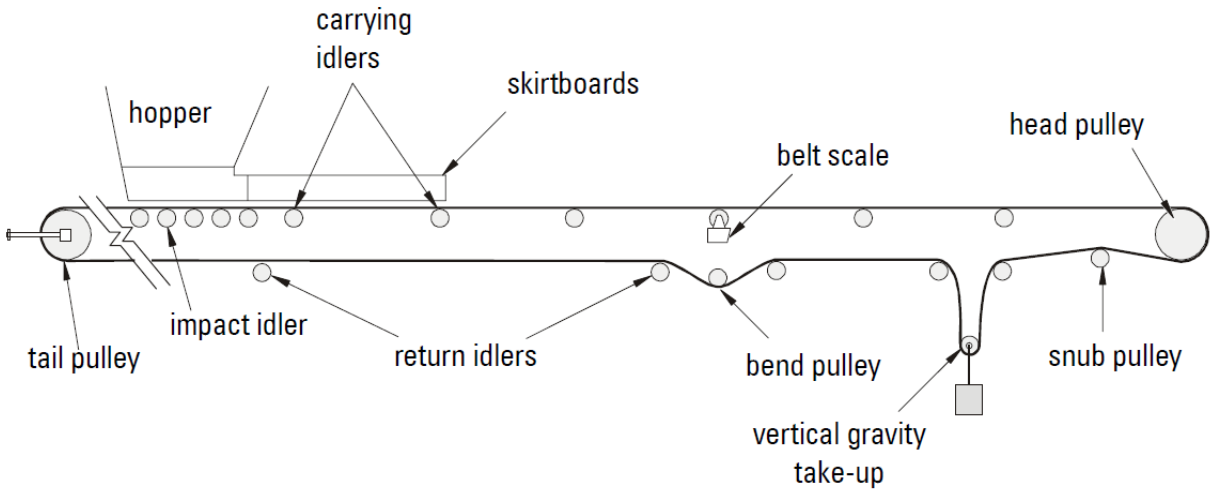
2. **Speed sensor**
   Speed sensors detect the speed of the conveyor belt.

3. **Integrator**
   Integrators collect the data from the scale and sensor and output:
   - Flow rate
   - Belt load
   - Belt speed
   - Totalization

Belt scales are generally not well suited to discrete weighing or check weighing applications or flow monitoring of batches or samples less than 10 minutes in duration.



Belt Conveyor Terminology



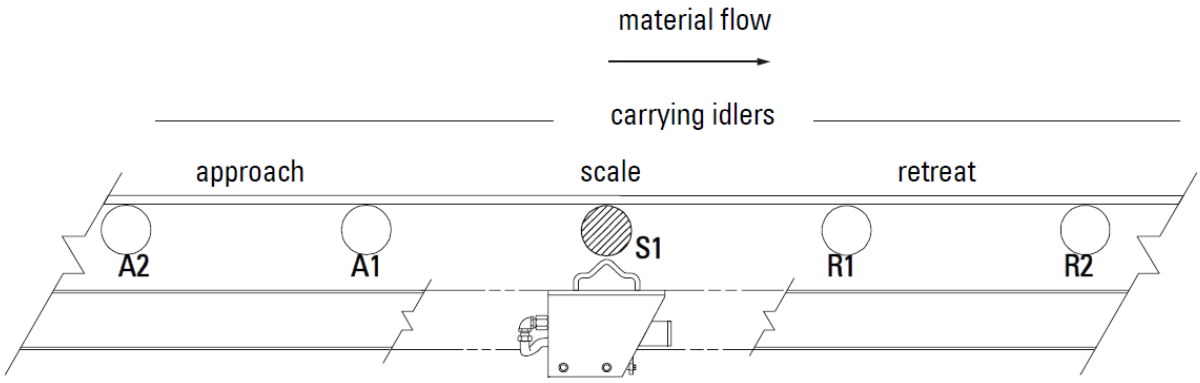
Belt Scale Selection

Choose a belt scale that best suits your application, based on the following criteria:

- Maximum flowrate.
- Belt speed.
- Conveyor width, length, incline, pulley diameter, idler diameter, and trough angle.

Use your application criteria to find an appropriate belt scale. Then, confirm your choice by checking the Scale Location and Conveyor Considerations starting on page 6.

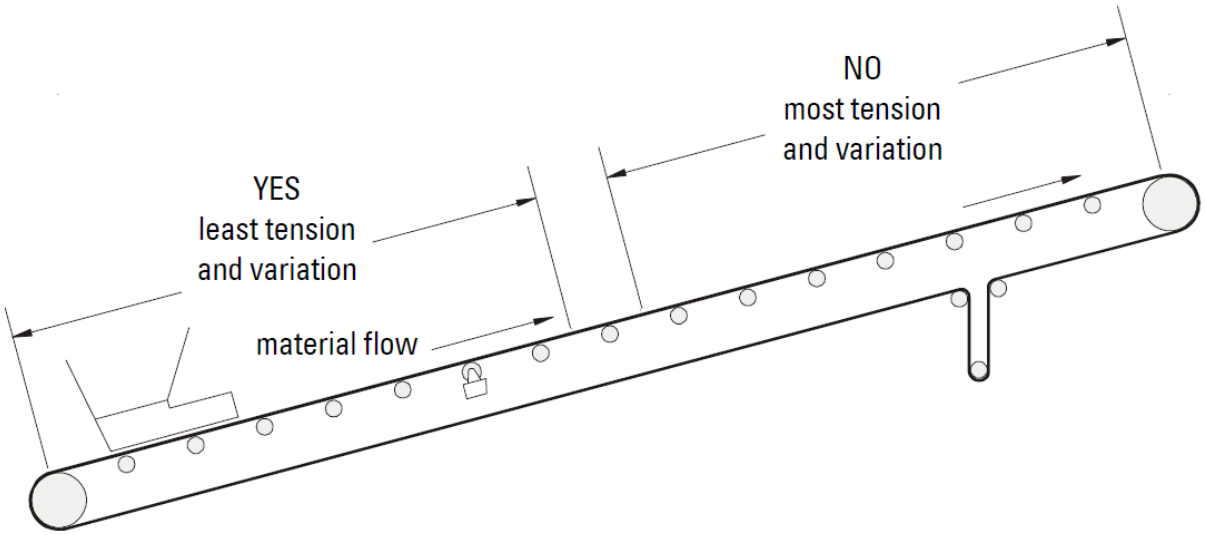
Idler Detail



Locating the Scale

Belt Tension

Belt tension varies in relation to material tonnage, belt speed, conveyor length, and the height that the material must be stacked. The larger these values, the greater the tension, and the greater the resulting effect on the scale.

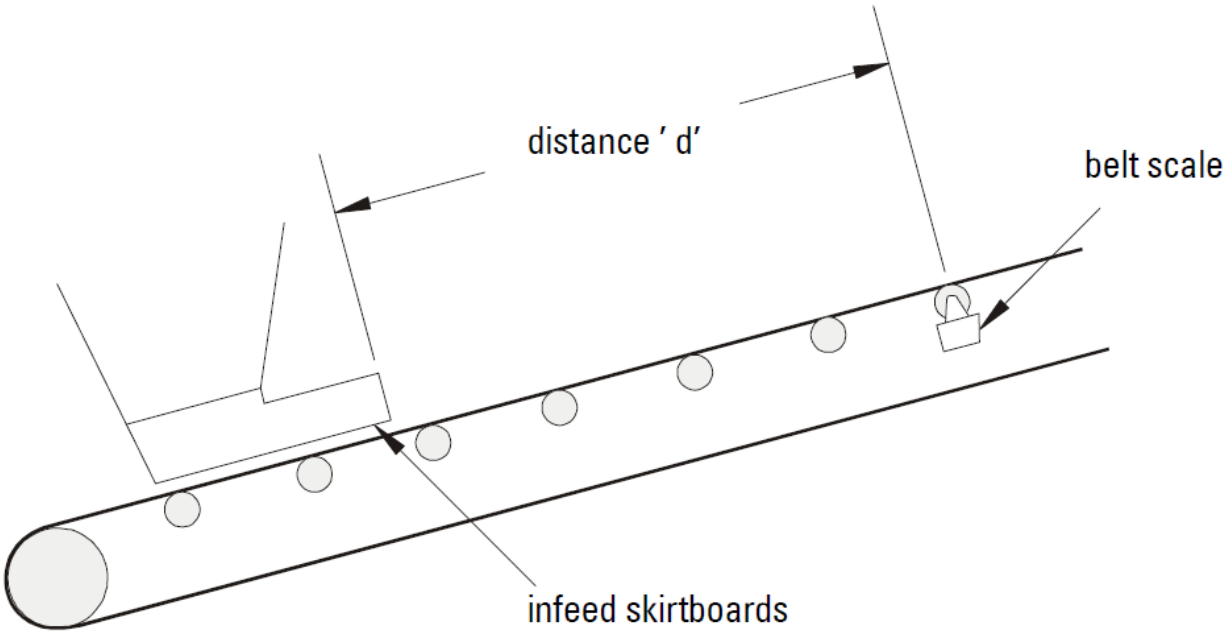


Recommendation

Install the scale close to the tail section where tension and tension variations from no load to full load are minimal. The scale must also be installed far enough away from the infeed to avoid material turbulence.

Material Turbulence

Material leaving the area of the feed point and associated skirtboards will be turbulent and will require a distance of belt to settle. Do not attempt to weigh the material before it settles completely. Locating the scale also depends on the conveyor belt speed and the characteristics of the material.



Recommendation

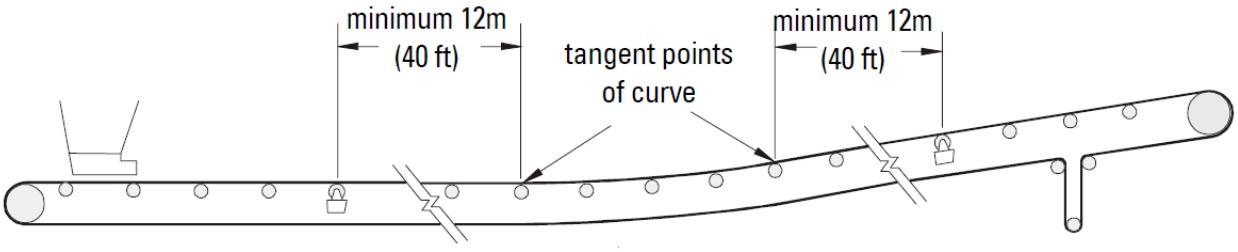
Locate the scale no less than one idler space beyond the point where turbulence stops. If that cannot be determined, refer to the following chart:

belt speeds	d
up to 1.5 m/sec (300 fpm)	2 m (6 ft)
up to 2.5 m/sec (500 fpm)	3 m (10 ft)
over 2.5 m/sec (500 fpm)	5 m (15 ft)

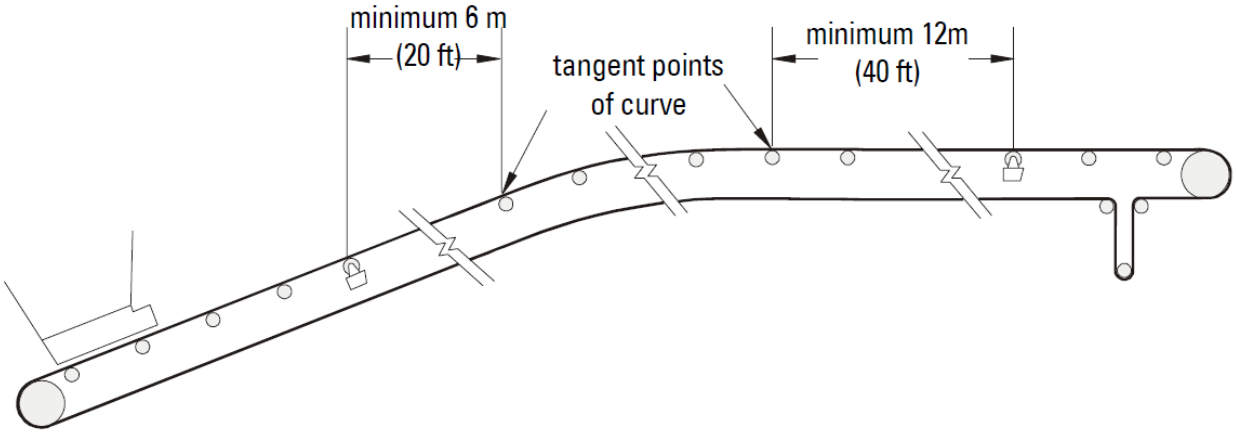
Curved Conveyors

Vertical curvature in the conveyor design can create difficulties with belt scales. Both concave and convex curvatures will disturb the idler alignment if the belt scale is installed in the area of the curve. The concave curvature is more difficult to manage because it may lift an empty belt off the idlers around the curve, preventing a good empty belt zero balance for the scale. The diagrams below illustrate the minimum distance the belt scale should be from the curvature to obtain accurate results.

Concave



Convex



Belt Ploughs

The use of belt ploughs or any conveyor or material control device that changes the profile of the carrying belt in or near the scale area is not recommended. These devices have a negative effect on the belt scale idler alignment, and may create drag on the belt which the scale may sense as a material force or load.

Recommendation

Do not install the belt scale within 9 m (30 ft) of belt ploughs or similar devices that change the profile of the material or belt.

Training/Tracking Idlers

Training or tracking idlers help ensure the belt continues to stay centered on the conveyor. These special idlers are pivoted and force the belt from side to side when the belt mis-tracks.

Recommendation

Do not install the belt scale 9 m (30 ft) from a training or tracking idler.

Metal Detectors

Metal detectors create a magnetic field around the conveyor belt. This magnetic field can disrupt load cell signal processing.

Recommendation

Install the scale at least 3 m (10 ft) from any metal detectors or equipment that generates a magnetic field.

Conveyor Trippers

A conveyor with a tripper is not as common as a conveyor with fixed curvature, but it can have a similar effect on belt scales. A tripper can cause varying belt tension and can cause lifting of the belt in the scale area if the belt scale is not located in the best position.

Recommendation

On a conveyor with a tripper, locate the scale according to the recommendations for fixed curves, but with the tripper in its fully retracted position.

Conveyor Considerations

Stacker Conveyors

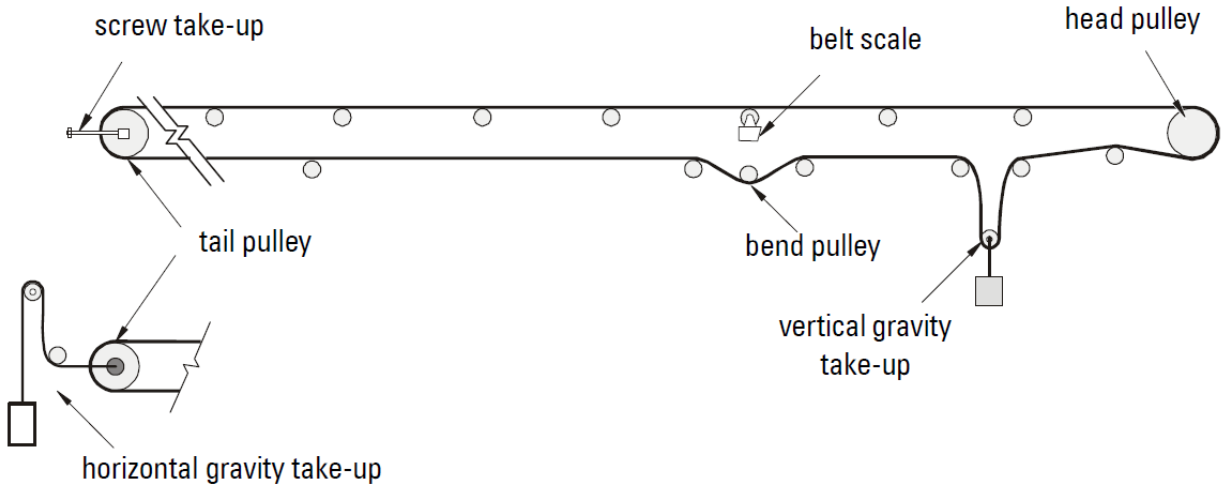
Any conveyor that is not a permanent structure or that varies in its incline, elevation or profile is not considered a good installation for an accurate belt scale. For applications where a belt scale can be used effectively with a conveyor of this type, please consult your Siemens representative.

Recommendation

Ensure that an inclinometer is used in applications with varying inclines and that accuracy will not normally achieve optimum specification.

Belt Scale Take-up Device

A variety of conveyor belt take-ups can control conveyor belt tension. Of the three basic types (screw, horizontal gravity, and vertical gravity), the vertical gravity take-up is the most reliable because it can react to changes in belt tension and maintain relatively uniform tension. Using a vertical gravity take-up greatly reduces the influence of belt tension on the scale and improves accuracy.



Recommendation

For the best accuracy, use a vertical gravity take-up. If that is not practical or possible, use a horizontal gravity take-up. The use of the screw type take-up should be limited to conveyors with pulley centers of less than 18 m (60 ft).

Material Feed Point

Some conveyor systems require that multiple feed points be in use at the same time. Belt tension can vary considerably depending upon the combination of feed points in use at any given time.

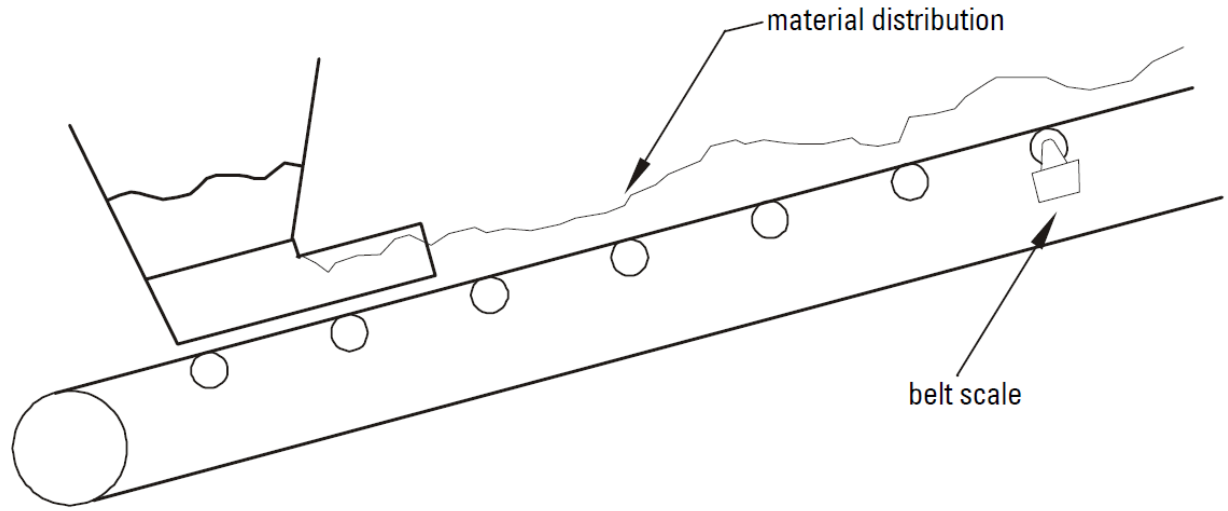
Recommendation

Whenever possible, install the scale on a conveyor that has only one feed point.

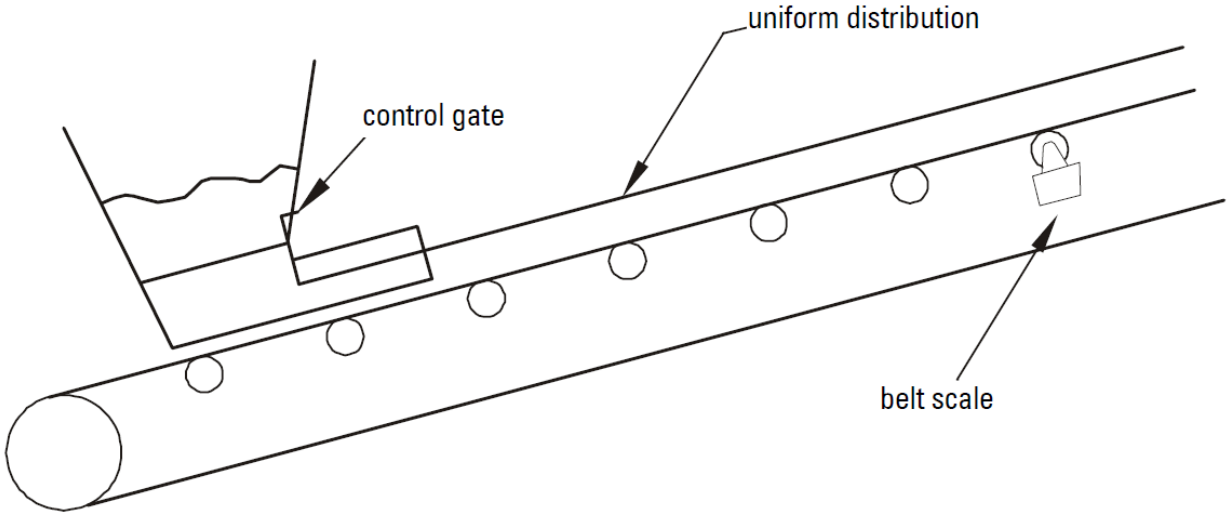
Material Loading

Various methods are used to feed material to the belt. Often, the flow of material from the pre-feeder to the belt is not uniform and at speeds different from the conveyor belt speed. These influences may reduce accuracy.

Without Control Gate



With Control Gate



Recommendation

Ensure steady and uniform material loading to the conveyor belt at or near the same speed as the belt. Install a material feed control gate or similar device to enforce the uniform flow of material.

Material Roll Back

Material roll back (sometimes referred to as material slip) occurs on a conveyor belt when the material, due to its size and shape, rolls back on itself even though the general direction is forward. It may be the result of any of the following:

- a conveyor with a steep incline,
- an inequality between material feed velocity and belt speed,
- poorly selected or installed rubber or chain curtains at the infeed (in this situation, the curtain is momentarily holding back the material on the top of the pile, causing it to slow down in comparison to the rest of the pile)

Generally conveyors at an incline of 15 degrees or less are ok; any more than that and material roll back can affect accuracy of the scale. Inclines of more than 30 degrees are not recommended for belt scales.

Recommendation

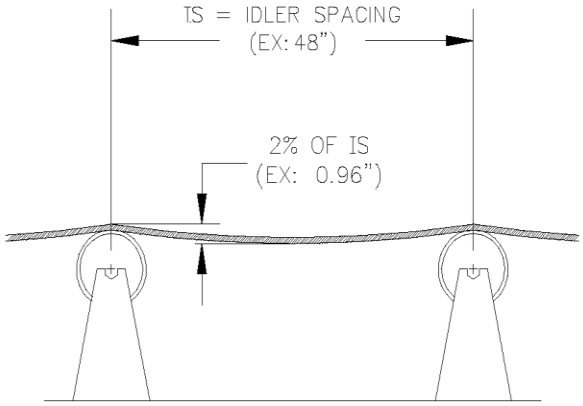
Make a close inspection of the installation to determine if the proper speed-to-feed, and incline versus material roll back relationships are in use.

Conveyor Belting

The variations in the number of belt plies, the cover thickness, and the type and quantity of splices in a given conveyor belt causes considerable variation in the weight per length of that belt. During the course of zero balancing, most belt scales average the weight of the belt over one complete circuit of the belt. The amount of the deviation (+ or -) from that average, if great enough, can make it difficult to obtain a good zero reference and subsequent scale accuracy.

Belt Sag

A properly tensioned belt should have a noticeable sag between idlers of approximately 2% of spacing when loaded at conveyor capacity. If the belt tension is too high, the material may “bridge” over the scale as the belt will not deflect under load with the load cells. If the belt tension is too low, the material will shift and move as it conveys over the idlers and in flat idler conveyers, cause spilling. If the belt speed is 5m/s (1000 fpm), the material may “launch” off the belt as it moves over the idler if the belt sag is excessive.

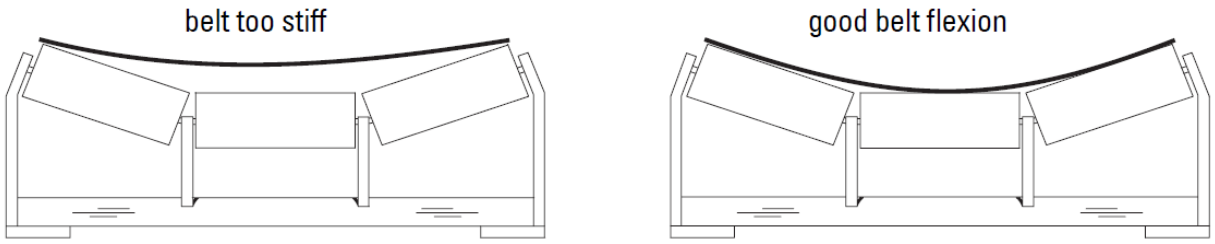


Recommendation

Ensure the belt tension is properly set and that the belt sag is within 2% of the idler spacing. Adjusting the idler spacing may be required to achieve the necessary belt sag.

Belt Stiffness

A belt that is over-rated for its intended use may be so stiff that it cannot flex enough to properly trough in the idlers. When this happens (especially in 35° and 45° idlers), the belt arches across the idler and neither a good zero of the belt nor a good span calibration can be obtained.

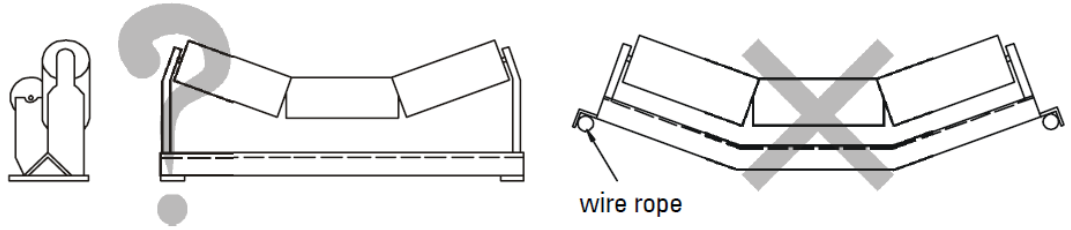


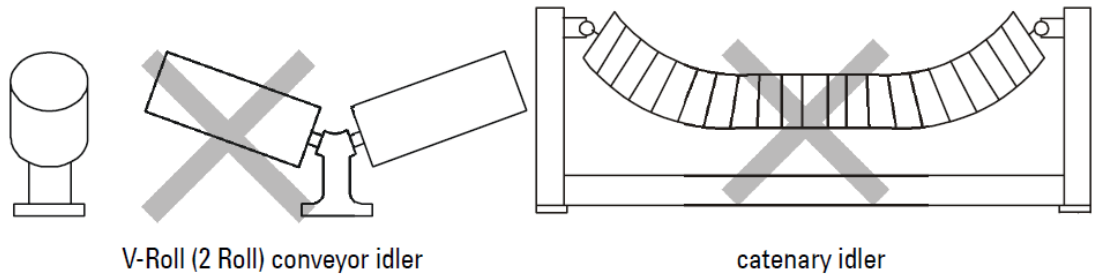
Recommendation

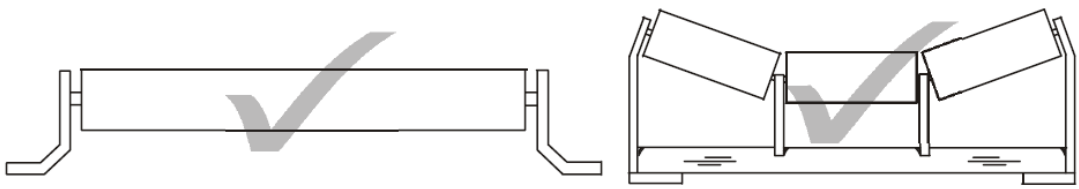
When replacing worn sections of belting, ensure that it is the same as the existing belting. When choosing a new belt, select one that suits the application. Avoid selecting an over-rated belt.

Idlers

Of the variety of idlers available, only certain types are permitted for use with a belt scale. Use of the proper idlers is necessary to achieve good idler alignment in and around the scale area.







Recommendations

A. Use scale quality idlers for the approach, retreat, and scale.
B. Do not use wire rope type, 2 roll "V" type, or catenary type idlers on or near the scale. Offset type may be acceptable in some installations, as long as all of the idlers on the conveyor are of this style. (consult Siemens regarding their use). The only truly acceptable types are the troughed 3 roll in-line type or single roll flat type idlers.
C. The most common troughed idlers are 20° and 35°. 45° troughed idlers may be used but accuracy may suffer. The deeper trough angle tends to magnify the effect that belt tension and belt stiffness have upon the scale, increasing the importance of good idler alignment.
D. Select idlers that have the same dimensions, that have rolls that are concentric within 0.5 mm (.020"), and that have troughs that match within 3 mm (0.12") when compared to a template. All idlers chosen for scale installation must be of the same manufacture and properly lubricated (in some cases, idlers having "Lube-for-life" bearings are required).
E. Keep all idler rolls clean, free from material build-up, and free spinning without over-greasing. Neglecting this may result in misalignment and poor belt tracking. Replace all idlers that have stiff, stopped, or eccentric rolls.

Idler Alignment

The proper and accurate alignment of idlers in the scale area is critical for belt scale function and accuracy. Refer to the installation procedure in the appropriate belt scale operating instructions.

Recommendation

Properly align the scale idlers and at least two (preferably three) idlers on each side of the scale. See diagram on page 5 (Idler Detail) for an example of correct idler alignment.

Idler Spacing

The approach, retreat, and scale idlers must be the same distance between each other for optimum scale performance. Large distances between idlers can also create excessive belt sag leading to material spillage and increased dynamic forces on the idlers.

Recommendation

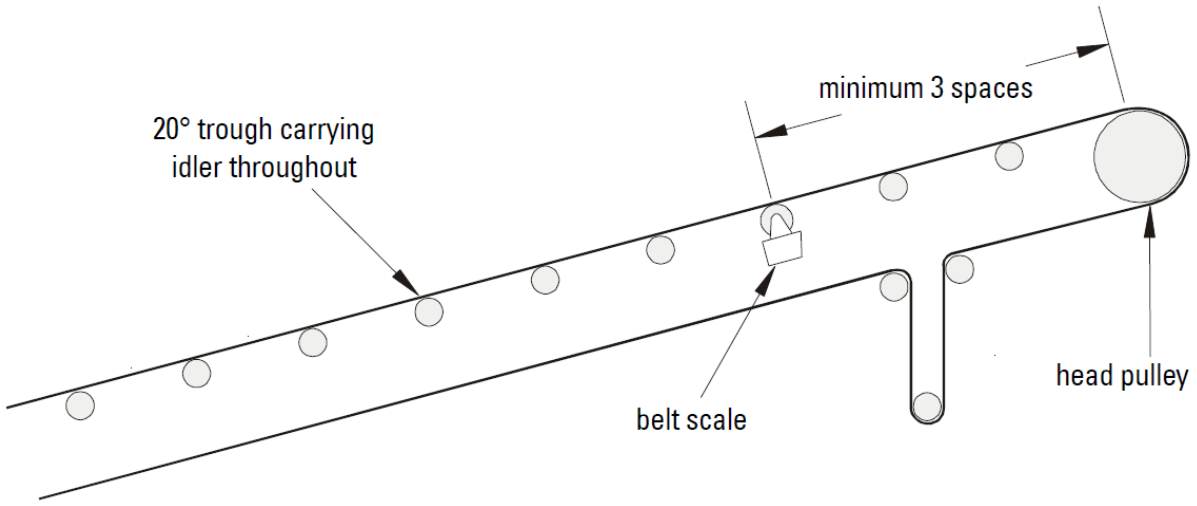
The idlers must be spaced equally for all of the approach, scale, and retreat idlers. Idler spacing generally should not exceed 1.5 m (5 ft)

Head Pulley

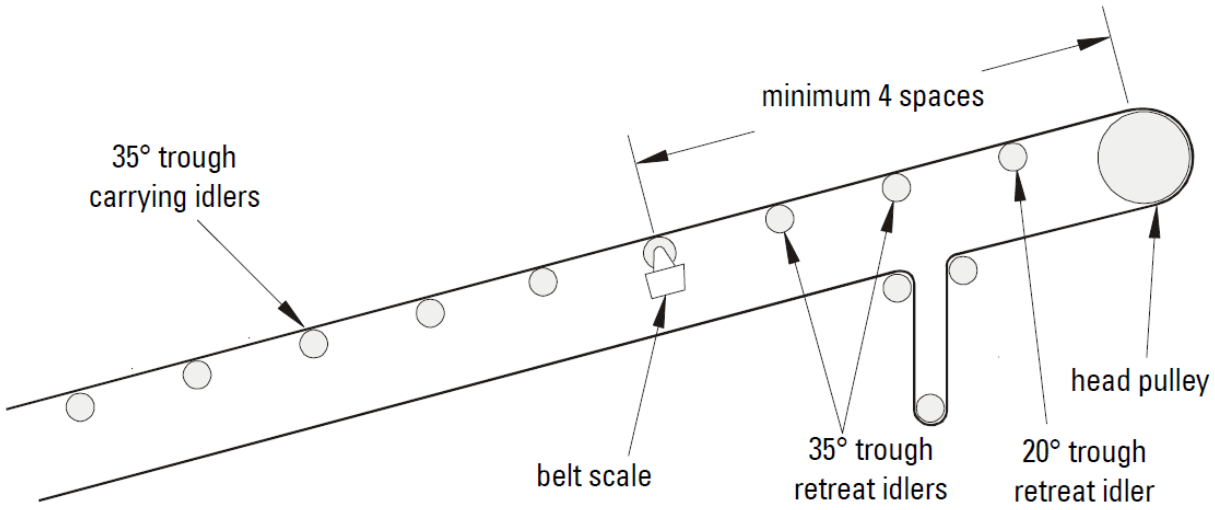
Be cautious when installing a scale in a short conveyor, or in conditions where the scale must be located in the area near the head pulley. Head pulleys are essentially flat faced with a slight crown so, when using troughed idlers, the belt profile must change from the troughed to flat in a short space. To accommodate this, the conveyor manufacturer designs a built-in vertical displacement of the head pulley above the top of the center roll of the adjacent idler. To further aid this transition, idlers of decreasing trough angles are inserted between the head pulley and the normal run of idlers. If these adjustments are not made, a considerable amount of stress is exerted on the belt edges and the idlers adjacent to the head pulley and, ultimately, these undesired forces are applied to the scale.

Recommendation

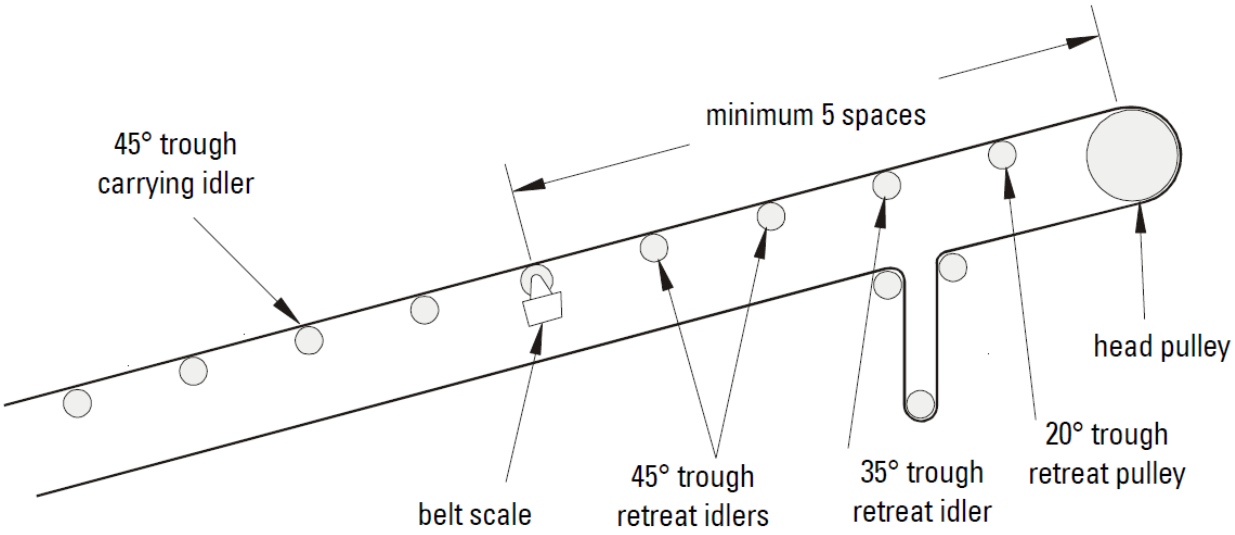
A. On conveyors with 20° trough idlers, a minimum of two fixed 20° idlers must be located between the belt scale and the head pulley.



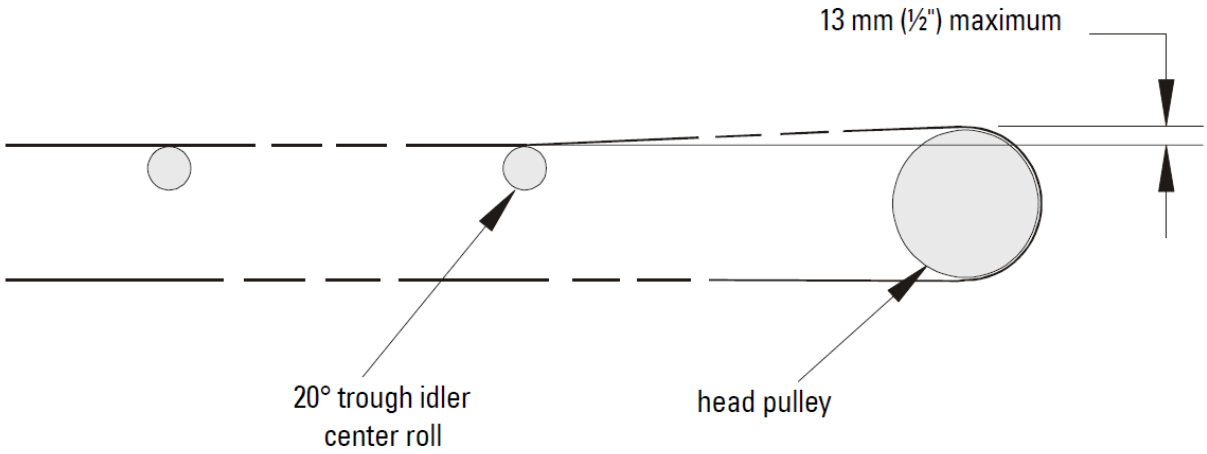
B. On conveyors with 35° trough idlers, a minimum of two 35° and one 20° retreat idlers must be located between the scale and the head pulley.



C. On conveyors with 45° trough idlers, a minimum of two 45°, one 35°, and one 20° retreat idlers must be located between the scale and the head pulley.



D. The vertical displacement of the head pulley relative to the adjacent retreat idler is normally in excess of what is acceptable for belt scale installations.



When locating a scale close to the head pulley, maintain a maximum of 13 mm (1/2") vertical displacement between the top of the head pulley and the top of the center roll of the adjacent idler by making the following adjustments:

1. Lower the head pulley on its mounting until the vertical displacement measured from the top of the head pulley does not exceed 13 mm (0.5") above the top of the center roll of the adjacent idler.

or

2. Shim all the retreat idlers between the head pulley and the scale, the scale idlers and at least two approach idlers to accomplish the same end result mentioned in option 1.

Tail Pulley

Usually, the space reserved for the infeed suppresses any effect the tail pulley might have upon the scale. A problem could occur if the tail pulley is the self-cleaning type with slats or beater paddles, often called a wing pulley. The beating action of this pulley may create oscillations that could be transmitted through the belt to the scale.

Recommendation

If possible, avoid the use of wing type pulleys. Use solid face welded steel pulleys.

Conveyor Rigidity

The conveyor stringers in the scale area should be strong enough to limit relative deflection to 1.6 mm (1/16") or less with supports 2.4 m (8 ft) apart throughout the range of conveyor loading. Stringers should also be straight so that the belt has a better chance of tracking centrally on the conveyor.

Vibration

A belt scale is an inherently sensitive device and should be isolated from equipment that can induce harmful or disturbing vibration. Equipment such as crushers, vibratory feeding equipment, bins subject to hammering, and hammer mills should be avoided. Mobile crushers present a unique problem as an alternative location for the scale is not possible. In these cases, specially designed scales and load cells should be used to ensure optimum performance. The Milltronics MCS belt scale is recommended.

Belt Speed

The combination of high belt speeds and belt sag can create a condition for material "lift off". As the material is conveyed on the belt and comes out of the sag across the idler, the high belt speed can launch the material off the belt as it passes the crown of the idler. When it falls back onto the belt, it "splashes", and needs to settle again. Both of these occurrences can have adverse effects on belt scale accuracy.

Recommendation

Ensure applications that have a belt speed higher than 5m/s (16 ft/min) are reviewed by an application engineering specialist to determine if lift off is a concern.

Conveyor Covers

Covers are required for outdoor installations involving belt scales.

Recommendation

Ensure that the covers do not interfere with the operation of the scale. Install additional shielding to counteract the adverse effects of the elements (wind in particular). The amount of shielding will depend on the geographical area, but typical dimensions are 9 m (30 ft) before and after the center of the scale and 1 to 1.2 m (3 to 4 ft) above and below the carrying belt line.

Temperature

Applications where the temperature can drop below -20 °C must use certain options for product selection and installation.

Recommendation

In extremely cold environments, select a shaft mount speed sensor, as frost or ice build-up on a belt can create unreliable speed sensing with return belt style sensors. The use of the SEN lines for the load cells should also be used between the termination box (if the load cell is not equipped with SEN lines) to the integrator. The use of the

SEN lines monitors the excitation voltage and adjusts for losses between the scale and electronics. In extremely cold environments, the resistance of the connection cable may change, resulting in poor scale performance.

Belt Tracking and Troughing

A combination of factors determine whether or not the conveyor belt will properly track (i.e. keep its position on the conveyor and idler centerline) and trough (i.e. lay in the idler trough and make good contact with all three idler rolls as intended). First, consider the belt:

- ensure sufficient ply rating to support the load without being overrated
- ensure that rubber covers are of the proper thickness
- ensure that splices are properly selected and installed

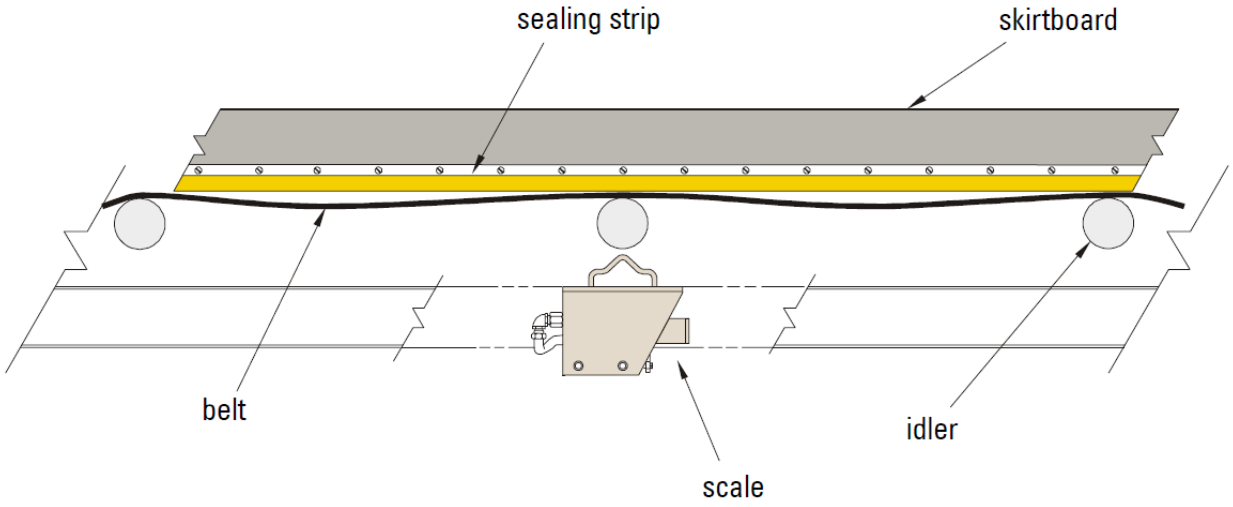
Second, ensure that the conveyor take-up is the right type for the application, and that it is properly adjusted and working properly.

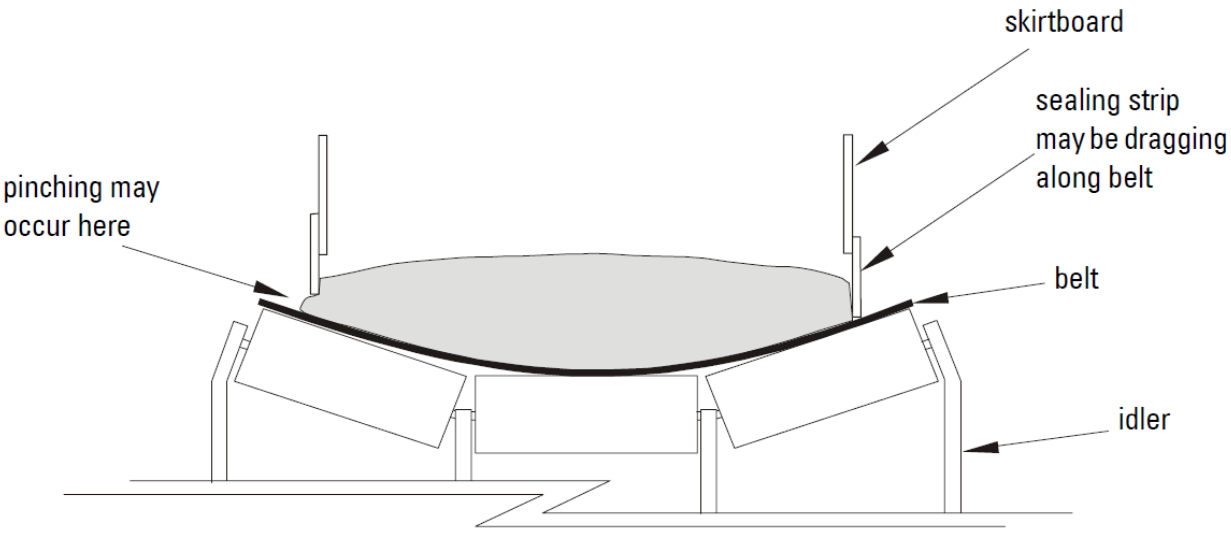
Third, consider the idlers:

- ensure the idlers are square to the conveyor and located centrally on the frame
- ensure that all idler rolls turn on their axis
- ensure that training idlers or idlers with guide rollers (if used) are not installed closer than 9 m (30 ft) from a scale idler

Skirtboards and Sealing Strips

In some applications, it is necessary to extend the infeed skirtboards and sealing strips the full length of the conveyor. Problems in weighing accuracy can result from the force the sealing strips exert on the belt, and indirectly on the idlers, especially when pinching occurs. Obtaining accurate zero balance and span calibrations under these circumstances is difficult.





Recommendation

Remove the sealing strips or raise them sufficiently to eliminate their effect upon the belt and idlers.

Belt scale verification

The best means of verifying belt scale performance is with weighed material samples. Material testing should be a consideration if the conveyor is in the design stage. For applications that cannot have a material test performed, the use of calibration test chains is the best alternative. The application of the chain on the belt mimics the material loading and also covers the entire weigh span. Calibration test weights are a good choice for belt scale verification but will not provide the same result as a test chain or material test, because the weights are placed on the scale directly. Influences from belt tension and other influences do not have the same impact with weights.

Maintenance and Modifications

Maintenance

Once the conveyor is fitted with a belt scale, it requires more attention, as it is now part of the weighing system. To ensure accurate weighing, take good care of the scale and the surrounding area. Perform the following maintenance for proper scale operation:

- lubrication of all pulleys and idlers
- proper belt tracking and training
- proper belt cleaning and scraping
- proper belt take-up operation
- proper material and spillage control

Maintenance Precautions:

- When welding near the scale, do not allow current to pass through the belt scale.
- Reset the shipping stops to reduce physical shock to the load cells during maintenance.

Modifications

Any changes to the conveyor and/or related equipment could have a profound effect upon the operation and resulting accuracy of the belt scale.

Recommendation

Consult your Siemens representative for advice regarding belt scale installation in a modified conveyor system.

Material Build-up

Keep the conveyor belt and associated equipment as clean as possible, so that the scale measures only the loads intended and not the added load due to material sticking to the belt. To remove materials that stick to the belt and conveyor equipment, use good quality belt cleaning equipment such as belt scrapers, rotary brushes, vibrating cleaners, shakers, and ploughs. Although scales can be frequently and automatically recalibrated at no load (zero), it is not a good practice to allow material build-up to remain on the belt.

Material Spills

General good housekeeping is always important. Material spillage results in lost production and can also adversely affect scale operation when spilled material wedges between dynamic parts preventing proper scale deflection. In addition, the build-up affects the zero balance of the scale.

Recommendation

Do not overload the conveyor. As a precaution, install deflectors to keep spills from reaching the scale.

General Installation Requirements for Legal For Trade Applications

General Conveyor Requirements

Legal for trade application have specific requirements depending on the governing body and specification requested by the end user. The following encompass a collection of all the metrological characteristics from multiple sources and should be considered when applying a belt scale intended to be approved for trade:

- Conveyor must be permanent construction.
- The conveyor length shall be no longer than 300 m (1000 ft), nor shorter than 12 m (40 ft) from head to tail pulley.
- The scale must be so installed, that the nearest weigh idler of the scale is at least 6 m (20 ft) or 5 idler spaces (whichever is greater) from either the end of the loading skirt boards or the head pulley.
- Scale must be mounted a minimum of 12 m (40 ft) from the tangent point of any curves in the conveyor.
- The conveyor must have a Gravity type take-up and that take-up must be operating properly.
- Material feed to conveyor to be uniform and centered.
- The conveyor belting shall be no heavier than is required for normal use.
- The conveyor must be covered on the top and sides for a minimum distance of 9 m (30 ft) each end of the scale idlers. The side covers must extend down to a distance approximately 0.6 m (2 ft) below the return belt line. The electrical power to the scale equipment must remain on at all times.
- The belt scale integrator must be located under cover, preferably in a control room, not subject to direct sunlight.

Special attention should also be paid to the conveyor where the scale will be mounted using all the information already provided:

- The belt scale shall be located close to a vertical conveyor support where conveyor stringer deflection is near zero.
- The conveyor stringers in the scale area should be strong enough to limit relative deflection to 0.8 mm (1\32").
- The conveyor stringers must be straight to prevent any belt tracking problems.

Conveyor idlers should all be scale quality to provide the best possible performance and alignment:

- On a single idler scale, the user must purchase and install "eleven (11) Scale Quality Idlers", one idler to be mounted on the scale weighbridge and 5 idlers to be mounted on the approach and retreat side of the scale weighbridge.
- On a dual idler scale, the user must purchase and Install "twelve (12) Scale Quality Idlers", two idlers to be mounted on the scale weighbridge and 5 idlers to be mounted on the approach and retreat side of the scale weighbridge.
- Do not use scale service idlers: use scale quality idlers.
- Scale quality idlers are high tolerance idlers for roll run-out, frame deflection and alignment; whereas scale service idlers are choice idlers selected from a production run having the best roll run-out.
- The scale-mounted idlers must be modified to ensure proper clearance for belt scale deflection.
- The scale quality idlers must be aligned to within 0.5 mm (0.02") of each other or better.
- The belt must remain in contact with all three rollers (center and wing rollers) of each of the aligned idlers.
- Idlers must be flat, 20 or 35 degree trough angle. All idlers on the conveyor must have the same trough angle.
- Training idlers must not be located within 18 m (60 ft) of any scale weigh idler.

Product Selection

Belt Scale

There are many different styles of belt scale available: modular designs, full width bridge, and single or multiple idler styles. Generally there are three drivers to selecting the proper scale:

1. Application needs
   Drives the specific selection of models and options. An application requiring 1% accuracy will generally suit a modular scale, 0.5% should have a full width bridge, and 0.25% or better should have full width bridge with multiple weighing idlers. The environment will also play a part: the scale should be stainless or galvanized in corrosive areas or near sea ports. If the location is considered hazardous, an approved scale will be needed.
2. Price point
   Influences the selection of the type of scale. Modular scales by their nature are less expensive, but if the application is not suited for them, they should not be used.
3. Scale sizing
   Limitations based on application needs and product features or performance will narrow the selection of the product in most cases. Product size, load cell optimization, and dynamic frequency are all considered when a belt scale is engineered.

Speed Sensor

There are two styles of speed sensors: a shaft mount style and a return belt mount style. Like a belt scale, the application and price point need to be considered for proper product selection:

Shaft mount
This style of speed sensor is ideal if it is mounted to a driven shaft on the conveyor. The resolution is typically better and the reliability is higher.
Belt mount
these speed sensors often perform as well as a shaft mount, however in high speed applications, they can slip or "bounce" creating inaccuracy.

It is important to note that a speed sensor should always be recommended even in constant speed applications as conveyor start, stop, and running is virtually never constant speed. Loading and variations in supply voltage can influence conveyor speed.

Notes

Siemens Level and Weighing
1954 Technology Drive
P.O. Box 4225
Peterborough, ON
Canada K9J 7B1
email: techpubs.smpi@siemens.com

For more information

www.siemens.com/weighing