FENNER DUNLOP
CONVEYOR BELTING AMERICAS

Conveyor Belt Manual






Conveyor Belt Manual

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CONVEYOR BELT CONSTRUCTION

Conveyor belts generally are composed of three main components:

1. Carcass
2. Skims
3. Covers (carry cover and pulley cover)

CARCASS

The reinforcement usually found on the inside of a conveyor belt is normally referred to as the "carcass." In a sense, the carcass is the heart of the conveyor belt since it must:

1. Provide the tensile strength necessary to move the loaded belt.
2. Absorb the impact of the impinging material being loaded onto the conveyor belt.
3. Provide the bulk and lateral stiffness required for the load support.
4. Provide adequate strength for proper bolt holding and/or fastener holding.

The carcass is normally rated by the manufacturer in terms of "maximum recommended operating tension" permissible (pounds per inch i.e., piw).

Similarly, the manufacturer rates the finished belt in terms of "maximum recommended operating tension" per inch of width (which is the total of the preceding, multiplied by the number of plies in the belt construction) i.e., 4 plies of 110# fabric = a 440 pound per inch of width (PIW) working tension belt.

The manufacturer determines the maximum recommended operating tension per inch of width with considerations given to:

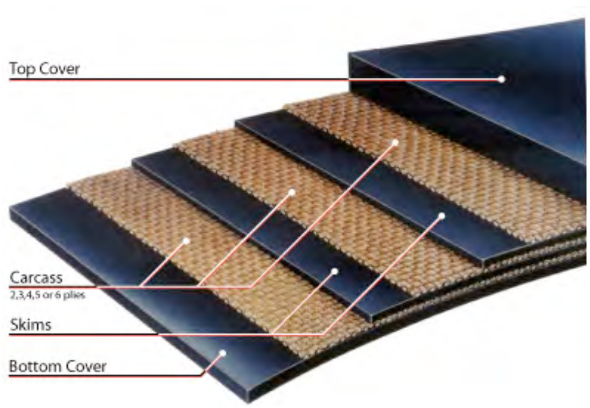
1. Stretch characteristics of the belt.
2. Fastener/bolt holding capability.
3. Load characteristics.
4. Stiffness.
5. Impact resistance of the belt.

There is a relationship between the recommended maximum operating tension per inch of width of the belt and the ultimate tensile strength (breaking strength) of the belt which will be explained later.

CARCASS DESIGN

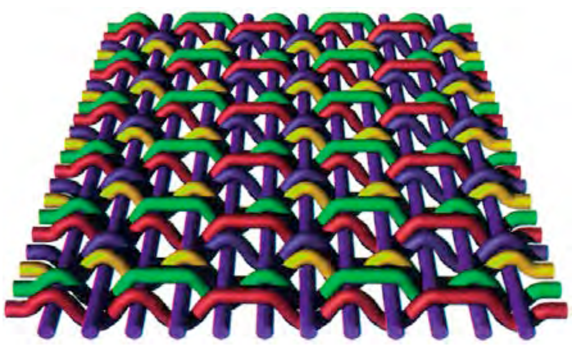
Multi-Plies + Elastomer = PSR®, RockMaster® and PitBull®

The most common carcass design is made up of layers or pliesof woven fabrics bonded together (see Illustration below). This "conventional plied" belt construction, generally employs a plain weave or twill weave carcass which is built up into as many layers as is required to provide the necessary belt strength, usually bound together with rubber.



In the **plain weave**, the **warp yarns** (lengthwise yarns) and the **fill yarns** (crosswise yarns) pass over and under each other. This means that both members are **crimped** (Essentially, each assumes a sine-wave-like configuration). This fact, plus the basic characteristics of the fiber used give the belt its stretch characteristics.

Conventional plied carcass belts have been used for decades. Consequently, they are the most common belt design used today. Most conveyor engineers and millwrights are familiar with conventional plied belting constructions and their characteristics. Virtually, all belting mechanics know how to splice conventional plied belts. This familiarity with the belt's characteristics and the ease of vulcanized splicing gives the conventional plied belting design its broad customer acceptance.



"Twill" Weave … one of many variations of the "Plain" weave

When cotton and similar materials were widely used as carcass components in plied belts, a **breaker strip**, an additional layer of open weave fabric, was added between the carcass and the top cover for heavy abuse constructions, helping absorb the loading impact. The switch to modern synthetic carcass materials (like polyester and nylon) has essentially eliminated the need for the breaker strip. Today, breaker strips are seldom found in plied belt constructions except in extreme impact applications.

Conventional plied belting constructions, employing all synthetic carcasses and elastomeric covers appropriate to the end use, are particularly recommended for:

- Hard Rock Mining
- Aggregate, sand and ore
- General purpose applications
- Forest products
- Soft Minerals
  - (A) Coal
  - (B) Potash, Phosphates
  - (C) Grain

SKIMS

The rubber between plies is called a **skim**. Skims are important contributors to internal belt adhesions, impact resistance, and play a significant role in determining belt load support and troughibility.

Improper or marginal skims can adversely affect belt performance in general and can lead to ply separation and/or idler junction failure.

STRAIGHT WARP UsFlex/Wearlok

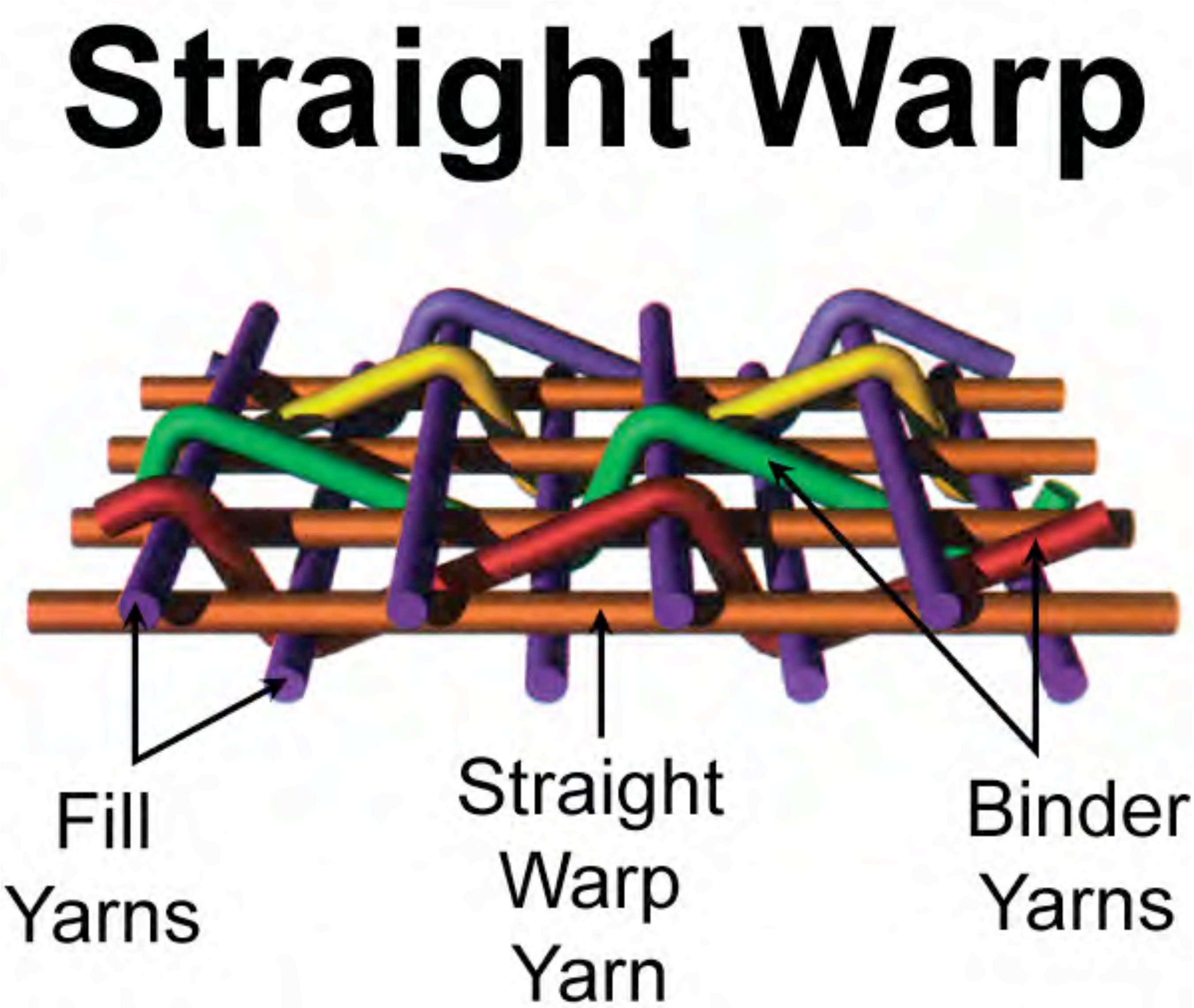
The straight warp carcass design yields a carcass construction wherein the basic lengthwise (warp) yarns are essentially uncrimped. These are the main load-carrying tension yarns. Fill yarns are then laid transversely and alternately, above and below the main tension yarns. This construction gives greater dimensional stability to the belt, and does employ a "beam" effect for better load support and transverse rigidity.

The yarns used are much thicker than yarns in conventional fabrics. Further, they are locked together by means of another series of lengthwise yarns, known as the binder warp system. The binder warp system locks the tension and fill cords tightly together creating a belt which is unusually tough and which has exceptional tear and impact resistance, as well as good fastener and bolt holding ability. **(Note, the "R" series Flexco fasteners were specifically designed for use in the UsFlex belt carcass)**

The design of the Straight Warp carcass provides a belt that delivers excellent load support – up to three times greater impact resistance than traditional plied belts and 5 times the longitudinal rip resistance of the equivalent rated multi-ply construction.

Straight Warp constructions are used for:

- Hard Rock Mining
- Aggregate, sand and ore
- High impact applications
- General purpose applications
- Soft Minerals
  - (A) Coal
  - (B) Potash, Phosphate
  - (C) Grain

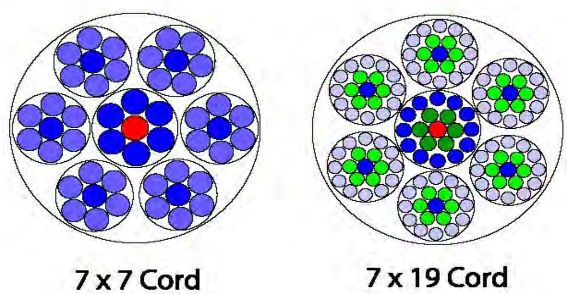


STEEL CORD + RUBBER

Steel Cord-type constructions utilize a single layer of uniformly tensioned steel cords as tension members, encased in rubber. Steel cord belts are generally found in high tension and/or long distance applications and/or where extremely low stretch is a necessity. These tensions typically range from ST500 kN/m to ST5400kN/m and up. Typical elongation for steel cord conveyor belting is less than 0.25 %.

Steel cord belts must be manufactured to width.

There are mainly two different types of cords. One is a 7x7 cord for low to mid tension and the other is a 7x19 cord for mid to high tension. These two types of cord enable rubber to fully penetrate to the center core. If rubber doesn't penetrate to the core, the cord may corrode from small cuts or at the belt ends.



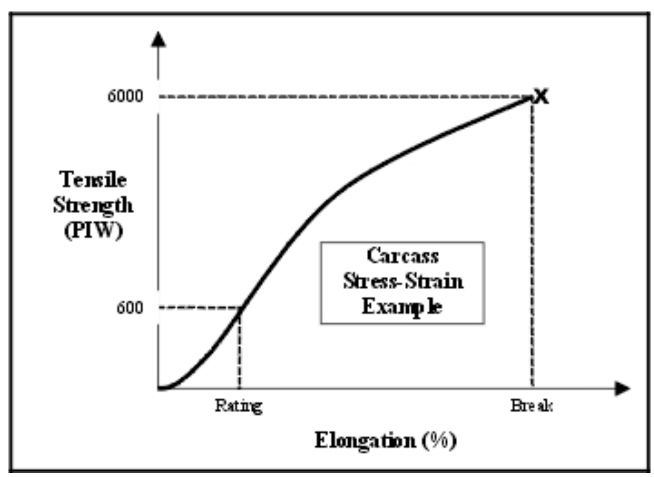
STRENGTH DESIGNATIONS

As a general rule, current fabrics in use are designated by the working tension or strength of the fabric, shown in pounds per inch of width (PIW), i.e. 80, 110, 125,150, 200, 250, 300 and 500 pound fabrics, etc.

When dealing with carcass fabrics, we work with two separate strength measurements. The first is the **Maximum Working Tension** or strength of the belt. This is the highest tension occurring in any portion of the belt on the conveyor system under normal operating conditions. This is the strength measurement used to determine the proper belt for the system. The second measurement is the **Ultimate Tensile Strength** of the belt. The ultimate tensile strength of a belt is the point at which the belt will rupture and fail due to excessive tension.

The difference between the maximum working tension and the ultimate tensile strength of the belt is often referred to as the **service factor**. On top quality domestic conveyor belting, this service factor is 8-10 to 1. Premium Fenner Dunlop Americas belting adheres to these service factors. This means that if the maximum working tension is 200 PIW, the ultimate tensile strength would be 2,000 PIW. Belting utilizing nylon constructions generally has a service factor of more than 10 to 1. This higher service factor is necessary to overcome some of the inherent properties of nylon, such as excessive elongation.

Most conveyor belt fabrics are produced today with polyester warps (lengthwise yarns) and nylon fills (crosswise yarns). This combines the best properties of both textiles, offering high strength/ low stretch conveyor belt with excellent impact resistance, troughability, load support, and fastener and/or bolt-holding ability.



Materials - Fibers

Carcass materials used in belt manufacture in recent years are listed as follows. Given is the common name, the composition and some general comments about each material. (Please note their characteristics and current position in the market place).

Cotton	**Natural Cellulose Composition** Only natural fiber used to any great extent in belting manufacture. Increases instrength when wet. High moisture absorption - consequently, poor dimensional stability. Susceptible to mildew attack. At one time represented 80% of the raw fiber input into belt manufacture. Currently less than 5%.
Rayon	**Regenerated Cellulose Composition** Slightly stronger than cotton, but tensile strength is lowered by water. Chemical resistance similar to cotton. High moisture absorption - consequently, poor dimensional stability. Susceptible to mildew attack. Almost nonexistent in conveyor belt today.
Glass	**Glass** Very high strength compared to rayon. Low elongation. Mainly used in high temperature applications. Poor flex life. Limited use in belt manufacture currently.
Nylon	**Polyamide** High strength, high elongation, good resistance to abrasion, fatigue and impact. While moisture absorption not as high as cotton, it will absorb up to 10% of its own weight in moisture. Consequently, poor dimensional stability.
Polyester	**Polyester** High strength, exceptionally good abrasion and fatigue resistance. Extremely low moisture absorption - consequently good dimensional stability. Unaffected by mildew.
Steel	**Steel** Used where high strength and extremely low stretch are a necessity. A small amount of woven steel carcass is found in today's market. However, more steel is used in steel cord-like belt constructions.
Kevlar	**Aramid** Aramid (the material used in flak jackets and bullet-proof vests) has twice the strength of steel, with stretch characteristics roughly halfway between steel and polyester. It is significantly lower in weight than steel and will not rust. Currently cost and availability of materials limit the use of Aramid in belt carcass construction.

COVERS

Covers are used in conveyor belt constructions in order to protect the base conveyor belt carcass and, if possible, to extend its service life. In addition, covers do provide the finished belt with a wide variety of desirable properties, including the following:

- Textures
  - (A) To increase inclination
  - (B) To control product
- Cleanability
- Cut resistance
- Enhanced impact resistance
- Wear Resistance
- Fire retardance
- Oil & Chemical use
- Heat & Cold

Cover type, quality and thickness are matched to the service life of the belt involved. A specific cover formulation used in an individual belt construction is determined by the material to be carried and the environment in which the belt will operate.

Historic belt constructions were highly susceptible to moisture and chemical attack because of their cotton carcass components. Accordingly, it was common to extend the belt covers over the edges of the belt in what is known as the **molded edge** construction. This type of manufacturing can be expensive because of the additional labor and machine time involved.

Modern day belt constructions, with their high adhesion levels and synthetic carcasses, are considerably less susceptible to moisture and chemical attack and do not require edge protection. They make possible the **slit-edge belt distribution** programs currently used in the belting industry.

ENVIRONMENTAL EFFECTS ON CONVEYOR BELTING

Moisture, sunlight, ozone, chemicals, heat, cold and petroleum products all have an influence on belt performance and life.

MOISTURE

Moisture has long been an enemy of conveyor belting, especially those made with cotton and rayon carcasses. When attacked by moisture they rot, weaken and lose adhesion. Early detection and repair of cover damage will help prevent these conditions.

Nylon and polyester carcasses are unaffected by moisture, but regular cover inspection and repairs are necessary to prevent abrasive particles from entering cuts and grinding on carcass fabrics.

Belts with steel cable reinforcement are also subject to deterioration from moisture if they are exposed due to cover damage. The cords may corrode which will lead to tensile strength loss and low adhesion.

Surface moisture can also be a problem. Material can cake on pulleys, idlers and belt surfaces to cause tracking problems. Moisture can also cause slippage. Material caking can be removed by installing belt wipers near the drive pulley.

EFFECTS OF SUNLIGHT

The effects of sunlight are especially severe in hot, dry climates and at high altitudes. Rubber, especially under tension, will dry out and crack. Because cracking can be expected under these conditions, any sort of protection will be beneficial. Leave belts in their protective packages while in storage. Fenner Dunlop Americas rubber covers are compounded to minimize the degradation that results from sunlight exposure.

EFFECTS OF OZONE

Regular exposure to ozone will cause rubber to crack and lose its tensile properties. Ozone is produced by ultra-violet rays from the sun, electric arc welders and electrical generating equipment. Although there may be no protection from sun-produced ozone, covering belts that are near electrical ozone producers will minimize industrial ozone effects. Fenner Dunlop Americas uses ozone inhibitors in their rubber compounds for above ground applications.

EFFECTS OF HEAT

Storage of belts at temperatures over 90° F for long periods of time can dry out and weaken covers. In carrying hot materials, the effect is the same.

If a hot load is carried in a closed area, the effects are more severe than in an open one. Where heat is a problem Fenner Dunlop Americas offers you a variety of heat resistant carcasses and cover compounds.

EFFECTS OF COLD

Although low temperatures rarely have a harmful effect on rubber compounds, the stiffening of the belt may cause training problems until it warms up. This is especially true of belts containing neoprene compounds. Before these belts will train properly, they must be warmed to a temperature above freezing.

Frost, snow and ice can also affect belt performance:

- On an incline surface a layer of frost can cause load slippage
- Ice can build up on conveyor hardware and cause more damage than material buildup
- Ice can form on the troughed side of the belt and plug chutes

The preferred method for removing cold-weather glazing is ethylene glycol. Calcium chloride solutions are also sometime used, but they can corrode conveyor parts.

Ice buildup should be removed before the conveyor is started. If the system must be kept ice-free at all times, the gallery should be covered and heated if possible.

The general effects of cold on conveyor systems are: increased power demands during startup, freezing up of rotating mechanical parts and causing drive motors to stall.

A wise course when running a conveyor in extremely cold conditions is to never shut the conveyor down. This can be done by either running the belt at full speed or by using a creeper drive on the system.

EFFECTS OF OIL

When rubber is attacked by oil or grease it swells and loses tensile strength, abrasion resistance and adhesions. Belts will wear rapidly or curl in reverse.

Fenner Dunlop Americas offers a complete line of oil service conveyor belts, compounded to specific oil resistance needs.

EFFECTS OF CHEMICALS

Certain chemicals can affect rubber compounds. The attack on the compound can cause blistering, cracking and total deterioration.

Fenner Dunlop Americas manufactures a wide variety of chemical resistant belt styles. Please consult with a FDA representative for a proper recommendation.

SELECTING PROPER COVER THICKNESS

In addition to selecting proper compounds for cover material, it is also necessary to determine the proper cover thickness. The thickness of a cover is influenced by the amount of abuse and wear the belt will receive. The cover is usually the lowest cost component of the belt.

The severity of the wear depends on the nature of the material and on the size, weight, shape and trip rate of the material conveyed. Sharp edges, particularly on large pieces, can quickly cut a cover badly.

On the other hand, if loading conditions are ideal and the material being loaded is loaded in the direction of travel of the belt with only a slight impact onto the belt, even very sharp material may not seriously cut or wear the belt surface.

Cover wear is also influenced by the loading area being on the horizontal compared to loading a conveyor belt on an incline, which will result in the product bouncing around more before the load settles down. This increased product movement will adversely affect cover wear.

Impact

Another consideration in cover thickness selection is the ratio of carry cover thickness as related to carcass thickness and pulley cover thickness. A carry cover that has more mass than the combination of the carcass thickness and pulley cover can and normally does result in belt cupping.

The more narrow the belt, the more consistent and serious the problem.

Turbulence

II. Selecting the Proper Conveyor Belt

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II.

SELECTING THE PROPER CONVEYOR BELT

Selection of the best conveyor belt construction, carcass and cover is based on the specific requirements of the particular conveyor system, the material being conveyed and the conditions under which it must operate, as well as its cost effectiveness. Some primary considerations involved are:

1. Maximum Operating Tension (Working Tension)
2. Minimum Pulley Diameters
3. Troughability, Transverse Rigidity
4. Load Support
5. Transition Distance
6. Impact Rating
7. Covers
8. Cost per unit handled

If this belt is a replacement belt, an examination of the old belt and a thorough study of the conveyor system itself can payoff in longer belt life and reduced maintenance cost.

Questions, such as the following, should be raised:

1. How did the old belt fail?
2. How long did it last?
3. What type carcass? Cover gauge?
4. Have operating or environmental conditions changed?
5. In view of the past history, what changes in belting specifications are recommended?

MAXIMUM OPERATING TENSION

Maximum operating tension is generally characterized in terms of pounds per inch of width and should be matched as closely as possible to the PIW working strength of the belt constructions under consideration. The working strengths of specific Fenner Dunlop Americas belt constructions can be found in the appropriate heavy duty belt brochure or belt specification data sheets.

Maximum operating tension, the highest tension occurring in any portion of the belt on the conveyor system under operating conditions, is a prime consideration in selecting the right belt. The conveyor system applies an appropriate amount of power to the belt in order to drive the belt at design speed. This power must be sufficient to accelerate and drive the empty conveyor, to move the material horizontally and vertically, all within the design of the conveyor system, and to overcome all flexural, inertial, frictional and gravitational forces operating on the system.

These aforementioned forces create tension in the belt. The amount of tension created can be computed in the time-honored fashion by careful consideration of each of these forces; however, there is a “Quick Method" which can be used and which generally proves satisfactory. Initially, let us consider effective tension.

Effective tension (T_e) is the tension created in the belt when sufficient power is applied to the system to drive the conveyor belt at a desired speed. This relationship can be derived from a knowledge of motor horsepower and belt speed as follows:

$$Te = \frac{Hp \times 33{,}000}{belt\_speed} \quad \text{(belt speed in feet per minute)}$$

(Horsepower [Hp] usually refers to the power actually applied to the belt. If, however, we simply use the nameplate horsepower rating of the motor in the system, we automatically build in a convenient safety factor, providing the motor efficiency is less than 100%).

Belt conveyors utilize a friction drive and accordingly, when power is applied to the drive system, one run of the belt will experience a higher tension than the other. Let us call this the tight side tension (T_1) and the other run, the slack side tension (T_2) Upon installation, a belt is normally tensioned until the belt fails to slip with the system fully loaded.

The amount of slack side tension required to prevent slippage at the drive is a function of several constant factors:

1. The coefficient of friction between the drive system and the belt (whether pulley is lagged or not)

2. Belt wrap at the drive, and type of drive. Type of drive is important, since this has a direct bearing on how the motor applies driving force to the belt. This has a direct impact on the maximum tension to which the belt will be exposed. (See illustrations on the following page).

3. Type of take-up (whether screw or gravity).

The ratio of slack side tension (T_2) and effective tension (T_e) can be represented by a constant.

$$K = \frac{T_2}{T_e} \qquad \textbf{Therefore; } \boldsymbol{T_2 = KT_e}$$

For convenience sake, a "K factor" table has been derived which takes these factors into consideration. This table can be seen below.

Maximum operating tension (tight side tension) can now be computed by $T_1 = T_e + T_2$ times the starting factor (1.5, 2.0, 3.0 etc.). Electric motors may have very high starting torques. CEMA recommends the use of a starting factor (multiplier) to compensate in calculations.

In the quick method we equate maximum operating tension to tight side tension since we are using a generous safety factor - total motor horsepower.

K Factor Table

ANGLE OF BELT WRAP AT DRIVE	TYPE OF DRIVE	SCREW TAKEUP		COUNTER WEIGHTED OR GRAVITY TAKEUP	
		BARE PULLEY	LAGGED PULLEY	BARE PULLEY	LAGGED PULLEY
180°	Plain	1.20	.80	.84	.50
200°	Snubbed	1.00	.70	.72	.42
210°	Snubbed	1.00	.70	.67	.38
220°	Snubbed	.90	.60	.62	.35
240°	Snubbed	.80	.60	.54	.30
380°	Tandem or Dual	.50	.30	.23	.11
420°	Tandem or Dual	---	---	.18	.08

For belts exposed to the weather and wet operating conditions, the K factor in the calculations should be increased by up to 50% to help prevent slippage. By increasing the K factor, the slack side tension (T_2) will be increased, thereby increasing the counterweight (Cwt).

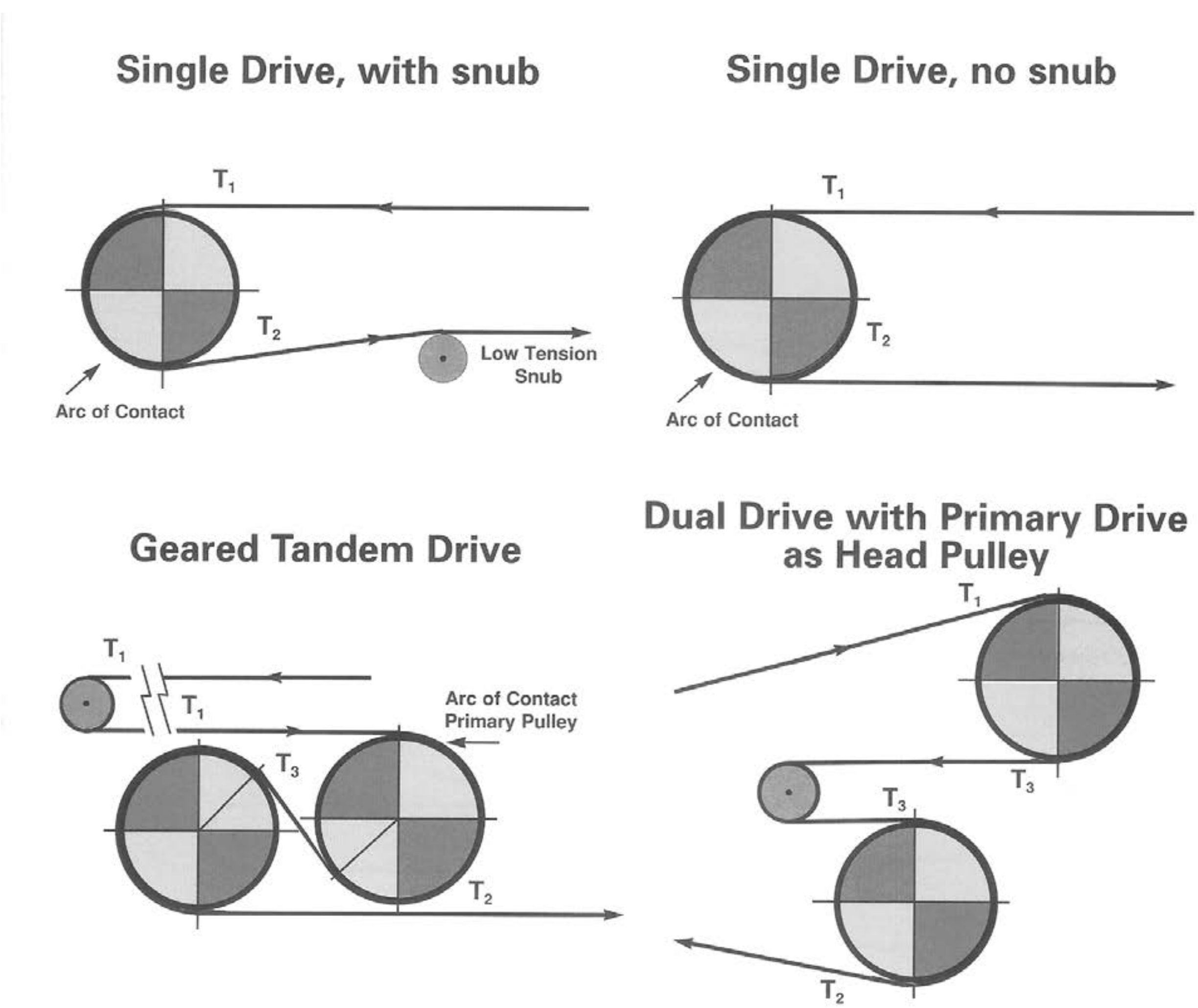
For conventional conveyors designed with a gravity take-up located near and behind the drive area, the counterweight (*Cwt*) has a direct relationship to the slack side tension (T_2). The amount of *Cwt* can be expressed as:

$$Cwt = 2T_2$$

This *Cwt* is the total amount of counterweight needed in the system to maintain proper conveyor tensions. It should be noted that this total also includes the weight of the take-up pulley, the take-up weight box and appropriate hardware associated with the gravity take-up.

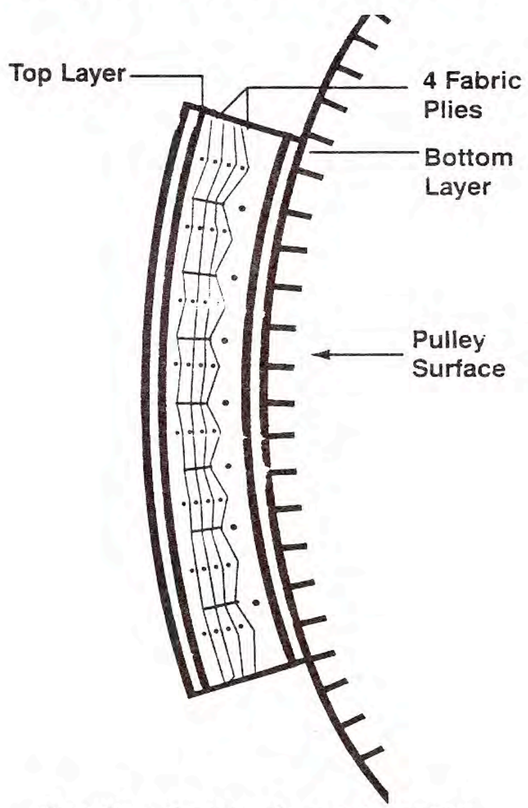
As the gravity take-up location moves toward the tail area and further away from the drive, the amount of take-up weight will increase. This increased take-up weight will be needed to overcome the return run friction factors between the drive and the take-up location.

The four drive systems shown below are only four of the many drive arrangements that can be constructed depending on the general conveyor profile.



Unique or special conveyor profiles offer many challenges for the conveyor engineer to establish conveyor tensions at various points along the belt path. This is particularly true when dealing with multiple drives, overland conveyors, reversing conveyors and regenerative conveyors. If a more accurate operating tension computation is desired, your Fenner Dunlop Americas TSM can use Belt Wizard to provide accurate belting information.

Buckling of Conveyor Belt by Bending



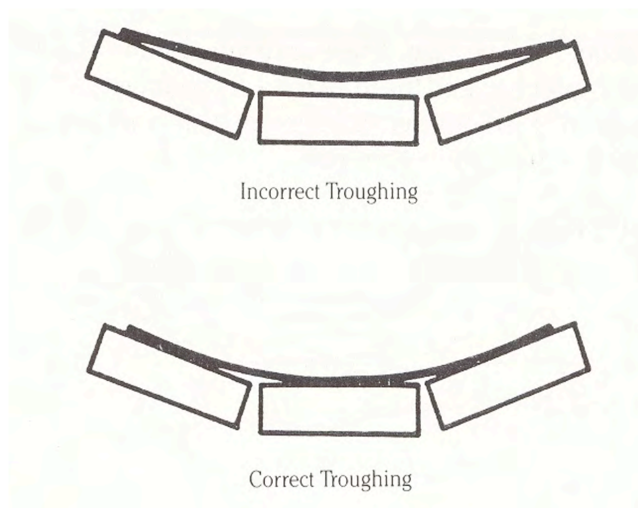
Buckling of inner plies at the pulley

MINIMUM PULLEY DIAMETER

The smallest pulley diameter the belt will encounter in the conveyor system is a primary consideration in selecting the proper conveyor belt. It is important that as the belt wraps around that pulley, under tension, the stress in the belt is below the fatigue limit of the bond between the belt components. Overstressing the belt, particularly the bond between the individual plies and the skim, can result in ply separation and premature belt failure, especially at the belt splices. In some applications, due to system limitations, smaller than recommended pulleys may be used. This will affect the service life of the belt and will result in more frequent splice replacements. A given belt construction has a characteristic "*flex*ibility" in the lengthwise direction. Our brochures and data sheets give recommendations based on calculated tension at the pulley location.

TROUGHABILITY

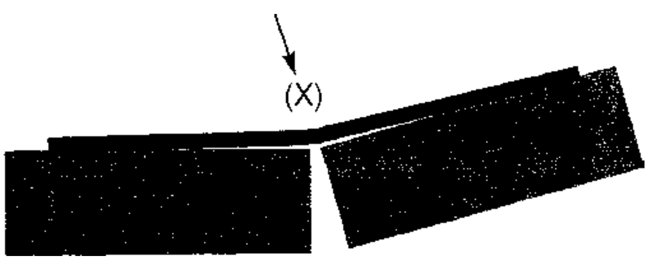
Transverse flexibility or rigidity of the belt is another significant consideration. It is important that the belt trough properly. The empty conveyor belt must make sufficient contact with the center roll in order to track properly. In the example shown below, the top belt is too stiff to contact the center rolls, and therefore, will wander from side to side with the possibility of causing considerable damage to the belt edges and to the structure. The bottom belt shows sufficient contact with the center roll and is the condition we strive for. The Troughability Table in the specification pages tells you that belt width exceeds a given dimension based upon the troughing angle of the idler systems.



LOAD SUPPORT

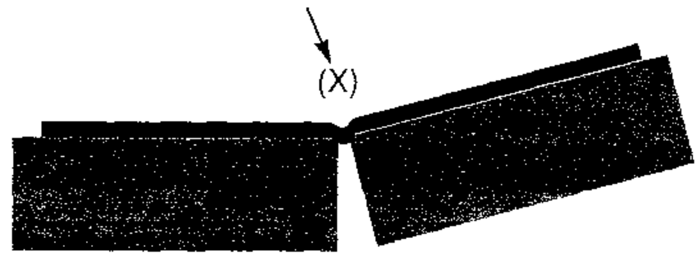
Most conveyor belts carrying "freely flowing" materials operate over troughed idlers. The troughing angle of these idlers will usually vary from 20 degrees to 45 degrees and beyond. Obviously, this trough-angle affects the belt by creating a line along which the belt is constantly flexed. The greater the trough angle, the greater the flexing action. When the belt is fully loaded, the portion of the load (X) directly over the idler junction gap forces the belt to flex to a shorter radius. The heavier the load, the smaller the radius through which the belt must flex. Further, at higher troughing angles (like 45 degrees), gravitational force is exerted on the portion of the belt in contact with the wing idler. All these forces are trying to pull the belt down into that idler junction gap.

The above illustrations show the necessity of flexibility at different troughing angles.



The above illustration demonstrates satisfactory belt design, in that it bridges the gap properly under full load.

In the illustration below, the weight of the load has forced the belt tightly into the gap, causing the possibility of premature failure.



Consequently, consideration must be given to designing the belt with sufficient transverse rigidity and flex life so that for a given idler angle and load weight, premature belt failure will not occur. This is done by designing the belt with sufficient transverse stiffness to bridge the idler junction gap with a satisfactory radius.

This belt characteristic is detailed in the load support or transverse rigidity section of the specification sheet or brochure. The load support number refers to the maximum width possible for a given belt construction at a given troughing angle and a material of a specific density. The TR number is a direct comparison of belts.

TRANSITION DISTANCE

Transition distance is traditionally defined as the distance from the center line of the first fully troughed idler roll to the center line of either the head or tail pulley. Fenner Dunlop feels transition distance should be defined as the distance from the center line of the terminal pulley to the center line of the first **effective** idler which may or may not be the first fully troughed idler in the system. For example, a system having 45 degree idlers as the primary idlers set at the proper distance from the terminal pulley but having either 35 degree or 20 degree idlers too close to the terminal pulley would shift the emphasis from the 45 degree idlers to the 35 or 20 degree idler closer to the terminal pulley.

If you just consider the geometry of the situation, you will realize that the edge of the belt is being stretched since it is following the hypotenuse of a right triangle. The distance from the pulley to the top of the wing idler is certainly greater than the distance from the pulley to the center roll of the troughing set. If the transition distance is too short, the edge of the belt can be over-stretched. This will adversely affect the splices, load support and belt life.

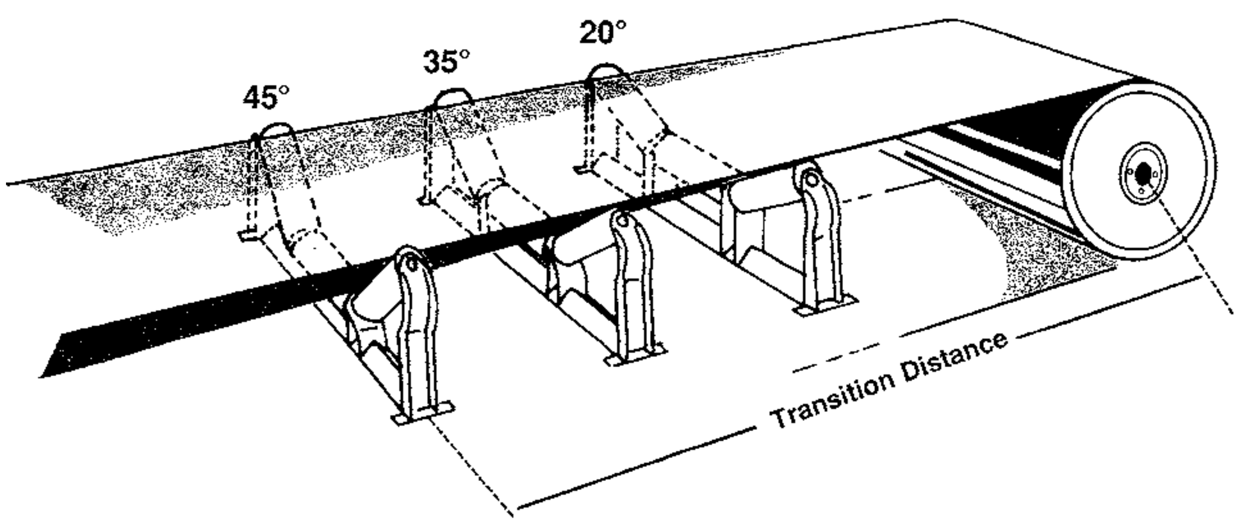
IMPACT RATING

Impact rating of the belt being selected needs to be considered relative to the material to be handled and the manner in which it will be loaded onto the belt. It is not unusual for a severe impact requirement to dictate a belt construction with a maximum working tension higher than otherwise required. Please consult Fenner Dunlop Americas for assistance in belt selection of impact applications.

CONVEYOR TAKE-UP REQUIREMENTS AND BELT STRETCH CHARACTERISTICS

Conveyor take-up requirements and belt stretch characteristics need to be matched. If the system has limited take-up capacity (say 1½ percent), using a high-stretch belting product like a nylon carcass belt could result in a continuous and excessive maintenance problem. Care should be taken to match belt modulus to take-up capabilities.

More information on transition distances can be found in the PSR or UsFlex brochure or contact your Fenner Dunlop Americas representative.



COVER SELECTION

SELECTING RUBBER COVERS

Cover compounds come in many varieties, and are selected to be compatible with the service they are going to perform and the atmosphere in which they are going to be working. A list of common cover compounds is shown in the **Cover Compound Properties** list.

In addition to selecting the correct cover compound, we must determine proper thickness. Accordingly, a consideration of "frequency factor" is in order.

Belt cycle frequency increases with the increased belt speed and decreases as the conveyor length increases. The more often a given section of the belt carries a load, the faster the wear rate will be. The cover of a 50 ft. belt carries twice as much material at 400 ft. per minute as it does at 200 ft. per minute. By the same token, at the same speed, the 50 ft. belt carries a load twice as often as does a 100 ft. belt. "Frequency Factor" can be calculated as follows:

Frequency Factor = Belt length in feet, divided by the Belt speed in Ft/Minute

The chart on the next page will help in selecting the amount of carry cover needed based on frequency factor, cover grade, lump size and product properties.

In the case of single-ply, straight-warp rubber belt constructions, it is wise to use balanced covers. Further, at no time should one cover be more than twice the thickness of the other. Belts where this ratio is exceeded are subject to cupping.

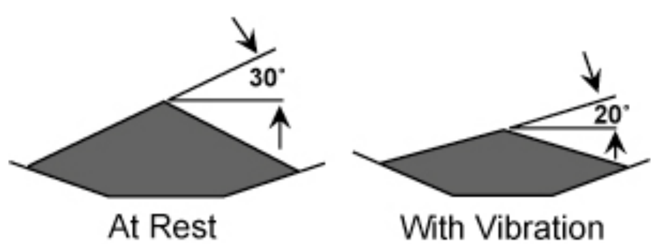
COVER TEXTURE/PROFILE

Textures applied to the belt surface can overcome natural limitations of the elastomers involved and provide for appropriate gripping action. Currently, there are many textures and cleat patterns available which do an exceptional job of handling freely flowing materials, such as wood chips, grain, sand, aggregate and fertilizer. They will enable you to handle inclines, limited only by the system and the surcharge angle of the material itself.

SURCHARGE ANGLE

If a "freely flowing" material (think of crystals of salt) is dribbled onto a stationary, horizontal surface, the top of the surface of this freely formed pile forms a unique angle to the horizontal. This angle is called **the angle of repose.**

If we now jiggle or vibrate this pile, as on a conveyor belt, the pile tends to flatten out. Depending on the characteristics of the material and the type and amount of movement and vibration (that is, the individual conveyor system), this angle will decrease, anywhere from 5° to as much as 20°. The resultant angle is known as the **angle of surcharge**. (It is important to note that the angle of surcharge will vary from conveyor to conveyor).



RECOMMENDATIONS FOR COLD BULK MATERIALS WITH NORMAL LOADING CONDITIONS

Frequency Factor	Cover Grade (RMA)	Non Abrasive Material such as lime, charcoal, wood chips, bituminous coal, grain				Abrasive Material such as salt, anthracite, coal, phosphate rock, limestone, fullers earth				Very Abrasive Material such as slag, copper ore, sinter, coke, sand, fine dust				Very Sharp Abrasive Material such as quartz, some ore, foundry refuse, glass batch, iron borings			
		Material Class 5 (CEMA)				Material Class 6 (CEMA)				Material Class 7 (CEMA)				Material Class 8 (CEMA)			
		Lump size, inch				Lump size, inch				Lump size, inch				Lump size, inch			
		Dust to 1/4	1/2 to 1 1/3	2 to 5	6 and over	Dust to 1/4	1/2 to 1 1/3	2 to 5	6 and over	Dust to 1/4	1/2 to 1 1/3	2 to 5	6 and over	Dust to 1/4	1/2 to 1 1/3	2 to 5	6 and over
0.2	2	3/32	3/16	3/16	3/8	3/16	3/8	-	-	3/16	-	-	-	3/8	-	-	-
	1	1/16	1/8	1/4	5/16	1/8	1/4	3/8	3/8	7/32	3/8	3/8	3/8	5/16	3/8	3/8	3/8
0.4	2	1/16	3/32	3/16	1/4	3/32	1/16	3/8	-	3/16	3/16	-	-	7/32	3/8	-	-
	1	1/16	3/32	1/8	3/16	3/32	1/8	1/4	3/8	1/8	1/4	3/8	3/8	3/32	5/16	3/8	3/8
0.6	2	1/16	3/32	1/8	3/16	3/32	1/8	1/4	3/8	1/8	7/32	3/8	-	3/16	3/16	-	-
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/16	1/4	1/8	3/32	1/4	3/8	1/8	7/32	3/8	3/8
0.8	2	1/16	3/32	1/8	3/16	3/32	1/8	3/16	9/32	1/8	3/32	3/16	-	1/8	7/32	3/8	-
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	7/32	3/8	1/8	3/32	5/16	3/8
1.0	2	1/16	3/32	1/8	3/16	3/32	1/8	3/32	7/32	1/8	1/8	1/4	3/8	1/8	3/16	3/8	-
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/16	1/4	1/8	1/8	1/4	3/8
1.5	2	1/16	3/32	1/8	3/16	3/32	1/8	5/32	3/16	1/8	1/8	3/16	1/4	1/8	1/8	1/4	3/8
	1	1/16	3/32	1/8	3/16	3/32	1/8	5/32	3/16	1/8	1/8	3/16	7/32	1/8	1/8	3/16	1/4
2.0	2	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/16	7/32	1/8	1/8	3/16	3/8
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/32	3/16	1/8	1/8	3/16	1/4
3.0	2	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/16	7/32	1/8	1/8	3/16	1/4
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/32	3/16	1/8	1/8	3/16	1/4
4.0 and over	2	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/16	7/32	1/8	1/8	3/16	1/4
	1	1/16	3/32	1/8	3/16	3/32	1/8	3/32	3/16	1/8	1/8	3/32	3/16	1/8	1/8	3/16	1/4

NOTE: *THE FREQUENCY FACTOR INDICATES THE NUMBER OF MINUTES FOR THE BELT TO MAKE ONE COMPLETE TURN OR REVOLUTION.*

The inclinability of a given material is obviously limited by the angle of surcharge of that material on that specific conveyor.

At conveyor angles that are less than the angle of surcharge, an appropriate textured surface will "lock" the material to the belt enabling the conveyor system to operate at that incline.

Fenner Dunlop America provides many such surfaces:

V-top
Y-top
C-top
Bucket Top
B-top
F18 & F36 Cleats
24” and 42” Chevrons
Mini Bucket
Unicleat

For angles of incline greater than the angle of surcharge, special means must be provided to handle the material such as:

Cleats
Pockets
Buckets
HAC type conveyors, etc.

Incline requirements may force you to select a belt elastomer with different release characteristics, depending upon the materials' surcharge angle. Rubber can handle "freely flowing materials" at inclines up to 18 degrees, under most weather conditions. PVC, on the other hand, would be limited to approximately 12 degrees.

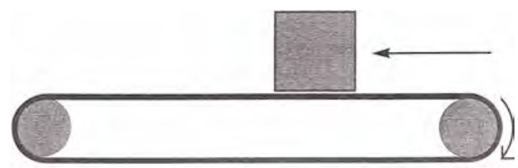
ABUSE RESISTANCE

Abuse resistance may be an important factor in selecting your belt. For instance, concern over excessive impact or rip-resistance could suggest an UsFlex straight warp construction might be preferable to the standard plied belt constructions.

Cover stock concerns can be handled by cover elastomers that are specifically formulated for the materials being handled.

For instance if cutting and gouging of the carry cover is a concern, **Matchless** and **Matchless Plus** compounds will help alleviate the problem.

Granite cover compounds are designed to handle the general run materials and are compounded to provide good cut and gouge resistance as well as good abrasion resistance. However, if the belt is seeing high abrasion cover loss, a **Titanium** cover stock would be recommended.



Slider belt conveyor systems generally require a bottom conveyor belt surface with a lower coefficient of friction than troughed conveyor systems. Normally a bare fabric or frictioned bottom surface would be used. Or if a rubber cover surface is desired, Fenner Dunlop Americas offers the **Duroslide** low coefficient of friction slider bed compound.

Loading conditions – **Favorable** - Ideally, the materials should be moving in the direction of belt travel and approximate belt speed when it is deposited on the belt. - **Unfavorable** –Material being loaded at a ninety degree angle to the belt direction or in the opposite direction as belt travel, as well as skirtboards and trippers, should be considered in your conveyor belt selection decision.

Flame retardance* is a highly desirable property in conveyor belts which are going to be used in systems where combustion or explosions are a concern, such as grain, underground mining, etc. In certain applications, flame retardant belting is mandatory. Be aware of such standards and advise your belt supplier of your requirement.

It is important to note that: ****All fire retardant belting will burn under some set conditions. If the defenses built into the belt are overwhelmed, the belt will burn.*** You can help protect your installation by being aware of and practicing, those safety standards that are currently in your industry, whether mandated by law or not.

Zero slip controls, side motion sensors, fire detection, and fire suppression equipment, such as required by MSHA, should be included in any appropriate approach to fire hazard control in addition to the use of the fire retardant belting.

The temperature range for the installation must be considered. Do consult your Fenner Dunlop Americas Representative or refer to the Cover Compound printouts available from the web site. (www.fennerdunlopamericas.com)

Chemical reaction from oils, acids, bleaches, vegetable and animal fats, ozone, ultraviolet, etc. needs to be considered when selecting the elastomer for your conveyor belt. In wood products applications, elastomers with at least a moderately oil-resistant characteristic do well particularly on pine and similar products.

Static control is a consideration in some conveyor applications (usually, grain and mining) due to the atmosphere in which the belt must operate. Rubber compounds are available which are static-conductive, and which will safely dissipate a static charge on a properly and contiguously grounded conveyor system.

GOVERNMENT REGULATIONS

It is the conveyor operator's responsibility to be aware of all safety standards and governmental regulations (example - Grain elevator standards) applicable to his or her specific system. Sources of such information include:

- Governmental bodies
- Industry associations
- Generally accepted standards
- Suppliers, etc.

IN SUMMARY

It is obvious from the preceding that selecting the correct conveyor belt for your application involves a myriad of considerations. Final selection may very well represent a compromise between what is desired and what is available. It is often necessary to modify one requirement in order to get a more important requirement satisfied.

To assist you in obtaining the proper information required to select a proper belt construction, the following check list is provided.

1. **Material Conveyed**
    a. General description
    b. Density, pounds per cubic foot (pcf)
    c. Lump size
    d. Presence of oils or chemicals, if any
    e. Maximum temperature of load, if hot
    f. Requirements of fire resistance
2. **Maximum loading rate or required maximum capacity, tons (2000 lbs.) per hour (tph)**
3. **Belt width, inches***
4. **Belt speed, feet per minute (fpm)**
5. **Center of center distance (length) of belt***
6. **Profile of Conveyor**
    a. Profile distance along conveyor path
    b. Elevations
    c. Locations of all vertical curves and angle of slope
7. **Drive**
    a. Single-pulley or two-pulley
    b. If two-pulley, geared tandem or dual-drive
    c. If dual-drive, distribution of total motor horsepower at primary and secondary drive pulleys
    d. Angle of belt warp on drive pulley(s)
    e. Location of drive; Pulley surface, bare or tagged; Type of lagging.
    f. Type of starting to be employed.
8. **Pulley Diameters. These may require confirmation according to the belt requirement.**

9. Take-up
   a. Type
   b. Location

10. Idlers
   a. Type, roll diameter, angle of trough
   b. Spacing, including transition distance at head and tail.

11. Type of loading arrangement
   a. Chutes
   b. Free-fall distance, lumps to belt
   c. Skirt board length

12. Lowest cold weather operating temperature anticipated if applicable

13. Type of belt splice to be used

Note: It is obvious that all of the above information is not required for the short method of belt selection. But, it is well to learn to look for this information.

To assist you in collecting as much information as possible on the conveyor system, a copy of the Fenner Dunlop Americas "Belting Data Sheet" is shown on the following page. When asking for Belt Wizard assistance in selecting a conveyor belt, please fill out as much of this information as possible.

*Belt length and width are, of course, determined by the conveyor system. It is wise to actually measure both, since memories are frequently faulty and conveyors are modified from time to time.

When measuring length, the take-up is run to the minimum position, the length required is determined by steel tape and a short length added for ease of splicing. The length should be such that the take-up pulley will be 30% down the slide for installation and splicing. This will allow for additional footage, in case another splice is required before the belt stretches to its final position. This will also allow 70% of the take-up area for belt stretch.

FENNER DUNLOP
CONVEYOR BELTING AMERICAS

"BELT WIZARD" DATA SHEET

Customer ____________________________________
Plant/Mine __________________________________
Location ____________________________________
Distributor _________________________________

* **Sketch Conveyor Profile Above**
(Note: Provide as a separate attachment, if necessary!)

Conveyor # ____________________________
Covered, "Open," or Underground? ____________
Tripper…Yes or No? _____
Min Ambient Temp (^{0}F) ______

Width (in) _______

Length (ft) … one of three required:
Total Belt Length __________
Horizontal C/C __________ Conv C/C__________

Elevation … one of three required:
Lift (ft) ________ Drop (ft) ________
Slope (degrees) _______

Speed (fpm) ___________

Capacity:
Tons/Hr (max) ___________ Hrs/Day _______
Days/Yr _______ Tons/Yr _______________

Material/Loading Info:
Type ____________________ Weight (pcf) ______
Max Size (in) ______ Drop to Belt (ft) ________
Temp (^{0}F) _________ Oil …Yes or No? _____
Load Angle … "In-line," 90^0, or "other?" _________
Skirting Length (ft) _______

Idlers:
Type/Style _______________ Roll Diam (in) _____
Degree Trough ______ Degree Return ______
Spacing (ft) … Troughers _____ Returns _____

Drive Details:
Type … Single, Dual, or Tandem? ______________
Horsepower ________ Wrap Angle (deg) ______
Location from Head (ft) _____________
Lagging …Yes or No? _____ Type ______________
Accel Time (sec) _______

Brakes … Yes or No? ______
Location _______ Brake Force (ft-lbs) ___________

Pulley Diameters (in):
Head _____ Tail _____ Drive _____ Snub _____
Takeup _____ TU Bends _____ "Other" _____

Takeup:
Type…Automatic, or Manual ________________
Movement (ft) _______ Cwt (lbs) ____________
Location from Head (ft) ___________

Transition Distances (ft):
@Head ______ @Tail ______ @Tripper ______

Turnovers:
Yes or No? ______ Length, each (ft) _______

Splice Type … Vulc or Mech? ________________

Belt History:
Spec ______________________________________
Service Life _____________________________
Problems / Failure? _________________________
____

Comments / Concerns / Suggestions ____
____
____
____

Submitted by _____________________________________ ***Date*** _______________ 6/4/04

III. Installation, Troubleshooting & Tracking

CONTENTS:

CONVEYOR BELT STORAGE AND INSTALLATION

RECEIVING THE ROLL

Upon delivery, check the factory packaging for damage, punctures, etc. Make any appropriate claim against the carrier at that time.

HANDLING THE ROLL

Factory packaging is designed to protect your conveyor belt during normal shipping and handling. When a belt arrives, be careful unloading it. Don't drop it or handle it roughly. This could break the packaging and cause the belt to telescope. Once a belt telescopes, it is almost impossible to re-roll.

Try not to roll it, but if you must, roll in the direction the belt is wound. Rolling a belt in the opposite direction can cause it to loosen and telescope.

The best way to move a belt is to slip a sturdy hoisting bar through the center core. Then, lift it with a sling or with strong cables. Be careful that these hoist cables don't damage the outer wraps at the belt edges. Protect the edges with special "spreader bars," or short wooden planks. Never apply a sling around the circumference of a roll of belting. . .it isn't safe!

You can also move a belt safely by laying the roll flat on a skid and hoisting the skid with a forklift. Just be sure the forks on the lift don't come in contact with the belt itself.

STORAGE

When storing a new conveyor belt, leave it hoisted or stand it upright, preferably on a dry surface (do not lay the roll on its side). A wooden skid is best. Block it safely so it can't accidentally roll.

Extreme temperature variations can have an adverse affect on a belt over long periods of time. The ideal storage range is between 50°F and 70°F.

Long exposure at temperatures even slightly below 40°F can harden or stiffen the compounds. If installed on a conveyor in this stiffened state, the belt may not train well until it adjusts or "warms up" to the system.

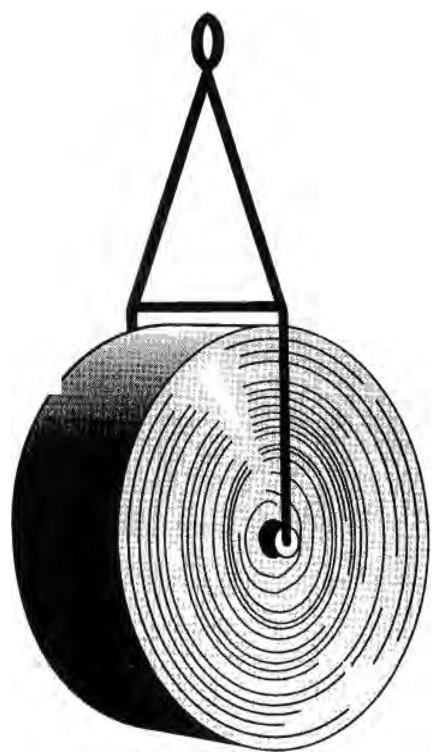
Temperatures over 90°F have an adverse effect as well, and should be avoided.

Sunlight and ozone can also deteriorate any exposed rubber over time. Store your belt out of the direct sunlight whenever possible. Electrical generators or arc welders can sometimes generate ozone. It is best to store your belt some distance away from this type of equipment.

In general, it's wise to keep any unused belt stored in its protective factory packaging until it's ready for installation.

Used belt should be thoroughly cleaned and dried prior to storage.

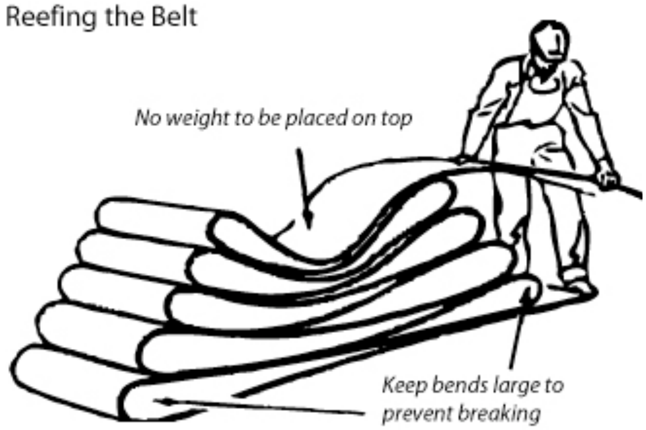
A dry place out of direct sunlight is preferred for storage, excessive temperature variations or extremes being avoided. Belts should not be stored in excessively wet places or in areas where oils, gasoline, paint and etc. are stored.

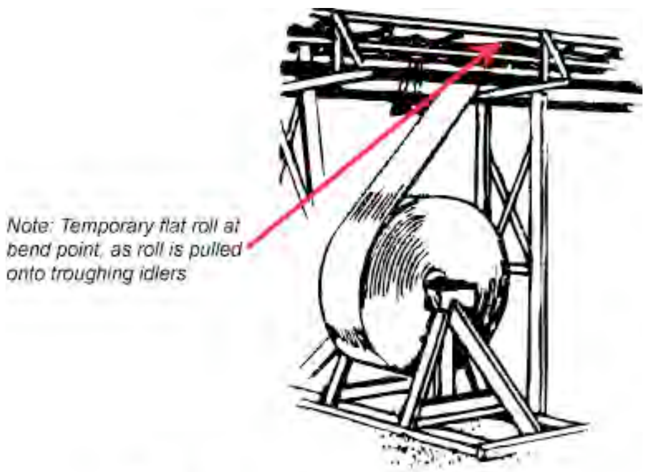


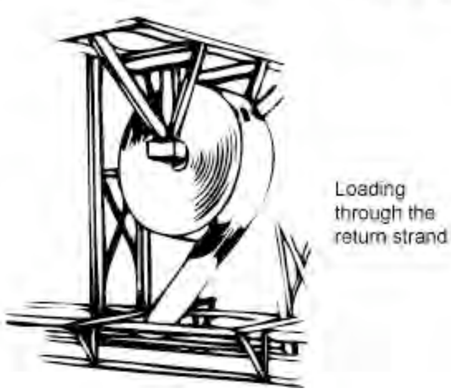
INSTALLATION

Once the roll of belting has been transported to the point of installation it should be mounted on a suitable shaft for unrolling and threading onto the conveyor. Conveyor belting is normally rolled at the factory with the carrying side out. Consequently, in mounting the roll, the belt must lead off the top of the roll if it is being pulled onto the troughing or carrying idlers but off the bottom of the roll if it is being pulled onto the return idlers. The illustrations below represent suitable methods of mounting and stringing belt for each case.

Reefing the Belt







In some cases, such as in the mines where head room does not permit maneuvering a roll, the belt may have to be pulled off the roll and reefed (above). Extreme care should be exercised to see that the loops have large bends to avoid kinking or placing undue strain on the belt. No weight should ever be placed on the belt when it is in this position. Another method of handling belting under such conditions is to lay the roll on a turntable with a vertical spindle.

Pull the new belt on by fastening it to the old belt and gently pulling it in place.

If this is the first belt install on the system, use a cable strung through the system and attach it to the belt with a clamp that distributes the tension of the pull through the width of the belt to avoid unequal stress.

TROUBLE SHOOTING

The enclosed conveyor belt trouble shooting chart can serve as a general guide for some of the more common conveyor belt problems.

If your belt problem does not seem to resolve itself with these corrective measures, or if your belt problem is not found on this list, then contact Fenner Dunlop Americas and request a visit by one of our factory representatives.

** The idler junction is the gap between the functioning surfaces of the center roll and one of the side rolls of the idler (See Fig. 1). This gap poses a potential hazard for the belt by providing a narrow space in which the belt can settle experiencing highly detrimental flex and possible exposure to oil or grease from the idler bearings (Fig. 2). When slipping of the belt into the idler junction is the cause of belt damage, it is called idler junction failure. The idler gap should be less than .4" or twice belt thickness - whichever is less.*

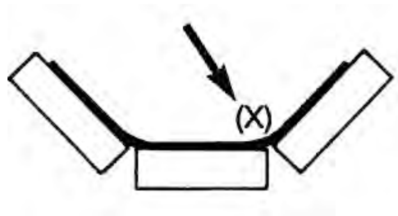


Fig. 1

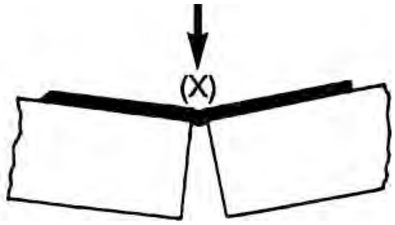


Fig. 2

TROUBLE SHOOTING

Problem/Cause	For Solutions Refer to Answer #					
A. Belt runs off at tail pulley.	39	10	1	19	31	
B. Belt runs to one side for long distance or entire length of conveyor.	39	8	5	1		
C. Particular section of belt runs to one side at all points on conveyor.	6	7	46			
D. Belt runs off at head pulley.	33	10	1	3		
E. Conveyor runs to one side at given point on structure.	5	4	1	2	3	44
F. Belt runs true when empty, crooked when loaded.	8	51	52			
G. Belt slips.	34	33	31	10	4	30
H. Belt slips on starting.	34	31	33	30	42	43
I. Excessive belt stretch.	12	35	32	43		
J. Grooving, gouging or stripping of top cover.	13	4	15	16	53	
K. Excessive top cover wear, uniform around belt.	19	20	10	8	36	
L. Severe pulley cover wear.	4	9	10	17	1	27
M. Longitudinal grooving or cracking of bottom cover.	4	10	9	33	36	
N. Covers harden or crack.	23	37				
0 Cover swells in spots or streaks.	21					
P. Belt breaks at or behind fasteners; fasteners pull out.	24	22	48	30	47	49
Q. Vulcanized splice separation.	38	30	12	17	25	
R. Excessive edge wear, broken edges.	8	10	40	7	50	38
S. Transverse breaks at belt edge.	18	25	26			
T. Short breaks in carcass parallel to belt edge, star breaks in carcass.	16	17				
U. Ply separation.	29	30	23			
V. Carcass fatigue at idler junction.*	25	26	27	28	29	36
W. Cover blisters or sand blisters.	45	21				
X. Belt Cupping-Old Belt (was OK when new).	21	23				

CONVEYOR SYSTEM PROBLEMS/CAUSES AND THEIR SOLUTIONS

1. Idlers or pulleys out-of square with center line of belt: readjust idlers in affected area.

2. Conveyor frame or structure crooked: straighten in affected area.

3. Idler stands not centered on belt: readjust idlers in affected area.

4. Sticking idlers: free idlers and improve maintenance and lubrication.

5. Build-up of material on idlers: remove accumulation; improve maintenance. Install scrapers or other cleaning devices.

6. Belt not joined squarely: remove affected splice and re-splice.

7. Bowed belt: for new belt this condition should disappear during break-in; in rare instances belt must be straightened or replaced; check storage and handling of belt rolls.

8. Off-center loading or poor loading: adjust chute to place load on center of belt; discharge material in direction of belt travel at or near belt speed.

9. Slippage on drive pulley: increase tension through screw take-up or add counterweight; lag drive pulley; increase arc of contact.

10. Material spillage and build-up: improve loading and transfer conditions; install cleaning devices; improve maintenance.

11. Bolt heads protruding above lagging: tighten bolts; replace lagging; use vulcanized-on lagging.

12 Tension too high: increase speed, same tonnage, same speed; reduce friction with better maintenance and replacement of damaged idlers; decrease tension by increasing arc of contact or go to lagged pulley; reduce CWT to minimum amount.

13. Skirt boards improperly adjusted or of wrong material: adjust skirt board supports to minimum 1" between metal and belt with gap increasing in direction of belt travel; use skirt board rubber (not old belt).

14. Load jams in chute: redesign chute for proper angle and width.

15. Material hanging up in or under chute: improve loading to reduce spillage; install baffles; widen chute.

16. Impact of material on belt; reduce impact by improving chute design; install impact idlers or impact bed.

17. Material trapped between belt and pulley: install plows or scrapers on return run ahead of tail pulley.

18. Belt edges folding up on structure: same corrections as for 1, 2, 3; install limit switches; provide more clearance.

19. Dirty, stuck, or misaligned return rolls: remove accumulations; install cleaning devices; use self-cleaning return rolls; improve maintenance and lubrication.

20. Cover quality too low: replace with belt of heavier cover gauge or higher quality rubber or other elastomer.

21. Spilled oil or grease/over-lubrication of idlers: improve housekeeping; reduce quantity of grease used; check grease seals

22. Wrong type of fastener, fasteners too tight or too loose: use proper fastener and splice technique; set up schedule for regular fastener inspection.

23. Heat or chemical damage: use belt designed for specific condition.

24. Fastener plates too long for pulley size: replace with smaller fasteners; increase pulley size.

25. Improper transition between troughed belt and terminal pulleys: adjust transition in accordance with CEMA standards and Fenner Dunlop Belting Catalogs.

26. Severe convex (hump) vertical curve: decrease idler spacing in curve; increase curve radius.

27. Excessive forward tilt of trough rolls: reduce forward tilt of idlers to no more than 2° from vertical.

28. Excess gap between idler rolls: replace idlers; replace with heavier belt.

29. Insufficient transverse stiffness: replace with the proper belt.

30. Pulleys too small: use larger diameter pulleys.

31. Counterweight too light: add counterweight or increase screw take-up tension to value determined from calculations.

32. Counterweight too heavy: lighten counterweight to value required by calculations.

33. Pulley lagging worn: replace pulley lagging.

34. Insufficient traction between belt and pulley: lag drive pulley; increase belt wrap; install belt cleaning devices.

35. System under belted: recalculate belt tensions and select proper belt.

36. Excessive sag between idlers causing load to work and shuffle on belt as it passes over idlers: increase tension if unnecessarily low; reduce idler spacing.

37. Improper storage or handling: refer to Fenner Dunlop for proper storage or handling instructions.

38. Belt improperly spliced: re-splice using proper method as recommended by Fenner Dunlop.

39. Belt running off-center around the tail pulley and through the loading area: install training idlers on the return run prior to tail pulley.

40. Belt hitting structure: install training idlers on carrying and return run.

41. Improper belt installation causing apparent excessive belt stretch: pull belt through counterweight with a tension equal to at least empty running tension; run belt in with mechanical fasteners.

42. Improper initial positioning of counterweight in its carriage causing apparent excessive belt stretch; check with Fenner Dunlop for recommended initial position.

43. Insufficient counterweight travel: consult Fenner Dunlop for recommended minimum distances.

44. Structure not level: level structure in affected area.

45. Cover cuts or very small cover punctures allow fines to work under cover and cut cover away from carcass: make spot repair with vulcanizer or self-curing repair material.

46. Worn edge: "press" edge.

47. Interference from belt scrapers: adjust belt scrapers.

48. Tension too high for fasteners: use vulcanized splice.

49. Belt carcass too light: select stronger carcass.

50. Belt misalignment: see training recommendations.

51. Variations in nature and formation of load: use notched chute to keep load peak in exact center of belt.

52. Belt not making good contact with all idlers: adjust height so all idlers contact belt.

53. Sharp edges of material or tramp iron coming in contact with cover: use jingle bars, impact idlers, and magnetic removal equipment.

CONVEYOR BELT TRACKING

Tracking, or training, is defined as the procedure required to make the conveyor belt run "true" when empty and also when fully loaded.

Tracking conveyor belt should be approached from a systems point of view. We should first examine some of the components of the conveyor system and see how they affect belt tracking before we discuss the actual methods used to train a belt.

We also need to look at a few non-structural components such as conveyor housekeeping, the belt itself and the splice before we discuss recommended training procedures.

CONVEYOR COMPONENTS

SUPPORTIVE STRUCTURE

The supporting structure is designed to hold conveyor sections firmly and in proper alignment. If it does not, for whatever reason, it is likely to have an effect on belt tracking. Support structure should be checked as a first step in belt tracking. Has a truck or loader run into the supporting structure and buckled it? Are the anchors firm?

Conveyor sections are bolted to the supporting structure. They should be "square" and "horizontal" (side to side). If the section is "racked" **it must be straightened.** Measure diagonals across the frame. They should be equal. Repeat for total, assembled bed.

Conveyor bed sections (slider or roller) must be properly aligned with no vertical off-set between sections. A taut line should be stretched over the top surface of the bed and adjustments made so that all points are in contact. The entire bed (and each section) must be horizontal (across the width). If they are not, the belt will be pulled by gravity and will drift toward the low side unless a compensating force of some kind is exerted on the belt.

PULLEYS / ROLLERS / IDLERS

All pulleys, snub rollers, carrying idlers and return idlers must be square with the frame (perpendicular to belt center line), parallel to each other and level.

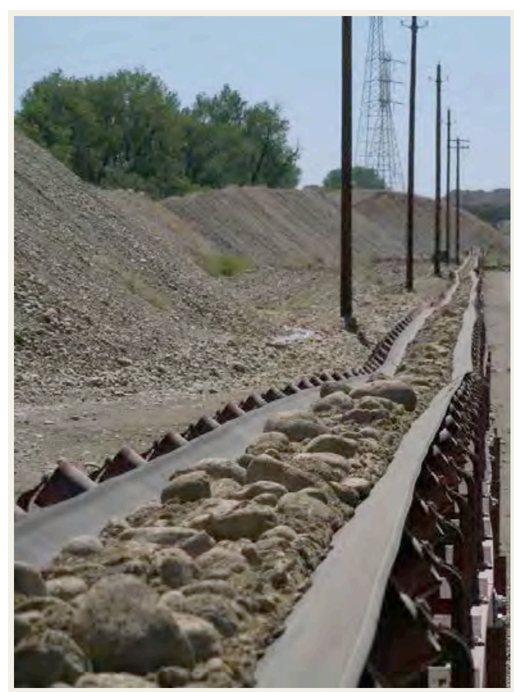
Squaring with the frame is a good preliminary adjustment. The final adjustment, however, requires that this squaring be done with the belt center line as the reference. All pulleys must be at right angles to the direction of belt travel (belt center line).

CROWNS

Crowned pulleys should not exceed 1/8" per foot on the diameter, and should ***not exceed*** *118"* ***total.*** The rate of crown seems to be very important as well as the total amount of crown in the system.

Crowned pulleys are not recommended for high modulus bulk haulage belting. Steel Cord belting requires fully machined straight-faced pulleys throughout the system. If a crowned pulley is used on nylon, polyester or Aramid style belting, the crown is best placed in a low tension area such as the tail on a conventional head drive conveyor or in the take-up. The tracking forces that the crown exhibits do not affect high modulus bulk haulage belting because the system lacks enough tension to make the crown effective. If enough tension could be introduced into the belt to force the belt to conform to the crown, the belt would be subjected to excessive tension resulting in splice and carcass failure.

Note: before enough tension could be applied to the system to cause splice and belt failure, the bearings, shafts and possibly the pulleys in the system would be compromised.



TAKE-UP

The take-up device in a conveyor belt system has three major functions:

1. To establish and maintain a predetermined tension in the belt.
2. To remove the accumulation of slack in the belt at startup or during momentary overloads, in addition to maintaining the correct operating tension.
3. To provide sufficient reserve belt length to enable re-splicing, if necessary.

Manual, as well as **automatic,** take-up devices are normally used in a typical conveyor belt system. The **manual** or **screw** take-up consists of a tension pulley (frequently the tail) which can be moved to tighten the belt by means of threaded rods or by steel cables which can be wound on a winch. These give no indication of the tension they establish and are adjusted by trial methods until slippage is avoided. They are unable to compensate for any length changes in the belt between adjustments and thus, permit wide variation in belt tension. Use is generally restricted to short and/or lightly stressed conveyors.

The manual take-up must be such that when tension is applied to the pulley, the pulley remains at right angles to the direction of belt travel. Also the tension must be high enough to allow elastic recovery of elongation due to starting forces, load changes, etc.

Automatic take-ups depend upon suspending a predetermined weight (gravity), by activation of a torque motor, by hydraulic pressure, or by spring loading. These devices maintain a predetermined tension at the point of take-up regardless of length changes resulting from load change, start-up, stretch, etc. This permits running the belt at the minimum operating tension and should be used on all long length conveyors and moderate to highly stressed conveyors.

The automatic take-up alignment must be such that the pulley or pulleys are maintained at right angles to the direction of belt travel. In a gravity or spring-loaded take-up, the carriage must be guided to maintain the pulley axis on a line perpendicular to the belt center line.

Adequate take-up is essential to satisfactory operation of a belt conveyor. The amount required depends on type of belting and on service conditions. Please refer to belt manufacturer for recommendations.

Normally, when a new belt has been properly installed and tensioned, the take-up roll or pulley (automatic take-up) will be initially set at a position of 30% along the line of travel, leaving 70% of the take-up area available for elongation.

NON-STRUCTURAL COMPONENTS

CLEANLINESS

Cleanliness is essential to good belt tracking. A buildup (of whatever material) on pulleys and rolls can easily destroy the perpendicularity of the roll or pulley face. Foreign matter in essence creates a new roll or pulley crown. This adversely affects tracking.

Likewise, cleanliness is essential to slider bed operation. A buildup of foreign materials (or a roughened portion of the slider bed face) can very easily throw a belt off-center since this will result in a differential of warp tensions across the width of the belt. This can seriously affect training.

Scrapers can be applied directly to bend rolls at the take-up area on a gravity take-up system to keep the rolls free from buildup. Ploughs installed prior to the tail roll under the loading section will prevent belt and pulley damage due to carry back.

BALANCED/NEUTRAL

It is extremely important that the final belt construction be *balanced*, or *neutral*, in terms of the internal stresses imparted to the belt during manufacture. Any unbalanced stress remaining in the belt will likely cause problems in tracking.

BELT CURL OR CUPPING

Belt curl (or "cupping" as it is sometimes referred to), comes in standard and reverse. When either occurs, belt training can be jeopardized. As the curl becomes more pronounced, the operator's ability to control, or *train*, the belt tends to become increasingly more difficult.

NOTE: For more information on curl or cupping ask your Fenner Dunlop Americas representative to provide you with a copy of our technical letter titled "Conveyor Belt Curl".

Belt Curl

CAMBER

If unbalanced warp tensions exist in a conveyor belt, the belt will usually assume a crescent or banana shape when laid flat upon a horizontal surface. This deviation from a straight line is hereby defined as **camber**.

To measure belt camber, it is recommended that the belt be unrolled on a flat surface like the warehouse floor, a flat horizontal driveway, etc. Next, one end of that belt should be grasped (and one end only) and the belt dragged in a straight line for approximately 10 feet. If the belt is too heavy for a man to move, then one end should be clamped to a forklift and the same procedure performed. At this point, the belt should lie flat. Unequal and unresolved warp tensions in the belt will cause it to assume a crescent or banana shape.

Camber is measured by drawing a taut line along one edge of the belt and measuring maximum deviation from that taut line to the belt at the point of maximum deviation. Compute % camber as follows:

$$\% \text{ Camber} = \frac{\text{Maximum Deviation (inches)}}{\text{Length of taut line (inches)}} \times 100$$

It is recommended that if the percent camber exceeds one-half of 1 %, the belt manufacturer be contacted. In lightweight, unit/package handling, 0.25% is the maximum.

Camber can be instilled into a belt during the slitting operation if one of the slitting knives is dull. A dull slitting knife will tear the fill yarns (crosswise yarns) rather than cut them. (While the belt is in roll form, the side of the belt that had gone through the dull knife will exhibit a "fuzzy" appearance due to the torn fill yarns.) Usually this type of camber will be less than one-quarter of 1 % and can be pulled out handily when the belt is properly tensioned.

Camber

SKEW (BOW)

The fill yarns (crosswise yarns) in the belt carcass will usually lie along the perpendicular to the belt center line. Any deviation from this perpendicular line by the fill yarn is hereby defined as "skew" or "bow."

A skewed pick in a **plain weave** or **twill weave** is cause for concern since it is generally indicative of unbalanced warp tensions and will usually go hand-in-hand with a significant camber.

In a **straight warp** or **solid woven carcass** design, however, **skew is of little significance.** It is a cosmetic defect and is not indicative of a cambered belt.

BELT TENSION

Belt tension must be great enough to prevent slippage between the drive pulley and belt.

Slippage will cause excessive wear to both drive pulley lagging and the belt. Further, an excessive heat buildup on the drive pulley lagging can result in rubber reversion. (Reversion is the softening of vulcanized rubber when it is heated too long or exposed to elevated temperatures. It is deterioration in physical properties, and frequently results in tackiness.) Once the pulley **lagging** has reverted, it frequently will offset onto the bottom side of the conveyor belt which will then distribute the reverted rubber throughout the system.

The resulting tackiness in certain conveyor systems (slider bed) will certainly drive horsepower consumption up, can actually result in a stalled system and can cause severe tracking problems.

SQUARE ENDS

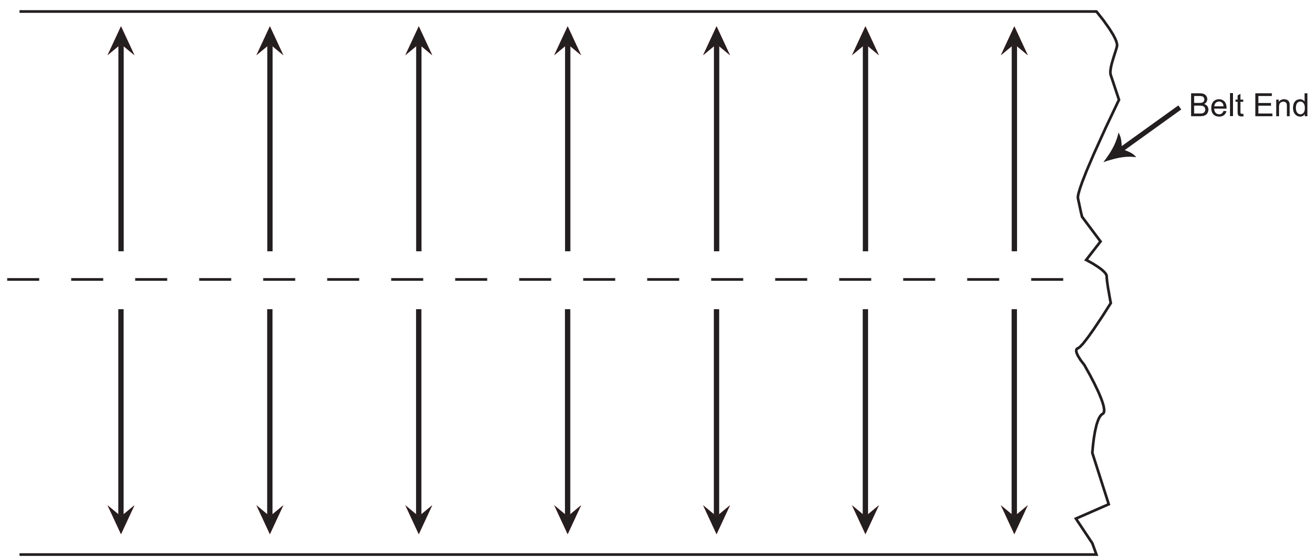
Accurate squaring of the belt ends prior to splicing is essential to belt tracking and helps distribute stress evenly throughout the splice.

To properly square the belt ends, we recommend the center line method.

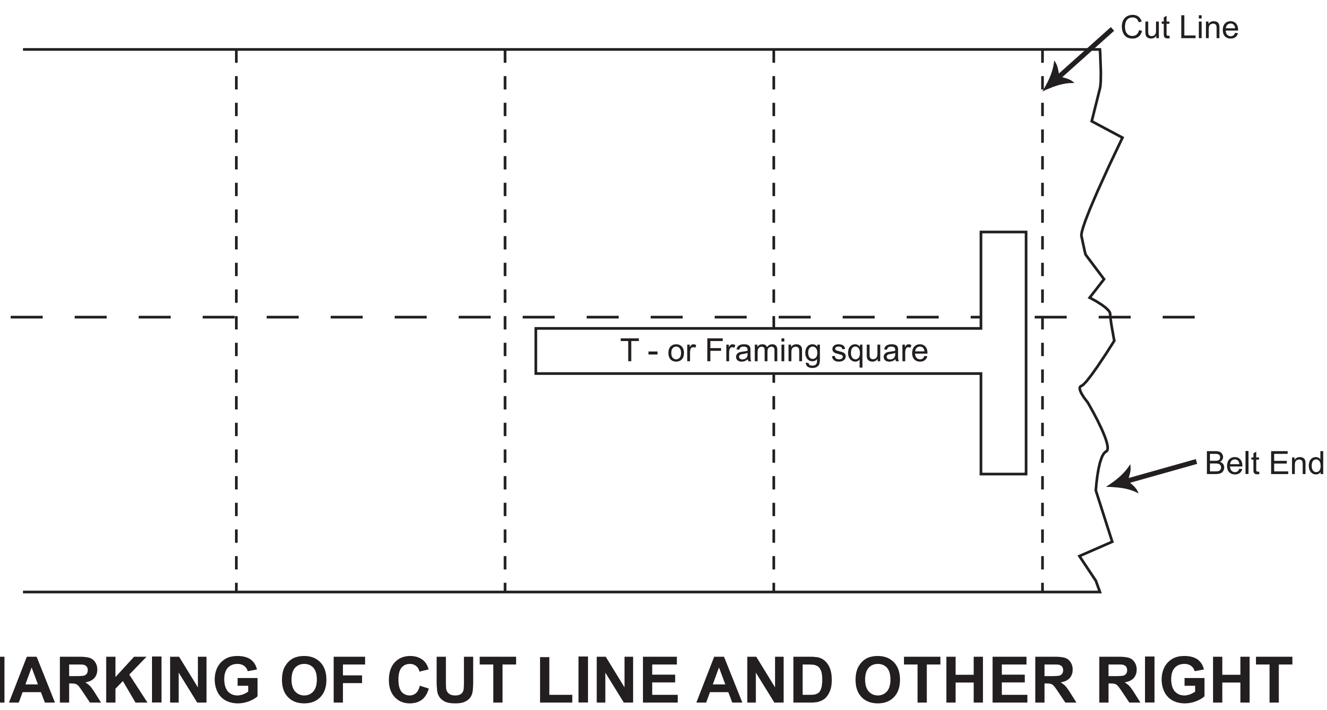
To establish the belt center line, start near the belt end as shown on the next page. Measure the belt width at seven points approximately 1 foot apart. Divide each measurement in two and mark these center points as shown.

Using these seven center points, pop a chalk line to form the belt's center line. Next, using a carpenter square or **'T'** square, draw a cut line across the width of the belt near the belt end as shown. Repeat this for the other belt end.

Using the cut line as the guide, cut off the end of the belt with a sharp razor knife. Make sure that the cut is clean and vertical. This operation should then be repeated on the other end of the belt. (Keep in mind that the final belt length may need to include an allowance for such things as diagonal splice, skive taper length, skive overlap, finger punching loss, fastener extension, etc., depending upon what kind of splice is being performed.)



BELT CENTER LINE



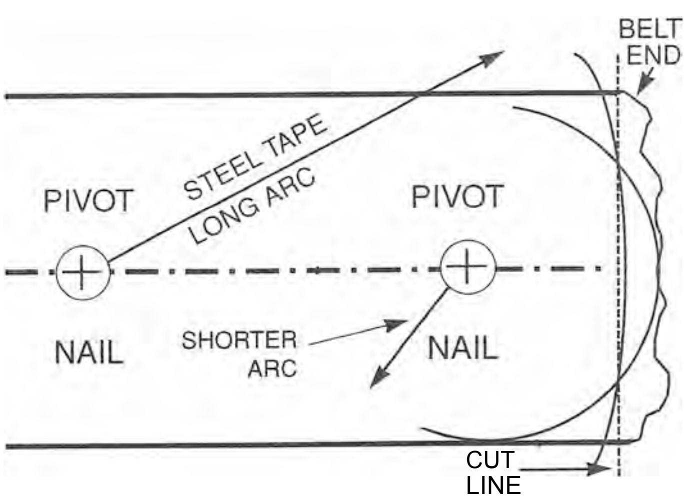
MARKING OF CUT LINE AND OTHER RIGHT ANGLE GUIDE LINES

An alternative method of squaring belt ends is called the "double intersecting arc" method.

First establish the center line as indicated previously. Once that center line has been established, pick a point on the center line and approximately 2 or 3 times the belt width from the belt end. An arc is now struck, as shown in the following sketch.

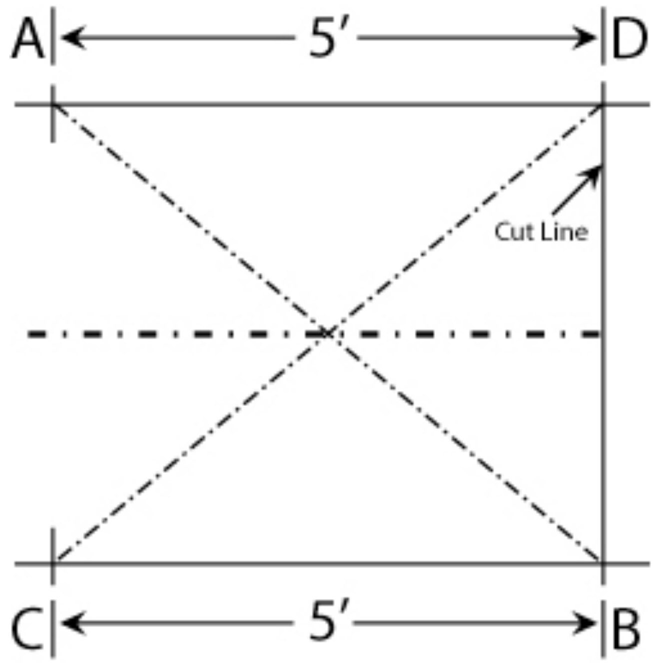
A nail can be used as the pivot point and an arc is struck with a steel tape. **Always mark the edge of the belt with the same side of the tape.**

A second arc is now struck as shown. The pivot point in this case is on the center line and is close to the belt end. The arc length is slightly less than one-half of the belt width. Now draw a line from one pair of intersecting arcs to the other. This is the cut line. This line is perpendicular to the center line of the belt. The reason for this may be edge wear or damage or to eliminate slitting alignment errors. Never assume both edges are straight and parallel.



ALTERNATIVE ARC METHOD OF SQUARING ENDS
JOINING OF THE POINTS WHERE THE ARCS INTERSECT GIVES THE RIGHT ANGLE CUT LINE

DOUBLE CHECK SQUARENESS



PROVING ACCURACY OF SQUARED-CUT END
LENGTH OF DIAGONAL AB IS EQUAL TO LENGTH OF DIAGONAL DC. ALSO AB AND DC INTERSECT ON THE BELT CENTER LINE

It is always a good idea to double-check the accuracy of the squared and cut end. Measure 5 feet along each edge from the end of the belt, then utilizing a tape measure, check the two diagonals. They should be equal and further, should intersect on the belt center line.

GENERAL TRACKING / TRAINING PROCEDURES

Tracking the belt is a process of adjusting idlers, pulleys, and loading conditions in a manner that will correct any tendencies of the belt to run other than true.

A normal sequence of training is to start with the return run working toward the tail pulley and then follow with the top run in the direction of belt travel. Start with the belt empty. After tracking is completed, run the belt with a full load and recheck tracking.

Tracking adjustment is done while the belt is running and should be spread over some length of the conveyor preceding the region of trouble. The adjustment may not be immediately apparent, so permit the belt to run for several minutes and at least three full belt revolutions after each idler adjustment to determine if additional tracking is required.

After adjustment, if the belt has overcorrected, it should be restored by moving back the same idler, and not by shifting additional idlers or rollers.

If the belt runs to one side at a particular point or points on the conveyor structure, the cause will probably be due to the alignment, or leveling of the structure, or to the idlers and pulleys immediately preceding that particular area, or a combination of these factors.

If a section or sections of the belt run off at all points along the conveyor, the cause is possibly in the belt itself, in the belt not being joined squarely, or in the loading of the belt. With regard to the belt, this will be due to camber. Its condition should improve after it is operated under full load tension. It is a rare occasion when a cambered belt (less than 1/2%) needs to be replaced.

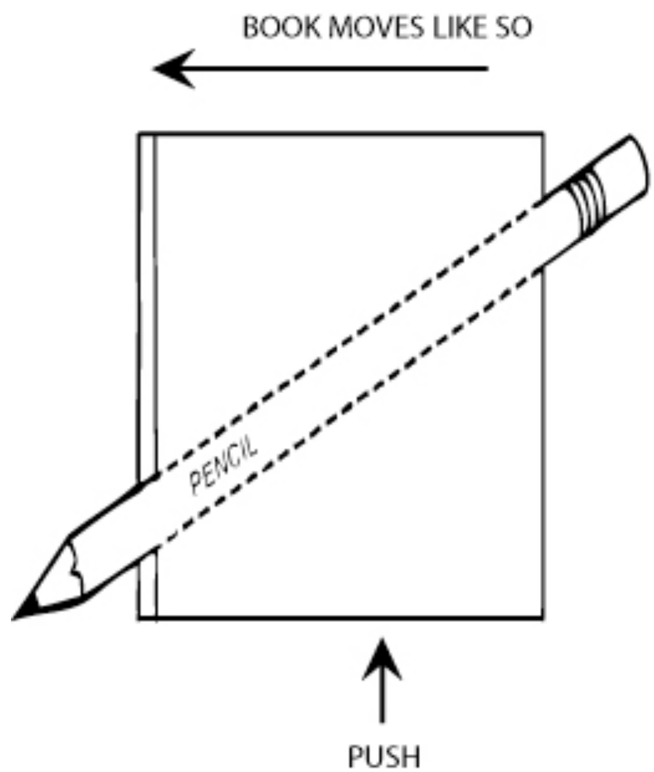
These basic rules can be used to diagnose a belt running poorly. Combinations of these rules sometimes produce cases that do not appear clear as to cause, but if there are a sufficient number of belt revolutions, the running pattern will become clear and the cause disclosed. In those unusual cases where a running pattern does not emerge, it is quite likely that at some point the belt is running so far off that it is fouling structure or mounting brackets, bolts, etc. This results in highly erratic performance and can be a real problem. We would suggest that in this event the full tracking procedure be employed. It is quite likely that the erratic performance will be resolved in the process.

When replacing a used belt, go through the system and square and level all rollers, idlers, pulleys and bed before training a new belt.

BASIC / PRIMARY RULE OF TRACKING

The basic and primary rule that must be kept in mind when tracking a conveyor belt is simple, **"THE BELT MOVES TOWARD THE END OF THE ROLL/IDLER IT CONTACTS FIRST."**

The reader can demonstrate this for himself very simply by laying a small dowel rod or round pencil on a flat surface in a skewed orientation. If a book is now laid across the dowel rod and gently pushed by one's finger in a line directly away from the experimenter, the book will tend to shift to the left or right depending upon which end of that dowel rod the moving book contacts first.



EQUIPMENT INDUCED CAMBER

Camber can be induced into a perfectly straight belt by the idlers or pulley preceding the camber. If the idlers or pulley are cocked, the belt will react and will move toward the end of the equipment which it contacts first. This, of course, throws the belt off-center. This camber may be removed by simply aligning the idlers or pulleys which are cocked.

BEFORE YOU START TRAINING

Square up and level the conveyor system. Be sure pulleys and idlers are square to the belt path. The movement of some idlers forward or backward in their mountings may be required. If idlers are being mounted for the first time, lightly tighten the bolts for easy adjustment. Return and tighten the bolts when training is complete.

PRE-TRAINING CHECKLIST

Be sure to make these checks before belt startup

- Has all splicing equipment been removed?
- Are pulley shafts parallel to each other?
- Are belt idlers horizontal, in-line and square with the conveyor centerline?
- Have self-training idlers been installed properly?
- Were belt idlers greased properly?
- Is the reducer oil at the proper level?
- Was the belt chain guard oiled?
- Does the motor have proper rotation?
- Were all tools, installation gear and foreign objects removed from the area?
- Was the belt gravity take-up blocking removed?
- Have belt wipers and skirting been properly adjusted?
- Are pulleys and idlers free of material buildup?
- Is the take-up carriage in good working order?
- Will head and tail pulleys be watched for possible belt runoff?
- **ARE BELT EMERENCY STOP CORDS INSTALLED AND SET?**

BELT TRAIN PROCEDURE

- Always train a belt empty.
- Shift only one idler at a time.
- Pulleys should be kept square to belt travel.
- Jog belt for several revolutions while checking at head, drive, take-up, tail and along carry and return runs for smooth passage.
- If everything is running smoothly, allow belt to run empty while continuing training steps.
- Start at the head pulley and work toward tail on the return run.
- Begin training 4-6 idlers before point of maximum run off.
- Follow direction of belt travel while making corrective shifts.
- Each idler shift should be very slight.

When the return run training is completed, begin training on the troughing side. Again, proceed in the direction of belt travel and move idlers only slightly while making adjustments.

NOTE – It is especially important that the belt be set to pass under the load point on-center, under all operating conditions. Belt will not track if it is loaded off-center.

THE BREAK-IN RUN

Begin by loading lightly, and increasing gradually to full capacity.

If necessary re-align idlers.

Be sure belt chutes are loading belt on center.

Check to see that the belt is still centered on the tail pulley.

NOTE – Where materials are loaded off-center, the belt can be forced out of alignment. Belt edges and conveyor parts can suffer severe damage if the condition continues.

TRAINING GUIDELINES

All major pulleys: head, tail, drive, snubs, bends, and take-up should be parallel, level and square. All idlers and pulleys need to be clean and functioning properly. All loading stations have to be centered so that product is introduced to the center of the belt. Any belt training idlers that are on the system must be in proper working order and be installed in the proper direction. The lagging on the drive pulley should be inspected and replaced if the lagging is damaged or if the surface is smooth and hard, which can result in slippage. It is good practice to replace rubber lagging when a new belt is installed, particularly if the lagging is old, as the rubber tends to harden with age and become less effective.

The new belt may have some internal stresses from manufacturing; therefore, the best procedure for a new belt is to run it for a while before making any adjustments. This run-in period will relieve most manufacturing stresses that can occur during weaving, treating, calendaring, assembly, curing and slitting. After installation, some belts may run perfectly from the beginning. If the new belt will stay out of the frame on the return side, then run it empty for an hour or two, then begin introducing a load to the belt. The belt should be constantly inspected during this break-in period. Full belt contact with all carry side idlers is important due to the training forces that are present with the troughed idler sets.

As stated in the beginning of this section, crowned pulleys are not required for bulk haulage belting. Crowned pulleys may offer a minor contribution towards training when the crowned face is used on a low-tension pulley like the take-up or the tail pulley. The crown will have no effect if used on the high tension head pulley or drive pulley. High modulus belt fabrics like nylon, polyester and Aramid do not respond to the centering forces of crowned pulleys, and in some cases, can actually have an adverse effect on the belt. Steel cord belts must have fully machined straight-faced pulleys to operate around because a crown will create adverse stresses in the belt and in the splice.

The theory of training a heavy duty belt is to feed the carry side square, use the troughers to keep the belt centered through the discharge, then train the empty belt on the return (slack side).

TRAINING DEVICES

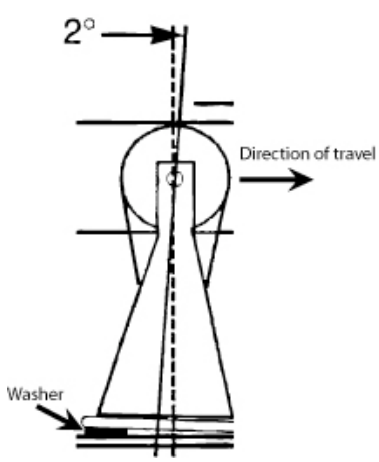
Self-training idlers should be on 100' centers on the return side, unless the conveyor is out of square, then 50' centers may be required in areas where the frame is out of square. The locations of the self-trainers are very important, as they cannot function properly if installed in the wrong place.

The first self-training idler on the return should be placed about 30' behind the head. This allows the training idler to align the belt coming out of the head (into the trainer) ... then 30' past the trainer. Self-training idlers do not work when placed too close to a terminal pulley, snub, bend or take-up. These pulleys have more belt wrap than the training idler, which off-sets any training forces that the idler has. At least 30' of free run on each side of the training idler is required to make it effective. On slow moving belts, 20' of free area on each side will work. At 800' per minute, the self-training idler should be placed 40' from a major pulley. The trainers can then be spread out over the return. If the take-up is 80' behind the head, place one self-trainer between the head and take-up areas. Following the take-up area (20' to 40'), place the trainers on 100' centers back to within 20' to 40' of the tail.

If the self-training return idlers are still not effective, shim the return trainers up to present the trainer with more belt surface area. **Equally effective is to use the next size up return run self-trainer, a 5" dia. to a 6" dia. trainer.** A good rule of thumb is never skew an idler that has *over* 90° of wrap, to ensure that the high modulus belt fabric will not be stretched out of square. This method will train the slack side belt, feed the tail square, and then run true on the carry side because of the centering forces from the troughers. Self-training troughing idlers should not be shimmed up because the additional pressure that is created on the belt in the idler gap area can cause premature belt failure in the idler junction area.

Another approach to training the slack side of long centered conveyors is the use of 2 roll "V" return idlers. With this type idler (generally 10°), gravity becomes the training force, and the belt edges are not subject to wear from the vertical arms on self-trainers. It should be noted that due to the small degree of angle with this type of return idler, if the frame is severely out of square the belt can run out of the "V" and into the return frame.

In areas along the carry side where the frame is not level and true, the following additional training method can be used. Each individual idler stand can be tilted in the line of travel by placing a washer under the rear legs of the idler stand. This forward tilt is not to exceed 2° from vertical. This is **NOT** to be done with reversing conveyors. The negative side of this training method is that excessive wear on the pulley cover and on the idler can result since the idler is no longer rotating on an axis 90° to the belt path.



FEEDER BELTS

Short centered feeder belts should be double checked for square with a steel tape. The two terminal pulleys need to be parallel, level and square.

All training should be done on the return, or slack side. On a short conveyor (50' centers or so) place one large diameter self-trainer on the return side in the middle of the conveyor. This roll can be shimmed up to increase the effectiveness of the roll.

The most important part of the tracking is not to use major pulleys for training and to allow the trainer to have slack belt feeding into and out of the trainer.

BI-DIRECTIONAL BELTS

Bi-directional belts should only use carry side troughers that are vertical and do not have any tilt added in. All return run self-trainers should be of the bi-directional type.

Bi-directional hardware such as pulleys, top side idlers and return side idlers must be level, parallel and square.

When pulling the load towards the drive pulley, the tight side is on the carry side and the slack side is on the return. When pulling from the return side, i.e., pushing the load, the tight side is on the return and the slack side is on the carry side.

The slack side of the belt will have more catenary, i.e., loose belt, to drape over the idlers than the tight side. Therefore the idlers on the slack side will have a more influential training effect than idlers on the tight side, i.e., less drape over theidler. Therefore it is mandatory that all idlers be level and square.

Skewing an idler on the tight side will allow certain training advantages. When the conveyor reverses, this same idler is now on the slack side and will have more catenary, or drape, and will now have a greater influence than before.

Keep in mind another potential problem when trying to train a bi-directional bulk haulage conveyor: a carry side trougher, when skewed, will have minimum effect when the belt is run empty and pulled over the idler. This same trougher with a load being pulled over it now becomes even more influential due to the weight on the belt forcing the belt down on the idler. If you now push the belt in the opposite direction with a load on it, this same idler has an even greater training effect.

These are some of the reasons that make training bi-directional conveyors so difficult. Therefore, all hardware must remain level and square and the use of bi-directional self-trainers is a must.

IV. Conveyor Considerations

CONTENTS:

VERTICAL CURVES

Vertical curves come in two different styles: *concave* and *convex*. Both types of curves create belt operational problems when the curve is designed with a shorter radius than required.

CONCAVE CURVES

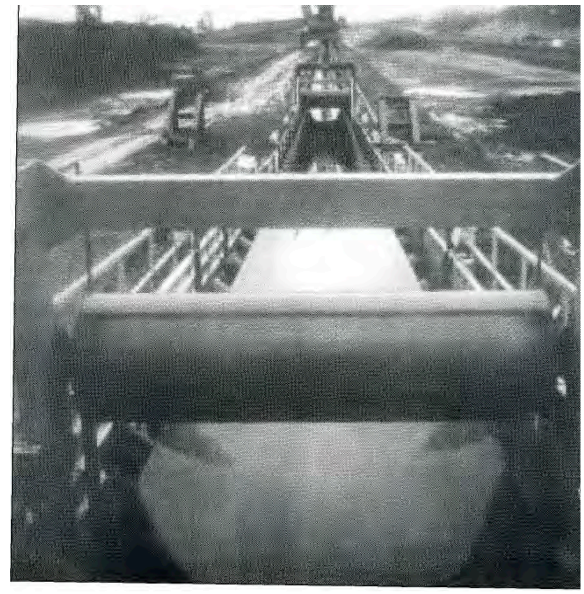
Concave curves, when designed properly, will allow the belt to lay in the idlers when the belt is running empty or full without lifting off of the idlers.

When concave curves are designed with a very short radius, belt lift off is a secondary problem. The stresses that develop in the belt are due to the very short radius and belt failure will happen quickly. The only way to combat the situation is by use of a very low modulus fabric. This fabric is extremely elastic or stretchy. These types of conveyor frames are rare and are usually designed around a low modulus fabric.

The simple concave curve is designed around Radii from around 300 feet to 800 feet. This is the type of curve that may create lift off problems. Lift off results from the curve being designed or built with a radius usually being 100 feet or 200 feet short of ideal. Lift off problems from this type of conveyor can be solved fairly simply.

Concave curve conveyors that have a hard start usually lift off at start up if the belt is empty. A soft start with an extended time delay to full RPM is the first step to keeping the belt in the idlers.

The next step is the installation of a hold down roll in the curve area.

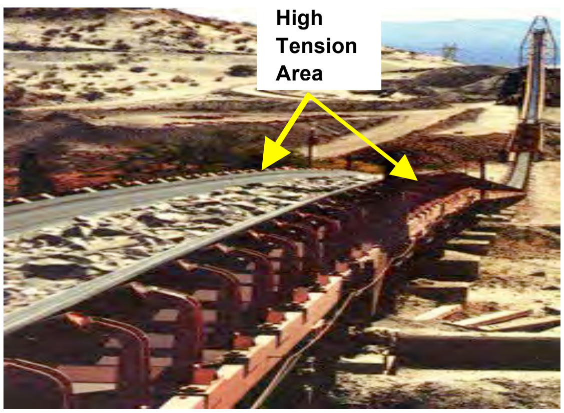


The preceding picture utilizes a hold down roll at the beginning of the curve and another roll in the middle of the curve. The hold down roll is set above the belt, so as not to interfere with product movement. The roll should only touch the belt when lift off occurs with an empty belt.

The last step, if needed, is to select a heavier belt. The increased belt weight will also help keep the belt laying in the idlers. The increase in belt weight will normally not require any change in motor horsepower or take-up weight.

CONVEX CURVES

Convex curves create another type of belt problem. A convex curve with a short radius will pull the belt down into the idler gap as the belt goes over the apex of the curve. This will create idler gap failure in the belt resulting in the belt developing a longitudinal slit in the idler junction area. Due to the lines that become visible on the pulley cover of the belt, this type of failure can be spotted early. This line later becomes a crease as the carcass starts to deteriorate. Another way to spot this problem early is to look in the idler junction area. The paint on the idlers in the gap area will wear off due to belt tension in the idler junction area.



The apex of the curve, if severe, will cause edge stresses so high that the splice will open up along the belt edge, the belt will suffer from edge delamination and fabric will rupture at the belts edge. A poorly designed curve takes the appearance of a mountaintop with one idler placed at the top of the peak. This problem is a result of a short radius curve causing excessive edge tensions.

Further complicating the problem of idler gap failure is that CEMA, the Association that sets idler standards, currently does not have any set standard on the amount of gap in the idler junction area. This gap between the rolls that the belt must span without being forced into the opening can easily approach 1”.

There are numerous ways to overcome problems associated with idler gap failure due to short radius curves and excessive idler gaps. The following is a series of ways to solve this problem.

1. Change the center distance of the idler sets in the curve area. Place the troughing idlers as close as possible to each other. This will help level out the curve.

2. If the conveyor uses 35° idlers, install closely spaced 20° idlers in the curve area, providing spillage does not occur.

3. The most common method is to utilize closely spaced long centered off-set idlers. This type of idler does not have a gap between the rolls.

4. The worst case will require numerous idlers on each side of the apex to be shimmed up to straighten out the curve.

5. The last step is to remove any self-training troughed idlers from the curve area.

Self-trainers are elevated in order to provide tracking and this elevated feature further accentuates the idler gap problem.

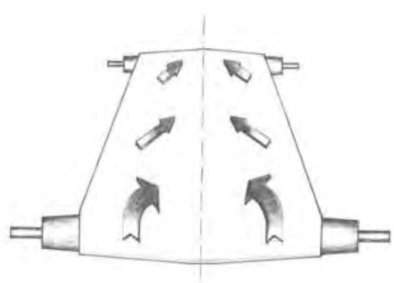
When dealing with excessive edge stress, the same 5 choices listed above should be used. A low modulus or "stretchy type" fabric may be required, in addition to shims and changing idlers.

PULLEY CROWNS

Crowned pulleys are designed to assist in tracking belting in conveyor systems. There are several approaches to the design of crowned pulleys, but they all have the same basic design feature: the center of the pulley has a larger diameter than the outer edges of the pulley, thus the “crown”.

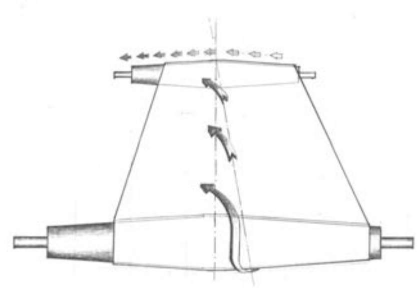
The rate of crown and total amount of crown in a system is very important and may vary by belting type and manufacturer, so it is wise to contact your belt manufacturer before installing a crown pulley in a conveyor system.

A crowned pulley exerts tracking forces on a belt in two ways. The first is associated with one of the basic rules of tracking: the belt will move in the direction of first contact with the roller. If we consider the crowned pulley as being divided into two halves, each half having a high spot in the center of the conveyor, we see as the belt approaches the pulley that the left half of the belt will make an effort to run in the direction of first contact or to the right of the system. At the same time, the right half of the belt will make an effort to run in the direction that it has first contacted or to the left. These forces will work on the belt until they balance one another and center the belt on the pulley.



In addition to the tracking effects that occur due to surface contact with the pulley, there are internal tensions in the tensile (warp) members of the belt that create a strong centering force. Belt manufacturers design their carcass material to be equal in tension across the width of the belt.

The crown of the pulley creates an area of higher tension in the center of the belt providing a point of balance in the tensile members across the width of the belt. If the belt wanders to one side or the other of the pulley, this movement creates imbalance in these tensions and stress in the warp yarns. The belt then moves on the pulley to equalize the tensions, relieve the stress and achieve balance once again, hopefully centering the belt in the conveyor system.



In order to be effective, a crown pulley requires that the conveyor system have enough tension in it to force the belt to conform to the configuration of the pulley. Experience has also shown that a crown is most effective when it has a long unsupported span of belt approaching the pulley (3 ft. plus with little added effect over 10 ft.). That is, the belt must be free of the effects of troughing idlers, rollers, slider beds, etc. for the crown to offer significant tracking advantages.

It is due to the above requirements that crown pulleys are not recommended for high modulus bulk haulage belting. Steel cord belting requires machined straight-faced pulleys through the entire system. Systems utilizing modern heavy-duty fabric belts should use crown pulleys only in low-tension areas.

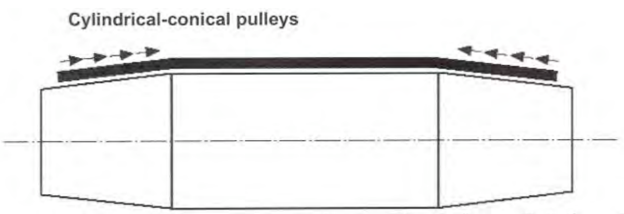
However, the full tracking forces that the crown pulley offers do not occur in bulk haulage systems because the tension required to cause the belt to conform to the crown is neither present nor available under normal circumstances.

In addition, the presence of troughing idlers on the carrying side and rolls on the return side leave very little unsupported belt to be directed by a crowned pulley.

It is not advisable to install a crowned pulley on the high-tension side or drive of a bulk haulage conveyor. At the very least, the crown can cause flex fatigue in the center of the belt with resultant fastener or splice failure. In the extreme, slippage may occur at the drive because the belt does not conform to the crown and the drive torque is being transferred by only a fraction of the pulley face. This generally results in weight being added to the counter weight, increasing the tension in the system adding stress to the belting, splices and conveyor components i.e., bearings, shafts and pulleys.

Package or unit handling conveyors that generally have fewer controlling components in the conveyor system, lend themselves more readily to the tracking capabilities of crowned pulleys.

Driving pulleys in unit handling systems are often cylindrical-conical in shape. They can on occasion also be convex. Both of these pulley profiles are capable of creating sufficient tracking force to guide correctly aligned conveyor belts.



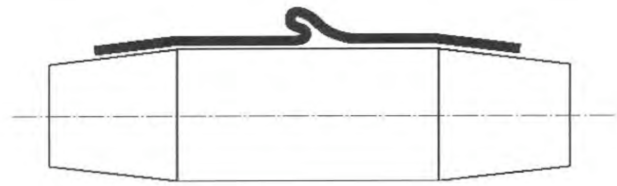
Cylindrical-conical (crowned) formed pulleys operate by the same method as other crowned pulleys. As the belt tries to run to the highest point of the pulley, which is at right angles to the direction of belt travel, it is constantly pulled towards the center of the pulley by the conical side elements. The belt is centered without the need to adjust the axis.

With long conveyors the tracking effect of only one cylindrical-conical pulley, normally the driving pulley, is frequently not sufficient to guide the belt effectively over its entire length. In these cases it is advantageous to give the tail roller a cylindrical-conical profile. This issue becomes critical for conveying lengths of 4-5 m and upward.

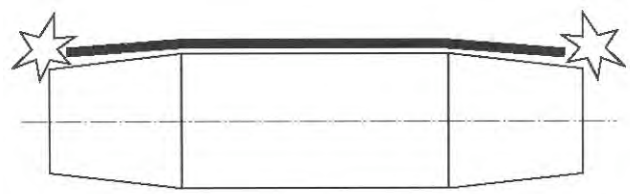
In reversing conveyor systems, both terminal rollers should be cylindrical-conical if no other measures are taken for belt tracking.

A crowned pulley should never be run against the coated conveying side of a lightweight belt.

In order to achieve optimum belt tracking without experiencing negative impact on belt operational behavior, belt service life or splice life. Please contact your belt supplier for proper pulley shape ratios. An exaggerated slope on the pulley may result in longitudinal creasing and in extreme cases, lead to belt overlapping.



Belts with high transverse rigidity require less slope to the face of the pulley to allow the belt to conform to the crown and influence the tracking of the belt.



LOADING STATIONS

Two of the more common reasons of belt failure are a direct result of the loading stations. These are: Holes being punched in the belt due to impact and carry cover deterioration due to abrasion.

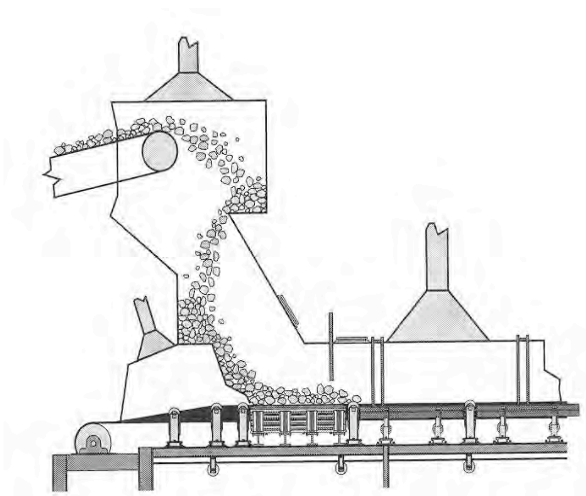
IMPACT

Large product lumps such as minus 8" limestone, granite or heavier products with irregular shapes will punch holes in a conveyor belt if not properly introduced to the belt's surface.

The following are the more common methods of presenting large product lumps to the belt and minimizing the damage that these lumps will cause.

ROCK BOXES

Rock boxes can absorb the impact from large lumps as the box fills up first, then other lumps bounce off of the pile onto the belt. The purpose of the rock box is to transfer the impact energy to the box rather than the belt. The box also will allow the height of the free fall to the belt to be greatly reduced.

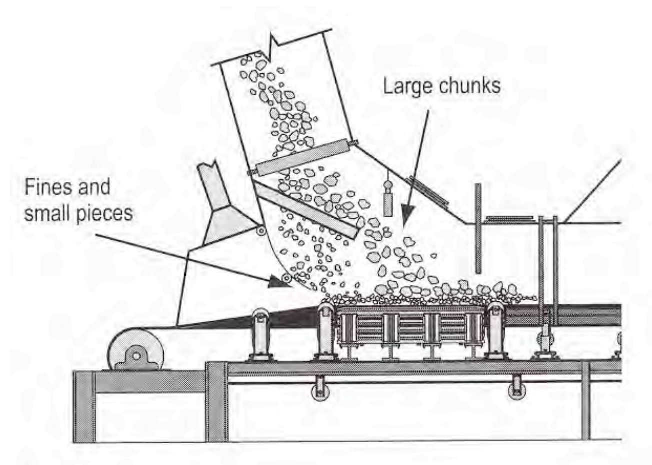


FEEDERS

Various types of feeders, such as belt feeders, pan feeders, reciprocating feeders and vibratory feeders can be utilized. The particular style of feeder that is used will be determined by product characteristics such as: lump size, product weight, moisture content and abrasion.

GRIZZLY BARS

Grizzly bars, if installed properly, can be used rather than a rock box. The bars need to be installed to absorb the impact energy from the lump and re-direct the lump to the belt in the line of travel. Grizzly bars must be installed so that the bars do not fill up with product and clog the loading station. Grizzly bars also allow a bed of fines to be introduced to the belt before the larger objects fall to the belt. This cushion effect helps to reduce the damage from larger lumps.



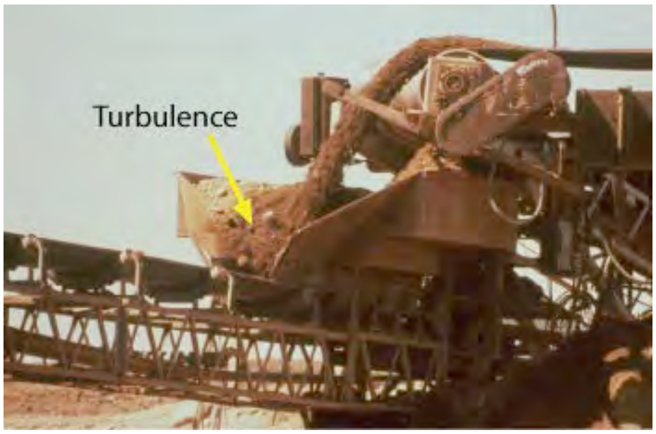
CHUTES/SPOONS

Chutes, spoons and deflector plates are quite common methods for diverting material onto the belt and reducing the vertical impact onto the belt.

All of these various methods serve the same purpose; The introduction of material to the center of the belt, loading in the direction of travel, loading product with velocity approaching belt speed, and reducing product freefall and impact to the belt.

CARRY COVER ABRASION DUE TO LOADING

Rubber cover abrasion due to poor loading is an ongoing problem for the conveyor operator. The first step in correcting this problem is the installation of a rock box, feeder, grizzly bar, chutes, spoons or deflector plates into the loading area. As previously discussed, the product needs to be introduced to the belt with a minimum of impact, loaded in the center of the belt, and product velocity approaching belt speed. As the product free fall decreases, the time required for the product to settle down on the belt also decreases. When products bounce around on the belt before settling down, the rubber cover gets cut, gouged and abraded.



Proper loading is best accomplished when products are loaded on the horizontal.

Loading on a decline conveyor increases product movement, increases abrasion and increases the opportunity for spillage. Loading on an incline increases cover cutting, gouging and cover wear.

Introducing large lumps at the feed point can result in impact energy that a given conveyor belt will be unable to absorb without damage to the cover and carcass. Impact energy is calculated in terms of foot-pounds of energy. The weight of the product times the free fall in feet to the belt will yield the impact energy imparted.

A lump of limestone that measures 12"x10"x18" equals 2160 cubic inches. 2160 cubic inches divided by 1728 (cubic inches in a cubic foot) equals 1.25 cubic feet. If limestone weighs 100 pounds per cubic foot, this lump would weigh 125 pounds. With a free fall drop of 7 feet, this lump would impart 875 foot pounds of impact energy to the belt. This example does not take into account sharp edges or abrasion. It is suggested that impact energy be calculated by the above method, then refer to the manufacturer's catalog for guidance in belt selection.

In addition to the product side of the belt, you must also consider the support area of the loading station. The belt needs to deflect under impact. Rubber impact idlers should be placed so that the load is introduced to the belt between the impact idlers as much as possible. This will allow the belt to deflect under impact. If the deflection of the belt is excessive, then product will be trapped between the skirt boards and the belt. This causes additional cutting, gouging and abrasion.

When impact idlers are moved closer together, it is impossible to load product between idlers. Loading over the idlers is quite common. With closely spaced impact idlers, it is imperative that these idlers be soft enough to deflect under impact.

Another common method of impact absorption is through the utilization of impact beds. Impact beds have a low durometer soft rubber that allows the impact energy to be transmitted through the belt, into the bed, and then absorbed by the bed. Impact beds are more suitable for applications where dust suppression or sealing is required. Impact beds are not recommended for **heavy** impact applications.

Special care is needed to make sure the impact beds are kept clean and free of build-up to avoid causing pulley cover abrasion.

TAKE-UPS

The automatic gravity take-up is the most common type used on bulk haulage conveyors. A movable pulley with a weight box maintains slack side (T2) tension during starting, stopping and load changes by moving to accommodate elastic stretch in the belt. Underground mine applications commonly use air and hydraulic take-up units to accommodate belt stretch.

Weight take-ups or other automatic types (springs, air or hydraulic) are also used on lightweight belt conveyor applications. Automatic take-ups are generally preferred where space allows them to be used as movable take-ups and they put less stress on the belt.

Gravity take-ups are generally low-maintenance and fool proof. When we try to determine where to position the pulley for its travel during new belt installation, we incur problems. The problems faced by the installer are:

- Getting slack pulled out during installation, allowing enough spare belt for re-splicing
- Where to set the take-up pulley initially
- Factors influencing belt elongation such as load, friction, drive type, carcass type, heat etc.
- Take-up bottoming out due to combination of slack, and elastic stretch
- How much will this belt stretch?

All these problems must be understood and answered in order to string and splice a new belt, as well as, avoid another shut down to remove a section of belt when the belt becomes too long for the take-up system.

There are several ways to pull slack out when stringing a new belt:

- Use gravity by stringing the belt from the low end around the conveyor and splicing at the lowest elevation.
- Use a motor to pull the new belt on, then tie and lock one end off while pulling out the slack. It is easier to pull the slack out of the belt down-hill rather than up-hill.

Determine if a mechanical or vulcanized splice will be used and allow enough extra belt for the type of splice chosen. **A good rule-of-thumb for vulcanized splices is 2.5 x belt width for belt consumed in a fabric belt splice.**

Positioning the take-up pulley is important. A few feet should be left at top-of-travel due to possible lift up of the take-up pulley during start-up. At least 75% of take-up travel distance should be available for elongation after the initial vulcanized splice.

This available travel can be adjusted to reflect splice length, total elongation, changes in loading, environmental changes, type of textile fiber and the carcass designs.

One factor influencing elongation is percent of load applied verses the amount of working tension available in the belt being utilized, i.e. a belt with a 440 PIW working tension would stretch more at 375 PIW than at 215 PIW. Fenner Dunlop Americas has stress/strain data in Build a Belt and Belt Wizard for each carcass type so that elastic elongation can be predicted.

Heat can also be a problem as hot belts stretch more due to changes in fiber properties.

Higher friction will raise tension resulting in more elongation. Examples of these increases would be frozen idlers, idlers with higher rolling resistance, heavier pulleys, skirtboards, plows, wipers, etc.

Drive location, belt wrap and lagging types influence tension applied to the belt.

There are various carcass types discussed earlier in this manual that will influence elongation (plain weave, twill, straight warp). The type of fiber used for the strength member in the carcass will also influence elongation, i.e. there are many types of belt carcass materials, including polyesters, nylons, aramids and steel, used in the construction of a belt carcass. The tension member chosen can influence elongation several percent (a variation of 0.5% to 7.0 % is not unusual).

The objective for the user and the installer is to involve the belt manufacturer in selecting the best belt for the application. A part of reaching this objective is to understand the difference between elastic and inelastic elongation. Elastic, by definition, means recoverable elongation. Inelastic, by definition, means non-recoverable elongation.

Elastic elongation occurs during acceleration, braking, and load changes during running. This is why automatic take-ups are so common - they compensate for these length changes easily. Typical elastic elongation with polyester fibers is 1% or less, usually more than 1% with nylon fibers and less than .5% with Aramids and steel.

Inelastic elongation is permanent and occurs during the break-in period. The fabric weave will influence the amount of stretch to be expected. The benefit of belts made with polyester fibers in the tensile member is that they break-in quickly, usually within the first 3-4 days of running at full capacity. Nylon warp yarns continue to "creep" and will continue to have permanent elongation (although small in percentage) for the entire life of belt.

Example:

To reach our objective of properly setting the take-up, we must calculate a total belt stretch.

A 500 ft. center-to-center conveyor with a taped belt length of 1,080 feet runs at 280 PIW using a 3 ply 330 PIW rated belt made with plain weave, polyester warp fabric. The belt runs at an ambient temperature of 72° F and is subjected to fully loaded, "hard" starts at a maximum of 392 PIW.

- Expected permanent (inelastic) elongation of 1.2 % x 1,080' or 13 feet.
- Expected elastic stretch of 0.8% (@392 PIW) x 1,080' or 9 feet.
- Plan to set the take-up at 5 feet from top of travel (Leaving 10ft. of belt in the take-up).

Total take-up travel is then:

- 5 feet for position
- 6.5 feet for permanent movement of 1 ft. = 2 ft. of belt take-up
- 4.5 feet for elastic elongation
- 16 feet of total travel (32 feet of belt) or approximately 1% of tape length + 5 feet for position (10.8 + 5 = 15.8 feet)

What if a mechanical take-up or screw take-up is used? How do we tension the belt properly to accommodate elastic and inelastic elongation? First, we must calculate operating tension at the worst possible condition and be able to pretension the belt so that the inelastic (permanent) stretch is pulled out. Then we have the belt tightened so that the elastic elongation will be recovered within the length of belt at the slack side. In other words the belt must act like a spring or rubber band. When the belt senses lower tension it must recover and remain tight enough to prevent slippage on the drive.

Usually we cannot achieve the required pretension at initial installation since there is not enough travel and screws cannot exert enough force on the belt. Therefore the belt must be re-tensioned during the break-in period, perhaps several times. Mechanical splices may be necessary, as the belt will require re-splicing to shorten and remain within travel limits of the screw take-up.

Unusual conveyor configurations can also result in abnormal belt stresses. Conveyors such as stackers that have the drive at or near the tail end will have almost the entire length of belt running at close to full operating tension. This condition can cause abnormal belt stresses.

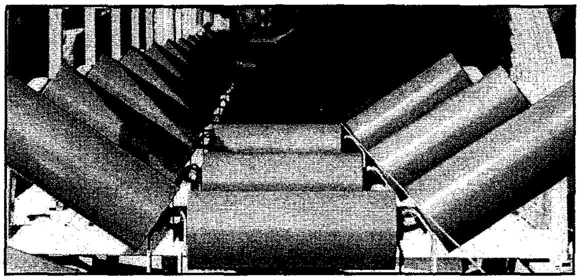
Reversible conveyors with only one motor and one take-up will exhibit greater than normal belt stretch. This is due to the counterweight being heavier than normal. The increased counterweight is required to maintain tension in the system when the motor is reversed. The increased weight results in greater tension applied to the belt.

TENSIONING THE TAKE-UP

The amount of take-up tension that will be required is determined by the location of the take-up assembly. The counterweight must apply the maximum static tension to prevent drive slips and belt sag under all operating conditions. For most installations, the counterweight need only equal the combined tension of the carrying and return sides of the belt.

Where take-up travel is restricted, a double-reeved counterweight system can be installed.

IDLERS

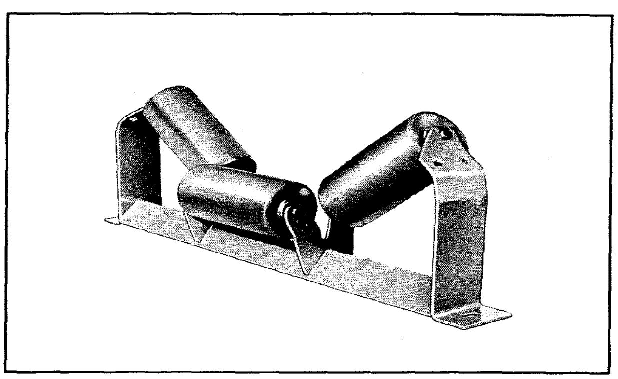


Standard troughing idlers have three rolls of equal length and diameter. They are usually mounted at 20°, 35° or 45° angles and roll on anti-friction bearings. Roll diameters vary from 4" to 7". Diameters below 5" are generally used where lighter duty is evident or where clearances are close. Larger diameters are usually required for heavier-duty applications.

The carrying capacity of a system can often be altered by changing the length of the center roll to widen or narrow the trough. Rolls of unequal length may also be specified, but only after the effects of this type of idler on material flow and belt performance have been studied.

OFFSET IDLERS

In an offset idler, the center roll is positioned behind the concentrating rolls. The most common use is in installations with minimal clearances. Offset idlers offer more protection against idler junction fatigue than the inline type.



DEEP TROUGH IDLERS

Although 20° troughing idlers were once standard, angles of 35° and 45° are now more commonly in use. The benefits of deeper troughs, inline or offset, are:

- Greater cross section for more tons per hour.
- Less cover wear per ton of material carried.
- Use of a narrower belt is possible - for savings on belting and hardware.
- Reduced potential for material spills.
- With most materials, a deeper trough allows for more distance between idlers.

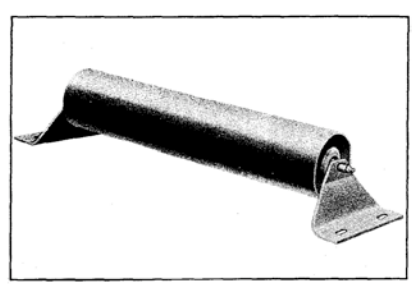
In choosing a deep-trough over a 20° trough, it must be kept in mind that deep-trough idlers require a larger curve radius and longer transition distances for optimum belt performance.

CATENARY IDLERS

Catenary idlers are most often used in handling light-to-medium materials such as coal and grain, and are mounted at each edge of the conveyor. They offer less of a jolt to transversing loads than standard idlers.

RETURN IDLERS

Return idlers are generally flat, with the same roll diameters as the carrying idlers. They should be at least three inches longer than the width of the belt to allow for lateral movement. Use of longer idlers will further reduce the risk of belt edge damage.



Because the belt is especially prone to wandering on this return side, self-aligning return idlers are a good investment, especially where the belt crosses the tail pulley. In this area, it is critical that the belt enter on center.

IDLER SPACING

Excessive sag between idlers can cause load shifts that abrade belts, spill materials, and in the case of steeply sloped belts, create an avalanche. Belt sag can be kept to a maximum of 2% with idler spacing at four-foot intervals along the carrying side. By increasing the tension, the idler spacing can be increased and still maintain the 2% maximum sag.

GRADUATED IDLER SPACING

Sag can be controlled by spacing idlers closer together at the tail pulley and farther apart towards the head. This method saves on belt wear, power and the total number of idlers required.

The principle behind this concept is simple. Belt tension is lower at the tail end, so that sag is more of a problem. In addition to possible load shifts, material jamming and spillage can occur between loads and skirtboards. To counteract sagging in this area, idlers are spaced at, perhaps, five-foot intervals for half the flight, and at six-foot intervals for the remainder. In some instances, idlers must be placed 12 to 18 inches apart to prevent excessive spillage and belt vibration.

Although six feet is generally considered the maximum spacing between carrying idlers, a spacing of eight to ten feet can be used on very high tension or heavy-duty troughing applications.

On undulating or declining conveyors, tension should be calculated for all loading conditions as the conveyor accelerates or decelerates. Idlers should be spaced to minimize belt sag along these systems.

IDLER SPACING ON CONVEX CURVES

To avoid belt edge overstress or idler junction fatigue, the curve radius and idler spacing must be designed properly. In cases of space limitations a lower trough angle may have to be installed. The drawback to that solution is reduced conveyor capacity.

Troughing idlers through the convex curve should be positioned on the curve arc, not on structural chords, and may require shimming to fit the arc profile. Idler spacing should be no more than half the spacing distance on the remaining idlers on the conveyor.

SPACING ON CONCAVE CURVES

On concave curves, radii should be large enough to prevent bending of belt edges. Idlers should be spaced to keep sag to a minimum when the belt is fully loaded. As with a convex curve, idlers should be placed on the arc of the curve - not on the structural chords. Shim idlers, if necessary.

IDLERS AT TRANSISTION POINTS

As a belt moves from a flat to a troughed configuration, the stress of the change can be eased through the use of idlers with adjustable concentrating angles. These idlers minimize junction strain through a gradual curving of the belt to a troughed contour.

IDLER CARE AND MAINTENANCE

Dirty or under-lubricated idlers can cause serious problems with your belt, as well as with your power costs.

Material buildup can move belts off line to damage edges and bearings can jam or freeze from material buildup. Jammed rollers drain system power and if the shells are scored badly enough, can damage the belt cover. Regular inspection and maintenance are essential.

Although you may maintain a schedule of lubricating idler bearings on a regular basis, it helps to check them periodically. Certain materials or environmental conditions may indicate that selected idlers may require more frequent attention. Even self-lubricating idlers should be inspected regularly.

Idlers should not be over-lubricated. If oil or grease fall on a belt that is not oil-resistant, the rubber will deteriorate and eventually not be able to protect the carcass.

Where bearing seals are over greased, dirt can mix with the grease and wear away the seal to damage bearings.

TURNOVERS

A conveyor turnover or twist is usually found on long overland conveyor systems where one turnover is located on the return side behind the drive and the take-up, and the other turnover is located in front of the tail pulley. This configuration is the most common use of the turnover system.

A single turnover can also be found in unusual applications. These will be discussed later.

The dual turnover system means that the carry side of the belt is returned "dirty side up" rather than "dirty side down" and in contact with the return idlers. This means the pulley *cover* side, or clean side, is in contact with the carry side idlers and the return side idlers also.

The dual system offers a variety of benefits to the conveyor operator such as:

- With build up on the carry *cover* you reduce the surface wear on the return idlers.
- *Cover* wear on the carry side is reduced because the dirty side is not being pulled across the return idlers.
- You eliminate the build-up of frozen or sticky material on the return idlers.
- Carry back or dribble under the conveyor is concentrated between the terminal pulley and the turnovers rather than the entire length of the return side.

Design of the turnover system is critical. The length of the twist must be long enough to prevent excess edge stresses and long enough to prevent the center of the belt from buckling. Generally, the turnovers should be on the return side of the conveyor because tensions are lower there.

A general rule of thumb for fabric belts is that the length of a 180° twist should be at a minimum of 1 foot of twist length per 1 inch of belt width. Twist lengths shorter than this can result in tensions at the belt center being too low and can cause instability in the twist area.

The belt tensions *must* be calculated at the point where the turnovers are located. Tensions such as running tension, acceleration tension, stopping tension and breakaway tension should be calculated in addition to other factors like belt weight, belt rated tension and belt modulus.

If the calculated tensions in the twist area are quite low, which will result in an exceptionally long twist length to prevent center buckling, additional counterweight can be added to the system to shorten the twist length. The addition of counterweight or slack side tension must be done with caution so as to not exceed the rated working tension of the belt.

The belt sag between the supporting pulleys could become large enough to affect the tensions in the belt at the turnover area. We suggest that sag be held to a maximum of 2% of the twist length.

Sag can be calculated as follows:

$$\text{SAG (feet)} = \frac{(W_b)\,(L_T)^2}{8\,(TT)}$$

Where W_b = belt weight in lbs/ft

L_T = horizontal length of twist in feet

TT = tension at twist in pounds

The actual amount of belt sag will be approximately 70% of the *above-calculated value* due to stiffness in the *vertical* position at the center of the turnover. It is also suggested that additional *vertical* clearance be allowed for the middle of the twist area to allow for changes in tensions that occur during acceleration and deceleration that can cause the belt to jump.

The following are also recommended for all turnover systems:

- All splices should be vulcanized
- When using a dual turnover system, the twists should be in the same direction to balance out any edge stress that occurs
- Automatic take-ups should be used to maintain a constant tension in the twist area
- Controlled acceleration and deceleration
- Vertical rolls mid-way in the twist that the belt passes through should be off-set a few inches and adjustable in all directions for containment and tracking purposes
- The horizontal end pulleys should be adjustable for tracking purposes
- The two twist pulleys should be 6" wider than the belt and set for a few degrees of belt wrap

The **single turnover,** or twist system, is constructed in the same manner as the dual system except that there is only one 180° twist in the belt. This means that the conveying run is alternated on the carry cover and then the pulley cover and so on.

The single twist system offers the conveyor operator a different set of benefits than what is found with the double twist system.

This system would be used conveying hot materials that will allow the belt to have additional cooling time as the load is alternated from one cover to the other.

Some products have an adverse reaction when exposed to rubber covers. Alumina is a typical example when conveyed over Grade II covers. The Alumina attacks the cover by extracting the plasticizers causing the rubber to get hard, crack and cup. The single pass turnover when using RMA Grade II covers will allow the Alumina to attack both sides of the belt at once which will offset the cupping problem.

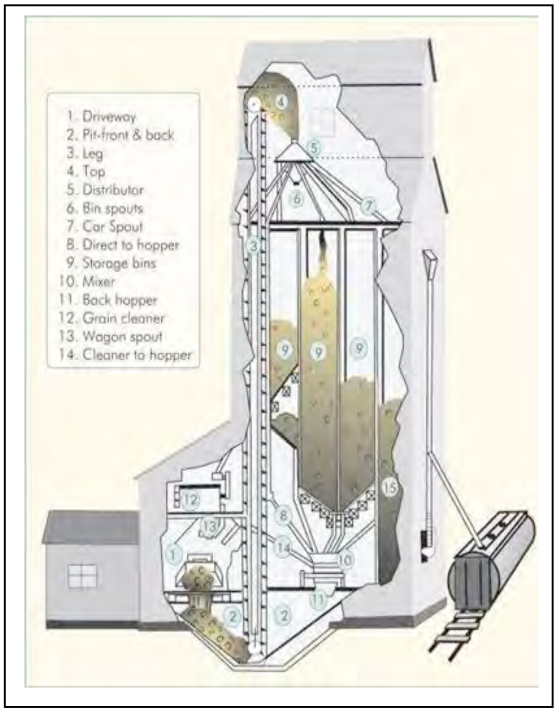
Some products are highly abrasive and by using a single pass twist in the belt, both sides of the belt will be worn away rather than the carry side only. This will extend normal belt life.

All rubber covers when exposed to a single pass turnover system should be purchased as balanced covers; Example: *1/8* x *1/8, 3/16* x *3/16, 1/4* x *1/4.*

The design of the single turnover system is concurrent to the double system and the same rules will apply as to turnover lengths, sag amounts and roll layout.

Contact your local Fenner Dunlop representative for assistance with your questions concerning conveyor belt turnovers.

ELEVATOR BELTING



Elevator belting is nothing more than conveyor belting with buckets bolted on, used to carry material vertically or at a near-vertical slope. A belt elevator system is preferable to a chain system in most applications because it operates more smoothly and quietly, it's higher in abrasion resistance and it is not subject to corrosion.

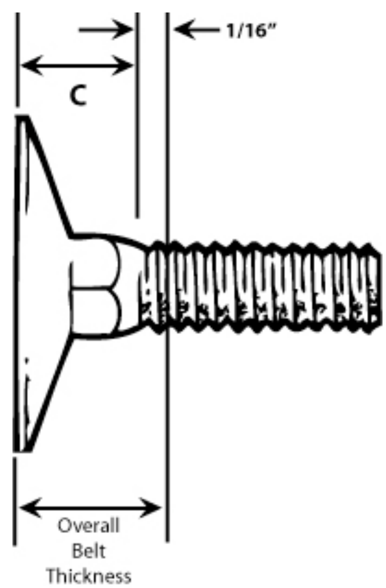
Because elevator belting is almost identical to conveyor belting, most of the care and maintenance principles given earlier apply here. Only the conditions that are unique to elevator operation will be covered in this section.

ELEVATOR BELTING INSTALLATION

BUCKET BOLT SPECIFICATIONS

Norway-type flathead bucket bolts are the ones most commonly used for elevator belting. Standard diameters are 1/4", 5/16", and 3/8". Standard lengths are 3/4", 7/8", 1", 1 ½ ", 1 ¾ ", 2", 2 ¼ ", 2 ½ ", 2 ¾ ", and 3". Sometimes the Excelsior bolt with a round head is used for heavy buckets and belting.

Carefully consider the bucket bolt dimensions to be sure there's enough compression when the bolt is tightened. Bolt dimension "C" should be 1/16" less than the belt thickness.



RIGGING AND PUNCHING

When preparing to make the bolt holes in a belt, first pass a heavy piece of pipe through the center of the roll. Rest it on a pair of horses high enough to keep the roll from touching the floor.

Draw the belt out over a strong temporary bench or table. Then mark off the bucket positions with a steel square and pencil. Outline the bolt holes either with a template or by aligning a bucket in position and marking through its bolt holes. (A template can be made from a sheet of plywood by nailing a strip to it so it can be easily squared with the edge of the belt.)

Make the bolt holes with a sharp belt punch. Punch size should be between the same diameter and 1/32" larger than the bolts.

SPECIFICATIONS FOR PRE-PUNCHED BELTING

Fenner Dunlop Americas distributors can pre-punch holes for you, provided you give them accurate specifications. By providing the information shown below, you can be sure the bolt holes will be correctly sized and spaced when the belt is delivered.

1. Belt width
2. Belt length
3. Spacing of buckets center to center of holes
4. Distance to start first row of holes from end of belt
5. Diameter of holes
6. Center to center of holes. Start at center line of belt
7. Distance between rows to be shown on double rows
8. Rows with most holes to be on top of double rows
9. Specify if belt is to be punched entire length
10. Show number of rows to be punched
11. When staggered buckets used, show spacing

STRINGING THE BELT

For new installations, follow the same general precautions you'd use when installing a conveyor belt on a new system. If a belt is being replaced, cut the old belt and attach the lead end of the new belt to it. Then as you pull the old belt off, the new one will follow it into place.

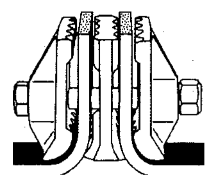
PREPARING FOR THE SPLICE

If it's at all possible, hang the belt over the head pulley for at least 24 hours before splicing with the buckets installed. When the splice is being made, pull the belt up as tightly as possible. Both of these recommendations are designed to take out some of the initial stretch in a new belt.

Position the take-up so it can travel fully when the new belt is first installed. Take-up travel will be limited by the boot pulley arrangement.

After the belt is initially installed, retighten the bolts and fasteners at least once after the first day of operation. Inspect the spikes to be sure they're holding firmly.

Dura Splice®



The Dura Splice® Elevator Belt fastening system provides the following advantages:

- One size fits all Elevator Belt styles and all pulleys
- Holds belts in a vice-like grip between three heavy duty grooved plates designed to remain secure.
- The joint never touches the pulleys. There is no problem of metal-to-metal contact
- Puts an end to the double belt thickness common to other joining systems. Stops the costly waste of extra belting necessary in lap and butt riderstrap joints
- Offers extra safety and increased load capacity because belts are not weakened with excess bolt holes
- Can be *used over and over again* for years of dependable service

- Each splice set joins 2 inches of belt width
- **Note: DURA SPLICE AND SIMILAR BAR TYPE SPLICES ARE NOT RECOMMENDED WHERE A WING TYPE *BOOT* PULLEY IS USED AS SUCH PULLEYS MAKE IMPROPER AND ABNORMAL CONTACT WITH THESE SPLICES AND THE CONSTANT ENCOUNTER TENDS TO ABRADE THE PULLEY SIDE OF ANY BELT PREMATURELY AND EXCESSIVELY AT THE SPLICE AREA.**

LAP JOINT

This splice is also commonly used in thin elevator belts. The lap area can extend under two to four buckets. Use the two-bucket lap only on elevators with low operating tension. The three or four-bucket lap should be used if the belt is operating near its rated tension.

Buckets are bolted through both of the belt strands. If only the top row of bolts passes through both of the belt strands, some of the shearing stresses will be relieved as the buckets pass around the terminal pulleys. The end of the inside belt strand can be stepped back or tapered for smoother operation over the pulleys.

BUTT JOINT

This is recommended for splicing heavy elevator belts. Cut the belt to the proper length and square both ends. Butt the ends together and fasten them with a strap cut from an extra piece of belting. Use bucket bolts, rivets, or button fasteners to fasten the belt to the strap. Use the same type of belting for the strap as you're using for the main belt.

The strap should be long enough to pass under at least two buckets. Use only one row of bolts in each bucket to pass through both of the belt strands.

The total number of fasteners used (including bucket bolts which pass through both belt strands) should be about 1 to 1½ times the belt width in inches.

NYLON BUTT STRAP JOINT

This is a very serviceable splicing method for thick, high-strength elevator belting. Three variations of this joint have been developed to provide a dependable splice, regardless of the bucket arrangement.

1. Use this splice and layout when no buckets are mounted over the pad.

2. Use this when buckets are placed over the splice pad (single row of buckets). The splice pad length is determined by the bucket size and spacing. The pad need only be long enough to pass under one bucket on each side of the belt butt joint. It should extend far enough beyond to accommodate one row of Flexco plates.

3. This type of butt strap joint works best with buckets over the pad (multiple rows of buckets). The splice pad length is determined by bucket size and spacing.

VULCANIZED SPLICE

Where space, time and take-up permit, vulcanized splices are sometimes considered for elevator belting. However, they're not nearly as popular in elevator service as they are for conveyor belts. It's simply not always convenient to provide the space and the additional belting that vulcanized splicing requires.

ELEVATOR BELT PREVENTIVE MAINTENANCE

The surest way to keep an elevator belt operating is to inspect it regularly. It's best to get in the habit of completely checking the belt and system at least once a week. Tighten loose bolts. Replace worn washers and faulty buckets when needed. Check all clearances and examine each of the joints carefully.

BOLT TIGHTNESS

When material wedges between the bucket and the belt, bolts will loosen, which can lead to problems. Even though this is one of the most common elevator belting problems, no washer or pad will totally prevent this occurrence. The best remedy is to check the bolts periodically and tighten, if necessary.

BUCKET WASHERS AND PADS

Rubber or leather washers relieve the strain on the bolts and allow the belt to conform to the pulley contour. In addition to absorbing the shock when the belt passes over a pulley, washers provide space between the bucket and the belt to prevent material buildup. They also help seal the bolt holes against moisture which can damage some belt carcasses.

Use pads whenever wear will be especially severe. They increase the belt life and also act as an insulator for hot materials. Pads can be made by cutting up an old piece of belting to the approximate size and shape.

FEEDING

There are two commonly used methods of feeding or loading the elevator buckets. One is the scoop feed, where material is delivered into the boot and scooped up by the buckets as they pass through it. The second is the fly feed, where a spout delivers the material well above the boot pulley directly into the buckets. With the fly feed, there should always be two empty buckets below the spout to catch any spilled material.

Most wear on an elevator belt is caused by abrasion from material that gets between the boot pulley and the belt, so it is very important to arrange your feeding system so as little material as possible falls back into the boot area.

You can also have problems when too much material piles up in the boot. When the belt starts up, the heavy load on the buckets can strain the belt enough to slacken the tension. This allows the belt to sway and buckets can scrape against the housing. The friction can build up enough to create a danger from heat or sparks. To protect yourself from bucket damage and any potential dangers from the heat of friction, be sure to watch the amount of load material in the boot closely.

LUMP CONTROL AT THE BOOT PULLEY

Lumps that spill between the belt and the boot pulley can jam and severely stress or even tear the belt. (A similar problem exists with the pulley at the bottom of a vertical gravity take-up.) A deflector shaped like an inverted V or a simple plow can prevent lump damage when erected over the boot pulley.

The deflector can be made of either sheet metal or planking and covered with a strip of old belting. When using such a device, be sure to inspect it frequently and adjust it as needed. If you don't, material can build up on it in time and come in contact with the belt.

"Wing" type pulleys have been very successful in preventing material from becoming trapped in elevator service.

PULLEY LAGGING

Pulley traction can be improved with standard pulley lagging. Either bolt or vulcanize the lagging to the pulley face. The lagging will prevent slipping at the head pulley and also cushion the wear between the belt and the pulley surface. In wet conditions, grooved lagging works best.

BELT ALIGNMENT

An elevator belt that trains poorly can scrape the buckets into the housing. This can damage the buckets, the elevator frame and the belt itself by putting a greater strain on the bolts and bolt holes. It can also create a danger from sparks and heat, a particular concern in grain elevator service.

A common cause of misalignment is a fly feed that delivers material at an angle. This loads the buckets off center. Material tends to accumulate on one side of the boot. The buildup in turn drives the belt toward the opposite side. Crowned head and boot pulleys will usually correct this tendency and keep the belt aligned.

BELT TENSION

Maintain proper tension in an elevator belt to prevent slipping and excessive pulley cover wear. This also eliminates belt sag along the return side, which is important to keep the belt from flapping and scraping the buckets on the housing or bins. Use your take-up to control the tension properly.

An approved type of take-up moves both ends of the boot pulley shaft equally so the belt is uniformly tightened. If there are separate take-up adjustments for each side, it is important to tighten them equally. Otherwise, the belt could become distorted and training problems could emerge.

ELEVATOR BELTING PROBLEM SOLVING GUIDE

Condition	Cause	Recommendation
Wear of belt cover on the bucket side.	Buckets abrade against belt cover when passing around terminal pulleys.	Rubber washers between buckets and belt help cushion buckets.
	Fine abrasive materials between belt cover and bucket.	Space between bucket and belt when washers are used permits fine material to pass through.
	If washers are used and material still is held between bucket and belt causing abrasive wear.	Rubber pad is occasionally used between bucket and belt. Material between bucket and pad wears only the pad. Material between pad and belt cover does not cause as serious abrasive wear because it is between two rubber surfaces.
	Abrasive wear caused by excess material in the boot.	If feed of material to the boot can be controlled, jamming and turbulence can be reduced.
	Cover gauge on bucket side may be too light or quality too low.	On future belts, bucket-side cover gauge may be increased or higher quality used or both.
Wear of belt cover on pulley side.	Abrasive material between belt and boot pulley.	Some type of slotted or self-cleaning boot pulley may be used. A conventional smooth-faced boot pulley can be lagged with soft rubber lagging. Improve design of discharge point, increase belt speed and do not overload buckets so that amount of material falling down through the casing into the boot is minimized.
	Belt slips at drive pulley.	If drive pulley is bare, lagging this pulley usually sufficiently reduces belt slip. For moist operating conditions, lagging may be grooved to reduce slipping. In rare cases, even with lagged drive pulley, additional tension may have to be applied to the belt. In this case, permissible belt operating tension should not be exceeded.
	Cover gauge on pulley side may be too light or quality too low.	On future belts, pulley-side cover gauge may be increased or higher quality used or both.
Rubber cover separates from belt.	Generally severe service with large-size lumps of heavy, abrasive material being handled.	Use higher grade conveyor belt.
	Slip at drive can start pulley-side cover separation.	Increase drive efficiency by lagging bare drive pulley. If belt will not be overstressed, additional tension for driving may be applied.
Belt ply separation.	One of the terminal pulleys may be too small.	Pulley diameters should be increased. But casing design often eliminates this possibility.
	Severe flexing service.	Higher quality belt carcass should be used in the future. This should include ample rubber skim coat between plies.

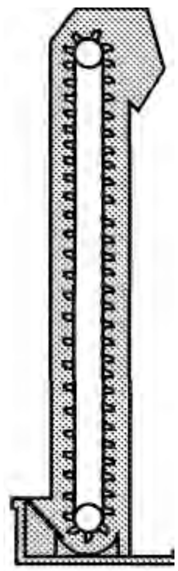
ELEVATOR BELTING PROBLEM SOLVING GUIDE

Condition	Cause	Recommendation
Breaks in belt carcass.	Lumps of material carried between belt and pulley.	Deflectors over boot pulley have helped in some cases. Some types of slotted or self-cleaning boot pulley may be used.
	Operating tension too high for existing belt	Check tension and elevator capacity. Belt with stronger carcass required for correct design in the future.
Buckets pull loose from belt or belt is torn at bolt hole.	Belt construction inadequate for proper bolt holding.	Besides withstanding necessary operating tension proper belt recommendations should have considered bolt holding.
	Buckets not bolted tightly.	Bucket bolts should be kept tight. If bucket bolts come loose, bucket may snag and be torn from belt.
	Jammed boot.	Controlled feed should help eliminate jams and turbulence in the boot.
	Improper clearance or obstruction in casing.	Redesign if at all possible. Be certain that terminal pulleys are aligned properly for straight running belt.
	Pulleys are too small so that bolts are strained as belt flexes.	Possibly a larger drive pulley cannot be installed in existing design. Belt construction may be improved. Washers cushion the buckets so if not already used, they might be tried here.
	Operating conditions changed from time of original design. Size or weight of material changed. Large lumps jam or strain buckets in the loading boot.	Recheck bolts for proper torque. Consider washers and pads. Use larger pulley diameter if necessary.

There are two types of bucket elevators-Centrifugal and Continuous. Both are loaded at the lower-most pulley (the boot) and discharged at the upper most-pulley (the head).

CENTRIFUGAL DISCHARGE

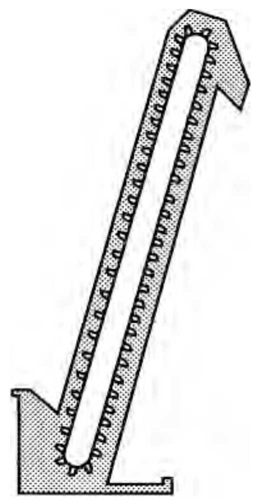
Popular in the grain, coal and fertilizer industries, centrifugal discharge elevators are high speed when compared to the continuous bucket elevator. This elevator is almost always built completely vertical. The buckets are loaded by digging in the elevator boot. Buckets are spaced in a predetermined uniform cycle in order to allow the material to be thrown out at the head pulley.



CONTINUOUS BUCKET

This type of elevator is used to carry either heavy, or large lump material. The continuous elevator is often used to convey materials such as cement or lime. This elevator's speed is much slower than that of the centrifugal discharge elevator.

Most of the time this elevator is at an angle between 15° - 30° from vertical. This allows materials to be dumped directly into the buckets via chute. Buckets are spaced close together so that the bottom of the previous bucket acts as a discharge for the following bucket.



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