CEMA Standard No. 403

Belt Driven Live Roller Conveyors

Unit Handling Conveyors

Conveyor Equipment Manufacturers Association
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FOREWORD

Belt driven live roller conveyors -- conveyors which use a roller bed for the carrying surface and a belt as a driving medium -- are used for the controlled movement of a great variety of regular or irregular shaped loads, from light and fragile to heavy and rugged unit loads. The bottom surface of the load must be conveyable on a roller bed.

The path is usually horizontal, but it can be slightly inclined or declined, limited only by the friction between the rollers, drive belt, and the load.

Belt driven live roller conveyors can be operated at the speed best suited for the work being performed. They are used where unit loads are allowed to accumulate causing blocked line conditions, as a pacesetter for assembly operation, for loading on and off, for transportation, or as a timing medium for integrated handling systems.

The purpose of this work is to establish certain minimum standards for use by concerns manufacturing or utilizing unit handling live roller conveyors.

For additional information relating to definitions and selection of common components, see the latest edition of the following publications: ANSI/CEMA Standard No. 102, Conveyor Terms and Definitions; ANSI/CEMA Standard No. 401, Belt Conveyors; ANSI/CEMA Standard No. 402, Belt Conveyors; ANSI/CEMA Standard No. 404, Chain Driven Live Roller Conveyors; ANSI/CEMA Standard No. 405, Slat Conveyors; and ANSI/CEMA Standard No. 406, Lineshaft Driven Live Roller Conveyors.

The illustrations throughout this book are schematic in nature and represent the general nature of a particular device. The illustrations are not intended to represent the recommended safety configurations since guarding has been omitted to permit clarity in showing the operational characteristics of the device. Refer to the current editions of ANSI/ASME B20.1, Safety Standard for Conveyors and Related Equipment; ANSI/ASME B15.1, Safety Standard for Mechanical Power Transmission Apparatus; and ANSI Z244.1, American National Safety Standards for Lock-out/Tag-out of Energy Sources - Minimum Safety Requirements; Title 29, Code of Federal Regulations (29 C.F.R.) Part 1910 Subpart O, Machinery and Machine Guarding. Consult ASME or ANSI for the latest editions.

In 2003 edition, all drawings have been cleaned up and enhanced for clarity, a Safety Notice regarding Industry Standard Safety Labels has been added, Terms and Definitions have been edited to conform with those in ANSI/CEMA Standard No. 102 “Conveyor Terms and Definitions”,
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SAFETY NOTICE

The Conveyor Equipment Manufacturers Association has developed Industry Standard Safety Labels for use on the conveying equipment of its member companies.

The purpose of the labels is to identify common and uncommon hazards, conditions, and unsafe practices which can injure, or cause the death of, the unwary or inattentive person who is working at or around conveying equipment.

The labels are available for sale to member companies and non-member companies.

A full description of the labels, their purpose, and guidelines on where to place the labels on typical equipment, has been published in CEMA’s Safety Label Brochure No. 201. The Brochure is available for purchase by members and non-members of the Association. Safety Labels and Safety Label Placement Guidelines, originally published in the Brochure, are also available free on the CEMA Web Site at http://www.cemanet.org/safety-labels-2/

Please Note: Should any of the safety labels supplied by the equipment manufacturer become unreadable for any reason, the equipment USER is then responsible for replacement and location of these safety labels.

Replacement labels and placement guidelines can be obtained by contacting your equipment supplier or CEMA.
SECTION 1 - DEFINITIONS

For general definitions see also ANSI/CEMA Standard No. 102, Conveyor Terms and Definitions.

Mechanical Elements

- **Conveyor, Width** - The dimension inside to inside (BF) of frame rails (see dimension B, Figures 1, 2 and 3). Overall width (OAW) of the bed (see dimension C, Figures 1, 2, and 3).

- **Drive** - An assembly of the necessary structural, mechanical, and electrical parts which provide the motive power for a conveyor.

- **Fill-in Plates** - Closely fitted plates positioned between the rollers of non-powered or powered roller conveyor.

- **Frame, Conveyor** - The structural member which supports the machinery components of a conveyor.

- **Guide Rails** - Members paralleling the path of a conveyor and limiting the product on the conveyor to movement in a defined path.

- **Hand** - the right hand or left hand of a conveyor is determined by facing the direction in which the material is flowing. In the case of a reversible conveyor, the hand is determined when the material is flowing toward the end closest to the drive.

- **Horizontal Curve** - A conveyor section used to change the direction of travel. Also, curved conveyor section equipped with a belt (round, "v", hex, etc.) driving a series of rollers to change the direction of the unit load. The curved radius is measured to the inside face of the inside frame rail. The hand of the curve is determined by facing in the direction of the unit load travel. Right hand curves transport unit loads to the right and left hand curves to the left.

- **Pop-Out Roller** - A special load carrying roller mounted in such a manner as to pop out when foreign objects are introduced between the belt and the roller.

- **Roller Bed** - A bed utilizing a series of rollers and channels used to support a conveyed load.

- **Roller, Carrier, Return, Pressure, and Gravity** - A cylindrical member with internal bearings mounted on a non-rotating shaft.
  - **Carrying Rollers** - A series of rollers used to support a conveyed load.
  - **Return Rollers** - A series of rollers supporting the return run of the conveyor drive belt.
  - **Gravity Rollers** - A series of rollers used to carry a live load but not driven.
  - **Pressure Rollers** - A series of rollers used for holding the driving belt in contact with the load carrier rollers in a belt driven live roller conveyor.

- **Snub Roller** - Any roller used to increase the arc of contact between a belt and drive or tail pulley.
• **Tracking training** - The process of adjusting idlers, pulleys, and loading conditions in a manner which will correct any tendency of the belt to run other than centrally.

**Belting**

• **Carcass** - The fabric tension carrying portion of a belt, as distinguished from the cover.

• **Covers** - Material applied to the outer surfaces of a conveyor belt for protection of the carcass and, where required, to provide special load carrying frictional characteristics.

• **Duck** - A term applied to a wide range of medium and heavy weight fabrics, commonly made of cotton or synthetic material, used to construct a conveyor belt carcass.

• **Edge**
  - **Cemented** - An application of rubber cement or other sealant over the raw or cut edge of a belt.
  - **Folded** - A belt construction wherein an outer ply is folded around a carcass to cover the edges.
  - **Raw** - The uncovered square edge of a belt created by cutting after vulcanization.

• **Friction Surface** - A rubber adhesive compound applied to and impregnating a conveyor belt fabric, to provide greater than normal traction.

• **PIW** - Belt strength is rated in Pounds (load) per Inch of Width

• **Ply** - A layer of duck or cords used in constructing the carcass of a conveyor belt

• **Skim or Skim Coat** - A layer of material applied to the belt fabric but not forced into the weave

• **Splice**
  - **Mechanical** - A joint made by fastening two ends of belting together by means of metal hooks or plates
  - **Vulcanized** - A joint made endless by means of vulcanizing two properly prepared ends of the belt.
  * **Step** - Each ply is cut back further than the previous on each end to allow overlapping and bonding of the plys.
  * **Finger** - Each end is cut in a long finger pattern and bonded to allow maximum flexibility.

**Types of Belt for Belt Driven Live Rollers**

• **Belt, Monofilament** - A belt utilizing many single strands of untwisted synthetic fiber.

• **Multiple Ply** - Carcass is usually made with three or more plies of fabric bonded together by elastomeric material. May be furnished smooth covers top and bottom, rough-top, friction-surface, bareback, or combinations using one type of surface for one side of the belt and another type of surface for the other side.
• **Reduced-Ply** - The necessary carcass characteristics are obtained using fewer plies than comparable multiple-ply belts. The carcass may be made as a single unit or from plies, usually two, of nylon, polyester, or combinations of these synthetics. When more than one ply is used, they are bonded together as in multiple-ply belts but with heavier skim coats between the plies. Covers available are similar to those for multiple-ply belts.

• **Ripple belt** - A special belt with raised pads spaced at uniform intervals along its length. Only the pad surface contacts the carrier rollers.

• **Solid Woven Cotton** - Layers of warp threads are woven with layers of filler threads and bound together in the loom with binder threads. There are no distinct plies, but the layers of warp threads are often counted as plies. They may be used with or without treatment or impregnation.

• **Solid Woven PVC** - Single-ply, solid woven carcass made from nylon, polyester or combinations thereof, impregnated and coated with PVC (polyvinyl-chloride) plastic.

• **Stitched Canvas** - Several plies of the fabrics (usually cotton duck) are stitched together and normally treated by immersion in special compounds.

• **V-belt** - A belt with a cross section in the general shape of a trapezoid.

Specifications and testing methods for various belting materials can be found in one of the following references:
- ASTM D 413 Method for Testing Rubber Property Adhesive to Flexible Substrates
- ASTM D 378 Method for Testing Rubber Belting, Flat Type
- ASTM D 430 Methods of Dynamic Testing for Ply Separation and Cracking of Rubber Products

**Pulleys**

See also latest edition of ANSI/CEMA Standard B105.1, Welded Steel Conveyor Pulleys

• **Balanced** - Wobbling and tracking problems suggest that the drive and tail pulley may need to be spin balanced
  - **Static** - The manipulation of the center of gravity of a pulley to fall along the axis of rotation from rest. (Usually requested from 150 to 299 fpm).
  - **Dynamic** - The manipulation of the center of gravity of a pulley to fall along the axis of rotation at high speed. (Usually requested at 300 fpm and above).

• **Hub**
  - **Compression** - A removable hub for shaft replacement that wedges around the shaft when installed.
  - **Bearing** - Internal bearings in the pulley shell which are used on a non-rotating shaft.
  - **Disk** - Round plates with a hole in the center for welding the pulley shell to the shaft, non-removable.

• **Key** - A square metal stock that transmits torque at the shaft to hub connection.
• **Lagging** - A smooth or embossed covering or coating applied to a pulley to reduce belt slippage and wear. Typical thicknesses are 1/4" to 3/8" with a durometer hardness of 55 to 65 shore A scale. Higher hardness is available by the manufacturer.

• **Pulley** - A cylindrical member with or without a crown face mounted on a revolving or fixed shaft (See also Pulley; Drive, Tail, etc.).

• **Pulley, Crown** - A pulley with differential diameters used for belt centering
  - **Formed** - A process that utilizes forming processes to push out or in the diameter difference.
  - **Machined** - A process of removing the outer shell material to the diameter difference.

• **Pulley, Drive** - A pulley mounted on the drive shaft that transmits power to the belt with which it is in contact.

• **Pulley, Powered Drive** - A pulley mounted with internal motor and reducer that transmits power to the belt with which it is in contact.

• **Pulley, Shell** - A cylindrical member with or without a crown that is attached to hubs and a shaft

• **Pulley, Tail** - A pulley mounted at the tail end of a conveyor.

• **Pulley, Take Up** - An adjustable pulley or roller arrangement to compensate for change in belt length due to wear, climate conditions, and stretch. Tail pulleys may be used as take-up. Adjustment may be one of the following types:
  - Screw – manual
  - Counterweight – automatic
  - Springs – automatic
  - Pneumatic – automatic
  - Hydraulic – automatic

• **Shaft** - A cylindrical bar used to support rotating pieces or to transmit power by rotation.
TYPICAL CROSS SECTIONS

Figure 1

Figure 2

Figure 3
HORIZONTAL BELT DRIVEN LIVE ROLLER CONVEYORS (Typical Side Elevations)

Key:

\( R \) = Return Roller
\( S \) = Snub Roller
\( P \) = Pressure Roller

Figure 4

Figure 5
BELT DRIVEN LIVE ROLLER TRANSFERS

Intermediate Merge Loading Transfer with Intersecting Gravity or Powered Section. Used for loading out to main line from spur line conveyor. Suitable for individual or closely spaced line load. When unloading from the main line live roller onto spur, both conveyors are reversed and deflectors are positioned as shown above in phantom.

Similar to Figure 8 except with positive loading section. Less gap at transfer point is particularly desirable for small loads. When unloading from the main line roller bed onto spur line, both conveyors are reversed and deflector is positioned as shown above in phantom.

Right Angle Live Roller to Live Roller Transfer. Requires separation of loads on incoming conveyor. Unusually long or odd shaped loads generally require Figure 8 or 9 Transfer.
Section View A-A

Figure 11. 90° Belt Driven Live Roller Curve
Figure 12. Traffic Controller

Figure 13. 90° Air Powered Push-off
Figure 14. Pop-out Rollers
SECTION 2 - APPLICATION

The following are some of the basic considerations governing the selection of belt driven live roller conveyors and components:

Conveyor Width

Normally the conveyor is at least 2" to 3" wider than the widest unit handled. Loads may require a greater width for clearance around horizontal curves. With certain types of installations, the loads are allowed to overhang the conveyor. Guide rails are provided where required.

Speed and Load

The number of unit loads a belt driven roller conveyor will handle is determined by its speed and the unit load spacing. The size and weight of the load govern the frame and roller construction (see ANSI/CEMA Standard No. 401, Roller Conveyors-Non Powered). For a given delivery rate, the speed should be as high as practical so that the loads are spaced further apart, thus reducing the working tension of the belt. Also, creating the maximum room for accumulation in that mode.

Pressure Rollers

Pressure rollers should be provided with height adjustment in relation to the bottom of the carrier rollers. Pressure rollers are normally spaced every second or third carrier roller, except at transfers, deflectors and on sloped conveyors, where they should be spaced every second carrier roller.

Pressure rollers should be adjusted to propel the maximum load with the minimum turning force on the carrier rollers.

Return Rollers

The return rollers used for supporting the return run of the belt are usually spaced on the same centers as the conveyor supports, sometimes being mounted on the support and other times on separate brackets. Some horizontal adjustment is advisable as the return rollers are used for tracking the belt.

Pulley Arrangement

The simplest form is to have a drive pulley at one end and an adjustable tail pulley at the other end (see Figure 4). When short unit loads are handled, small diameter tail pulleys are normally used at ends to power as many carrier rollers as possible (see Figure 7). Employing grooved rollers and elastomeric drive belts can also be used to power the very end rollers.

Take-ups

Take-ups are required on all belt driven live roller conveyors to compensate for changes in belt length and to maintain belt tension. Take-up devices may be located at any point along the return run of the belt, after the drive, or at the tail pulley. The most desirable take-up location is immediately adjacent to the drive, on the slack belt side (see Figures 4 through 7 for typical side elevations)
Take-ups should be designed to provide a movement of at least one percent of the conveyor length measured between end pulleys with a travel of two inches as a minimum. Thus, if a conveyor is 100 ft long, center to center of terminal pulleys, the take-up should have a minimum travel of one foot.

Additional movement is generally required for belts constructed from stitched canvas, solid woven cotton, or PVC with solid woven polyester carcass.

On all automatic take-ups, except vertical type, some mechanical device is desirable to keep the take-up pulley square with the axis of the belt. A device frequently employed is a squaring shaft, which forces both take-up shaft bearings to travel an equal amount.

A short piece of belt called a "Dutchman," can be spliced into a main belt to be conveniently removed after all mechanical take-up has been used. The removal of the "Dutchman" allows mechanical take-up to return to starting position.

**Drive Arrangement**

There are many variations in drive arrangements. A gearmotor is the most common type. The output shaft of this unit is connected to the drive pulley shaft, by a chain or flexible coupling. Another type of drive is a speed reducer, with hollow output shaft to fit over the conveyor drive shaft. The motor may be directly coupled or connected by a v-belt to the reducer input shaft. The shaft mounted reducer must be held stationary by a torque arm. When variable speed is required, a mechanical speed changer between the motor and reducer may be used. Electrically, the speed may be changed using SCR or variable frequency drives. Important considerations in the design of belt driven live roller conveyors are pulley lagging and the angle of belt wrap. Lagging increases the life of the belt and machinery by requiring less belt tension. Snub idlers or pulleys are used to increase the angle of belt wrap (see Technical Data).

**Supports**

Floor supports should be provided with vertical adjustment for leveling the conveyor. Adjustable hangers, such as rods with threaded ends, are generally used with conveyors at elevations over the distance specified in ASME B20.1 (Guarded by Location).

Support spacing is dependent on the loading, and in some cases, on the building construction. Supports must be spaced to limit frame deflection as detailed in ANSI/CEMA Standard No. 401, Roller Conveyors-Non Powered.

**Transfers**

- **Spur** - Probably the most universally used transfer between belt driven live roller conveyors is the gravity curve, either roller or wheel type. For intermediate receiving or feeding, a spur section of roller or wheel conveyor is used at an angle of approximately 30 degrees to the direction of travel of the through conveyor. The tapered portion of the transfer is fitted with varying length rollers or with a series of wheels or casters. The rollers in this section may also be power driven (see Figures 8 and 9).

- **Right Angle** - Another method of power transfer is the right angle transfer, where the feed line is brought in at a right angle to the main line and a turning wheel or roller is used to assist the load in negotiating the turn (see Figure 10). Such an arrangement works very
well if there is always sufficient space between unit loads to permit one unit load to negotiate the turn before the next one arrives

- **Deflectors** - There are a number of different types of deflectors in use, the simplest being straight or curve bars set at an angle to the direction of travel to move the load to one side as it slides along the bar. These bars may be faced with special friction reducing materials. They are sometimes lined with closely spaced ball bearing wheels. Another type employs a motor-driven flat or v-belt set in a vertical plane and backed up by a supporting structure. The moving belt causes the load to discharge positively from the conveyor. The deflectors may be made removable by mounting on vertical pins or may be hinged on vertical shafts. Control may be provided by hand levers or remotely by means of air cylinders, gear motors, or other devices.

- **Push-Off** - A device used to physically push unit loads off to other lines (usually at 90 degrees). Push-offs are normally air powered or motor-driven, controlled electrically by photo eyes or limit switches. (See Figure 13)

### Pop-Out Rollers

Conveyor frames are made with the "Pop-Out Roller" feature primarily for safety of those working around the conveyor. One method to achieve this is to provide long vertical slots in the conveyor frame. The slots extend up through the top flange of the frame. The "Pop-Out Roller" shafts are seated in these slots, allowing them to be pushed upward and out through the top flange when a foreign object is introduced between the "Pop-Out" or "Carrier" rollers, flat belt, and pressure rollers (see Figure 14). Another type of pop-out roller is a small diameter roller placed in a slot between two units to bridge the gap. Typically this roller is slightly below the conveying surface. This type of roller usually has a safety cord attached to it if mounted overhead.

### Traffic Controller

Controls traffic flow of converging lines (see Figure 12). In Figure 12A, traffic controller arms are in normal disengaged position. When a unit load approaches either arm, the arm pivots, easily allowing the load to pass. While the arm is in pivotal position, the other arm is locked, holding back any unit loads coming from the other direction (see Figures 12B and 12C)

### Horizontal Curves

Belt driven roller curves with straight faced or tapered rollers are made up to 180 degrees (see Figure 11). Special curves can be made for any degree required, with or without tangents on ends. Curves are generally driven by v-belt or similar type belt. They are powered separately or from connecting conveyors and can be reversible.

### Accumulation Conveyor

A specialized belt driven live roll conveyor designed to minimize or eliminate the back pressure under blocked load conditions, zero or low pressure being obtained through zone controlled type operation. The following are typical examples:
• **Movable Carrying Rollers** - The carrier rollers are mounted on inclined planes to relieve belt contact pressure when load is stopped.

• **Movable Pressure Rollers** - Auxiliary sensing rollers are used to release driving traction progressively by lowering sections of pressure rollers. The carrier rollers are always powered in the first section of the discharge end to assure product flow upon release of accumulated product.

• **Ripple Belt** - Primarily for low flow rate applications. Drive belt speed is much less than the load speed.

• **Special Shaped Rollers** - Deformed or eccentric carrier rollers or pressure rollers are rotated to a minimum drive position when the load is stopped. A ripple belt may be used for starting flow.

• **Spring Mounted Pressure Rollers** - Means to limit tractive force on carrier rollers.

Some of the above are proprietary and may be patented.

Counterweights or other mechanisms can also be used to maintain a controlled pressure between the belt and carrier rollers.

**Belt Selection**

A wide variety of belting types and materials is available for unit handling conveyor application (see Section 1, Definitions). Some of the considerations given to belt selection are cost, strength, surface friction, abrasion resistance, flexibility, dimensional stability, resistance to humidity conditions, noise generated by the belt, oils, greases, acids and chemicals. The conveyor manufacturer or belting manufacturer should be consulted to select the proper type of belt to suit the application.
SECTION 3 – TECHNICAL DATA

Symbols

Note: Units involved in the following terms are listed both in English and metric systems.

- BDLR  Belt Driven Live Roller
- BW    Belt Width, [in (cm)]
- Ci    Number of return rollers, [per ft (per m)]
- Cp    Number of pressure rollers, [per ft (per m)]
- Ct    Number of carrying rollers, [per ft (per m)]
- Eo    Drive Efficiency
- Fr    Friction factor for rollers
- Ft    Terminal loss and contingencies factor
- g     Acceleration factor (0.11 Nominal) * 
- h     Net change of elevation, [ft (m)]. Usually 0.0 for this type of conveyor.
- hp    Horsepower
- L     Conveyor length, [ft (m)]
- PIW   Belt rating, [pounds per inch of belt width (kilograms per centimeter of belt width)]
- psi   Pressure, [lb/in² (kg/cm²)]
- Ri    Unit weight of return roller less shaft, [lbs (kg)]
- Rp    Unit weight of pressure roller less shaft, [lbs (kg)]
- Rt    Unit weight of carrier roller less shaft, [lbs (kg)]
- T1    The larger belt tension at the drive pulley, [lbs (kg)]
- T2    The smaller belt tension at the drive pulley, [lbs (kg)]
- Te    Effective belt pull required to move the load, Te = T1 - T2, [lbs (kg)]
- v     Conveyor or belt speed, [fpm (m/min)]
- W     Total moving weight, [lbs/ft (kg/m)]
- Wb    Weight of belt, [lbs/ft (kg/m)]
- Wm    Weight of conveyed material, [lbs/ft (kg/m)]

*\[ g = \frac{\text{Estimated Acceleration (ft/s}^2)}{32.2 \text{ (ft/s}^2)} \]
Effective Belt Pull

\[ T_e = \left( F_r \times L \times \left( W_m + (2 \times W_b) + (R_p \times C_p) + (R_t \times C_t) \right) + (W_m \times h) + (W \times L \times G) \right) \]

(1)

Consideration must be given to the effects of varying load conditions.

Table 1. Friction and Contingency Factors

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<tr>
<td>(F_r)</td>
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<tr>
<td>(F_t)</td>
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Drive Horsepower

Driveshaft Horsepower = \( \frac{T_e \times V}{33,000} \) = hp … English or \( \frac{T_e \times V}{4500} \) = Watt… Metric

(2)

Motor Horsepower = \( \frac{\text{Driveshaft Horsepower}}{\text{Overall Drive Efficiency}} = \frac{hp}{E_o} \)

(3)

Chain drive efficiency can be assumed at 95%.

Gear Reducer efficiency should be obtained from the manufacturer’s literature.

Motors are rated at the following: 1/3, 1/2, 3/4, 1, 1-1/2, 2, 3, 5, 7-1/2, 10, etc. hp

Belt Tension

Table 2. Factors

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</tr>
<tr>
<td>215 deg</td>
<td>1.64</td>
<td>0.64</td>
</tr>
<tr>
<td>220 deg</td>
<td>1.62</td>
<td>0.62</td>
</tr>
<tr>
<td>240 deg</td>
<td>1.54</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Based on Table 2, belt tensions are computed by the following equations (Refer to ANSI / CEMA Standard B105.1 for graphical representation of the tension conditions):

\[ T_1 = K_1 \times T_e = (1 + K_2) \times T_e \quad (4) \]
\[ T_2 = K_2 \times T_e \quad (5) \]
\[ \frac{T_1}{T_2} = C \quad (6) \]

**Note:** The factors in Table 2 are compatible with normal conveyor applications using either automatic or manual take-up. For long, heavily loaded conveyors where manual take-up is used, it is acceptable practice, where experience dictates, to increase the \( K_2 \) factor by 20%. \( K_1 = 1 + K_2 \)

The factors \( K_1 \) and \( K_2 \) in Table 2 have been derived from the following equations to determine the required force between the belt and the drive pulley:

\[ K_1 = \frac{C}{C - 1} \quad (7) \]
\[ K_2 = \frac{1}{C - 1} \quad (8) \]

Where \( C \) is constant equal to \( 10^{0.00758 f a} \)

\[ 10^{0.00758} = e^{(a/180)} \text{ where } e = 2.7183 \]

\( f = \) coefficient of friction between conveying belt and drive pulley = 0.25 for bare steel pulley 0.35 for lagged pulley

\( a = \) arc of contact between belt and pulley (degree of wrap)
Example #1: Horizontal Belt Driven Live Roller Conveyor with End Drive

Known:
- Load = 45 lbs/ft, blocked
- Belt Speed = 30 fpm constant, D₁ = 4.082, D₃ = 5.032
- Belt Weight = 0.48 lbs/ft
- Carrier, Return, and Pressure Roller = weight of roller shell and bearings = 2.66 lbs per roller
- Conveyor Length = 100’ 0”
- Overall Drive Efficiency = 69% = Eₒ
- Belt Wrap = 220 deg at drive (lagged), 180 deg at tail

Using equation (1):

\[ Tₒ = \frac{L \times (W_m + (2 \times W_b) + (R_i \times C_i) + (R_p \times C_p) + (R_i \times C_i)) + (W_m \times h) + (W \times L \times G)}{F_i} \]

Since, G = 0 and h = 0, the above equation reduces to the following:

\[ Tₒ = \frac{L \times (W_m + (2 \times W_b) + (R_i \times C_i) + (R_p \times C_p) + (R_i \times C_i))}{F_i} \]

Using the following known values:
- \( W_m = 45 \text{ lbs/ft} \)
- \( W_b = 0.48 \text{ lbs/ft} \)
- \( L = 100 \text{ ft} \)
- \( R_i = R_r = R_p = 2.66 \text{ pounds per roller} \)
- \( C_i = 4 \text{ rollers per foot} \)
- \( C_r = 0.10 \text{ rollers per foot} \)
- \( C_p = 2 \text{ rollers per foot} \)

From Table 1:
- \( F_r = 0.075 \)
- \( F_i = 0.75 \)
Using equations (2) and (3):

\[ T_e = \frac{0.075 \times 100 \times (45 + (2 \times 0.48) + (2.66 \times 4) + (2.66 \times 2) + (2.66 \times 0.10))}{0.75} = 466.40 \text{ lbs} \]

Using equations (2) and (3):

Motor Horsepower = \( \frac{T_e \times v}{E_o \times 33,000} = \frac{466.40 \times 30}{0.69 \times 33,000} = 0.61 \text{ hp} \) Rounded to 3/4 hp

Using equations (4), (5), and Table 2:

\[ T_1 = K_1 \times T_e \] - Table 2, lagged drive pulley, belt wrap 220 deg

\[ T_2 = K_2 \times T_e \] \( K_1 = 1.30 \) and \( K_2 = 0.30 \)

\[ T_1 = 1.30 \times 466.40 \ldots \ldots \; T_1 = 606.32 \text{ lbs} \]

\[ T_2 = 0.30 \times 466.40 \ldots \ldots \; T_2 = 139.92 \text{ lbs} \]
Example #2: Belt Driven Live Roller Bed Conveyor with Center Drive

Known:
- Load = 50 lbs/ft
- Belt Speed = 60 fpm at discharge end from rest at infeed end
- Belt Width and Type = 12" wide, PVC
- Belt Weight = 0.48 lbs/ft
- Carrier, Return, and Pressure Rollers = weight of roller shell and bearings = 2.66 lbs per roller
- Conveyor Length = 50’ – 0”
- Overall Drive Efficiency = 69% = E_o
- Transport condition only
- Belt Wrap = 220 deg at drive (lagged)
  200 deg at tail

Using equation (1):

\[
T_e = \frac{\left( F_r \times L \times \left( W_m + (2 \times W_b) + (R_i \times C_i) + (R_p \times C_p) + (R_s \times C_s) \right) + (W_m \times h) + (W \times L \times G) \right)}{F_i}
\]

Since, h = 0, the above equation reduces to the following:

\[
T_e = \frac{\left( F_r \times L \times \left( W_m + (2 \times W_b) + (R_i \times C_i) + (R_p \times C_p) + (R_s \times C_s) \right) \right) + (W \times L \times G)}{F_i}
\]

Using the following known values:

\[ W_m = 50 \text{ lbs/ft} \quad C_i = 4 \text{ roller per foot} \quad G = 0.11 \]
\[ W_b = 0.48 \text{ lbs/ft} \quad C_i = 0.10 \text{ rollers per foot} \]
\[ L = 50 \text{ ft} \quad C_p = 2 \text{ rollers per foot} \]
\[ R_i = R_t = R_p = 2.66 \text{ pounds per roller} \]

From Table 1
\[ F_r = 0.075 \]
\[ F_i = 0.85 \]
\[ W = W_m + (2 \times W_b) + (R_e \times C_i) + (R_1 \times C_j) = 67.19 \text{ lbs} \]

\[
T_e = \frac{(0.075 \times 50 \times (50 + (2 \times 0.48) + (2.66 \times 4) + (2.66 \times 2) + (2.66 \times 0.10))) + (67.19 \times 0.11 \times 50)}{0.85}
\]

\[ T_e = 731.19 \text{ lbs for the Roller Bed} \]

Using equations (2) and (3):

\[
\text{Motor Horsepower} = \frac{T_e \times v}{E_o \times 33,000} = \frac{731.19 \times 60}{0.69 \times 33,000} = 1.93 \text{ hp} \text{ Rounded to 2 hp}
\]

Using equations (4), (5), and Table 2:

\[ T_1 = K_1 \times T_e \quad \text{- Table 2, lagged drive pulley, belt wrap 220 deg} \]
\[ T_2 = K_2 \times T_e \]

\[ K_1 = 1.35 \text{ and } K_2 = 0.35 \]

\[ T_1 = 1.35 \times 731.19 \text{........... } T_1 = 987.11 \text{ lbs} \]
\[ T_2 = 0.35 \times 731.19 \text{........... } T_2 = 255.92 \text{ lbs} \]