Papers in the Perspectives series have appeared in conference proceedings of the Material Handling Institute between 1992 and the present. As such they provide a point of reference as to how the industry is changing as well as insight into accepted practice during this period. In many cases the authors credited have either changed jobs or are no longer in the industry. Some companies as well have been the subject of mergers or reorganization with a new corporate identity.

THE BASICS OF CONVEYOR ENGINEERING (BELT, ROLLER AND GRAVITY)

BY

RICK GARRITY
MANAGER, SYSTEMS ENGINEERING
INTERLAKE CONVEYORS, INC.
300 HWY 44 EAST
SHEPHERDSVILLE, KENTUCKY 40165

ABSTRACT

Technology should not be applied as a goal but used as a means to reach a goal.

INTRODUCTION

Prior to the selection of any conveyor equipment, we must first have an in-depth understanding of the problem we need to solve. The understanding should ideally be understood by all areas that may be involved in the problem or solution. These areas may include operations, distribution, maintenance, marketing, MIS and management.

When the problem has been defined, a team with representatives (especially those who will operate the system) from all involved areas should be assigned to begin to explore solutions. Quite often these teams can recommend simple procedural changes that can save thousands of dollars in material handling purchases.
We must have a basic understanding of what any given technology’s capabilities are before we can apply it to solve our problem. This is why a basic understanding of conveyor engineering is required. Again, technology of any kind should never be applied just because it exists. It must improve your ability to meet your goals.

Any system design should have a planned design life, sometimes referred to as the “design year”. This is the projected capacity required, usually a minimum of 5 years from the current year. Utilize marketing input and manufacturing or processing ability to match the design year rate with the system capacity. As an example, it would not be a good business decision to put in a system that can run 1 20 cartons per minute at design year if your facility cannot physically accommodate the number of production machines, storage or truck docks that would be required for this rate.

To assist our team in the proper application of conveyor technology, we will be discussing the basic construction and technical capabilities for some of the most common types of conveyors utilized in conveyor systems.

The types of conveyors we will discuss are:

- Non-Powered Conveyor (commonly referred to as gravity conveyor)
- Powered Conveyor
  - Belt
  - Roller
  - Lineshaft (refer to separate paper by Mike Coleman, Interlake Conveyors, Inc., “The Basics of Lineshaft Conveyor Engineering”)
GRAVITY CONVEYOR

Gravity roller conveyors provide one of the most versatile and economical means of moving product. Gravity conveyors can quickly move large quantities of items in virtually any direction with a minimum of effort and expense.

Gravity conveyors move product in two ways:
1. on a pitch, utilizing the natural flow of gravity, or
2. on a level line where conveyance of the item is accomplished by pushing.

Gravity, or non-powered, roller conveyors are ideal for moving most unit loads which have a firm, flat bottom surface. They can be used in both permanent and portable applications.

To select the proper equipment for the required application, the following steps must be considered:

1. Load Characteristics
2. Conditions and Bearing Selection
3. Roller Center Spacing
4. Roller Capacity
5. Width and Settings
6. Frame Requirement
7. Support Capacity
8. Conveyor Pitch
9. Support Heights and Quantities

LOAD CHARACTERISTICS

The single, most important consideration to insure your system reliability is known as the Footprint: the bottom surface of the load which is to be conveyed. The load bottom must be firm and free of projections which could prevent smooth travel over rollers. A slip sheet could provide the necessary rigidity. If at this step, all load characteristics are not favorable, do not proceed. Consider power conveyor.

![Diagram of conveyor systems]

Check the condition of your pallets. Loose boards, not protruding will stop your system.
CONDITIONS AND BEARING SELECTION

CLEAN AND DRY
Plain Bearing

HIGH HUMIDITY
Dust-tight Grease Packed or Greaseable Bearing

DUSTY
Dust-tight Bearing

EXCESSIVE HEAT
Plain or Greaseable Bearing

BEARINGS

OPEN DRY BEARING
Open dry bearings offer the least resistance to turning of all bearing types. They are constructed with an outer shield, which is fixed to the stationary inner race of the bearing and does not touch any rotating part. Manufactured with a light oil lubricant, the open dry bearing gives satisfactory results in most normally clean, dry, indoor applications.

DUST PROTECTED BEARINGS
Dust protected bearings, non-lubricated, have the same easy rolling action as a plain bearing because the dust shield is a non-contact type seal. The shield which is fit to the stationary inner race does not touch any rotating parts of the bearing. In a reasonably moisture-free environment, excellent results are achieved with absolutely no lubrication.

FACTORY LUBRICATED BEARINGS
The lubricated bearings are similar in construction to the dust protected incorporating the same dust shield arrangement with an additional rear grease seal.

The factory lubricated bearings are recommended for all powered roller applications, both for live roller and belt conveyor applications. Caution should be used in applying this construction in areas where excessive grit or dust exists, as there are no means provided for regreasing these bearings as there are with pressure-lubricated construction.

PRESSURE LUBRICATED BEARINGS
The pressure lubricated bearings are similar in construction to the factory lubricated bearings; however, requiring in application the necessity of drilling the hex axle for grease fittings for delivery of grease to internal parts of the bearing. Grease delivered under pressure to the interior of the bearings forces out old grease, thereby producing a new effective seal. The advantages of the re-greasable feature are obvious when considering application in extremely dirty environments.
DETERMINE ROLLER CENTER SPACING

A MINIMUM OF THREE ROLLERS MUST SUPPORT THE SMALLEST UNIT LOAD.

Divide the minimum package length you anticipate conveying in your system by three (or the number of rollers needed) to arrive at the roller center to center distance. Choose a roller section with roller centers the same or less than this figure.

Formula:

Maximum Roller Spacing = \frac{\text{Package Length (In.)}}{3}

Example:

\frac{18'' \text{ Long Package}}{3} = 6'' \text{ Roller Centers}

Note: Recommended maximum roller spacing is 12 inches.

DETERMINE ROLLER CAPACITY

Roller capacity is determined by dividing the weight of the heaviest load by the minimum number of rollers that will carry the load at any single moment.

Formula:

\frac{\text{Maximum Package Weight}}{\text{Minimum Capacity}} = \frac{\text{Number of Rollers Under Load}}{\text{Required Per Roller}}

Example:

\frac{198 \text{ lbs.}}{3} = 66 \text{ lb. Capacity Required Per Roller}

If drop or shock loading is anticipated rollers with a thicker gauge tube may be required to prevent denting or damage to the tubes.

Typical roll centers are 1 1/2", 3", 4 1/2", 6", 8", and 12"
Determine Width & Settings

Straight Sections
If your application consists only of straight conveyor sections, the recommended conveyor width is:

Conveyor Width = Package Width + 2 Inches

Set High
With this setting conveyor can be used with or without guardrail.

Set Low
With this setting conveyor slide frames act as guardrail.

Overhang Load
Minimum IF can be determined by the following formula:

\[ IF = \frac{\text{PACKAGE WIDTH}}{1.25} \]

Curve Units
If curves are required, the conveyor width (inside frame) must be based on the swing the package requires to stay within the conveyor frame.

Formula for Determining Distance Between Frame:

\[ IF = \sqrt{(W + R)^2 + (L / 2)^2} - (R - 2) \]

Curve Types

Straight Face Roller Curves
Straight faced rollers are recommended for curves where it is not objectionable for the package to slide against the outside guard rail. The pitch required on the curve will be more than that required for the straight sections.

Differential Construction
The differential effect of multiple roller construction facilitates the package in turning rather than skewing diagonally across the conveyor. This construction may have multiple rollers on a common shaft or a staggered roller pattern with intermediate frame rails to accommodate heavier loads. This curve will also require a greater pitch than a straight section.

Tapered Roller Curves
This curve provides the best possible performance in maintaining package orientation on the conveyor. The orientation in which a package enters the curve is duplicated at the exit of the curve. If the package enters square, it will exit square. Guard rails for these curves are not required; however, they are often provided as an additional safety measure for gravity applications. These curves require only slightly more pitch than a straight conveyor.
Determine Frame Requirement

To extend the life of the conveyor or to avoid damage from overloading, it is best to be on the safe side in calculating frame capacity. Allow for extra loading. In many cases conveyors are subjected to greater abuse and loads than they were intended for. Frame requirements should be carefully calculated. Locating supports on closer centers is one way to increase frame capacities.

In doing this, compare the cost of an increased frame to the number of extra supports to see which method is most economically feasible. When figuring capacities, include the weight of the conveyor section and be sure to check the capacities of each type of frame against the total load.

**Formula:**

**Live Load:** Multiply Number of Loads in 10'-0" Long Section x Weight of Each Load

+ **Dead Load:** Multiply Number of Rollers in 10'-0" Long Section x Weight on Each Roller

= Total Load

Determine Support Capacity

The supports to be selected must have a load carrying capacity equal to or greater than the maximum loading condition and weight of section itself.

**Condition “A”**

Non-coupled

\[
\text{END SUPPORT} = \text{TOTAL LOAD} / 2
\]

**Condition “B”**

Coupled

\[
\text{SUPPORT CAPACITY} = (\text{TOTAL LOAD PER 10'-0" SECTION}) / 2
\]

**Condition “C”**

\[
\text{END SUPPORT} = (\text{TOTAL LOAD PER 10'-0" SECTION}) / 4
\]

\[
\text{INTERMEDIATE SUPPORT CAPACITY} = (\text{TOTAL LOAD PER 10'-0" SECTION}) / 2
\]
DETERMINE CONVEYOR PITCH

Two conditions affect the determination of the conveyor pitch to be used. Generally speaking, the smoother and harder the load bottom, and greater the weight, the less pitch needed. For more uneven, softer (corrugated) bottom load, and lighter weight, more pitch is required. Consider these additional factors:

- Boxes with cords, straps or uneven bottoms
- The more rollers under the load, the more pitch needed.
- Rollers with lubricated bearings require more pitch and are usually better suited for powered conveyor.
- Pallet conditions — badly nailed, banded or indented pallets require more pitch.

The following chart can be a starting point to estimate pitch under normal room temperatures and conditions. Variances noted above should be considered. Advise your conveyor representative of the type of loads to be conveyed. He can make suggestions as to the pitch required. The final pitch must be determined at time of installation or prior testing with your product.

DETERMINE SUPPORT HEIGHTS AND QUANTITIES

SUPPORT HEIGHTS

Conveyor heights are generally considered to be the distance from the top of the rollers to the floor. To calculate support heights, (B), subtract the distance from the top of the roller to the bottom of the frame, (A), from the total conveyor height, (C), at the point the support will be located. The balance is the support height at that point.

Use your conveyor layout (or make one) to determine the quantity (by height) of conveyor supports necessary. Both top and full run side views are required to determine the number of sections, plot the pitch and calculate the height of each support.
POWERED CONVEYOR

Belt Conveyors — Types and Applications

Being the most versatile of power conveyors, belt conveyors are the most frequently used. One reason for the versatility is the “work surface” belt which can handle loads of almost any shape and over a moving platform for process or production work. Belt conveyors are also one of the least expensive power conveyors.

Slider Bed

The belt slides over a continuous metal bed which is attached between the tops of the conveyor channel frames. Because support for the entire belt surface is provided, the belt friction (30% friction coefficient) is increased, thus limiting loads to 52 lbs. per sq. ft. or less. Operation is quiet and the bed offers a no sag, no bump surface.

Slider bed conveyors are excellent for production work where small parts of varying sizes and shapes must be carried or assembled. The surface remains constantly flat.

Roller Bed

The belt rolls over rollers rather than a metal bed. Friction is greatly reduced thus smaller motors and drives can be used. For light loads, one roller is sufficient under each load but for heavier loads and inclines, two or more rollers should be used. (See your conveyor supplier for specific roller capacities.)
Inclines and Declines

When elevation must be changed, incline or decline belt conveyors are used at a maximum 30° angle.

This rule can only be used for evenly weighted loads! A vertical line dropped from the exact center of the load (center of gravity) should fall within the center one third of the bottom of the load. Outside of this area, the load would be unstable. If the weight within the carton is off center or unevenly distributed, do not use this rule! Testing may be necessary to determine the center of gravity and exact incline.

\[ \text{Correct} \]

\[
\begin{align*}
L & \quad \text{Length} \\
H & \quad \text{Height} \\
\frac{L}{H} & \quad \text{Incline Angle}
\end{align*}
\]

\[ \text{Wrong} \]

\[
\begin{align*}
\frac{L}{H} & \quad \text{Incline Angle}
\end{align*}
\]

Example:

A package is 28" L x 20" H x 12" W

\[ X'' = \frac{L}{H} \]

\[ X'' = \frac{28}{20} = 1.4 \]

Maximum incline angle = 25°

HANDY INCLINE TABLE

This chart is also to be used only with evenly weighted loads. Divide carton length by carton height to find:

\[ X'' = \frac{L}{H} \]

On the table the degree of incline next to your value of "X" will be the maximum incline guideline you should use.

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<th>&quot;X&quot;</th>
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<td>29°</td>
<td>1.662</td>
</tr>
<tr>
<td>30°</td>
<td>1.732</td>
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BOOSTER CONVEYOR

This is a term applied to a belt conveyor used to "boost" loads up at a slight elevation (not more than 15°). Boosters are generally used in gravity accumulation lines where elevation must be brought up to original levels.

FEED CONVEYORS

All incline, or decline, conveyors over 15° angle require a "feeder" conveyor to prevent the tops of closely spaced loads from pinching or crushing. Feeders are generally short (but at least twice the width of the belt, or longer if loads are long).

A feeder feeding onto an incline must be set slower than the speed of the incline conveyor. A feeding removing loads from a decline conveyor must be set faster than the decline unit. (See Meter Spacing Belts.)

METER OR SPACER BELTS

Meter or spacer belts are used to separate loads with a specified space distance between each load.

To determine the conveyor speed (in feet per minute FPM) required to space unit loads at a specified distance, follow this formula:

\[ FPM = (LL+S) \times LPM \]

- FPM = Feet per minute.
- LL = Load length (in feet).
- S = Space between loads (in feet).
- LPM = Loads per minute being fed to spacer belt.

Spacer belt speed in ft. per min. = (Load length + space desired between loads) \times \text{the number of loads per minute being fed to spacer belt}.

Example: Should 3 ft. long loads be fed to the spacer belt at the rate of 20 loads per minute and the desired space between loads is 18", then the FPM rate of the spacer belt should be set at 90 FPM.

\[ 90 \text{ FPM} = (3 + 1.5) \times 20 \]

BRAKE BELTS

Generally, brake belt conveyors are used at the ends of gravity or powered accumulation conveyors* to "brake," slow the line or reduce space between packages.

Brake-Belts are usually slider bed belt conveyors with a roughtop belt to achieve a maximum amount of friction. The general formula for finding how long a brake belt conveyor should be is to divide the total length of the maximum accumulated load* by 6.

*NOTE: This formula applies to "MR" conveyor only.

\[ \frac{\text{Total length of accumulated load}}{6} = \text{Brake Belt Length} \]

Example: suppose you have a proposed maximum accumulated load length of 78 feet. Divide by 6:

\[ \frac{78}{6} = 13 \]

You would need a 13 ft. Brake Belt.
NOSEOVERS
Adjustable vertical noseovers are used at the top of incline conveyors to provide a smooth transfer of load to a horizontal conveyor without "dropping" the leading edge. Noseovers are suggested for inclines over 10 degrees and are considered a requirement for any slope over 15 degrees. Interlake adjustable vertical noseovers are fully adjustable for 0° to 30°.

ROLLER CONVEYOR
Belt Driven Live Roller Conveyor
-Types and Applications
Belt driven live roller conveyor is widely used for cartons, boxes or tote pans. Live roller offers easier adaptability to transferring or diverting loads than does belt conveyor.
Live roller conveyors must be kept as horizontal as possible for effective transport of product.

Adjustable Pressure Belt Driven Live Roller Conveyor
Live roller conveyors that are belt driven are a versatile conveyor offering many benefits. Loads ride directly on the steel carrier rollers that provide easy movement with a minimum of power. Loads are easily merged, deflected or transferred. Conveyable loads must have flat, smooth, hard, bottoms.

One type of BDLR utilizes numbered cams affixed to the shaft of the pressure rollers. These rollers can be adjusted up or down in stages. This movement increases or decreases, respectively, the amount of driving force transmitted from the belt to the carrier rollers. As a result, the belt driven live roller conveyor is excellent for both general horizontal transporting and moderate accumulation.
Adjustable pressure rollers can be set to use less force on a straight-away or more force at a transfer of diverting point. Less pressure extends both the drive belt and roller life.
Zoned Zero Pressure Accumulation B.D.L.R. Conveyor

ZZPA is a belt driven live roller conveyor with air controlled zones to accomplish a "zero-driving" force of the conveyed product at the accumulation point. The product introduced onto the conveyor will travel uninterrupted at the given speed to the exit end of the conveyor where it will either continue on to the next conveyor or stop in accumulation mode, depending on the designed mode of operation. Once the initial product is stopped on the ZZPA conveyor, a box hitting the first sensor roll upstream of product flow will cause the driving force under that box to cease in that zone. This is accomplished by dropping the tension rolls away. When the sensor roll is depressed, it also primes the next zone upstream so it will go to "zero drive" when depressed and so on until the conveyor line is completely full. A ZZPA conveyor being fed from a non-accumulating conveyor should have a full line photo-eye to stop the feeding conveyor once the ZZPA is full, otherwise, the zero pressure feature will be defeated. Once the first initial product is removed, the next zone upstream becomes unprimed, in turn becoming a driving zone, and so on until all the product is moving.
Minimum Pressure Accumulation B.D.L.R. Conveyor

"MR" conveyor is a minimum pressure accumulation conveyor. The MR performs two key package accumulation functions:

- Training or Slug Discharge
- Package Singulation

One design is as follows:

The "MR" conveyor operates as a normal belt driven live roller conveyor. The difference is in a pressure relieving feature consisting of each carrying roll axles in a bushing rising in a specially designed ramp type slot. The rollers ride in the lower portion of the slot when the conveyor is used as straight transport conveyor, (see detail "A"). As soon as a load meets an obstruction, such as a stopped or blocked load, an opposite reaction causes the carrying roll bushing to roll up the ramp slot, (see detail "B"), thus relieving some of the pressure between the belt and carrying rolls. When the obstruction is removed the carrying rolls will return back to their original lower position, thus re-engaging with the drive belt, (see detail "C"). The "MR" conveyor accumulates packages with:

- Minimum pressure
- Minimum systems wear
- Maximum efficiency

Packages move freely and immediately when they are released.

The MR conveyor, without any additional controls or mechanical hardware, provides slug discharge — forwarding packages end to end. It can also operate in conjunction with a brake-metering belt to perform package singulation — forwarding individual packages at evenly-spaced intervals. The MR conveyor requires no more maintenance than a standard belt driven live roller conveyor. Adjustable dial cam feature offers the most efficient method available to achieve variable pressure control for the driving action. The MR can operate at slower rates than other types of accumulation conveyors because the MR can be used to perform a slug release function. The MR requires less footage to absorb a given degree of surge.

This style of conveyor requires minimal case size weight variation with uniform ends. Also, cartons should be columnized to minimize carton jams and skewing.

![Diagram of conveyor system with details A, B, and C, showing the movement of packages through the conveyor system.](image-url)
Photoeye Sensors vs. Sensor Rollers

Sensor rollers are compatible with product which will convey on lineshaft conveyor and weighs 5 pounds or more. Photoeye sensing should be used if any of the following conditions are encountered:

- Tapered totes
  Tote pans with tapered sides create a void between loads which a sensor roll will not detect. The conveyor will not drop into accumulation properly if the sensor roll is not depressed.

- Photoeyes can be skewed up to 15° off perpendicular to prevent “seeing through the gaps.”

- Light packages: Cases, envelopes, etc., less than 5 pounds are prime candidates for photoeye sensors.

- Non-marring surfaces: Product which cannot be marred sometimes requires coated rollers. The sensor roller is aluminum and cannot be coated.

- Uneven bottom surfaces: The sensor roller will project 1/8”-1/4” above the carrying surface; cases with rounded bottoms may not depress the sensor.

- Loads pushed on, thrown on, or conveyed on from the side of a lineshaft ZP conveyor may damage the sensor roller.

Some applications require that the photoeye be adjusted down to look at a reflector under the carrying surface. As long as the eye can see any part of the reflector, the eye will not be “blocked.” This creates a blind area on the conveyor surface. This is not a good application if small cases can pass by the eye without being sensed and if the operators are not instructed to push the cases across the conveyor to the photocell side.
Belt Driven Live Roller Curves

Belt driven curves are used with live roller conveyors. However, their use does have some limitations, such as it can be used for transportation only and cannot accumulate. Pressure rollers are not used in curves. In their place, sheaves along the inner frame (smaller radii) are used to guide a V-Belt and apply belt pressure to the carrying rollers. The carrying rolls thru the curve are tapered to keep loads properly aligned. There is a maximum 400 lb. limit of distributed load per curve. Powered curves generally operate faster than straight conveyors to keep loads separated and from “bumping” each other.

CHAIN DRIVEN LIVE ROLLER CONVEYOR

Chain driven live roller conveyors utilize a roller bed for the carrying space. They provide controlled movement of a great variety of commodities from the lightest to the heaviest loads. Unit loads travel directly on the roller surface.

The positive drive afforded by chain on sprockets makes chain driven live roller conveyor the choice for heavy loads (pallets, etc.) and for conveyors used in applications where heat, dirt, oil, grease or other contaminants may cause belt damage. Two sprockets are welded to each roller and individual loops of chain connect rollers in a staggered pattern. The driving chain or chains are at one end of the roller s and are shielded or guarded. This driving arrangement is desirable for heavy loads and for applications which require frequent stopping or reversing.

The path is usually level, but can be slightly inclined or declined, limited by the coefficient of friction between the rollers and the load. Because the drive is positive, there is no slippage; all rollers turn at the same speed. Both straight sections and curves are available.

![Diagram of Belt Driven Live Roller Curves]

UNIT LENGTH (EVEN MULTIPLES OF ROLL CENTERS)
Guidelines for Selecting and Sizing Powered Conveyor

When products must be moved horizontally, up an incline, around curves or down steep declines, powered conveyors must be used. They allow continuous control of unit loads in all these situations. Powered conveyors can be used as single units or combined in many ways to build a complete material handling conveyor system.

To determine the proper Powered Conveyor for a particular application, it will be necessary to become familiar with the following steps:
1. Type required
2. Calculating conveyor load capacity
3. Calculating conveyor speed

SELECTING CONVEYOR TYPE

LOAD CHARACTERISTICS:
- For loads with irregular shaped or uneven bottom — use belt conveyor.
- Flat bottom load, corrugated, wood, metal or plastic — use belt or live roller. Application to determine type.
- Horizontal travel only — use belt or live roller. Application determines type.
- Heavy loads — use chain driven live roller or multi-strand chain.

APPLICATIONS AND CONVEYOR RECOMMENDATIONS:
- General horizontal transportation:
  - Horizontal belt
  - Belt driven live roller
  - Chain driven live roller
  - Lineshaft
- Warehousing:
  - Horizontal belt
  - Belt driven live roller
  - Belt driven accumulation roller
  - Lineshaft
- Accumulation:
  - Belt driven accumulation roller
  - Lineshaft
- Assembly line:
  - Horizontal belt
  - Chain driven live roller
  - Belt driven live roller
  - Belt driven accumulation roller
  - Lineshaft
- Order picking:
  - Horizontal belt
  - Belt driven live roller
  - Lineshaft
- Processing:
  - Horizontal belt
  - Belt driven live roller
  - Chain driven live roller
  - Lineshaft
- In-process storage:
  - Belt driven live roller
  - Belt driven accumulation roller
  - Lineshaft
- High speed sortation:
  - Belt driven live roller
  - Horizontal belt
  - Lineshaft
- Change of elevation:
  - Incline/decline belt
  - Vertical lifts
- Controlled load spacing:
  - Horizontal belt
  - Belt driven accumulation roller
  - Lineshaft
- Pallet loads:
  - Chain driven live roller
  - Multi-strand chain
  - Heavy Duty Lineshaft
- AS/RS input/output:
  - Chain driven live roller
  - Multi-strand chain
- Packaging & palletizing infeed:
  - Horizontal belt
  - Belt driven live roller
  - Belt driven accumulation
  - Chain driven live roller
  - Lineshaft
CALCULATING CONVEYOR SPEED

Speeds will vary according to production or other equipment rates. Generally conveyor speeds will be slightly faster than production rates and must not be slower. Use this formula to arrive at conveyor speed:

\[
\text{Load length in ft. x Production rate in loads per minute = Conveyor Speed FPM}
\]

Example: Cartons 3 ft. long weighing 30 lbs. are leaving production at 15 per minute. Conveyor (FPM) speed (minimum) should be 45 feet per minute.

Minimum Speed = \( \frac{30 \text{ lbs.}}{3} = 10 \text{ lbs./ft.} \)

(Recommended Speed = 60 FPM)

Note: Always base the conveyor speed on "Peak Rates."

CALCULATING CONVEYOR LOAD CAPACITY

3A. TRANSPORTING LOADS:

To find the Load per Foot (LF) of a conveyor transporting loads in a continuous stream with little or no space between loads use one foot weight of the heaviest carton.

Example: A carton 3 ft. long weighs 30 lbs.

\[
LF = \frac{30 \text{ lbs.}}{3} = 10 \text{ lbs./ft.}
\]

To find the load per foot (LF) of spaced loads, use the formula:

\[
LF = \frac{\text{Maximum Carton Wt. x Cartons per minute}}{\text{Conveyor speed in ft. per minute}}
\]

Example: Cartons 3 ft. long weighing 30 lbs. are traveling at 60 ft. per minute at 15 per minute:

\[
LF = \frac{30 \text{ lb. carton} \times 15 \text{ per minute}}{60 \text{ ft. per minute}} = 7.5 \text{ lbs./ft.}
\]

3B. ACCUMULATION

To find the load per foot (LF) of a conveyor accumulating loads in a continuous stream with no space between loads use one foot weight of the heaviest carton.

Example: A carton 3 ft. long weighs 30 lbs.

\[
LF = \frac{30 \text{ lbs.}}{3} = 10 \text{ lbs./ft.}
\]

LIMITATIONS AND SUGGESTIONS

1. Live roller conveyor should be horizontal. However, if pitch is unavoidable it should not exceed 5°.
2. Belt conveyors are used for inclines or declines up to 30°. Consideration should be given to the load characteristics and type of belting in determining the degree of pitch.
3. Curves are available in live roller as well as belt conveyors. However, belt curves are generally more expensive than roller CURVES.
   On the other hand, straight belt conveyors generally cost less than straight live roller units.
4. Extremely heavy loads may require multi-strand chain conveyor.
5. On incline/decline conveyors over 13°, rough belting is used.
ACCESSORIES

When designing a complete conveyor system, it is rare that numerous accessories are not required along with the actual conveyors. Accessories are used to control flow. They stop, combine, divert and perform other functions in the systems. Shown here are some of the accessories and their functions:

SPUR FOR LIVE ROLLER

The use of spurs is to merge loads onto or off of live roller conveyors. Deflectors must be used in situations where loads are diverted off of the main line.

90° ROLLER SPURS

These are used for the same purpose as 30° spurs except to move loads at 90° to the main line. Therefore, curves are used for this purpose. As in 30° straight spurs, deflectors are required in situations when diverting loads off of the main line.

STOPS

Stops to halt loads in any desired section of conveyor are available as a roller which “pops-up” to halt the loads. They can be manually or automatically air operated and are used in gravity roller or live roller applications. Loads are allowed to pass over the stop roller when it is in the lowered position.
ACCESSORIES

ROLLER TURNING POSTS

When transferring loads from one conveyor to another at 90° or more, turning rolls installed at the corner of the turn facilitate turning and help protect the carton load from damage or hang-up.

POWERED TRANSFERS — 90°

In cases where transfer forces are desired other than deflectors, powered transfers are available. These are either wheel, belt or chain transfers that raise or lower within the transfer intersection to change loads from one conveyor to another. For complete weight and speed specifications on these units, consult your conveyor supplier.

TRAFFIC COP

"Traffic cop" is the name applied to a mechanical arm which is used to stop loads and control the load flow at a merging of two conveyor lines. Pivoting arms operate independently to stop or release the correct loads into the merging situation, and operate on a "First come-First served" basis.

TRAFFIC COPS CAN BE USED
AT MERGING PARALLEL CONVEYORS
30, 45 and 90 DEG. MERGING CONVEYORS
ACCESSORIES

FIXED OR MOVABLE DEFLECTORS

When it is desirable to deflect loads onto spurs, from one conveyor line to two or more, or to merge two parallel conveyors into one, deflectors are used. They can be either manually or automatically operated. When automatically operated, timing, size and weight of load and the speed of the conveyor are factors to be considered.

PUSHERS

Used for 90° transfers when packages are required to be transferred from one lane to another in parallel conveyor lanes.
SUMMARY

To insure a cost effective solution to material handling problems, we must:

• Obtain an in-depth understanding of the problem
• Assemble a team of all involved parties to work toward an efficient organizationally agreeable solution to the problem.
• Obtain enough understanding of proposed technological solution capabilities to apply the technology as needed to reach a cost effective solution. Apply technology only when it is required.