Department of Mining, Dressing and Transport Machines AGH

Belt Conveyors for Bulk Materials Calculations by CEMA 5th Edition

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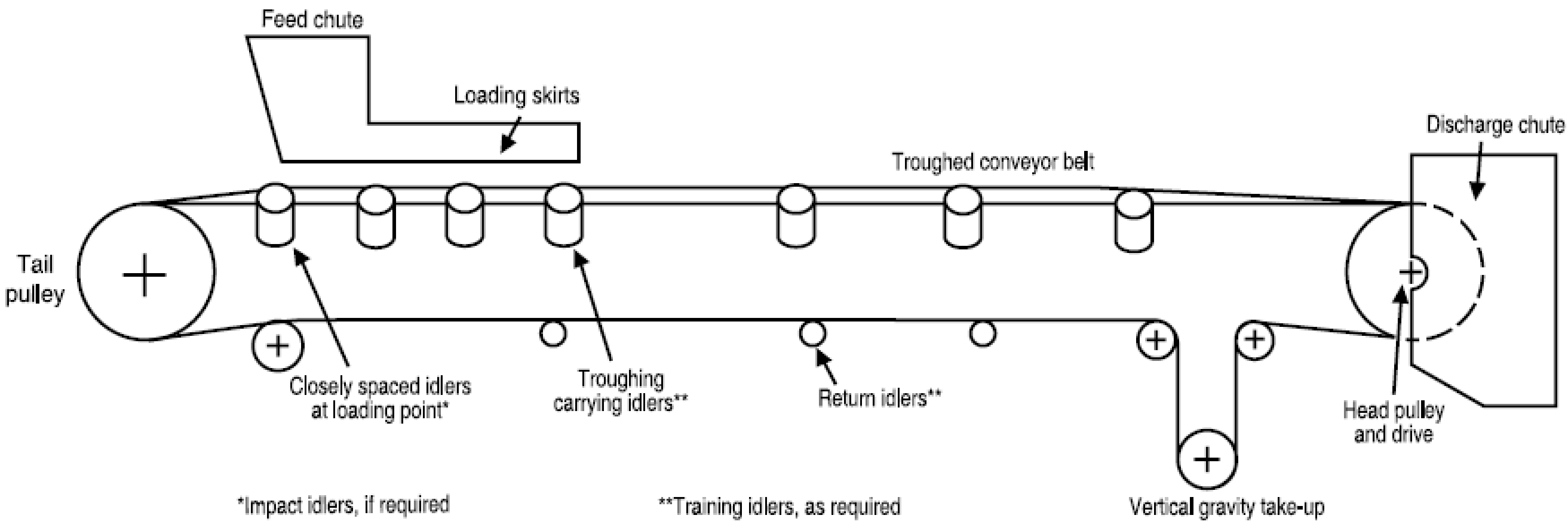
Nomenclature of components of a typical belt conveyor



TYPICAL BELT CONVEYOR TRAVEL PATHS

Figure 2.2 Horizontal belt.

Figure 2.3 Horizontal and ascending path, when space will permit vertical curve and belt strength will permit one belt.

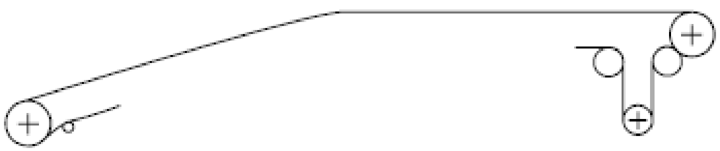


Figure 2.4 Ascending and horizontal path, when belt tensions will permit one belt and space will permit vertical curve.

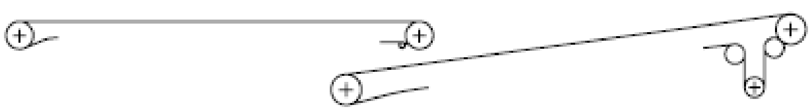


Figure 2.5 Possible horizontal and ascending path, when space will not permit a vertical curve or when the conveyor belt strength requires two belts.

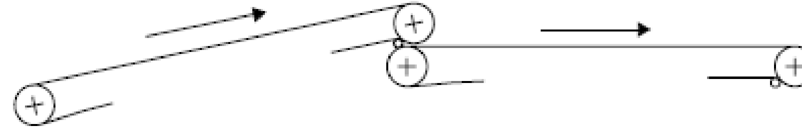


Figure 2.6 Ascending and horizontal path, when advisable to use two conveyor belts.

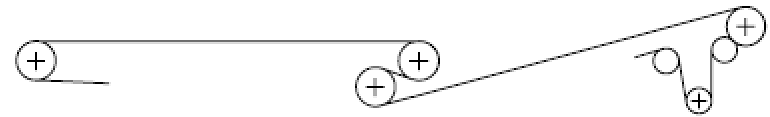


Figure 2.7 Possible horizontal and ascending path, when space will not permit vertical curve but belt strength will permit only one belt.

Figure 2.8 Compound path with declines, horizontal portions, vertical curves, and incline.

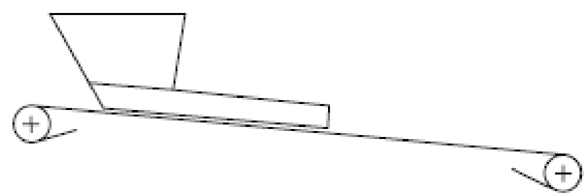


Figure 2.9 Loading can be accomplished, as shown, on minor inclines or declines.

Design Considerations

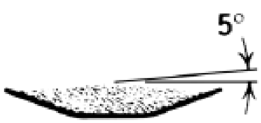
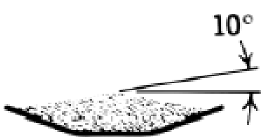
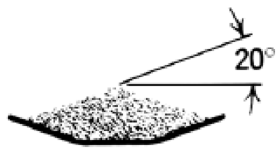
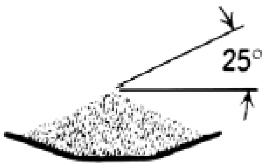
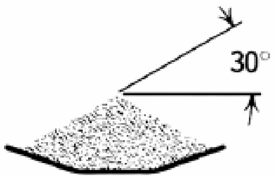
- Characteristics and Conveyability of Bulk Materials
- Capacities, Belt Widths, and Speeds
- Belt Conveyor Idlers
- Belt Tension, Power, and Drive Engineering
- Belt Selection
- Pulleys and Shafts
- Vertical Curves
- Steep Angle Conveying
- Belt Takeups, Cleaners, and Accessories
- Conveyor Loading and Discharge
- Conveyor Motor Drives and Controls
- Operation, Maintenance, and Safety

Characteristics and Conveyability of Bulk Materials

- The **angle of repose** of a material is the acute angle which the surface of a normal, freely formed pile makes to the horizontal.

- The **angle of surcharge** of a material is the angle to the horizontal which the surface of the material assumes while the material is at rest on a moving conveyor belt.This angle usually is 5 degrees to 15 degrees less than the angle of repose, though in some materials it may be as much as 20 degrees less.

Flowability–angle of surcharge–angle of repose

Flow				
Very free flowing 1*	Free flowing 2*	Average flowing 3*		Sluggish 4*
Angle of Surcharge				
5°	10°	20°	25°	30°
				
Angle of Repose				
0-19°	20-25°	30-34°	35-39°	40° - up
Material Characteristics				
Uniform size, very small rounded particles, either very wet or very dry, such as dry silica sand, cement, wet concrete, etc.	*Rounded, dry polished particles, of medium weight, such as whole grain and beans.*	*Irregular, granular or lumpy materials of medium weight, such as anthracite coal, cottonseed meal, clay, etc.*	*Typical common materials such as bituminous coal, stone, most ores, etc.*	*Irregular, stringy, fibrous, interlocking material, such as wood chips, bagasse, tempered foundry sand, etc.*

Characteristics of Bulk Solid Materials - CEMA

	Material Characteristics	Code
Size	Very fine—100 mesh and under Fine—1/8 inch and under Granular—Under 1/2 inch Lumpy—containing lumps over 1/2‘ inch Irregular—stringy, interlocking, mats together	A B C D E
Flowability Angle of Repose	Very free flowing—angle of repose less than 19° Free-flowing—angle of repose 20° to 29° Average flowing—angle of repose 30° to 39° Sluggish—angle of repose 40° and over	1 2 3 4
Abrasiveness	Nonabrasive Abrasive Very abrasive Very sharp—cuts or gouges belt covers	5 6 7 8
Miscellaneous Characteristics (Sometimes more than one of these characteristics may apply)	Very dusty Aerates and develops fluid characteristics Contains explosive dust Contaminable, affecting use or saleability Degradable, affecting use or saleability Gives off harmful fumes or dust Highly corrosive Mildly corrosive Hygroscopic Interlocks or mats Oils or chemical present—may affect rubber products Packs under pressure Very light and fluffy—may be wind-swept Elevated temperature	L M N P 0 R S T U V W X V Z

Example: A very fine material that is free-flowing, abrasive, and contains explosive dust would be designated: **Class A26N.**

Material characteristics and weight per cubic foot - CEMA

Material	Average weight (lbs/cu ft)	Angle of repose (degrees)	Recommended maximum inclination (degrees)	Code
Ashes, fly	40-45	42	20-25	A37
Cement, Portland	72-99	30-44	20-23	A36M
Coal, anthracite, river, or culm, ⅛ inch and under	60	35	18	B35TY
Coal, lignite	40-45	38	22	D36T
Copper ore	120-150	30-44	20	*D37
Dolomite, lumpy	80-100	30-44	22	D36
Gravel, dry, sharp	90-100	30-44	15-17	D37
Lignite, air-dried	45-55	30-44		*D35
Rock, soft, excavated with shovel	100-110	30-44	22	D36
Salt, common dry, fine	70-80	25	11	D26TUW
Sandstone, broken	85-90	30-44		D37
Wood chips	10-30	45	27	E45WY
Coal, anthracite, river, or culm,1/8 inch and under	60	35	18	B35TY
Coal, anthracite, sized	55-60	27	16	C26
Coal, bituminous, mined 50 mesh and under	50-54	45	24	B45T
Coal, bituminous, mined and sized	45-55	35	16	D35T
Coal, bituminous, mined, run of mine	45-55	38	18	D35T
*Coal, bituminous, mined, slack,1/2 inch and under	43-50	40	22	C35T
Coal, bituminous, stripping, not cleaned	50-60			D36T
Coal, lignite	40-45	38	22	D36T

Belt Widths

- The belt widths are as follows: 18, 24, 30, 36, 42, 48, 54, 60, 72, 84, and 96 inches.

- The width of the narrower belts may be governed by the size of lumps to be handled. Belts must be wide enough so that any combination of prevailing lumps and finer material does not load the lumps too close to the edge of the conveyor belt.

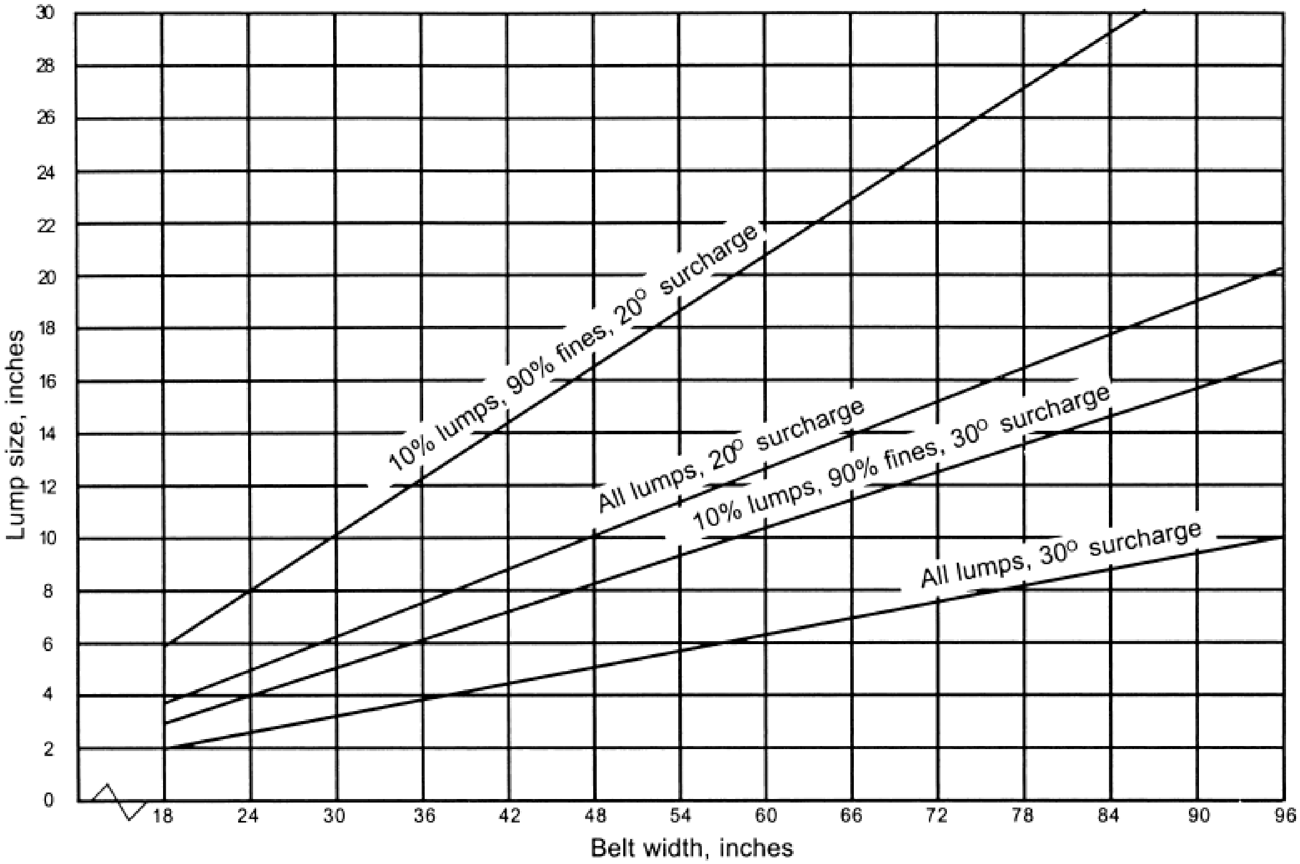


Figure 4.1 Belt width necessary for a given lump size. Fines: no greater than 1/10 maximum lump size.

Recommended maximum belt speeds

1 m/s = 196,85 ft/min

1 ft = 0.3048 m

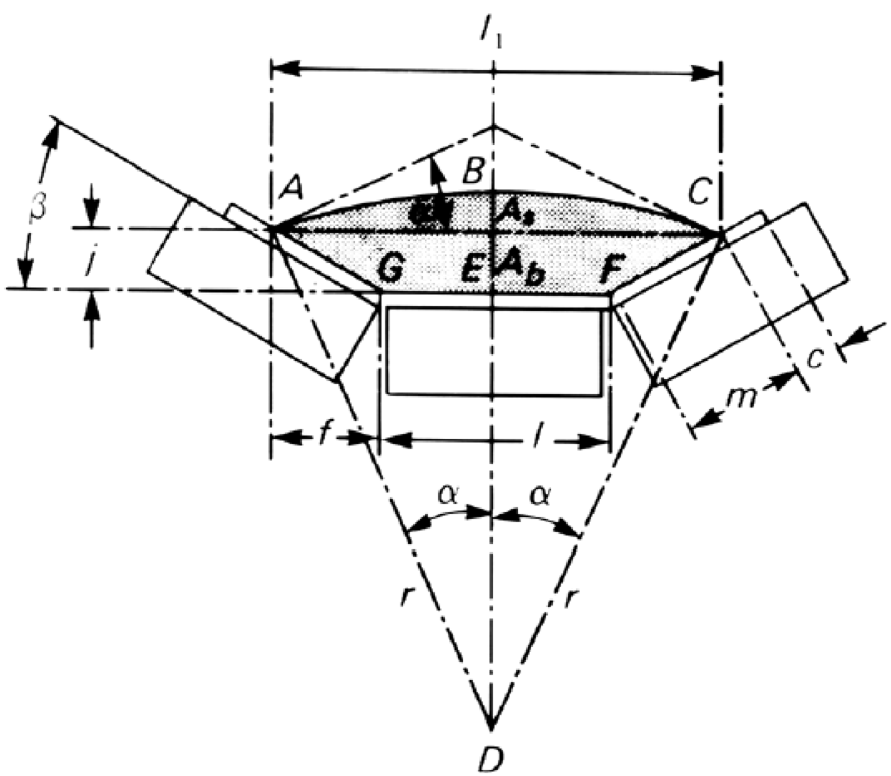
Material Being Conveyed	Belt Speeds (fpm)	Belt Width (inches)
Grain or other free-flowing, nonabrasive material	500	18
	700	24-30
	800	36-42
	1000	48-96
Coal, damp clay, soft ores, overburden and earth, fine-crushed stone	400	18
	600	24-36
	800	42-60
	1000	72-95
Heavy, hard, sharp-edged ore, coarse-crushed stone	350	18
	500	24-36
	600	Over 36
Foundry sand, prepared or damp; shake-out sand with small cores, with or without small castings (not hot enough to harm belting)	350	Any width
Prepared foundry sand and similar damp (or dry abrasive) materials discharged from belt by rubber-edged plows	200	Any width
Nonabrasive materials discharged from belt by means of plows	200, except for wood pulp, where 300 to 400 is preferable	Any width
Feeder belts, flat or troughed, for feeding fine, nonabrasive, or mildly abrasive materials from hoppers and bins	50 to 100	Any width

Example: Belt Conveyor Parameters

- Coal, anthracite, sized
- Capacity: 1000 tph
- Length: 1000 m → 3300 feet
- Lift: 115 feet

- Belt speed: 600 fpm
- Belt width: 42 inches

Area of load cross section



α = angle of surcharge, degrees

β = angle of idler roll, degrees

A_s = area of surcharge, square inches

A_b = base trapezoidal area, square inches

l = length, one edge of trapezoidal area, inches

l_1 = length, other edge of trapezoidal area, inches

j = height of trapezoidal area, inches

m = slant length trapezoid, inches

r = radius of surcharge arc, inches

f = horizontal projection of slant side of trapezoid, inches

c = edge distance, edge of material to edge of belt, inches

b = width of belt, inches

Standard edge distance $c = .055\,b + 0.9$, inches

Belt Conveyor Capacity Table

1 lb = 0.4536 kg

1 ft^3 = 0.0283 m^3

1. Determine the surcharge angle of the material.

Coal, anthracite, sized	27

   - *The surcharge angle, on the average, will be 5 degrees to 15 degrees less than the angle of repose.*

   *(ex. 27° - 12° = **15°**)*

2. Determine the density of the material in pounds per cubic foot (lb/ft^3).

Coal, anthracite, sized	55-60

3. Choose the idler shape.
4. Select a suitable conveyor belt speed.
5. Convert the desired tonnage per hour (tph) to be conveyed to the equivalent in cubic feet per hour (ft^3/hr).

$$ft^3/hr = \frac{\text{tph} \times 2000}{\text{material density}}$$

   (ex. 1000 tph x 2000 / 60 = 33333 ft^3/hr*)*

6. Convert the desired capacity in cubic feet per hour to the **equivalent capacity** at a belt speed of 100 fpm.

$$\text{Capacity (equivalent)} = (ft^3/hr) \times \left(\frac{100}{\text{actual belt speed (fpm)}}\right)$$

   (ex. Capacity (eqiuv) = 33333 x (100 / 600 fpm) = 5555 ft^3/hr

7. Find the appropriate belt width
8. Selected belt speed may require revision

Belt Conveyor Capacity Table

1 lb = 0.4536 kg

1 ft^3 = 0.028 m^3

1 ft^2 = 0.093 m^2

Table 4-3. 35-degree troughed belt—three equal rolls standard edge distance = 0.055*b* + 0.9 inch.

Belt Width (Inches)	A_t - Cross Section of Load (ft^2)							Capacity at 100 FPM (ft^3/hr)						
	Surcharge Angle							Surcharge Angle						
	0°	5°	10°	15°	20°	25°	30°	0°	5°	10°	15°	20°	25°	30°
18	.144	.160	.177	.194	.212	.230	.248	864	964	1066	1169	1274	1381	1492
24	.278	.309	.341	.373	.406	.440	.474	1668	1857	2048	2241	2438	2640	2847
30	.455	.506	.557	.609	.662	.716	.772	2733	3039	3346	3658	3975	4300	4636
36	.676	.751	.826	.903	.980	1.060	1.142	4058	4508	4961	5419	5886	6364	6857
42	.940	1.044	1.148	1.254	1.361	1.471	1.585	5644	6266	6891	7524	8169	8830	9511
48	1.248	1.385	1.523	1.662	1.804	1.949	2.099	7491	8312	9138	9974	10825	11698	12598
54	1.599	1.774	1.950	2.128	2.309	2.494	2.686	9598	10646	11700	12768	13855	14969	16118
60	1.994	2.211	2.429	2.651	2.876	3.107	3.345	11966	13269	14580	15906	17257	18642	21058
72	2.913	3.229	3.547	3.869	4.197	4.532	4.879	17484	19378	21285	23215	25182	27196	29275
84	4.007	4.440	4.876	5.317	5.766	6.226	6.701	24043	26641	29256	31902	34597	37360	40210
96	5.274	5.842	6.415	6.994	7.584	8.189	8.812	31645	35058	38490	41966	45506	49134	52876

Idler Spacing

Factors to consider when selecting idler spacing are **belt weight**, **material weight**, **idler load rating**, **belt sag**, **idler life**, **belt rating**, **belt tension**, and **radius in vertical curves**

Table 5-2. Suggested normal spacing of belt idlers (S_i).*

Belt Width (inches)	Troughing Idler Spacing						Return Idlers
	Weight of Material Handled, lbs/cu ft						
	30	50	75	100	150	200	
18	5.5	5.0	5.0	5.0	4.5	4.5	10.0
24	5.0	4.5	4.5	4.0	4.0	4.0	10.0
30	5.0	4.5	4.5	4.0	4.0	4.0	10.0
36	5.0	4.5	4.0	4.0	3.5	3.5	10.0
42	4.5	4.5	4.0	3.5	3.0	3.0	10.0
48	4.5	4.0	4.0	3.5	3.0	3.0	10.0
54	4.5	4.0	3.5	3.5	3.0	3.0	10.0
60	4.0	4.0	3.5	3.0	3.0	3.0	10.0
72	4.0	3.5	3.5	3.0	2.5	2.5	8.0
84	3.5	3.5	3.0	2.5	2.5	2.0	8.0
96	3.5	3.5	3.0	2.5	2.0	2.0	8.0

* Spacing indicated in feet. Spacing may be limited by load rating of idler. See idler load ratings in Tables 5-7— 5-11.

Example: Belt Conveyor Parameters

- Belt speed: 600 fpm
- Belt width: 42 inches
- Trough Angle: 35°
- 5555 [ft^3/hr] / 7524 [ft^3/hr] = 74%
- Idler spacing: 4.5 feet

The Selection of Idlers

Idler life is determined by a combination of many factors, such as **seals**, **bearings**, **shell thickness**, **belt speed**, **lump size/material density**, **maintenance**, **environment**, **temperature**, and the proper CEMA series of idler to handle the maximum calculated idler load.

Table 5-1. Idler classification.

Classification	Former Series Number	Roll Diameter (inches)	Belt Width (inches)	Description
A4	STANDARD WITHDRAWN			
A5	OCTOBER 1, 1996			
B4	II	4"	18" through 48"	Light Duty
B5	II	5"	18" through 48"	"
C4	III	4"	18" through 60"	Medium Duty
C5	III	5"	18" through 60"	"
C6	IV	6"	24" through 60"	"
D5	None	5"	24" through 72"	"
D6	None	6"	24" through 72"	"
E6	V	6"	36" through 96"	Heavy Duty
E7	VI	7"	36" through 96"	"

CEMA B load rating based on minimum L_{10} of 30,000 hours at 500 rpm
CEMA C load rating based on minimum L_{10} of 30,000 hours at 500 rpm
CEMA D load rating based on minimum L_{10} of 60,000 hours at 500 rpm
CEMA E load rating based on minimum L_{10} of 60,000 hours at 500 rpm

Step No. 1 Troughing Idler Series Selection

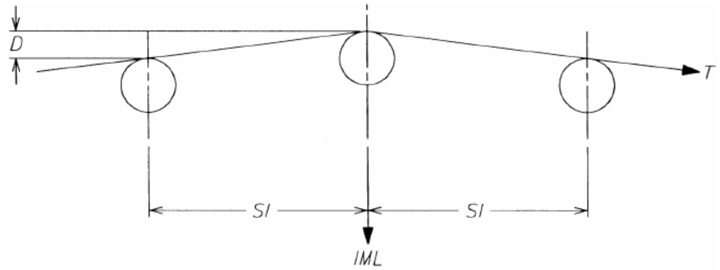
Calculated Idler Load (lbs) = ***CIL = ((WB + (WM x K1)) x SI) + IML***

Where:

- *WB = Belt weight (lbs/ft) use actual or estimate from Table 5-5*
- *WM = Material weight (lbs/ft) = (Q x 2000) / (60 x Vee)*
- *Q = Quantity of material conveyed (tons per hour)*
- *Vee = Design belt speed (fpm)*
- *SI = Spacing of idlers (ft)*
- *Kl = Lump adjustment factor (see Table 5-6)*
- *IML = Idler misalignment load (lbs) due to idler height deviation and belt tension = (D x T) / (6 x SI)*

  Where:

  - *D = Misalignment (in.)*
  - *T = Belt tension (lbs)*
  - *SI = Idler spacing (ft)*



Step No. 1 Troughing Idler Series Selection

- *WB = Belt weight (lbs/ft)*

Table 5-5. *WB*-Estimated average belt weight, multiple- and reduced-ply belts, lbs/ft.

Belt Width (inches (*b*))	Material Carried, lbs/cu ft		
	30-74	75-129	130-200
18	3.5	4.0	4.5
24	4.5	5.5	6.0
30	6.0	7.0	8.0
36	9.0	10.0	12.0
42	11.0	12.0	14.0
48	14.0	15.0	17.0
54	16.0	17.0	19.0
60	18.0	20.0	22.0
72	21.0	24.0	26.0
84	25.0	30.0	33.0
96	30.0	35.0	38.0

1. Steel cable belts increase the above value by 50%.

Step No. 1 Troughing Idler Series Selection

- *Kl = Lump adjustment factor*

Table 5-6. K1-Lump adjustment factor.

Maximum Lump Size (inches)	Material Weight, lbs/cu ft						
	50	75	100	125	150	175	200
4	1.0	1.0	1.0	1.0	1.1	1.1	1.1
6	1.0	1.0	1.0	1.1	1.1	1.1	1.1
8	1.0	1.0	1.1	1.1	1.2	1.2	1.2
10	1.0	1.1	1.1	1.1	1.2	1.2	1.2
12	1.0	1.1	1.1	1.2	1.2	1.2	1.3
14	1.1	1.1	1.1	1.2	1.2	1.3	1.3
16	1.1	1.1	1.2	1.2	1.3	1.3	1.4
18	1.1	1.1	1.2	1.2	1.3	1.3	1.4

Idler Series Selection

1 lbf = 4.45 N

Calculated Idler Load (lbs) = *CIL = ((11+ (55 x 1.0)) x 4.5) + 0 = 297 lbs*

Where:

- *WB = 11 lbs/ft*
- *WM = (1000 x 2000) / (60 x 600) = 55 lbs/ft*
- *Q = 1000 tons per hour*
- *Vee = 600 fpm*
- *SI = 4.5 ft*
- *Kl = 1.0*
- *IML = 0*

Calculated Return Idler Load (lbs) = *CILR = (11 x 10) + 0 = 110 lbs*

- *SI = 10.0 ft*

Load ratings for CEMA idlers, lbs

Notes:
1. Troughing idler load ratings (Tables 5.7–5.10) are for three equal length rolls.
2. Load ratings also apply for impact rolls.
3. Troughing idler load ratings are based on a load distribution of 70% on center roll and 15% on each end roll for all trough angles.
4. Unequal length rolls or picking idlers are not covered by this standard.

Table 5-7. Load ratings for CEMA B idlers, lbs (rigid frame).

Belt Width (inches)	Trough Angle			Single Roll Return
	20°	35°	45°	
18	410	410	410	220
24	410	410	410	190
30	410	410	410	165
36	410	410	396	155
42	390	363	351	140
48	380	353	342	130

Ratings based on minimum L_{10} of 30,000 hours at 500 rpm.

Table 5-8. Load ratings for CEMA C idlers, lbs (rigid frame).

Belt Width (inches)	Trough Angle			Single Roll Return	Two Roll "Vee" Return
	20°	35°	45°		
18	900	900	900	475	
24	900	900	900	325	500
30	900	900	900	250	500
36	900	837	810	200	500
42	850	791	765	150	500
48	800	744	720	125	500
54	750	698	675	*	500
60	700	650	630	*	500
66				*	500

Ratings based on minimum L_{10} of 30,000 hours at 500 rpm.
*Use CEMA D return idler

Table 5-9. Load ratings for CEMA D idlers, lbs (rigid frame).

Belt Width (inches)	Trough Angle			Single Roll Return	Two Roll "Vee" Return
	20°	35°	45°		
24	1200	1200	1200	600	
30	1200	1200	1200	600	
36	1200	1200	1200	600	850
42	1200	1200	1200	500	850
48	1200	1200	1200	425	850
54	1200	1116	1080	375	850
60	1150	1070	1035	280	850
66				215	850
72	1050	977	945	155	850
78				125	850

Ratings based on minimum L_{10} of 60,000 hours at 500 rpm.

Table 5-10. Load ratings for CEMA E idlers, lbs (rigid frame and catenary where applicable).

Belt Width (inches)	Trough Angle			Single Roll Return	Two Roll "Vee" Return
	20°	35°	45°		
36	1800	1800	1800	1000	1300
42	1800	1800	1800	1000	1300
48	1800	1800	1800	1000	1300
54	1800	1800	1800	925	1300
60	1800	1800	1800	850	1300
66				775	1300
72	1800	1800	1800	700	1300
78				625	1300
84	1800	1674	1620	550	1300
90				475	1300
96	1750	1628	1575	400	1300
102				250	1300

Ratings based on minimum L_{10} of 60,000 hours at 500 rpm.

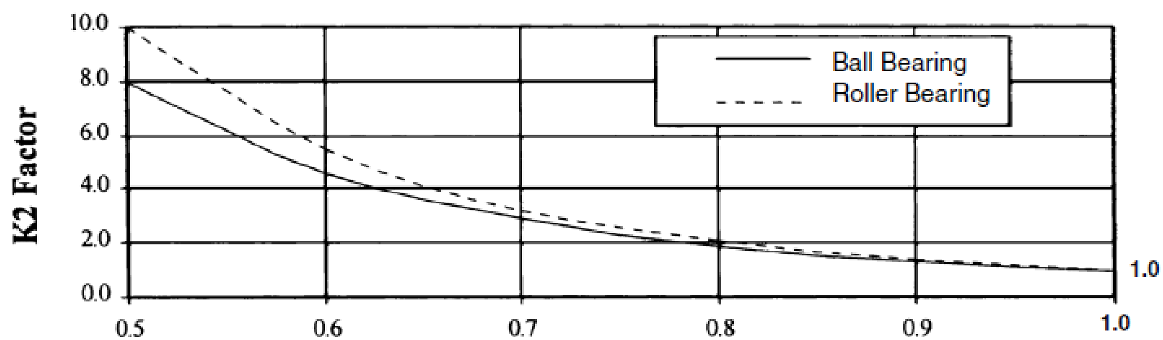
K2 = Effect of load on predicted bearing L10 life

Table 5-7. Load ratings for CEMA B idlers, lbs (rigid frame).

Belt Width (inches)	Trough Angle			Single Roll Return
	20°	35°	45°	
18	410	410	410	220
24	410	410	410	190
30	410	410	410	165
36	410	410	396	155
42	390	363	351	140
48	380	353	342	130

Ratings based on minimum L_{10} of 30,000 hours at 500 rpm.

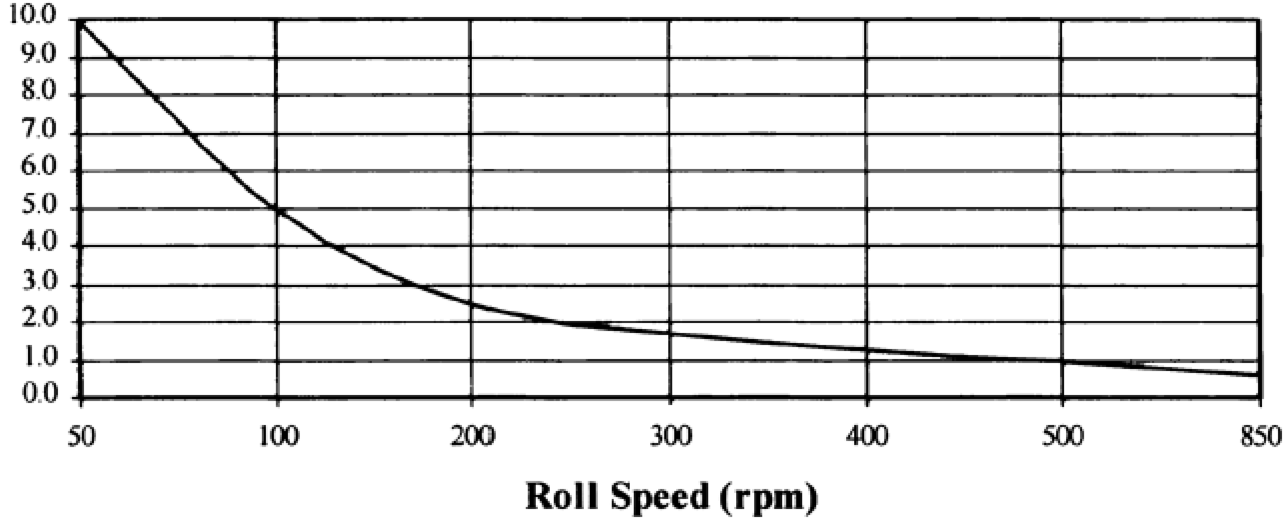
L_{10} (CORRECTED) = L_{10} (RATING) x K2 x K3A x K3B (IF APPLICABLE)



$\dfrac{\text{CIL (Calculated Idler Load)}}{\text{Idler Load Rating}}$ ***= 297 / 363 = 0.82 → K2 = 2.0***

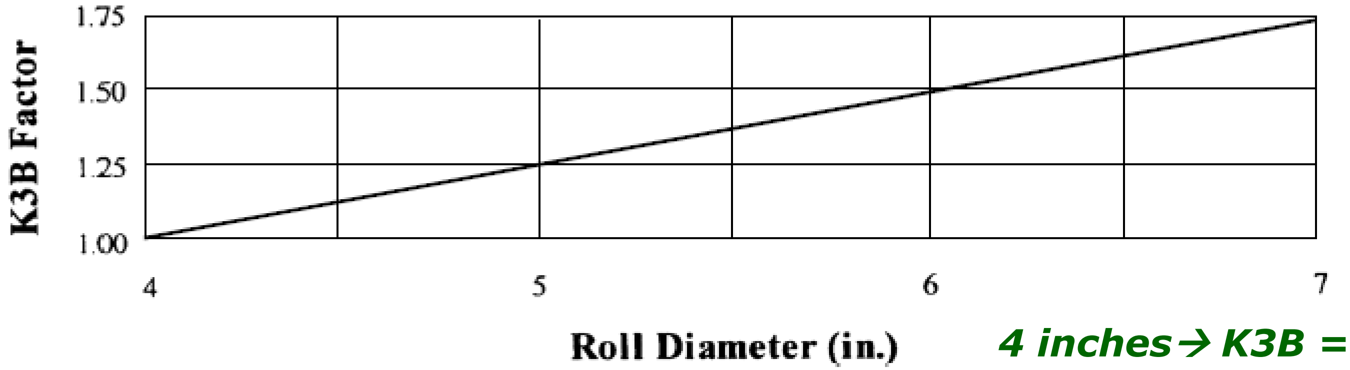
Bearing L10 = (30,000 x 2.0) = 60,000 hours

K3A = Effect of belt speed on predicted bearing L10 life



$$rpm = \frac{\text{Belt Speed (fpm)} \times 12}{\text{Roll Diameter (in)} \times \pi}$$ ***= 600 x 12 / (4 x 3.14) = 573 rpm → K3A = 0.9***

K3B = Effect of roll diameter on predicted bearing L10 life



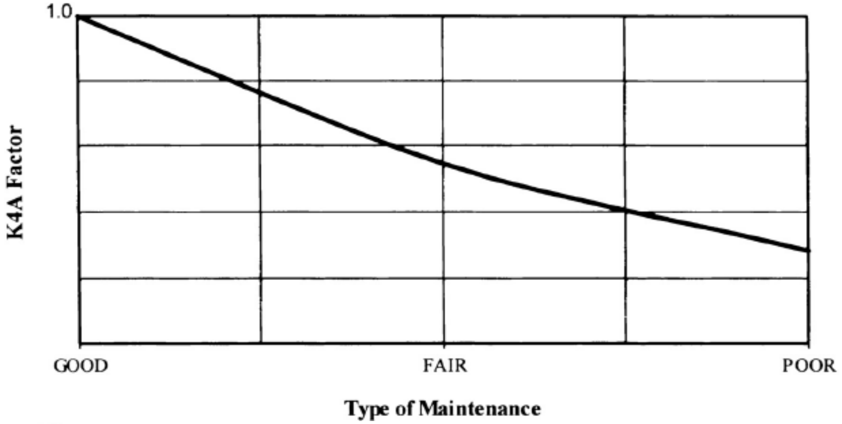
4 inches → K3B = 1.0

Bearing L10 = (60,000 x 0.9 x 1.0) = 54,000 hours

K4 = Environmental, maintenance, and other special conditions

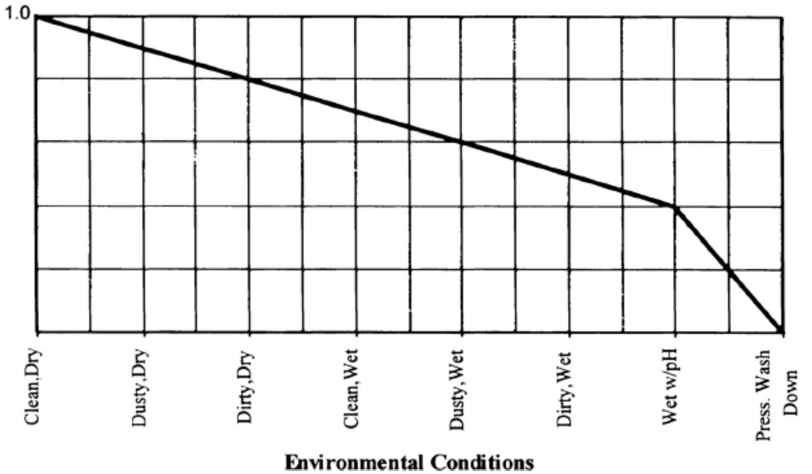
- K4A = Effect of maintenance on potential idler life.

  FAIR→ K4A = 0.5



- K4B = Effect of environmental conditions on potential idler life.

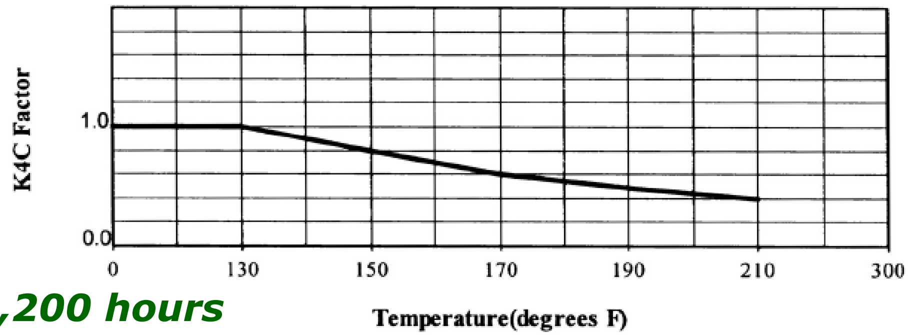
  Dusty, Wet→ K4B = 0.6



1 deg F = 0.5556 C
C = 5/9 (F-32)
F = 9/5 * C + 32

- K4C = Effect of operating temperature on potential idler life.

  9/5*26°C+32 = 79 °F→ K4C = 1.0



Bearing L10 = (54,000 x 0.5 x 0.6 x 1.0) = 16,200 hours

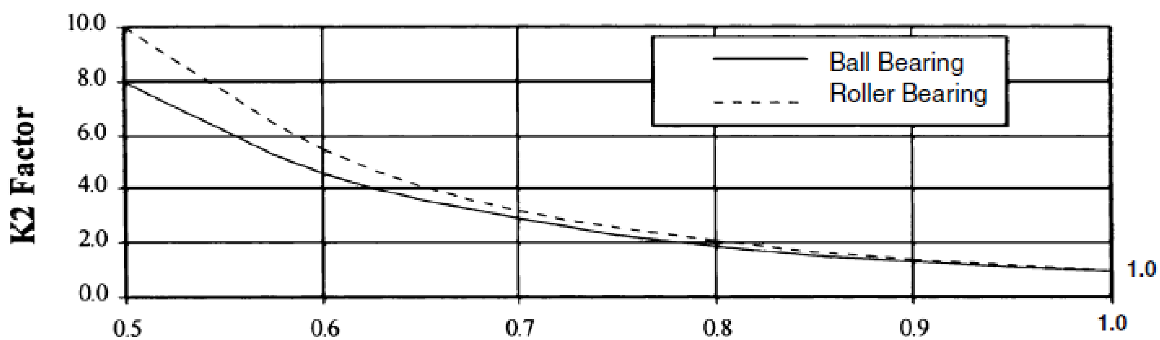
CEMA C Idlers

Table 5-8. Load ratings for CEMA C idlers, lbs (rigid frame).

Belt Width (inches)	Trough Angle 20°	35°	45°	Single Roll Return	Two Roll "Vee" Return
18	900	900	900	475	
24	900	900	900	325	500
30	900	900	900	250	500
36	900	837	810	200	500
42	850	791	765	150	500
48	800	744	720	125	500
54	750	698	675	*	500
60	700	650	630	*	500
66				*	500

Ratings based on minimum L_{10} of 30,000 hours at 500 rpm.

*Use CEMA D return idler



$$\frac{\text{CIL (Calculated Idler Load)}}{\text{Idler Load Rating}} = 297 \;/\; 791 = 0.4 \rightarrow K2 = 10.0$$

Bearing L10 = (30,000 x 10.0 x 0.9 x 0.5 x 0.6) = 81,000 hours

Average weight (lbs) of idler rotating parts–steel rolls.

Table 5-11. Average weight (lbs) of troughing idler rotating parts–steel rolls.

Belt Width (inches)	CEMA Idler Class								
	B4	B5	C4	C5	C6	D5	D6	E6	E7
18	15.0	19.2	14.5	19.1	26.7				
24	18.3	24.2	17.5	23.2	32.6	23.2	32.6		
30	21.8	28.3	20.5	26.8	38.0	26.8	38.0		
36	25.3	33.0	23.5	31.3	43.6	31.3	43.6	64.8	81.8
42	30.8	38.1	26.5	35.2	49.2	35.2	49.2	73.3	91.7
48	32.9	41.6	29.5	39.3	54.8	39.3	54.8	81.9	101.3
54				45.9	62.3	45.9	62.3	93.6	121.8
60				50.1	68.3	50.1	68.3	102.2	132.7
72						57.9	77.8	119.4	154.5
84								132.0	164.0
96								145.3	173.0

Table 5-12. Average weight (lbs) of return idler rotating parts–steel rolls.

Belt Width (inches)	CEMA Idler Class								
	B4	B5	C4	C5	C6	D5	D6	E6	E7
18	13.1	16.3	12.2	16.6	21.6				
24	16.3	20.9	15.2	20.1	27.1	20.9	30.1		
30	19.5	24.5	18.2	24.0	32.3	25.8	35.4		
36	22.7	28.5	21.2	28.0	37.6	30.1	40.5	59.0	70.0
42	26.0	33.0	24.6	32.1	43.3	34.3	47.2	67.4	80.1
48	27.4	36.1	27.6	36.1	48.4	38.7	54.4	75.6	89.9
54						43.4	60.8	83.2	99.9
60						49.2	68.1	92.2	109.4
72						55.1	74.9	109.4	129.0
84								114.0	136.2
96								122.0	149.8

Basic Power Requirements

- The horsepower, *hp*, required at the drive of a belt conveyor, is derived from the pounds of the effective tension, T_e, required at the drive pulley to propel or restrain the loaded conveyor at the design velocity of the belt *V*, in fpm:

$$hp = \frac{T_e \times V}{33,000}$$

- T_e is the final summarization of the belt tensions produced by forces such as:
  1. The gravitational load to lift or lower the material being transported.
  2. The frictional resistance of the conveyor components, drive, and all accessories while operating at design capacity.
  3. The frictional resistance of the material as it is being conveyed.
  4. The force required to accelerate the material continuously as it is fed onto the conveyor by a chute or a feeder.

Effective tension, T_e

$$T_e = LK_t(K_x + K_yW_b + 0.015W_b) + W_m(LK_y \pm H) + T_p + T_{am} + T_{ac}$$

Where:

L = length of conveyor, ft

K_t = ambient temperature correction factor

K_x = factor used to calculate the frictional resistance of the idlers and the sliding resistance between the belt and idler rolls, lbs per ft

K_y = carrying run factor used to calculate the combination of the resistance of the belt and the resistance of the load to flexure as the belt and load move over the idlers. For return run use constant 0.015.

W_b = weight of belt in pounds per foot of belt length.

W_m = weight of material, lbs per foot of belt length

$$W_m = \frac{Q \times 2{,}000}{60 \times V} = \frac{33.33 \times Q}{V}$$

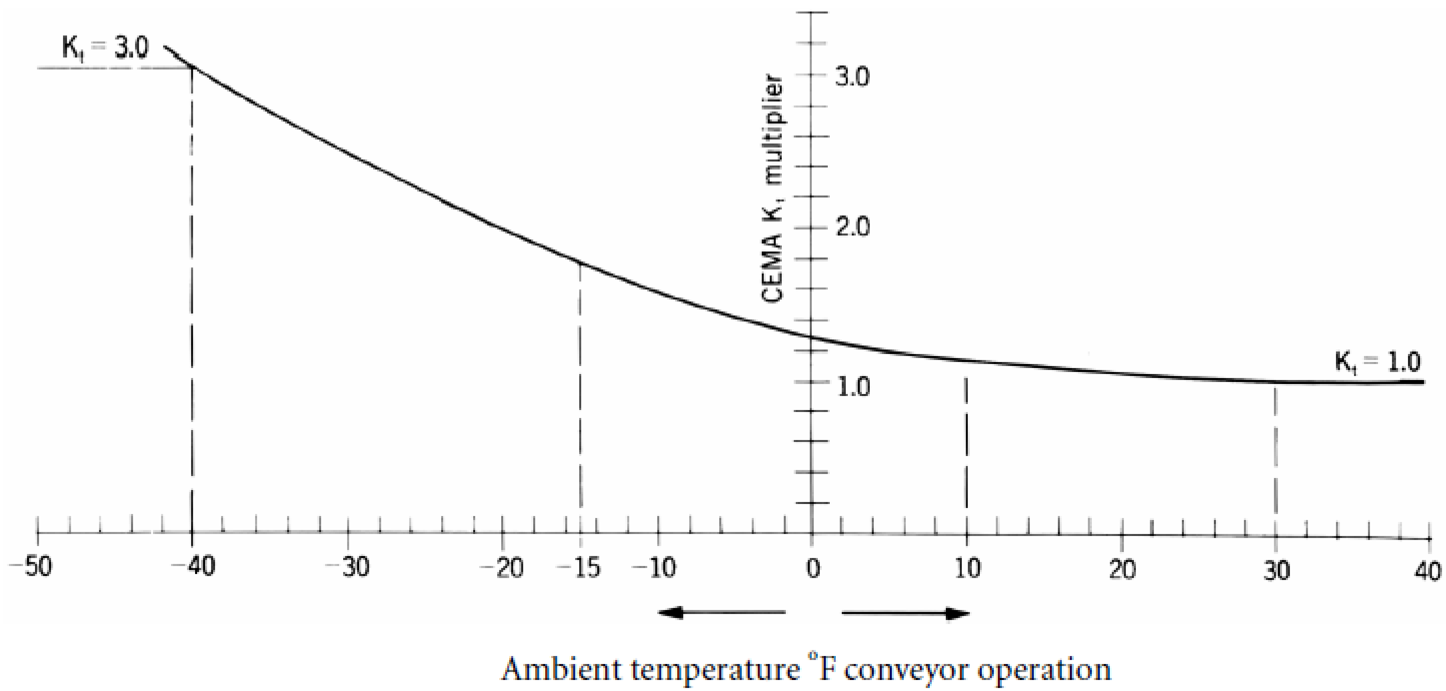
H = vertical distance that material is lifted or lowered, ft

T_p = tension resulting from resistance of belt to flexure around pulleys and the resistance of pulleys to rotation on their bearings, total for all pulleys, lbs

T_{am} = tension resulting from the force to accelerate the material continuously as it is fed onto the belts, lbs

T_{ac} = total of the tensions from conveyor accessories, lbs

K_t — Ambient Temperature Correction Factor



79 °F → K_t = 1.0

K_x — Idler Friction Factor, lbs/ft

- The frictional resistance of idler rolls to rotation and sliding resistance between the belt and the idler rolls.

- Values of K_x can be calculated from the equation:

$$K_x = 0.00068(W_b + W_m) + \frac{A_i}{S_i}, \text{ lbs tension per foot of belt length}$$

A_i = 1.5 for 6" diameter idler rolls, CEMA C6, D6
A_i = 1.8 for 5" diameter idler rolls, CEMA B5, C5, D5
A_i = 2.3 for 4" diameter idler rolls, CEMA B4, C4
A_i = 2.4 for 7" diameter idler rolls, CEMA E7
A_i = 2.8 for 6" diameter idler rolls, CEMA E6

For regenerative declined conveyors, $A_i = 0$.

W_b = 11 lbs/ft
W_m = (1000 x 2000) / (60 x 600) = 55 lbs/ft
S_i = 4.5 ft
CEMA B4

Kx =** 0,00068(11+55)+2.3/4.5 = 0.0449 + 0.51 **= 0.555 lbs/ft

K_y — Factor for Calculating the Force of Belt and Load Flexure over the Idlers

- Resistance of the belt to flexure as it moves over idlers
- Resistance of the load to flexure as it rides the belt over the idlers

Table 6-2 gives values of K_y *for carrying idlers as they vary with differences in the* weight/ ft of the conveyor belt, W_b *; load,* W_m *; idler spacing,* S_i *; and the percent of* slope or angle that the conveyor makes with the horizontal.

$W_b + W_m = 66$ lbs/ft
$S_i = 4.5$ ft
Lenght: 3300 feet
Height: 115 feet
Slope: 2 degrees

→ $K_y = 0.020$

Table 6-2. Factor K_y values.

Conveyor Length (ft)	$W_b + W_m$ (lbs/ft)	Percent Slope						
		0	3	6	9	12	24	33
		Approximate Degrees						
		0	2	3.5	5	7	14	18
3000	50	0.024	0.022	0.019	0.017	0.016	0.016	0.016
	75	0.023	0.019	0.016	0.016	0.016	0.016	0.016
	100	0.022	0.017	0.016	0.016	0.016	0.016	0.016
	150	0.022	0.016	0.016	0.016	0.016	0.016	0.016
	200	0.019	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.018	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.018	0.018	0.018	0.018	0.018	0.018	0.018

Idler spacing: The above values of K_y are based on the following idler spacing (for other spacing, see Table 6-3).

(W_b+W_m), lbs per ft	S_i, ft	(W_b+W_m), lbs per ft	S_i, ft
Less than 50	4.5	100 to 149	3.5
50 to 99	4.0	150 and above	3.0

Table 6-2. Factor K_y values.

Conveyor Length (ft)	$W_b + W_m$ (lbs/ft)	Percent Slope						
		0	3	6	9	12	24	33
		Approximate Degrees						
		0	2	3.5	5	7	14	18
250	20	0.035	0.035	0.034	0.031	0.031	0.031	0.031
	50	0.035	0.034	0.033	0.032	0.031	0.028	0.027
	75	0.035	0.034	0.032	0.032	0.030	0.027	0.025
	100	0.035	0.033	0.032	0.031	0.030	0.026	0.023
	150	0.035	0.035	0.034	0.033	0.031	0.025	0.021
	200	0.035	0.035	0.035	0.035	0.032	0.024	0.018
	250	0.035	0.035	0.035	0.035	0.033	0.021	0.018
	300	0.035	0.035	0.035	0.035	0.032	0.019	0.018
400	20	0.035	0.034	0.032	0.030	0.030	0.030	0.030
	50	0.035	0.033	0.031	0.029	0.029	0.026	0.025
	75	0.034	0.033	0.030	0.029	0.028	0.024	0.021
	100	0.034	0.032	0.030	0.028	0.028	0.022	0.019
	150	0.035	0.034	0.031	0.028	0.027	0.019	0.016
	200	0.035	0.035	0.033	0.030	0.027	0.016	0.014
	250	0.035	0.035	0.034	0.030	0.026	0.017	0.016
	300	0.035	0.035	0.034	0.029	0.024	0.018	0.018
500	20	0.035	0.033	0.031	0.030	0.030	0.030	0.030
	50	0.034	0.032	0.030	0.028	0.028	0.024	0.023
	75	0.033	0.032	0.029	0.027	0.027	0.021	0.019
	100	0.033	0.031	0.029	0.028	0.026	0.019	0.016
	150	0.035	0.033	0.030	0.027	0.024	0.016	0.016
	200	0.035	0.035	0.030	0.027	0.023	0.016	0.016
	250	0.035	0.035	0.030	0.025	0.021	0.016	0.015
	300	0.035	0.035	0.029	0.024	0.019	0.018	0.018
600	20	0.035	0.032	0.030	0.029	0.029	0.029	0.029
	50	0.033	0.030	0.029	0.027	0.026	0.023	0.021
	75	0.032	0.030	0.028	0.026	0.024	0.020	0.016
	100	0.032	0.030	0.027	0.025	0.022	0.016	0.016
	150	0.035	0.031	0.026	0.024	0.019	0.016	0.016
	200	0.035	0.031	0.026	0.021	0.017	0.016	0.016
	250	0.035	0.031	0.024	0.020	0.017	0.016	0.016
	300	0.035	0.031	0.023	0.018	0.018	0.018	0.018
800	20	0.035	0.031	0.030	0.029	0.029	0.029	0.029
	50	0.032	0.029	0.028	0.026	0.025	0.021	0.018
	75	0.031	0.029	0.026	0.024	0.022	0.016	0.016
	100	0.031	0.028	0.025	0.022	0.020	0.016	0.016
	150	0.034	0.028	0.023	0.019	0.017	0.016	0.016
	200	0.035	0.027	0.021	0.016	0.016	0.016	0.016
	250	0.035	0.026	0.020	0.017	0.016	0.016	0.016
	300	0.035	0.025	0.018	0.018	0.018	0.018	0.018
1000	50	0.031	0.028	0.026	0.024	0.023	0.019	0.016
	75	0.030	0.027	0.024	0.022	0.019	0.016	0.016
	100	0.030	0.026	0.022	0.019	0.017	0.016	0.016
	150	0.033	0.024	0.019	0.016	0.016	0.016	0.016
	200	0.032	0.023	0.017	0.016	0.016	0.016	0.016
	250	0.033	0.022	0.017	0.016	0.016	0.016	0.016
	300	0.033	0.021	0.018	0.018	0.018	0.018	0.018
1400	50	0.029	0.026	0.024	0.022	0.021	0.016	0.016
	75	0.028	0.024	0.021	0.019	0.016	0.016	0.016
	100	0.028	0.023	0.019	0.016	0.016	0.016	0.016
	150	0.029	0.020	0.016	0.016	0.016	0.016	0.016
	200	0.030	0.021	0.016	0.016	0.016	0.016	0.016
	250	0.030	0.020	0.017	0.016	0.016	0.016	0.016
	300	0.030	0.019	0.018	0.018	0.018	0.018	0.018
2000	50	0.027	0.024	0.022	0.020	0.018	0.016	0.016
	75	0.026	0.021	0.019	0.016	0.016	0.016	0.016
	100	0.025	0.020	0.016	0.016	0.016	0.016	0.016
	150	0.026	0.017	0.016	0.016	0.016	0.016	0.016
	200	0.024	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.023	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.022	0.018	0.018	0.018	0.018	0.018	0.018
2400	50	0.026	0.023	0.021	0.018	0.017	0.016	0.016
	75	0.025	0.021	0.017	0.016	0.016	0.016	0.016
	100	0.024	0.019	0.016	0.016	0.016	0.016	0.016
	150	0.024	0.016	0.016	0.016	0.016	0.016	0.016
	200	0.021	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.021	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.020	0.018	0.018	0.018	0.018	0.018	0.018
3000	50	0.024	0.022	0.019	0.017	0.016	0.016	0.016
	75	0.023	0.019	0.016	0.016	0.016	0.016	0.016
	100	0.022	0.017	0.016	0.016	0.016	0.016	0.016
	150	0.022	0.016	0.016	0.016	0.016	0.016	0.016
	200	0.019	0.016	0.016	0.016	0.016	0.016	0.016
	250	0.018	0.016	0.016	0.016	0.016	0.016	0.016
	300	0.018	0.018	0.018	0.018	0.018	0.018	0.018

Table 6-2. Factor K_y values.

Idler spacing: The above values of K_y are based on the following idler spacing (for other spacing, see Table 6-3).

(W_b+W_m), lbs per ft	S_i, ft	(W_b+W_m), lbs per ft	S_i, ft
Less than 50	4.5	100 to 149	3.5
50 to 99	4.0	150 and above	3.0

Idler spacing: The above values of K_y are based on the following idler spacing (for other spacing, see Table 6-3).

(W_b+W_m), lbs per ft	S_i, ft	(W_b+W_m), lbs per ft	S_i, ft
Less than 50	4.5	100 to 149	3.5

Corrected factor K_y

Table 6-3. Corrected factor K_y values when other than tabular carrying idler spacings are used.

$W_b + W_m$ (lbs/ft)	S_i (ft)	Reference Values of K_y for Interpolation									
		0.016	0.018	0.020	0.022	0.024	0.026	0.028	0.030	0.032	0.034
Less than 50	3.0	0.0160	0.0160	0.0160	0.0168	0.0183	0.0197	0.0212	0.0227	0.0242	0.0257
	3.5	0.0160	0.0160	0.0169	0.0189	0.0207	0.0224	0.0241	0.0257	0.0274	0.0291
	4.0	0.0160	0.0165	0.0182	0.0204	0.0223	0.0241	0.0259	0.0278	0.0297	0.0316
	4.5	**0.016**	**0.018**	**0.020**	**0.022**	**0.024**	**0.026**	**0.028**	**0.030**	**0.032**	**0.034**
	5.0	0.0174	0.0195	0.0213	0.0236	0.0254	0.0273	0.0291	0.0031	0.0329	0.0348
50 to 99	3.0	0.0160	0.0162	0.0173	0.0186	0.0205	0.0221	0.0239	0.026	0.0274	0.029
	3.5	0.0160	0.0165	0.0185	0.0205	0.0222	0.024	0.0262	0.0281	0.030	0.0321
	4.0	**0.016**	**0.018**	**0.020**	**0.022**	**0.024**	**0.026**	**0.028**	**0.030**	**0.032**	**0.034**
	4.5	0.0175	0.0193	0.0214	0.0235	0.0253	0.0272	0.0297	0.0316	0.0335	0.035
	5.0	0.0184	0.021	0.023	0.0253	0.027	0.029	0.0315	0.0335	0.035	0.035
100 to 149	3.0	0.0160	0.0164	0.0186	0.0205	0.0228	0.0246	0.0267	0.0285	0.0307	0.0329
	3.5	**0.016**	**0.018**	**0.020**	**0.022**	**0.024**	**0.026**	**0.028**	**0.030**	**0.032**	**0.034**
	4.0	0.0175	0.0197	0.0213	0.0234	0.0253	0.0277	0.0295	0.0312	0.033	0.035
	4.5	0.0188	0.0213	0.0232	0.0253	0.0273	0.0295	0.0314	0.033	0.0346	0.035
	5.0	0.0201	0.0228	0.0250	0.0271	0.0296	0.0316	0.0334	0.035	0.035	0.035
150 to 199	**3.0**	**0.016**	**0.018**	**0.020**	**0.022**	**0.024**	**0.026**	**0.028**	**0.030**	**0.032**	**0.034**
	3.5	0.0172	0.0195	0.0215	0.0235	0.0255	0.0271	0.0289	0.031	0.0333	0.0345
	4.0	0.0187	0.0213	0.0235	0.0252	0.0267	0.0283	0.0303	0.0325	0.0347	0.035
	4.5	0.0209	0.023	0.0253	0.0274	0.0289	0.0305	0.0323	0.0345	0.035	0.035
	5.0	0.0225	0.0248	0.0272	0.0293	0.0311	0.0328	0.0348	0.035	0.035	0.035
200 to 249	**3.0**	**0.016**	**0.018**	**0.020**	**0.022**	**0.024**	**0.026**	**0.028**	**0.030**	**0.032**	**0.034**
	3.5	0.0177	0.0199	0.0216	0.0235	0.0256	0.0278	0.0295	0.031	0.0327	0.0349
	4.0	0.0192	0.0216	0.0236	0.0256	0.0274	0.0291	0.0305	0.0322	0.0339	0.035
	4.5	0.021	0.0234	0.0253	0.0276	0.0298	0.0317	0.0331	0.0347	0.035	0.035
	5.0	0.0227	0.0252	0.0274	0.0298	0.0319	0.0338	0.035	0.035	0.035	0.035

→ $K_y = 0.0214$

K_y vs. Belt Tension

After estimating the average belt tension and selecting an idler spacing, refer to Table 6-4 to obtain values for *A* and *B* for use in the following equation:

Table 6-4. *A* and *B* values for equation $K_y = (W_m + W_b) \text{ x } A \text{ x } 10^{-4} + B \text{ x } 10^{-2}$

Average Belt Tension, lbs	Idler Spacing, ft									
	3.0		3.5		4.0		4.5		5.0	
	A	*B*	*A*	*B*	*A*	*B*	*A*	*B*	*A*	*B*
1,000	2.150	1.565	2.1955	1.925	2.200	2.250	2.2062	2.584	2.1750	2.910
2,000	1.8471	1.345	1.6647	1.744	1.6156	1.982	1.5643	2.197	1.5429	2.331
3,000	1.6286	1.237	1.4667	1.593	1.4325	1.799	1.4194	1.991	1.4719	2.091
4,000	1.4625	1.164	1.3520	1.465	1.3295	1.659	1.3250	1.825	1.3850	1.938
5,000	1.2828	1.122	1.1926	1.381	1.1808	1.559	1.1812	1.714	1.2283	1.839
6,000	1.1379	1.076	1.0741	1.318	1.0625	1.472	1.0661	1.627	1.0962	1.761
7,000	1.0069	1.039	0.9448	1.256	0.9554	1.404	0.9786	1.549	1.0393	1.657
8,000	0.9172	0.998	0.8552	1.194	0.8643	1.337	0.8875	1.472	0.9589	1.583
9,000	0.8207	0.958	0.8000	1.120	0.7893	1.272	0.8339	1.388	0.8911	1.507
10,000	0.7241	0.918	0.7362	1.066	0.7196	1.216	0.7821	1.314	0.8268	1.430
11,000	0.6483	0.885	0.6638	1.024	0.6643	1.167	0.7375	1.238	0.7768	1.340
12,000	0.5828	0.842	0.5828	0.992	0.6232	1.100	0.6750	1.180	0.7411	1.242
13,000	0.5207	0.798	0.5241	0.938	0.5732	1.040	0.6179	1.116	0.6821	1.169
14,000	0.4690	0.763	0.4810	0.897	0.5214	0.996	0.5571	1.069	0.6089	1.123
15,000	0.4172	0.718	0.4431	0.841	0.4732	0.935	0.5179	1.006	0.5607	1.063
16,000	0.3724	0.663	0.3966	0.780	0.4232	0.875	0.4589	0.958	0.5054	1.009

A minimum K_y value of .016 should be used when tensions exceed 16,000 lbs. Refer to page 92 for further explanations.

$W_b + W_m = 66$ lbs/ft
$S_i = 4.5$ ft

$\rightarrow K_y = 0.04036$

$\rightarrow K_y = 0.01261$

T_p = total of the belt tensions required to rotate each of the pulleys on the conveyor

Table 6-5. Belt tension to rotate pulleys.

Location of Pulleys	Degrees Wrap of Belt	Pounds of Tension at Belt Line
Tight side	150^0 to 240^0	200 lbs/pulley
Slack side	150^0 to 240^0	150 lbs/pulley
All other pulleys	less than 150^0	100 lbs/pulley
Note: Double the above values for pulley shafts that are not operating in antifriction bearings.		

2 x 200 = 400 lbs

3 x 150 = 450 lbs

T_p= 950 lbs

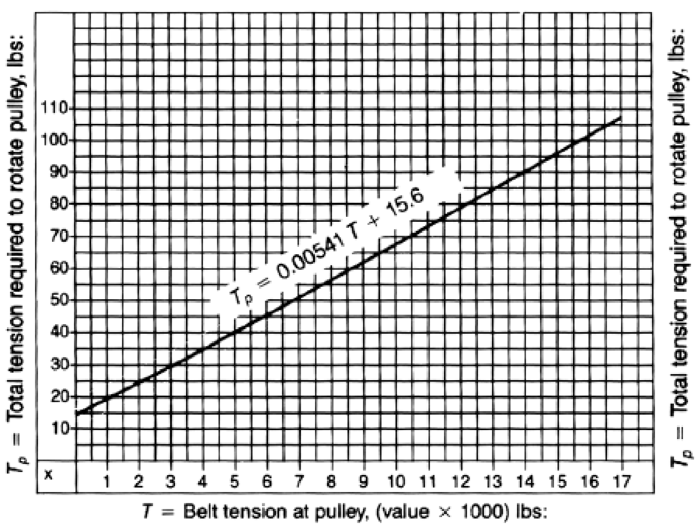


Table C-1. T_p determination — graphical method for fabric carcass belts.

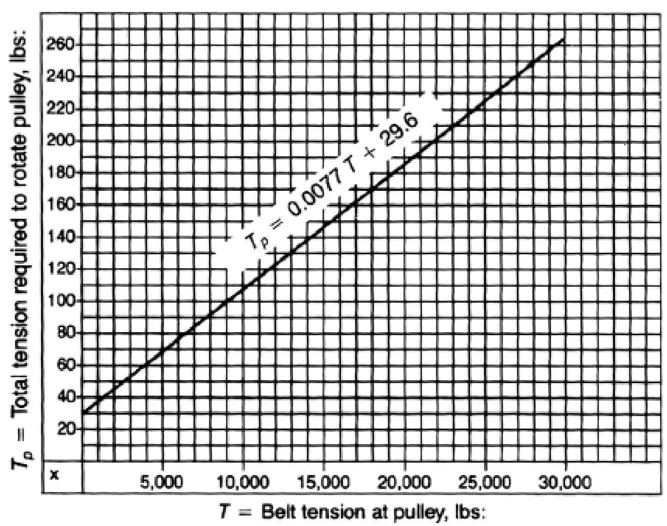
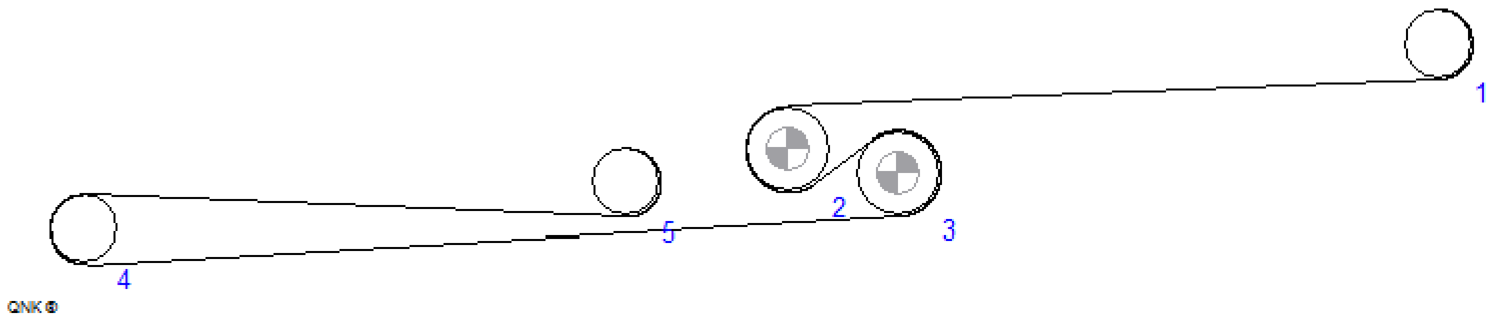
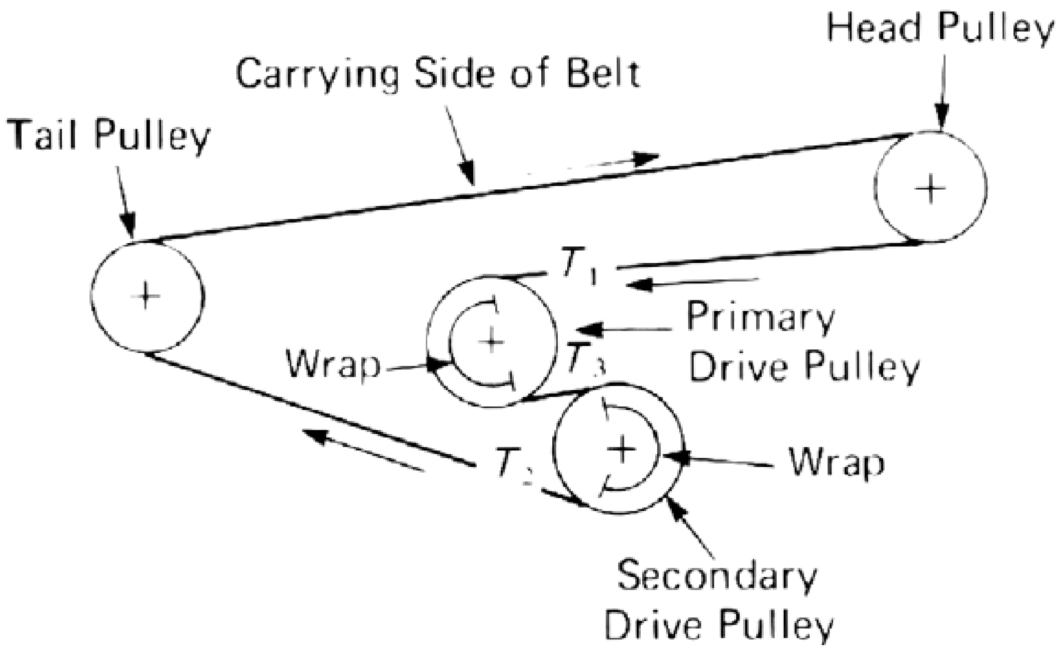


Table C-2. T_p determination — graphical method for steel cable belts.

Pulleys

1-2


1
2
3
4
5
QNK ©

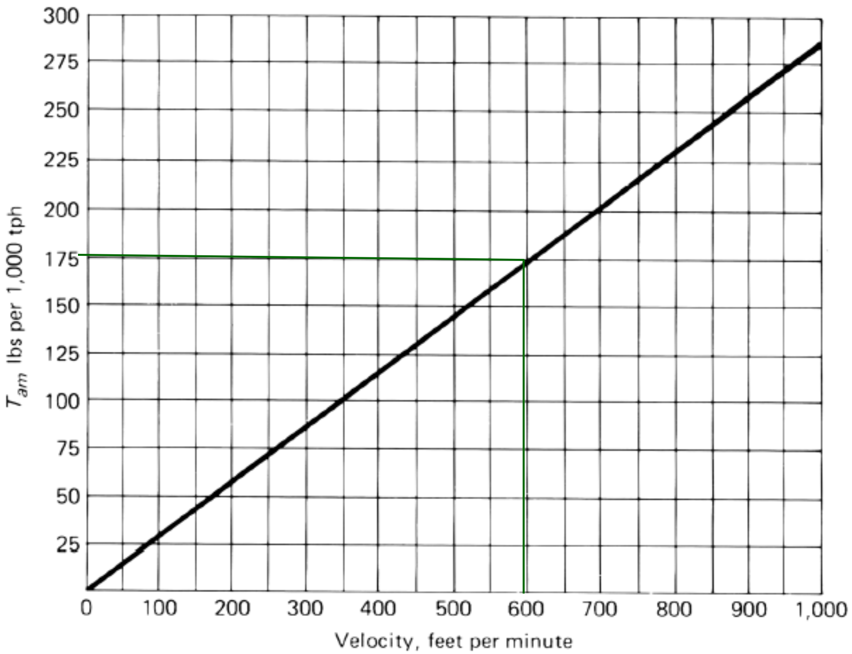

Head Pulley
Carrying Side of Belt
Tail Pulley
T_1
Primary
Drive Pulley
Wrap
T_3
T_2
Wrap
Secondary
Drive Pulley

T_{am} — force to accelerate the material continuously as it is fed onto the belt

$$T_{am} = \frac{Q \times 2000}{3600 \times 32.2} \times \frac{V - V_0}{60}$$

Where:

Q = Capacity of loading point, tph
g = 32.2 ft/sec²
V = design belt speed, fpm
V_0 = initial velocity of material as it is fed onto belt, fpm



To use this chart:

Enter chart at belt velocity and read T_{am} per 1,000 tph.

Again enter chart at material velocity in direction of belt travel and read T_{am} per 1,000 tph. This may be positive, zero, or negative.

Subtract the second T_{am} reading from the first T_{am} reading and convert the difference from 1,000 tph to the value for the actual tonnage. This will be the T_{am} desired, lbs.

T_{am} = 2.8755 x 10^{-4} x Q x (V – V_0)
= 2.8755 x 10^{-4} x 1000 x (600 – 0) = 172.53 lbs

T_{ac} — resistance generated by conveyor accessories

Conveyor accessories such as trippers, stackers, plows, belt cleaning equipment, and skirtboards usually add to the effective tension, T_e

- T_{tr} — from trippers and stackers
- T_{pl} — from frictional resistance of plows

Table 6-6. Discharge plow allowance.

Type of Plow	Additional Belt Pull per Plow, at Belt Line (lbs/in belt width)
Full V or single slant plow, removing all material from belt	5.0
Partial V or single slant plow, removing half material from belt	3.0

- T_{bc} — from belt-cleaning devices
- T_{sb} — from skirtboard friction

$$T_{sb} = L_b\,(C_s h_s^2 + 6)$$

L_b = skirtboard length, ft one skirtboard =10 ft

h_s = depth of the material touching the skirtboard, in =10 in

T_{tr}= 0 lbs

T_{pl}= 0 lbs

T_{bc}= 0 lbs

T_{sb}= 113.8 lbs

Table 6-7. Skirtboard friction factor, C_s.

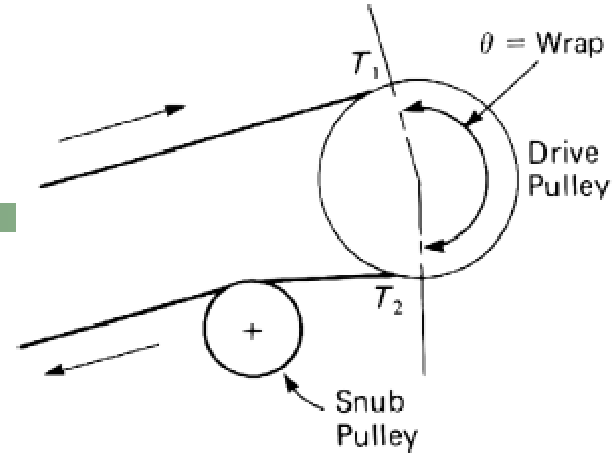
Material	Factor C_s	Material	Factor C_s	Material	Factor C_s
Alumina, pulv. dry	0.1210	Coke, ground fine	0.0452	Limestone, pulv., dry	0.1280
Ashes, coal, dry	0.0571	Coke, lumps and fines	0.0186	Magnesium chloride, dry	0.0276
Bauxite, ground	0.1881	Copra, lumpy	0.0203	Oats	0.0219
Beans, navy, dry	0.0798	Cullet	0.0836	Phosphate rock, dry, broken	0.1086
Borax	0.0734	Flour, wheat	0.0265	Salt, common, dry, fine	0.0814
Bran, granular	0.0238	Grains, wheat, corn or rye	0.0433	Sand, dry, bank	0.1378
Cement, Portland, dry	0.2120	Gravel, bank run	0.1145	Sawdust, dry	0.0086
Cement clinker	0.1228	Gypsum, ½" screenings	0.0900	Soda ash, heavy	0.0705
Clay, ceramic, dry fines	0.0924	Iron ore, 200 lbs/cu ft	0.2760	Starch, small lumps	0.0623
Coal, anthracite, sized	0.0538	Lime, burned, ⅛"	0.1166	Sugar, granulated dry	0.0349
Coal, bituminous, mined	0.0754	Lime, hydrated	0.0490	Wood chips, hogged fuel	0.0095

Resistance Calculations

T_e equals the total of the following:		lbs
T_x , *idler friction*	$= L \times K_x \times K_t$	$= 3300 \times 0.555 \times 1.0 = 1831.5$
+ Tyc , *belt flexure, carrying idlers*	$= L \times K_y \times W_b \times K_t$	$= 3300 \times 0.0214 \times 11 \times 1.0 = 776.8$
+ T_{yr} , *belt flexure, return idlers*	$= L \times 0.015 \times W_b \times K_t$	$= 3300 \times 0.015 \times 11 \times 1.0 = 544.5$
Subtotal (A)	$LK_t(K_x + K_yW_b + 0.015W_b)$	**3152.8 lbs**
+ T_{ym} , *material flexure*	$= L \times K_y \times W_m$	$= 3300 \times 0.0214 \times 55.0 = 3884.1$
+ T_m , *lift or lower*	$= H \times W_m$	$= 115 \times 55 = 6325$
Subtotal (B)	$W_m(LK_y \pm H)$	**10209.1 lbs**
T_p , *pulley resistance*		950
T_{am} , *accelerated material*		172.5
T_{ac} , *accessories*	$(T_{tr} + T_{pl} + T_{bc} + T_{sb})$	113.8
Subtotal (C)		**1236,3 lbs**
	$Te = \Sigma$ *Subtotals (A), (B), and (C)*	**14598,2 lbs**
CEMA Horsepower Formula	$hp = T_e \times V / 30{,}000$	**265,4 hp**

If drive efficiency = .94, horsepower at motor shaft = 265.4/.94 = 282.3 hp.

Wrap Factor, C_w



$T_e = T_1 - T_2$ = effective belt tension, lbs

T_1 = tight-side tension at pulley, lbs

T_2 = slack-side tension at pulley, lbs

e = base of naperian logarithms = 2.718

f = coefficient of friction between pulley surface and belt surface (0.25 rubber surfaced belt driving bare steel or cast iron pulley; 0.35 rubber surfaced belt driving rubber lagged pulley surface). Values apply to normal running calculations

θ = wrap of belt around the pulley, radians (one degree = 0.0174 radians)

C_w = wrap factor

$$\frac{T_2}{T_e} = \frac{1}{e^{f\theta} - 1}$$

$C_w = 0.08$

Table 6-8. Wrap factor, C_w (Rubber-surfaced belt).

Type of Pulley Drive	θ Wrap	Automatic Takeup		Manual Takeup	
		Bare Pulley	Lagged Pulley	Bare Pulley	Lagged Pulley
Single, no snub	180°	0.84	0.50	1.2	0.8
Single with snub	200°	0.72	0.42	1.0	0.7
	210°	0.66	0.38	1.0	0.7
	220°	0.62	0.35	0.9	0.6
	240°	0.54	0.30	0.8	0.6
Dual*	380°	0.23	0.11	0.5	0.3
	420°	0.18	0.08	—	—

Tension Relationships and Belt Sag Between Idlers

For 3 percent sag, $T_0 = 4.2 S_i (W_b + W_m)$

$$\text{Sag, ft} = \frac{W S_i^2}{8T} \rightarrow$$

For 2 percent sag, $T_0 = 6.25 S_i (W_b + W_m)$ $\rightarrow T_0 = 1856.2$ *lbs*

For 1½ percent sag, $T_0 = 8.4 S_i (W_b + W_m)$

where :

- W = *weight,* $(W_b + W_m)$*, lbs/ft of belt and material*
- S_i = *idler spacing, ft*
- T = *tension in belt, lbs*

Table 6-10. Recommended belt sag percentages for various full load conditions.

Idler Troughing Angle	Material		
	All Fines	One-half the Maximum Lump Size*	Maximum Lump Size*
20^o	3%	3%	3%
35^o	3%	2%	2%
45^o	3%	2%	1½%

Maximum and Minimum Belt Tensions

Slack Side Tension, T_2

- $T_2 = T_e C_w$

  or

- $T_2 = T_0 \pm T_b \pm T_{yr}$

Use the larger value of T_2

$T_2 = 1167.8$ lbs

$\mathbf{T_2 = 1856.2 + 1256 – 544.5 = 2567.7}$ **lbs**

Tension, T_b . The weight of the carrying and/or return run belt for a sloped conveyor is carried on the pulley at the top of the slope. This must be considered in calculating the T_2 tension, as indicated above.

$\mathbf{T_b = 115 \times 11 = 1265}$ **lbs**

- $T_b = H \times W_b$

where:

W_b = *weight of belt, lbs/ft*

H = net change in elevation, ft

Return Belt Friction Tension, T_{yr} *.* The return belt friction is the belt tension resulting from the empty belt moving over the return run idlers:

$\mathbf{T_{yr} = 544.5}$ **lbs**

- $T_{yr} = 0.015 \times L \times W_b \times K_t$

where:

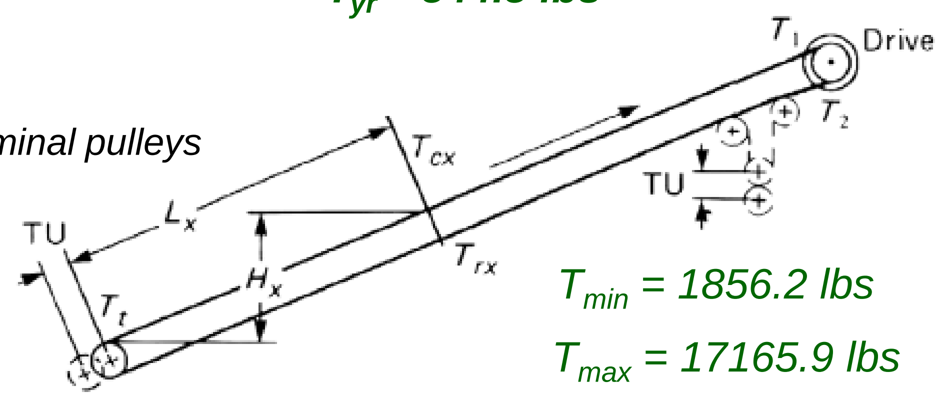
L = length, ft, of conveyor to center of terminal pulleys

K_t = *temperature correction factor*

$T_t = T_0$ *or* $T_t = T_2 – T_b + T_{yr}$

$T_t = T_{min}$

$T_1 = T_2 + T_e = T_{max}$



$T_{min} = 1856.2$ lbs

$T_{max} = 17165.9$ lbs

Belt Selection

Item	Units	Description	System
PIW	**LB/In-Width**	**Max. Oper. Strength**	**USA**
EP	**N/mm or Kn/m**	**Breaking Strength**	**Metric**
ST	**N/mm or Kn/m**	**Breaking Strength**	**Metric**

Belt stress = *T1* / Belt width = *17166/42* = 409 lbs per inch of width(PIW)

Table 7-13. Typical ratings for multi- or reduced-ply conveyor elevator rubber belting.

CONVEYOR																
Working Strength (PIW)		150	220	300	400	500	240	345	475	625	775	480	660	880	1000	1200
Number of Plies		2	2	2	2	3	3	3	3	3	3	4	4	4	4	6
Approximate Carcass Thickness (in.)		.12	.14	.14	.20	.210	.14	.19	.22	.25	.27	.265	.28	.335	.38	.50
Approximate Carcass Weight (lb/in. width)		.05	.075	.10	.104	.110	.08	.10	.108	.12	.135	.125	.141	.165	.188	.25
Minimum Pulley Diameter (in.)																
	81-100%	14	16	16	18	24	18	24	24	30	30	30	30	36	42	--
	61-80%	12	14	14	16	20	16	16	20	20	24	20	24	24	30	36
	41-60%	10	12	12	14	18	12	14	18	18	20	16	20	20	24	30
	To 40%	10	10	10	12	16	12	12	16	16	18	14	18	18	20	24
TROUGHABILITY																
Idler Troughing		**MINIMUM BELT WIDTH (INCHES) FOR EMPTY TROUGHING**														
Angle	20°	14	14	18	24	24	20	24	24	30	36	36	42	48	--	--
	35°	16	18	24	30	30	24	24	30	30	36	30	36	42	42	48
	45°	NR	NR	24	30	30	30	30	30	36	42	36	42	48	48	54
		MAXIMUM BELT WIDTH (INCHES) FOR LOAD SUPPORT														
Material Weight (lbs/cu ft)																
20°	0-40	42	54	72	66	72	60	72	84	84	84	72	84	84	84	116
	41-80	36	42	60	60	66	60	60	72	72	72	72	72	84	84	108
	81-120	36	42	54	54	60	42	54	72	72	72	72	72	84	84	108
	Over 120	NR	36	48	48	54	42	48	48	60	60	60	60	72	84	96
35°	0-40	36	48	60	66	72	54	66	66	72	84	72	72	84	84	108
	41-80	30	36	54	60	66	48	60	66	60	72	60	66	72	84	96
	81-120	30	36	48	54	60	42	54	54	60	72	60	60	72	84	96
	Over 120	NR	30	42	48	54	36	48	48	54	60	54	54	60	72	84
45°	0-40	36	48	60	60	66	48	60	60	72	72	72	72	84	84	108
	41-80	30	42	48	54	60	60	42	54	60	60	54	72	72	84	96
	81-120	24	36	48	48	54	36	48	48	54	60	54	72	72	84	84
	Over 120	NR	30	36	42	48	30	42	42	54	54	48	54	54	72	84

Convert from PIW to EP:

$$\frac{(409 \text{ PIW} \times 10 \text{ SF})}{5.71} = 716 \text{ N/mm}$$

Bibliography

- Continuous handling equipment – Nomenclature, ISO 2148-1974
- Belt Conveyors for Bulk Materials, Calculations by CEMA 5th Edition
- Kulinowski, Kasza: Wykłady „Conveyors”, www.kmg.agh.edu.pl
- www.conveyorbeltguide.com
- IDLER CATALOG, Superior Industries, LLC

Pound-force, lbf	x	4.4482	=	N
Mass, lbs	x	.4536	=	kg
Length, ft	x	.3048	=	m
Velocity, fpm	x	.0051	=	m/sec
Mass per length, lbs/ft	x	1.4882	=	kg/m
Acceleration, ft/sec^2	x	.3048	=	m/sec^2
Area, ft^2	x	.0929	=	m^2
Volume, ft^3	x	.0283	=	m^3
Horsepower, hp (US)	x	745.7	=	W (Watts)

***g* - Acceleration due to gravity, 32.2 ft/sec^2**

Questions?