

## SELECTION GUIDELINES

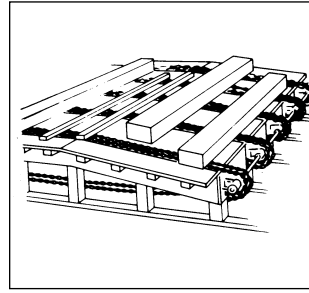
A wide variety of chains are available for the purpose of material handling, conveying, and elevating. An accurate assessment of the basic conditions in which the chain will function is essential for optimum performance. In general, the basic steps of conveyor chain selection are as follows:

- Select a conveyor type appropriate for the material being handled.
- Choose the chain type best suited for the conveyor style selected and the material being handled.
- Select the specific chain size necessary to successfully handle the loading conditions of the conveyor, attachment spacing, space limitations, and other service conditions that are encountered.

Union Chain Division Conveying and Elevating Chains are built to withstand challenging operating conditions including shock loadings and exposure to environments conducive to abrasive wear and/or corrosion. In some more severe applications, special materials or heat treatments are required for successful performance. If you have any questions, contact Union engineering for assistance in making the best choice for your conveying application.

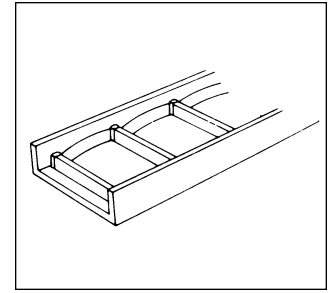
## Conveyor Types

There are, in general, nine types of chain conveyors. The material being handled and the service environment typically determine which type is chosen.



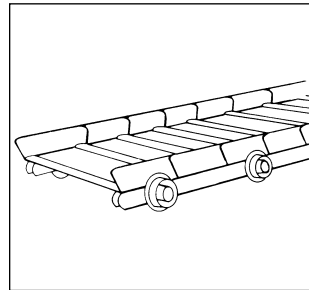
### Plain Chain

The chain runs in tracks and the load is carried directly on the chain.



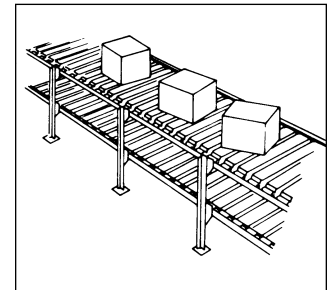
### Drag Conveyors

One or more endless strands with or without integral flights moves material in a trough or pan.



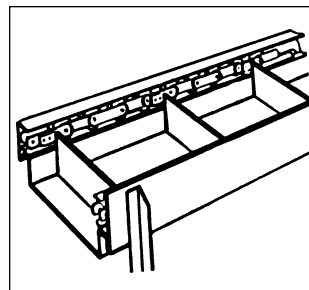
### Apron Conveyors

Die formed steel plates or pans mounted on two or more strands of chain. They are good for impact, abrasion and high temperature applications.



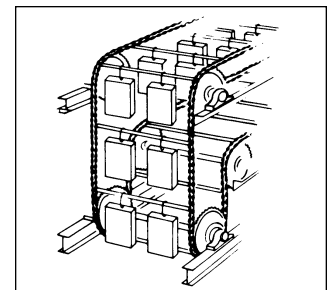
### Slat Conveyors

Two or more strands of chain with slats attached at intervals. This is used primarily for unit handling.



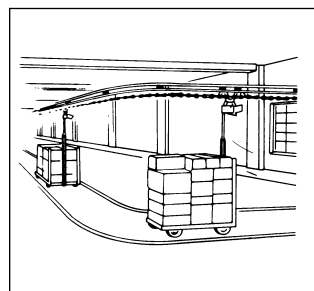
### Scraper Flight

One or two endless chains with flights attached to push material in a trough.



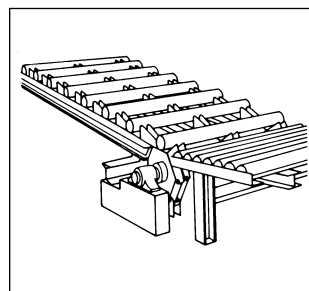
### Cross Bar

Two strands of chain connected by cross-bars, which can be arranged in paths from inclined to serpentine.



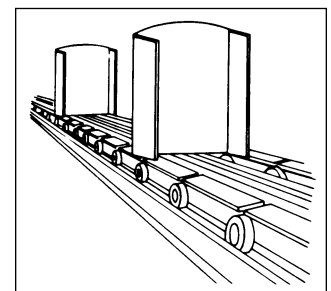
### Trolley and Tow

An endless strand of chain is suspended from an overhead track with carrying attachments at intervals. Tow conveyors have pickups to engage truck masts.



### Pusher Chain

One or more strands of endless chain are utilized with attachments to push the load. Load slides or rolls on rails. The chain does not carry the load.



### Carrier Chain

Attachments are connected to part of the chain and form a carrying surface for an individual part on a continuous surface.

### Material Classifications

- Bulk materials (example: limestone)
- Unit materials (example: TV sets)

**Table 1 — Typical Material Classifications of Conveyor Types**

Conveyor Type	Bulk <sup>1</sup>	Unit <sup>2</sup>
Plain Chain		X
Drag Conveyors	X	
Apron Conveyors	X	
Slat Conveyors		X
Scraper Flight	X	
Cross Bar		X
Trolley and Tow		X
Pusher Chain		X
Carrier Chain		X

<sup>1</sup>Bulk material capacities are typically given as tons per hour (TPH).

<sup>2</sup>Unit material capacities are typically given as pieces (or units) per hour (pcs./hr.)

### General Conveyor Chain Types

- Roller Conveyor Chains
- Steel Bushed Rollerless
- Welded Steel Mill Chain
- Welded Steel Drag Chain
- Cast Combination Chain
- Drop Forged Rivetless Chain
- Bar/Pin Chain

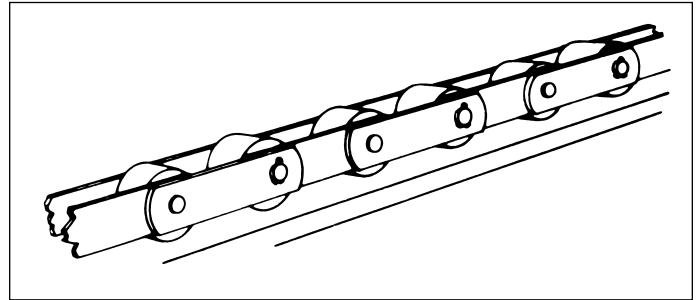
**Table 2 — Typical Chain Types for Conveyor Service**

Conveyor Types	Conveyor Chain Types						
	Roller Conveyor	Steel Bushed	Welded Steel	Welded Drag	Cast Combination	Drop Forged	Bar/Pin
Plain Chain	X	X	X	X	X		X
Drag Conveyors		X	X	X	X		
Apron Conveyors	X						
Slat Conveyors	X						
Scraper Flight	X	X	X		X	X	X
Cross Bar	X						
Trolley and Tow						X	X
Pusher Chain	X	X	X	X	X		X
Carrier Chain	X						

**Table 3 — General Characteristics of Conveyor Chain Types**

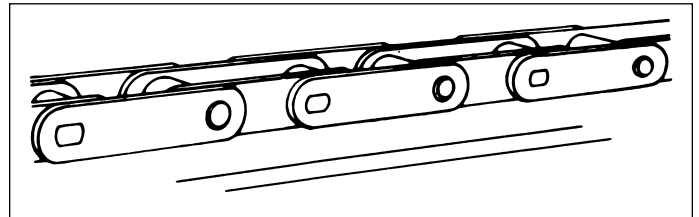
Chain Type	Pitch Range (in.)	Weight Range (lbs./ft.)	Working Loads (lbs.)	Operating Speeds (fpm)	Wear Life Rating
Roller Conveyor	1.654 to 24.0	3.7 to 35.0	2,100 to 22,300	10 to 200	A
Steel Bushed	2.609 to 7.0	3.8 to 67.0	2,750 to 21,800	10 to 150	B
Welded Steel	2.609 to 6.05	4.0 to 30.0	3,000 to 15,300	10 to 100	C
Welded Drag	5.0 to 8.0	12.0 to 29.0	8,500 to 15,000	10 to 100	C
Cast Combination	2.609 to 6.05	3.6 to 16.3	2,340 to 10,400	10 to 75	D
Drop Forged	3.031 to 9.031	2.2 to 10.0	1,100 to 21,600	10 to 75	C
Bar/Pin	4.0 to 12.0 (Avg.)	5.2 to 33.0	—	10 to 50	C

### Chain Rolling or Sliding



#### Chain Rolling

- Best suited when chain carries materials.
- Smoother operation, less pulsation.
- Less friction — allows longer centers, smaller motors, and lower operating costs.
- Less horsepower required.
- Not suited for “dirty” applications where foreign materials can jam rollers.



#### Chain Sliding

- Best suited when conveyor deck supports materials and chains carry, push, drag or scrape.
- Rugged construction — ideal for impact loadings.
- Greater horsepower required.
- Works well in “dirty” applications because this chain has fewer moving parts.

## Friction Coefficients

**Table 4 — Sliding Friction Coefficients ( $f_s$ )**

	Dry	Lubricated
Chains on Steel Rail	.33	.20
Chains on Bronze	—	.15
Chains on Hardwood	.35	.25
Chains on UHMW Plastic	.25	.15
Cast Iron on Steel	.50	.30

**Table 5—Sliding Friction of Materials on Steel Troughs ( $f_s$ )**

Material	Friction	Material	Friction	Material	Friction
Aluminum	.40	Coal, Bituminous, Run of Mine	.60	Lime, Ground	.40
Ashes Dry < 3"	.50	Coal, Bituminous, Slack, Dry	.50	Lime, Pebble	.50
Ashes Wet < 3"	.60	Coal, Bituminous, Slack, Wet	.70	Sand, Dry	.60
Bagasse	.40	Coke, Sized	.40	Sand, Foundry, Shakeout	.70
Beans, Whole	.35	Coke, Mixed	.60	Sand, Foundry, Tempered	.85
Cement, Portland	.65	Coke, Breeze	.65	Sawdust	.40
Cement, Clinker	.70	Cottonseed	.35	Stonedust	.50
Coal, Anthracite	.30	Grains	.40	Stone, Screened Lumps	.60
Coal, Anthracite, Run of Mine	.40	Gravel, Dry, Screened	.45	Stone Lumps and Fines	.65
Coal, Anthracite, Pea	.45	Gravel, Run of Bank	.60	Wood Chips	.40
Coal, Anthracite, Buckwheat	.55	Ice, Crushed	.20		
Coal, Bituminous, Sized	.55	Ice Cakes	.10		

**Table 6 — Approximate Rolling Friction Coefficients ( $f_r$ )**

Roller O.D.	Dry	Lubricated
1 1/2	.22	.16
2	.20	.15
2 1/2	.16	.12
3	.14	.09
4	.12	.08
5	.11	.07
6	.10	.06

Roller Bearing  $f_r = .05$   
 Ball Bearing with hardened race  $f_r = .03$

### Specific Rolling Friction Coefficients ( $f_r$ )

$$f_r = \frac{d}{D} f_s$$

Where:

D = O.D. of chain roller (in.)

d = O.D. of chain bushing (in.)

$f_s$  = Sliding friction coefficient from Table 4

**Table 7 — Maximum Speeds of Conveyor Chains (fpm)**

All dimensions are in inches unless otherwise indicated.

Number of Teeth	Pitch				
	4	6	9	12	18
6	180	145	120	105	85
7	210	170	140	120	100
8	240	195	160	140	115
9	270	220	180	155	125
10	300	245	200	175	140
11	330	270	220	190	155
12	360	295	240	205	170
13	390	320	260	225	185
14	420	345	280	240	200
15	450	365	300	260	210

For economical speeds when conveyors are heavily loaded and the load is carried over the terminal sprockets use 75% of above values.

**Table 8 — Allowable Roller and Bushing Bearing Pressures**

Roller and Bushing Materials	Allowable Bearing Pressure (PSI)	
	Dry	Lubricated
Case Hardened Steel and Case Hardened Steel	700	1,400
Case Hardened Steel and Through-Hardened Steel	700	1,400
Case Hardened Steel and Untreated Steel	500	1,200
Case Hardened Steel and Chrome Iron	500	1,100
Case Hardened Steel and Chilled Iron	600	1,000
Case Hardened Steel and Bronze	200	400
Case Hardened Steel or Stainless Steel on Plastic	100	150

Engineering Formulas	Horsepower (HP)
<p><b>Material Weight per ft. on Conveyor (M) for Bulk Materials (lbs./ft.)</b></p> <p>Where:</p> $M = \frac{(33.3) (Q)}{S}$ <p>Q = Capacity (tons/hr.) S = Chain speed (ft./min.)</p> $M = \frac{(CFM) (d)}{S}$ <p>CFM = Capacity or conveyed material flow rate (ft.<sup>3</sup>/min.) d = Material density (lbs./ft.<sup>3</sup>)</p>	<p>Where:</p> $HP = \frac{(t) (rpm) (1.1)}{63,025}$ <p>t = Torque transmitted by headshaft (in./lb.)</p> $HP = \frac{(T) (rpm) (1.1)}{5,252}$ <p>T = Torque transmitted by headshaft (ft./lb.) rpm = Speed of headshaft</p> $HP = \frac{(P) (S) (1.1)}{33,000}$ <p>P = Total conveyor pull (lbs.) S = Chain Speed (ft./min.) (Note: 1.1 compensates for motor efficiency.)</p>
<p><b>Chain Speed (S)</b></p> <p>Where:</p> $S = \frac{(P) (N) (RPM)}{12}$ <p>S = Speed (ft./min.) P = Chain pitch (in.) N = Number of teeth in sprocket RPM = Rotational speed of sprocket</p>	<p><b>Estimated Chain Weight for Selection (lbs./ft.*)</b></p> <p>Where:</p> <ul style="list-style-type: none"> <li>For Chain Rolling: Chain Weight = (.002) (M) (C)</li> <li>For Chain Sliding: Chain Weight = (.004) (M) (C)</li> </ul> <p>M = Weight of material being conveyed on conveyor (lbs./ft.) C = Center distance between sprockets * = Weight of each strand without slats</p>

To locate compatible sprockets for your chain, refer to the Product Cross-Reference in Section D.

Note: Dimensions are subject to change. Contact Union Chain to obtain certified prints for design and construction.

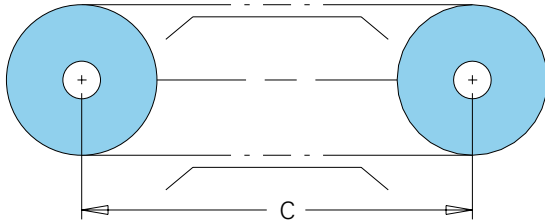
**Conveyor Chain Pull Formulas**

**Horizontal**

Material Carried:  $P = (2.1W + M) f_r C$   
(Slat or Apron Conv.)

Material Sliding:  $P = (2.1Wf_s + Mf_s) C + J$   
(Drag or Scraper Conv.)

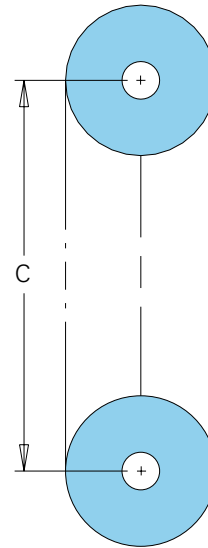
**Horizontal**



**Vertical**

Material Carried:  $P = (M + W) C + \frac{P_1}{2}$

**Vertical**



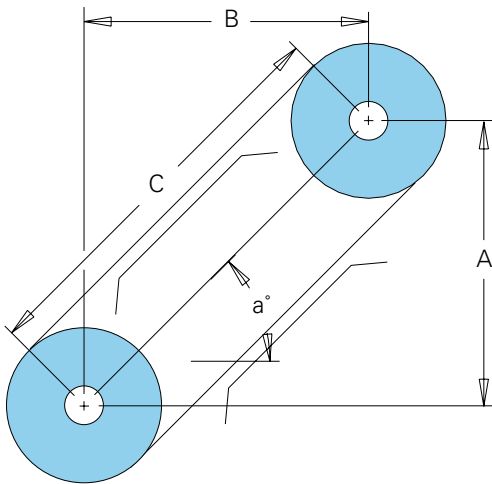
**Inclined**

Material Carried:  $P = [(M + W) f_r \text{COS}a + (M + W) \text{SIN}a] C + (Wf_r \text{COS}a - W\text{SIN}a) C + J$   
(Slat or Apron Conv.)

Material Sliding:  $P = [(Mf_s + Wf_s) \text{COS}a + (M + W) \text{SIN}a] + J$   
(Scraper Conv.)

*Note: When  $(Wf_r \text{COS}a - W\text{SIN}a) C$  is positive, multiply quantity by 1.1 to account for tail shaft friction.*

**Inclined**



**Glossary**

$P$  = Total Conveyor Pull (lbs.)

$P_1$  = Take-up Force (lbs.)

$W$  = Weight of chains, attachments, slats, etc., and other moving elements of the conveyor per ft. (lbs./ft.)

$M$  = Weight of material per ft. on the conveyor (lbs./ft.)

$f_r$  = Friction coefficient of chain rolling on support rail (Table 6)

$f_s$  = Sliding friction coefficient of material or chain sliding (Tables 4 and 5)

$C$  = Center distance (ft.)

$J$  = Pull (lbs.) caused by sideboard sliding friction (Table 9)

**Table 9 — Additional Pull on Conveyor (J)  
Material Sliding Against Sideboards**

Material	R
Coal	14.0
Coke	35.0
Limestone	7.5
Gravel	7.0
Sand	5.5
Ashes	14.0

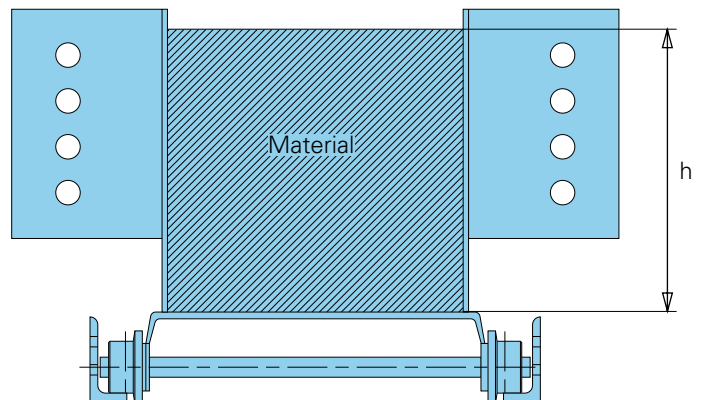
$$J = \frac{Ch^2}{R} \quad \text{SIN}a = \frac{A}{C}$$

Where:  $\text{COS}a = \frac{B}{C}$

$h$  = Height of material in inches

$R$  = Variable factor for different materials

$C$  = Length of conveyor in feet



## Selection Procedure

### Step 1: Determine the Conveyor's Basic Requirements

- Type of conveyor to be used and layout of its dimensions (C, a, etc.).
- Type of chain including attachments.
- Determine weight of conveyed material (M) on the conveyor (lbs./ft.).
- Estimate weight of chain, attachments, and other moving parts of conveyor (W) (lbs./ft.).
- Friction Coefficients (Tables 4–6).
- Conveyor speed (S) (ft./min.).
- Determine pull due to sideboard friction (J).
- Determine service factor (V) from Table 10.

### Step 2: Calculate Conveyor Pull

Use the appropriate formula from page A-48 to determine conveyor pull (P).

### Step 3: Select Sprocket Size

Using Table 11, under conveyor speed read down to the number nearest 1.00 (this will be in the vicinity of the heavy dividing line). Read across to the left to obtain the optimum sprocket size. If space limitations require using smaller sprockets read across from the right from the number of teeth to the column under conveyor speed — obtain the Speed Correction Factor (E).

### Step 4: Calculate Design Conveyor Pull (DP)

$$DP = (P) (V) (E)$$

### Step 5: Calculate Chain Tensions (T)

- Single strand conveyor  $T = DP$
- Double strand conveyor  $T = (DP) (1.2) / 2$
- Triple strand conveyor  $T = (DP) (1.2) / 3$
- More than three strands Consult Union Engineering

### Step 6: Select Chain Size

Choose a chain that has a maximum allowable load rating greater than the calculated chain tension of Step 5.

### Step 7: Recalculate Actual Chain Tension

Repeat Steps 2–5 using actual chain weights. For roller conveyor chains, specific rolling friction coefficient values can be obtained from Table 6 on page A-46.

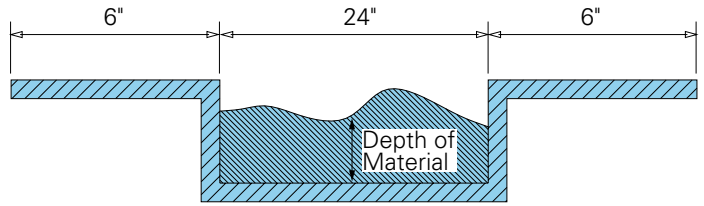
### Step 8: Check Roller/Bushing Bearing Pressure (Roller Conveyor Chain Only)

Calculate bearing pressure from:

$$\text{Bearing Pressure} = \frac{\text{Maximum Load per Roller (lbs.)}}{\text{Bushing OD (in.)} \times \text{Roller Length (in.)}}$$

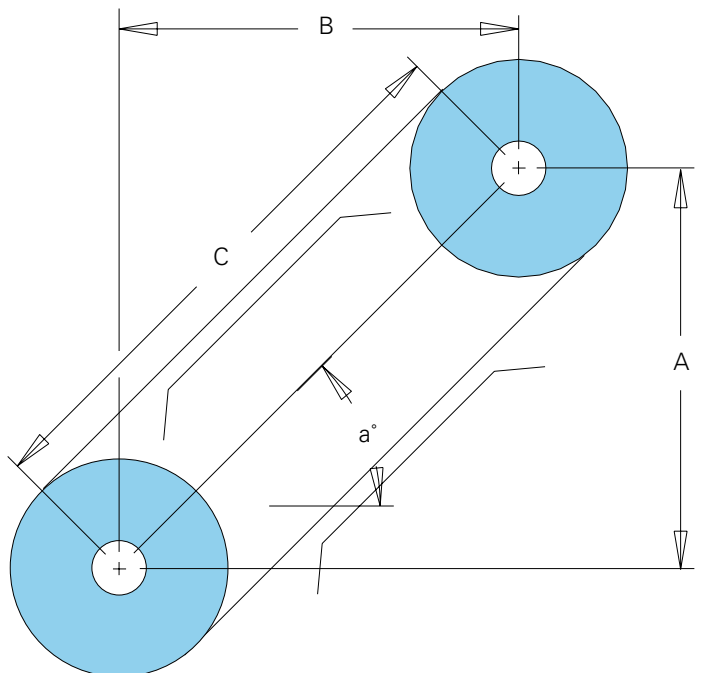
This value should be less than that shown in Table 8.

## Selection Example



An incline scraper conveyor has been tentatively selected to handle bituminous coal. The sketch above shows the steel trough; other details are given below:

- Operating capacity:  $Q = 150$  ton/hr.
- Operating speed:  $S = 100$  ft./mn.
- Depth of material:  $d = 6$ "
- Total lift:  $A = 30$  ft.
- Total horizontal run:  $B = 40$  ft.
- Sprocket centers:  $C = 50$  ft.
- Infrequent moderate shock
- 24-hour operation—"Dirty" conditions
- Scraper paddle:  $5/16$ " x  $12$ " x  $23$ "—22.8 lbs. each, spaced every 12".
- Use roller conveyor chain



## Selection Chain Pull Factors

**Table 10 — Service Factors (V)**

Frequency of Shock	Character of Conveyor Loading	Conditions of Operation	Daily Operating Period
Infrequent (1)	Uniform or Steady (1)	Relatively clean and moderate room temperature (1)	8–10 hours (1) <sup>1</sup>
Frequent (1.2) <sup>1</sup>	Moderate Shock (1.2) <sup>1</sup> Heavy Shock (1.5)	Moderately dusty (1.2) Unprotected from weather, dirty corrosive conditions or unusual temperatures within permissible operating range (1.4) <sup>1</sup>	24 Hours (1.2)

<sup>1</sup>Example V = 1.2 x 1.2 x 1.4 x 1.0 = 2.02

**Table 11 — Speed Correction Factors (E)**

All dimensions are in inches unless otherwise indicated.

Teeth	Conveyor Speed (ft./min.)														
	10	25	50	75	100	125	150	175	200	225	250	275	300	400	500
6	.92	1.09	1.37	1.68	2.00	2.40	2.91	3.57	4.41	5.65	7.35	10.60	16.70		
7	.86	.97	1.13	1.27	1.44	1.61	1.81	2.04	2.29	2.60	2.96	3.42	3.95	8.62	
8	.81	.91	1.04	1.16	1.26	1.37	1.49	1.63	1.76	1.93	2.10	2.29	2.48	3.62	6.21
9	.79	.87	.98	1.07	1.17	1.26	1.36	1.45	1.55	1.65	1.76	1.88	2.00	2.56	2.94
10	.78	.84	.94	1.02	1.09	1.16	1.24	1.31	1.37	1.45	1.53	1.61	1.68	2.03	2.41
11	.76	.82	.90	.97	1.03	1.09	1.15	1.22	1.28	1.34	1.40	1.46	1.52	1.78	2.05
12	.74	.79	.86	.93	.99	1.05	1.10	1.16	1.21	1.26	1.32	1.37	1.42	1.63	1.84
14	.74	.77	.83	.89	.94	.98	1.02	1.07	1.11	1.15	1.19	1.24	1.28	1.47	1.61
16	.73	.76	.81	.86	.89	.94	.97	1.01	1.05	1.08	1.12	1.16	1.19	1.34	1.48
18	.72	.75	.80	.83	.88	.91	.94	.98	1.01	1.04	1.08	1.11	1.14	1.27	1.40
20	.72	.75	.79	.83	.86	.89	.92	.95	.98	1.01	1.04	1.07	1.10	1.22	1.34
24	.71	.74	.77	.80	.82	.85	.88	.90	.94	.96	.98	1.01	1.04	1.15	1.26

## Conveyor Selection Example

### Step 1: Determine the Conveyor's Basic Requirements

- Incline scraper conveyor
- Roller conveyor chain with attachment for flight every 12".
- Determine (M) from formula on page A-47.

$$M = \frac{33.3 (Q)}{S} = \frac{33.3 (150)}{100}$$

$$M = 50 \text{ lbs./ft.}$$

- Determine W:

$$W = (CW) (N) + Ws$$

$$CW = \text{Wt. of Chain (lbs./ft.)}$$

$$N = \text{No. of chain strands} = 2$$

$$Ws = \text{Wt. of slats} = 22.8 \text{ lbs./ft.}$$

From formula on page A-47.

#### For Chain Rolling

$$CW = .002 (M) (C)$$

$$CW = .002 (50) (50)$$

$$CW = 5.00 \text{ lbs./ft.}$$

(very light duty rolling)

#### For Chain Sliding

$$CW = .004 (M) (C)$$

$$CW = .004 (50) (50)$$

$$CW = 10.00 \text{ lbs./ft. (sliding)}$$

From Table 3 note that minimum chain weight = 3.70 lbs./ft., so use the 5.00 value rather than the 3.70 (lbs./ft.)

#### For Chain Rolling

$$W = (5.00) (2) + 22.8$$

$$W = 32.8 \text{ lbs./ft. (rolling)}$$

#### For Chain Sliding

$$W = 10.00 (2) + 22.8$$

$$W = 42.8 \text{ lbs./ft. (slide)}$$

Friction Coefficients

From Table 5:

$$f_s = .55 \text{ (Sliding Coal)}$$

From Table 6:

$$f_r = .20 \text{ (Rolling Chain)}$$

- Conveyor Speed:

$$(s) = 100 \text{ ft./min.}$$

- Determine Sideboard Friction (J) from Table 9:

$$J = \frac{Ch^2}{R}$$

$$J = \frac{50 (6)^2}{14}$$

$$J = 128 \text{ lbs.}$$

- Determine Service Factor (V) from Table 10:

$$V = (1.0) (1.2) (1.4) (1.2)$$

$$V = 2.02$$

### Step 2: Calculate Conveyor Pull (P)

From formula on page A-48.

#### For Chain Rolling

$$P = [(Mf_s + Wf_r) \text{ COS} \alpha + (M + W) \text{ SIN} \alpha] C + (Wf_r \text{ COS} \alpha - W \text{ SIN} \alpha) C$$

$$P = [(50 (.55) + (32.8) (.2)) .8 + (50 + 32.8) .6] 50 + [(32.8) (.2) (.8) - 32.8 (.6)] 50$$

$$P = 3,850 \text{ lbs.} - 720 \text{ lbs.}$$

$$P = 3,130 \text{ lbs. (rolling)}$$

#### For Chain Sliding

$$P = [(Mf_s + Wf_s) \text{ COS} \alpha + (M + W) \text{ SIN} \alpha] C + (Wf_s \text{ COS} \alpha - W \text{ SIN} \alpha) C$$

$$P = [(50 (.55) + (42.8) (.33)) .8 + (50 + 42.8) .6] 50 + [(42.8) (.33) (.8) - 42.8 (.6)] 50$$

$$P = 4,450 \text{ lbs.} - 720 \text{ lbs.}$$

$$P = 3,730 \text{ lbs. (sliding)}$$

### Step 3: Select Sprocket Size

From Table 11 we obtain 12-tooth sprocket as best selection choice.

$$E = .990$$

### Step 4: Calculate Design Conveyor Pull (DP)

#### For Chain Rolling

$$DP = (P) (V) (E)$$

$$DP = (3130) (2.02) (.99)$$

$$DP = 6,260 \text{ lbs. (rolling)}$$

#### For Chain Sliding

$$DP = (P) (V) (E)$$

$$DP = (3,730) (2.02) (.99)$$

$$DP = 7,460 \text{ lbs. (sliding)}$$

### Step 5: Calculate Chain Tension

#### For Chain Rolling

$$T = (DP) (1.2)/2$$

$$T = (6,260) (1.2)/2$$

$$T = 3,760 \text{ lbs. (rolling)}$$

#### For Chain Sliding

$$T = (DP) (1.2)/2$$

$$T = (7,460) (1.2)/2$$

$$T = 4,480 \text{ lbs. (sliding)}$$

### Step 6: Select Chain Size

#### For Chain Rolling

Referring to page A-32, G-29 or G-19 attachments are convenient for bolting scraper flights. Since attachment spacing is every 12", choose either 4", 6", or 12" pitch chain.

Select 1131R with G-29 every 2nd pitch.

#### For Chain Sliding

Note that chain U-3945 with K-3 attachments every 3rd pitch could suit this application. In addition, mining industry chains should be considered. Choose the chain that offers the best overall economy.

Select U-3945 with K-3 attachments every third pitch. (See Asphalt Batch Plants and Finishing in the Selected Industry Applications Section.)

**Step 7: Recalculate Chain Tension**For Chain Rolling

$$W = 22.8 + 13.9$$

$$W = 36.7 \text{ lbs./ft.}$$

$$f_r = .33 (1.125/3)$$

$$f_r = .12$$

$$DP = 2,960 (2.02) (.99)$$

$$DP = 5,920 \text{ lbs.}$$

$$T = 5,920 \text{ lbs. } (1.2)/2$$

$$T = 3,550 \text{ lbs./strand (rolling)}$$

Since the maximum allowable working load rating of 1131R is 5,900 lbs., the selection is satisfactory. We could, however, economize by selecting a smaller chain (for example, 627R). To do this, recalculate chain tension by repeating Steps 2, 3, 4, and 5.

For Chain Sliding

$$W = 22.8 + 9.8$$

$$W = 32.6$$

$$f_s = .33 \text{ (Sliding Steel)}$$

$$f_s = .55 \text{ (Sliding Coal)}$$

$$DP = 3,720 (2.02) (.99)$$

$$DP = 7,440 \text{ lbs.}$$

$$T = 7,440 \text{ lbs. } (1.2)/2$$

$$T = 4,460 \text{ lbs./strand (sliding)}$$

Since the maximum allowable working load rating of U-3945 is 5,740 lbs., the selection is satisfactory. If bolted flight attachments are not necessary, mining industry chain could be considered.