ENGINEERING DATA

MOLINE ENGINEERING CLASS STEEL DRIVE CHAIN SELECTION DATA

The following tables have been compiled for your convenience to cover several of the more popular types of drive chain.

Applications requiring speeds over 1000 FPM should be referred to Moline Engineering Department for recommendations.

HORSEPOWER RATINGS

The Horsepower Ratings of MXS Class Offset Steel Drive Chain may be determined by applying the following formulas:

$$HP = \frac{\text{Working Load} \times P \times T \times R}{396{,}000 \times Fs}$$

$$WL = \frac{HP \times 396{,}000 \times Fs}{P \times T \times R}$$

When:
- **HP** = Horsepower
- **P** = Chain Pitch in inches
- **T** = Number of teeth in the driving sprocket
- **R** = Full load speed of the driving sprocket in revolutions per minute
- **Fs** = Speed Factor (Table 2)
- **WL** = Working Load

SERVICE FACTOR (FP)—TABLE 1

	CONDITIONS AFFECTING CHAIN LIFE EXPECTANCY	SERVICE FACTORS
Frequency of Shock	Infrequent Shock	1
	Frequent Shock	1.2
Character of Chain Loading	Uniform or Steady Load	1
	Moderate Shock Load	1.2
	Heavy Shock Load	1.5
Atmospheric Conditions	Relatively Clean and Moderate Temperature	1
	Moderately Dirty and Moderate Temperature	1.2
	Exposed to Weather, Very Dirty, Abrasive, Mildly Corrosive, and Reasonably High Temperatures	1.4
Daily Operating Range	8 to 10 Hours	1
	12 to 24 Hours	1.2

MOLINE CONVEYOR AND ELEVATOR CHAIN SELECTION DATA

ELEVATOR AND CONVEYOR CHAIN SELECTION

In determining the proper chain and sprockets for use in a particular conveyor or elevator operation, chain speed and pull are the most important factors. The pull or force needed to overcome the friction and load of a conveyor is transmitted by the chain; therefore, the chain must have sufficient strength to withstand the starting and live loads of the conveyor.

In selecting a conveyor chain, there are many practical aspects to decide upon in addition to strength and speed: factors such as length of operation, ambient conditions, loading methods, result of failure (such as loss of life, production, etc.), and lubrication. Use the General Design Procedure Check List below to aid you in designing your conveyor system.

General Design Procedure Check List:

a) Conveyor type (single strand, parallel strand, inclined, etc.)
b) Speed of both shafts (feet per minute)
c) Approximate shaft center distance (feet)
d) Approximate bore and diameter of each sprocket (inches)
e) Chain pitch (inches)
f) Chain speed (feet per minute)
g) Chain pull
h) Required horsepower
i) Kind of conveyed materials (bulky, abrasive, packaged, etc.)
j) Weight of conveyed material (pounds per conveyor foot)
k) Weight of carriers (pans, shafts, slats, etc.—pounds per conveyor foot)
l) Size and spacing of carriers (inches)
m) Practical factor checks (loading speed, hours of daily operation, protected or unprotected from weather, lubrication, etc.)

STEEL CHAIN WORKING LOAD SPEED FACTORS (FS)—TABLE 2

NUMBER OF TEETH	FEET PER MINUTE 10	25	50	75	100	125	150	175	200	225	250	275	300	400	500	600	700	800	900	1000
6	.917	1.09	1.37	1.68	2.00	2.40	2.91	3.57	4.41	5.65	7.35	10.6	16.7							
7	.855	.971	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	.813	.909	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	.794	.870	.980	1.07	1.17	1.26	1.36	1.45	1.55	1.65	1.76	1.88	2.00	2.56	2.94	4.29	6.09	9.90		
10	.775	.840	.943	1.02	1.09	1.16	1.24	1.31	1.37	1.45	1.53	1.61	1.68	2.03	2.41	2.81	3.31	3.82	4.48	5.37
11	.758	.820	.901	.971	1.03	1.09	1.15	1.22	1.28	1.34	1.40	1.46	1.52	1.78	2.05	2.33	2.63	2.96	3.37	3.82
12	.741	.787	.862	.926	.990	1.05	1.10	1.16	1.21	1.26	1.32	1.37	1.42	1.63	1.81	2.05	2.26	2.51	2.77	3.05
14	.735	.769	.833	.885	.935	.980	1.02	1.07	1.11	1.15	1.19	1.24	1.28	1.47	1.61	1.78	1.94	2.10	2.29	2.48
16	.725	.763	.813	.855	.893	.935	.971	1.01	1.05	1.08	1.12	1.16	1.19	1.34	1.48	1.63	1.77	1.93	2.09	2.28
18	.719	.752	.800	.833	.877	.909	.943	.980	1.01	1.04	1.08	1.11	1.14	1.27	1.40	1.53	1.67	1.80	1.95	2.11
20	.717	.746	.787	.826	.855	.893	.917	.952	.980	1.01	1.04	1.07	1.10	1.22	1.34	1.45	1.57	1.69	1.82	1.96
24	.714	.735	.769	.800	.820	.847	.877	.901	.935	.962	.980	1.01	1.04	1.15	1.26	1.37	1.48	1.59	1.71	1.84

ENGINEERING DATA

SELECTING THE PROPER LAYOUT

From the layouts presented here, select the one which best typifies the conveyor system you wish to install. The following symbols are used in the formulas which accompany the layouts:

C = average weight of chain, slats, buckets, etc. per conveyor foot in pounds

D = diameter of roller in inches

d = diameter of roller bore in inches

f_1 = coefficients of sliding friction for Moline Chain (Table "B")

f_2 = coefficients of sliding materials (Table "C")

f_3 = friction coefficient for bulk material over 6″ deep sliding against trough sides (Table "C")

f_4 = friction coefficient for chain roller on runaway $= \frac{f5d}{D}$

f_5 = friction coefficient for rolling chain=.45 dry, .35 lubricated—cored bore, .40 dry, .25 lubricated—machine bore

H = horsepower (at head shaft)

K = depth of material in inches (used only with bulk material over 6 inches deep)

MOLINE CONVEYOR AND ELEVATOR CHAIN SELECTION DATA

L = length of conveyor in feet as shown in diagrams

M = factor for estimating additional pull for buckets digging or picking up material (Table "A")

θ = angle of inclination of conveyor in degrees

P = maximum chain pull in pounds

P_A
P_B = chain pull in pounds (at points indicated in diagram)

R = radius of foot sprocket in inches

S = chain speed in feet per minute

T = torsional pull in pounds

V = vertical lift on elevators in feet, as shown in diagram

W = average weight of material per conveyor foot in pounds

Y = WRM (additional pull caused by buckets digging or picking up material)

CONVEYOR CHAIN SELECTION CHART (PGS. 10, 11)

CHAIN TYPE	LAYOUT NO. 1 HORIZONTAL CONVEYOR Material Being Carried Chain Sliding	LAYOUT NO. 2 HORIZONTAL CONVEYOR Material Being Carried Chain Rolling	LAYOUT NO. 3 HORIZONTAL CONVEYOR Material Sliding Chain Sliding	LAYOUT NO. 4 HORIZONTAL CONVEYOR Material Sliding Chain Rolling	LAYOUT NO. 5 INCLINED CONVEYOR Material Being Carried Chain Sliding	LAYOUT NO. 6 INCLINED CONVEYOR Material Being Carried Chain Rolling	LAYOUT NO. 7 INCLINED CONVEYOR Material Sliding Chain Sliding	LAYOUT NO. 8 INCLINED CONVEYOR Material Sliding Chain Rolling	LAYOUT NO. 9 VERTICAL CONVEYOR Material Being Carried
SS CLASS BUSHED STEEL	X		X		X		X		X
MSR CLASS BUSHED ROLLER	X	X	X	X	X	X	X	X	X
COMBINATION	X		X		X		X		X
"H" CLASS MILL	X		X		X		X		X
REFUSE-DRAG			X				X		
COMBINATION TYPE REFUSE			X				X		
TRANSFER	X				X				
ROLLER TOP	X				X				
400 CLASS PINTLE	X		X		X		X		X
700 CLASS PINTLE	X		X		X		X		X
900 CLASS PINTLE	X				X				
DETACHABLE	X		X		X		X		X
MC-33 CLASS PINTLE	X				X				

ENGINEERING DATA

MOLINE CONVEYOR AND ELEVATOR CHAIN SELECTION DATA

TABLE A—M VALUES

Factors Used in Estimating Additional Pull Due to Buckets Digging or Picking Up Material

NATURE OF MATERIAL	M FACTORS CENTRIFUGAL ELEVATOR	CONTINUOUS ELEVATOR
Fine	1.70	.50
Mixed	2.00	.84
Lumpy	2.30	1.18

TABLE B—f_1 VALUES (SLIDING FRICTION)

FRICTION COEFFICIENTS FOR SLIDING MOLINE CHAIN

Moline Chain on Cast Ferrous . . . . .30—.50
Moline Chain on Hard Wood 45
Moline Chain on Steel (Dry) 33
Moline Chain on Steel (Lubricated) 20

SPEED CORRECTION FACTORS

Due to variations in the ratio of chain speed to the number of teeth in the driving sprockets, it is necessary to use speed correction factors. These factors are listed in Table "D".

The calculated chain pull is multiplied successively by the appropriate service and speed correction factors according to this formula:

(Calculated chain pull) X (Service factors) X (Speed correction factor) = Corrected chain pull

The result is a corrected chain pull which approximates actual operating conditions. The selected chain should have a working load in excess of the corrected chain pull to assure long, trouble-free chain life.

TABLE D—CORRECTION FACTORS: DETACHABLE, PINTLE, AND COMBINATION CHAIN

Number of Teeth in Driving Wheel	Chain Speed in Feet Per Minute (FPM) 10	25	50	75	100	125	150	175	200	225	250	275	300
6	1.05	1.25	1.57	1.92	2.28	2.75	3.31	4.08	5.03	—	—	—	—
7	.97	1.10	1.29	1.46	1.64	1.84	2.07	2.34	2.62	2.98	3.39	3.92	4.52
8	.93	1.04	1.19	1.32	1.44	1.57	1.71	1.86	2.02	2.20	2.40	2.62	2.85
9	.91	.99	1.12	1.23	1.34	1.44	1.55	1.66	1.77	1.89	2.01	2.15	2.29
10	.89	.96	1.07	1.16	1.25	1.33	1.41	1.49	1.57	1.66	1.75	1.84	1.92
11	.87	.94	1.02	1.10	1.18	1.25	1.32	1.39	1.46	1.53	1.60	1.68	1.74
12	.85	.90	.99	1.06	1.13	1.20	1.26	1.32	1.38	1.45	1.51	1.56	1.62
14	.84	.89	.95	1.01	1.06	1.12	1.17	1.22	1.27	1.32	1.37	1.42	1.46
16	.83	.87	.92	.97	1.02	1.07	1.11	1.15	1.20	1.24	1.28	1.33	1.37
18	.82	.86	.91	.95	1.00	1.04	1.08	1.12	1.15	1.19	1.23	1.27	1.30
20	.82	.85	.90	.94	.98	1.02	1.05	1.09	1.12	1.16	1.19	1.23	1.26
24	.81	.84	.87	.91	.94	.97	1.00	1.03	1.06	1.09	1.12	1.16	1.19

TABLE C—f_2 f_3 VALUES AND WEIGHTS OF MATERIALS (SLIDING FRICTION)

Average Weight per Cubic Foot Pounds and Vertical and Horizontal Coefficients of Friction for Various Materials on Steel Plate

MATERIAL	AVERAGE WEIGHT Per Cubic Foot	f_2 Vertical Factor	f_3 Horizontal Factor
Ashes (dry)	35—40	.50	.026
Ashes (wet)	45—50	.60	.018
Cement (clinker)	75—80	.70	.082
Cement (Portland)	75—85	.65	.086
Coal (Anthracite)	52—57	.38	.050
Coal (Bituminous)	40—50	.60	.049
Coke (Breeze)	25—35	.65	.028
Grain	38—45	.40	.044
Gravel	90—100	.60	.084
Sand (wet)	90—110	.60	.135
Sand (dry)	110—130	.85	.165
Sand (foundry)	90—110	.85	.068
Sawdust	10—13	.40	.005
Stone (crushed)	90—95	.60	.112
Wood Chips	12—20	.40	.005

SERVICE FACTORS

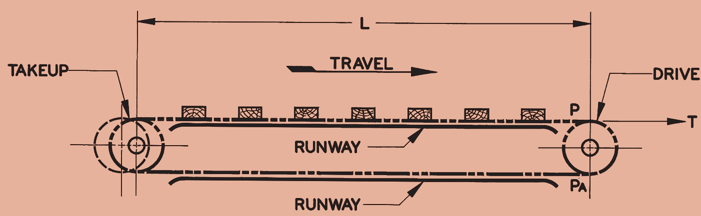
Service factors are used to compensate for unfavorable operating conditions, such as shock, characteristics of loading, conditions of operation, and daily operating periods. They are listed in Table "E".

TABLE E—SERVICE FACTORS

CONDITIONS OF OPERATION	SERVICE FACTOR
Shock Frequency	
Infrequent	1.0
Frequent	1.2
Type of Loading	
Uniform or Steady	1.0
Moderate Shock Load	1.2
Heavy Shock Load	1.5
Ambient Conditions	
Clean and Moderate Temperature	1.0
Moderately Abrasive	1.2
Abrasive, High Temperature, Unprotected	1.4
Length of Operation	
8 to 10 hours per day	1.0
10 to 24 hours per day	1.2

ENGINEERING DATA

MOLINE CONVEYOR AND ELEVATOR CHAIN SELECTION DATA



LAYOUT NO. 1 HORIZONTAL CONVEYOR

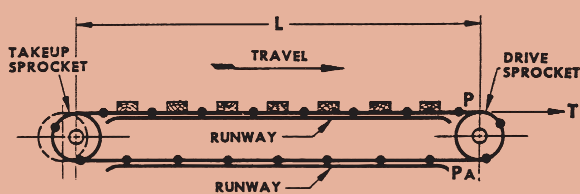
Material Being Carried—Chain Sliding

$P_A = \text{ZERO}$

$P = Lf_1\,(2C+W)$

$T = P$

$H = \dfrac{TS\ 1.15}{33{,}000}$



LAYOUT NO. 2 HORIZONTAL CONVEYOR

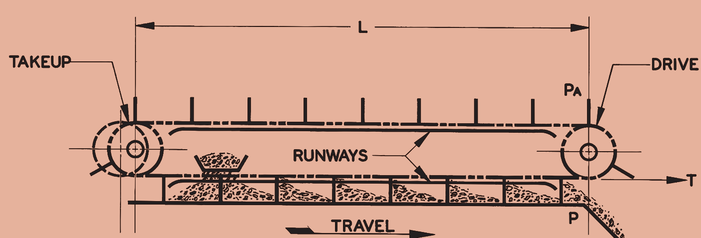
Material Being Carried—Chain Rolling

$P_A = \text{ZERO}$

$P = Lf_4\,(2C+W)$

$T = P$

$H = \dfrac{TS\ 1.15}{33{,}000}$



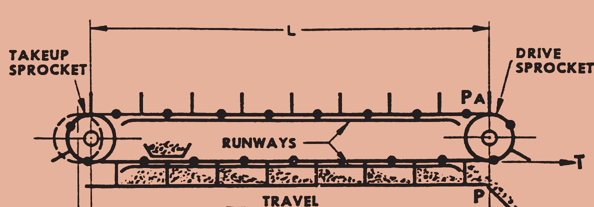
LAYOUT NO. 3 HORIZONTAL CONVEYOR

Material Sliding—Chain Sliding

$P_A = \text{ZERO}$

$P = L\,(2\,Cf_1+Wf_2+K^2f_3{}^*)$

*Use K^2f_3 only when material is over 6″ deep



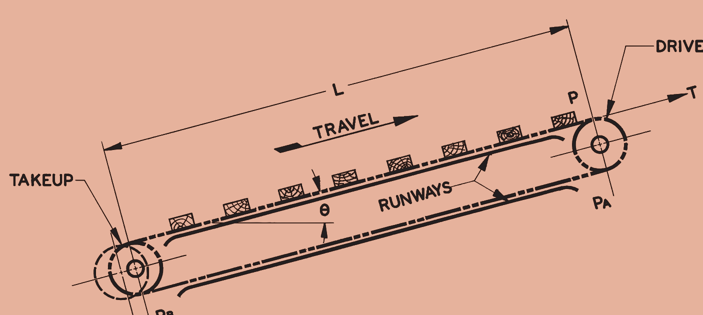
LAYOUT NO. 4 HORIZONTAL CONVEYOR

Material Sliding—Chain Rolling

$P_A = \text{ZERO}$

$P = L\,(2\,Cf_4+Wf_2+K^2f_3{}^*)$

*Use K^2f_3 only when material is over 6″ deep



LAYOUT NO. 5 INCLINED CONVEYOR

Material Being Carried—Chain Sliding

$P_A = \text{ZERO}$ when $f_1 \cos\theta$ is more than $\sin\theta$

$P_A = LC\,(\sin\theta - f_1\cos\theta)$ when $f_1\cos\theta$ is less than $\sin\theta$

$P_B = \text{ZERO}$ when $f_1\cos\theta$ is less than $\sin\theta$

$P_B = LC\,(f_1\cos\theta - \sin\theta)$ when $f_1\cos\theta$ is more than $\sin\theta$

$P = L\,[(C+W)\,(f_1\cos\theta+\sin\theta)]+P_B$

$T = P - P_A$

$H = \dfrac{TS\ 1.15}{33{,}000}$

ENGINEERING DATA

LAYOUT NO. 6 INCLINED CONVEYOR

Material Being Carried—Chain Rolling

P_A = ZERO when $f_4 \cos\theta$ is more than $\sin\theta$

$P_A = LC(\sin\theta - f_4\cos\theta)$ when $f_4\cos\theta$ is less than $\sin\theta$

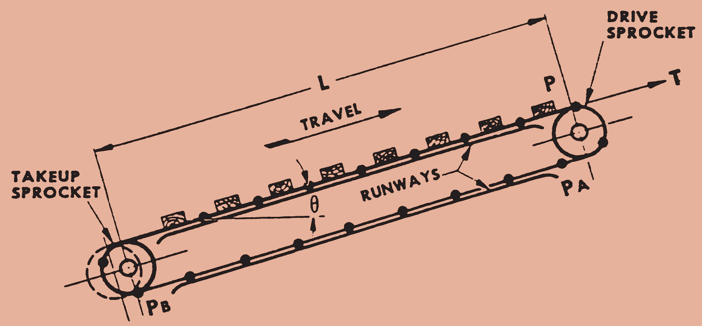
P_B = ZERO when $f_4\cos\theta$ is less than $\sin\theta$

$P_B = LC(f_4\cos\theta - \sin\theta)$ when $f_4\cos\theta$ is more than $\sin\theta$

$P = L[(C+W)(f_4\cos\theta+\sin\theta)]+P_B$

$T = P - P_A$

$H = \dfrac{TS\ 1.15}{33{,}000}$



LAYOUT NO. 7 INCLINED CONVEYOR

Material Sliding—Chain Sliding

P_A = ZERO when $f_1\cos\theta$ is more than $\sin\theta$

$P_A = LC(\sin\theta - f_1\cos\theta)$ when $f_1\cos\theta$ is less than $\sin\theta$

P_B = ZERO when $f_1\cos\theta$ is less than $\sin\theta$

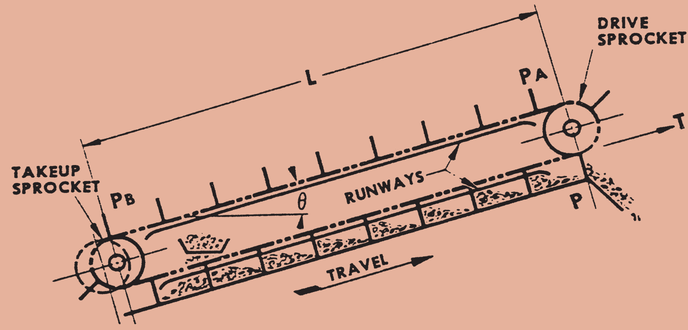
$P_B = LC(f_1\cos\theta - \sin\theta)$ when $f_1\cos\theta$ is more than $\sin\theta$

$P = L[C(f_1\cos\theta+\sin\theta)+W(f_2\cos\theta+\sin\theta) + K^2 f_3{}^*]+P_B$

$T = P - P_A$

$H = \dfrac{TS\ 1.15}{33{,}000}$

*Use $K^2 f_3$ only when material is over 6″ deep



LAYOUT NO. 8 INCLINED CONVEYOR

Material Sliding—Chain Rolling

P_A = ZERO when $f_4\cos\theta$ is more than $\sin\theta$

$P_A = LC(\sin\theta - f_4\cos\theta)$ when $f_4\cos\theta$ is less than $\sin\theta$

P_B = ZERO when $f_4\cos\theta$ is less than $\sin\theta$

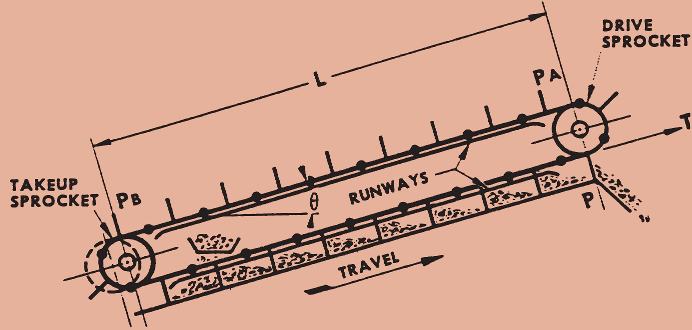
$P_B = LC(f_4\cos\theta - \sin\theta)$ when $f_4\cos\theta$ is more than $\sin\theta$

$P = L[C(f_4\cos\theta+\sin\theta)+W(f_2\cos\theta+\sin\theta) + K^2 f_3{}^*]+P_B$

$T = P - P_A$

$H = \dfrac{TS\ 1.15}{33{,}000}$

*Use $K^2 f_3$ only when material is over 6″ deep



LAYOUT NO. 9 VERTICAL CONVEYOR

Material Being Carried

$P_A = VC$

P_B = ZERO

$P = V(C+W)+Y$

$T = P - P_A$

$H = \dfrac{TS\ 1.15}{33{,}000}$