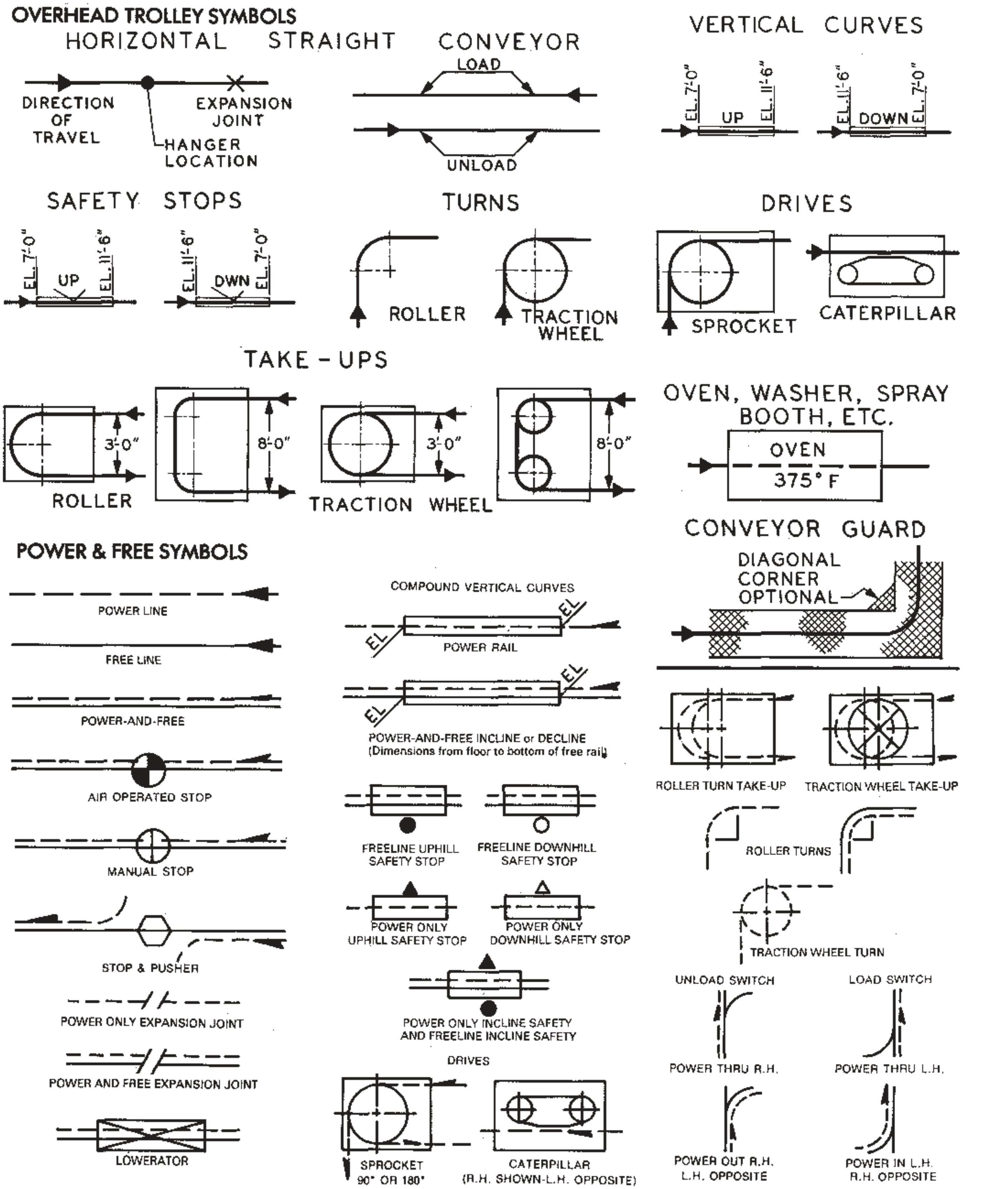
OVERHEAD CONVEYOR SYMBOLS

These symbols are used by the overhead conveyor industry for overhead conveyor and Power & Free. The use of these symbols will aid others in reviewing your conveyor layout.



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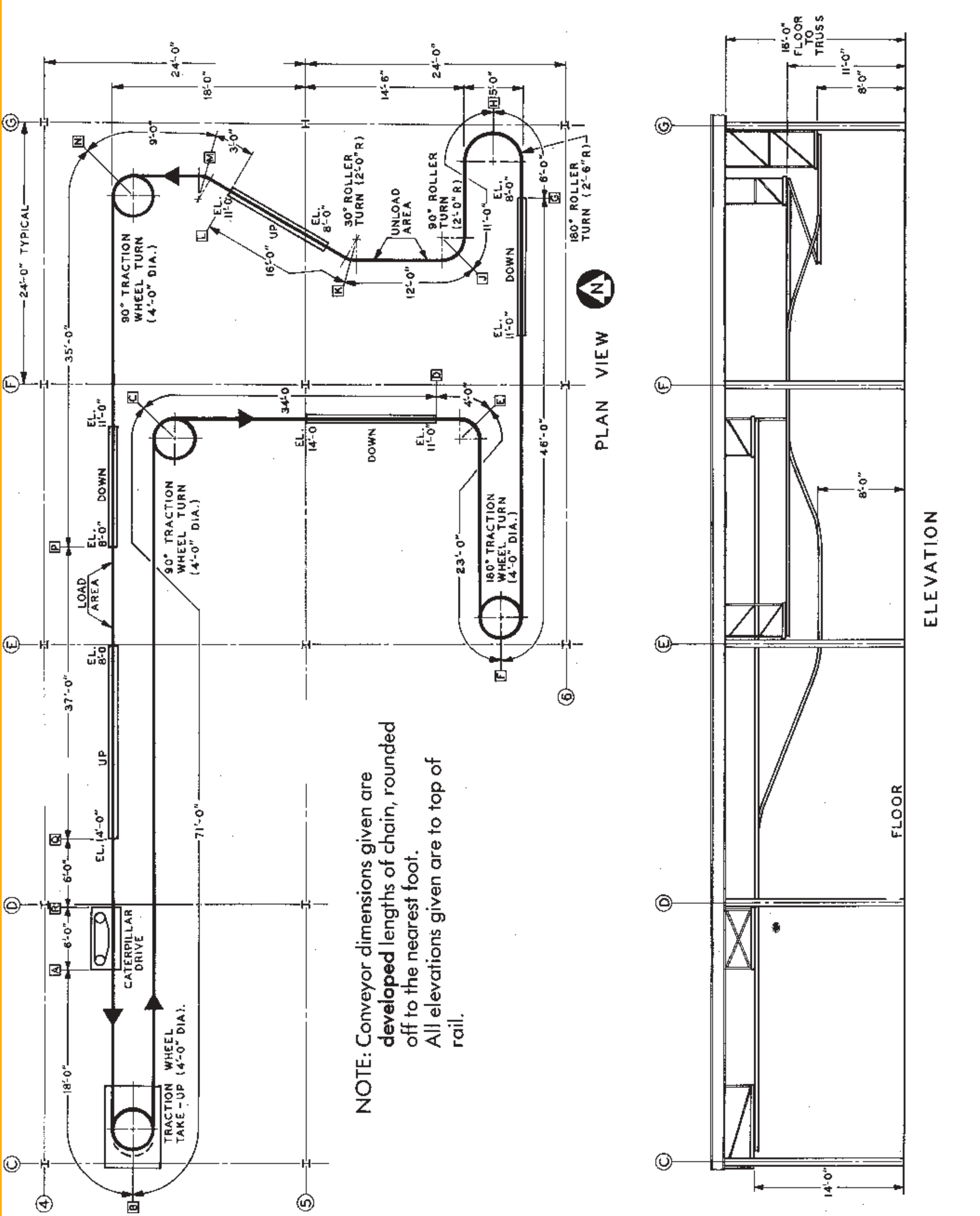
TYPICAL OVERHEAD CONVEYOR LAYOUT



NOTE: Conveyor dimensions given are **developed** lengths of chain, rounded off to the nearest foot.
All elevations given are to top of rail.

DESIGN GUIDE FOR OVERHEAD CONVEYOR

The following design guide steps are recommended for use and assistance in designing Overhead Trolley Conveyor systems. The steps follow established procedures and practices that have become standardized in the overhead conveyor industry and are based on the results of satisfactory performances over many years of conveyor design, manufacture and field installations.

By following the outlined steps, the user can readily design his own conveyor system that will assure optimum performances utilizing standard components. WEBB-STILES engineers are always available for assistance in designing more complex systems involving special custom-engineered components for unusual applications.

STEP NO. 1 — LAYOUT AND CONVEYOR PATH

a) Draw to largest possible scale (¼″ = 1′-0″ or ⅛″ = 1′-0″) plan of building area in which the conveyor system is to be installed.

b) Indicate columns or bay markings and dimension column centers.

c) Locate and label all obstructions that might affect the path of conveyor, such as walls, machinery, aisles and work areas.

d) Indicate "Load" and "Unload" points, and all stations that must be served by the conveyor.

Draw conveyor route so that it connects all stations with the most economical path. Use closely spaced parallel lines to reduce amount of supporting members and guards. Check that the path of conveyor does not interfere with machines or work areas.

e) Indicate location of drives, horizontal turns, vertical dips, take-ups, etc. Dimension conveyor in relation to building columns.

f) Show "North" direction relative to building.

g) Draw elevation view of the plant area where conveyor is to be erected. Establish elevation of building steel and building construction from which the conveyor is to be supported. Locate duct work or pipe lines that may affect conveyor elevation.

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STEP NO. 2 — CARRIERS

a) Determine number of parts to be carried on one carrier. Establish overall carrier size, keeping overall dimensions as compact as possible. Check for maximum weight of carrier and allowable trolley loads.

b) Design of carrier should permit easy loading and unloading. Typical examples of carrier designs are shown in CARRIER section.

c) Design carrier bracket to fit trolley and chain attachments. Selecting a carrier bracket to fit one of the standard trolley attachments eliminates the increased costs of "special" attachments.

d) Carriers that are loaded from one side only must have proper direction of travel at "Unload" point.

e) Make layout of carrier at turns and elevation view of typical vertical dip to determine proper carrier centers. Remember carrier and trolley spacing must be in multiples of 6" for 3" systems, 8" for 4" systems and 12" for 6" systems.

STEP NO. 3 — ELEVATION

a) Elevation of rail at "Load" and "Unload" areas with carriers assembled on trolleys or chain, is determined by parts handled and the convenience of which the operator can load or unload the carrier.

b) Elevations are measured from floor level to top of the conveyor track.

c) Clearance over work areas or aisles should be at least 8'-0".

d) All conveyors require guards where bottom of carrier exceeds 7'-0". See GUARD section for typical guards. Keep in mind that guards add to clearance requirements.

STEP NO. 4 — DETERMINE CONVEYOR SIZE

a) Select trolley size by checking maximum allowable load with carrier weight.

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b) Usually the trolley capacity will determine the size of conveyor in the average conveyor application. In some cases, the maximum allowable chain pull may be exceeded even though the trolley loads may be well within the capacity of rail and trolleys. In these cases either specify the next larger system or go to multiple drives.

To check chain pull, see **STEP NO. 13.**

STEP NO. 5 — REQUIRED CARRIERS PER MINUTE

a) Refer to Step No. 2 for number of parts carried per carrier.

b) Determine required production rate per hour.

Sample: Carrier capacity = 6 parts

Production requirements =
1440 pieces per hour

Required number of carriers per hour =
1440 ÷ 6 = 240

Required number of carriers per minute =
240 ÷ 60 = 4

STEP NO. 6 — DETERMINE TROLLEY SPACING

a) Refer to Step No. 2 for carrier size.

b) Refer to trolley section for recommended maximum spacing of trolleys.

c) If carrier size is larger than recommended trolley spacing, intermediate trolleys are required for chain support.

d) Refer to Step No. 7 for selection of vertical curves and Step No. 8 for horizontal turns.

STEP NO. 7 — SELECTION OF VERTICAL CURVES

a) Always use the largest possible radius for vertical curves to assure longer conveyor life. Use minimum radius curves where absolutely necessary. Refer to vertical curve chart for standard curve radii and recommended minimums and maximums.

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b) Make two "Elevation" templates of carrier and move properly spaced templates over scale drawing of path of vertical curve. Check that carriers clear each other and also clear the chain. Determine tentative carrier spacing.

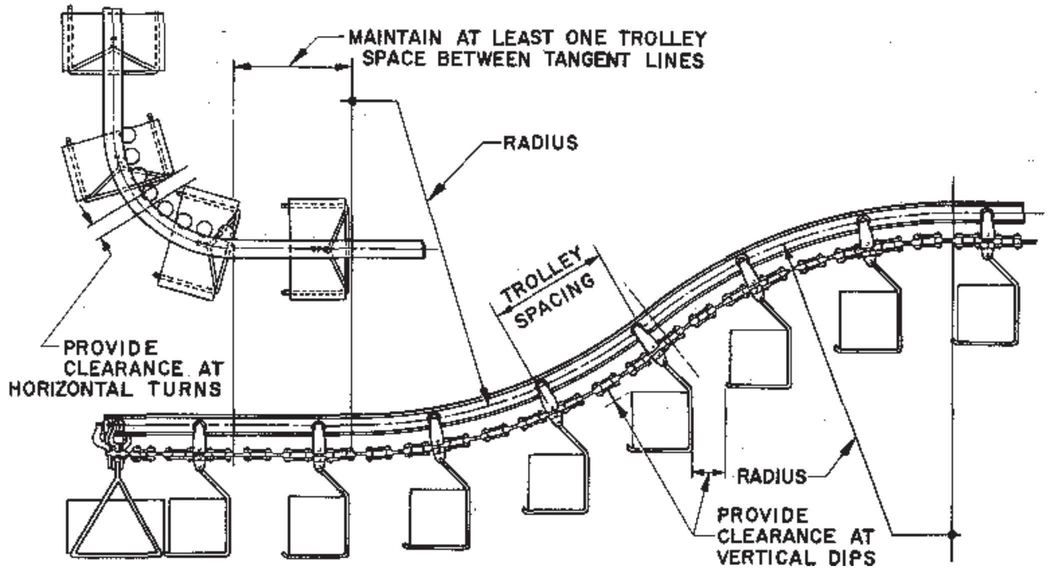
c) Indicate on drawing the horizontal length between tangent points of each vertical curve, its radius and degree.

d) Locate each vertical curve in relation to building column or adjacent component.

STEP NO. 8 – SELECTION OF HORIZONTAL TURNS

a) Make large scale layout of horizontal turns. Make two "Plan" templates of carrier and move properly spaced templates over scale drawing of path of horizontal turn. Check that carriers clear each other.

b) Select the horizontal turns best suited for the requirements from Roller Turn or Traction wheel section and as determined by carrier clearance. A length of straight rail equal to one trolley space should always be provided between the tangent point of a horizontal turn and the tangent point of a vertical curve. See illustration below.



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c) If an automatic take-up is preferred or required it should be located as near as possible to the output side of the drive unit. A manually or screw operated take-up can be located any other place in the conveyor layout, not necessarily directly after a drive unit. (See Take-up section for detailed take-up analysis.)

d) Use same "Plan" templates of carriers to determine width of conveyor guards on horizontal turns. Allow for 6-inch clearance on each side of carrier unless carriers or load are exceedingly long and would sway excessively.

STEP NO. 9 — CONVEYOR SPEED

a) The speed of the conveyor should be determined by its function (typical example shown in (b)), but in no case should the conveyor be operated faster than necessary as the wear of the chain, trolleys, turns, etc., can be directly proportioned to the speed.

b) The required conveyor speed in F.P.M. is determined by multiplying the number of required carriers per minute by the carrier spacing in feet.

Example: Number of carriers per minute = 4
Carrier spacing = 24" or 2'-0"
Conveyor speed = 4 x 2 = 8 F.P.M.

c) For variation of production requirements on delivery and take-away conveyors, it is advisable to set the maximum conveyor speed at least two (2) times the calculated conveyor speed.

It is suggested that on single drive systems a simple 3:1 variable speed spring-loaded pulley with adjustable motor base be provided so the conveyor can be made to run as slow as practical.

STEP NO. 10 — DETERMINE OVERALL CONVEYOR LENGTH

a) Add all straight track dimensions. (Refer to typical overhead conveyor layout drawing.)

b) Add all arc length dimensions for horizontal turns.

c) Add all arc lengths of the vertical curves. (Refer to vertical curve charts.)

d) The total conveyor length is the sum of all above additions. When ordering chain, add 3% or a minimum of 10'-0" to the total conveyor length.

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STEP NO. 11 — DETERMINE MOVING LOAD

a) The moving load on a conveyor system is the grand total sum of weights of all moving parts; chain, trolleys, carriers and loads.

b) Add all straight track, horizontal and vertical arc lengths from the "Load" to the "Unload" points. Determine the number of loaded carriers on the system between load and unload points. Determine the number of empty carriers between unload and load points.

Example: Total conveyor length	=	337'-0"
Trolley spacing	=	2'-0"
Carrier spacing	=	2'-0"
Total number of trolleys	=	168
Total number of carriers	=	168
Loaded carriers	=	133 @ 164#
Empty carriers	=	35 @ 44#

Solving for Total Moving Load:

337'-0" X-458 chain @ 3.15/lbs. ft.		1,060#
168 Trolleys @ 7.5#	=	1,260#
133 Loaded carriers @ 164#	=	21,812#
35 Empty carriers @ 44#	=	1,540#
Total Moving Load	=	25,672#

STEP NO. 12 — DETERMINE LIFT LOAD

a) A lift load is the amount of force required to pull the moving load upward along the vertical curves from a low point to a high point in the system.

b) To calculate a lift load, determine the difference in elevation of a loaded vertical curve traveling upward in the system. The lift load or chain pull for an elevation change of the conveyor is equal to the lift height in feet multiplied by the individual live load weight in pounds and then divided by the load spacing in feet.

Example: Net vertical rise = 6'-0"

Carrier load = 164#

Carrier spacing = 2'-0"

$$\text{Lift load} = \frac{6'\text{-}0" \times 164}{2'\text{-}0"} = 492 \text{ pounds}$$

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c) In most cases the lift loads due to loaded inclines will be balanced by loaded declines, however, unless other information exists **at least one** lift load (loaded incline) should be added to the friction chain pull to obtain total chain pull. (Short Method.)

NOTE: The chain, trolleys and individual carriers are not included in the lift load calculation because they are balanced by the portion of the system that moves down the vertical curves.

STEP NO. 13 — DETERMINE CHAIN PULL
(Short Method Chain Pull Calculation)

a) Chain pull is developed from the friction losses on the trolleys caused by the travel of the Total Moving Load, Vertical curves and friction losses at the horizontal turns. The friction figure is represented as a small percentage and is listed under Friction Factors for individual size conveyors and operating conditions.

b) Friction Factors listed are for average conveyors that operate under normal conditions. A large number of vertical and horizontal curves will increase the friction factor.

c) To determine chain pull due to friction, multiply the Total Moving Load by the selected friction factor (see table).

Example: Total Moving Load = 25,672# (Step No. 11)
Friction factor = .025 (2½%)
Friction Chain Pull = 25,672# x .025 = 641.8#

d) To determine the Total Chain Pull, add to the Friction Chain Pull the Lift Load.

Example: Friction Chain Pull = 641.8#
Lift Load = 492#
Total Chain Pull =1133.8#

Select 2000# caterpillar drive.

e) Refer to Chain section to determine if chain size selected has ample capacity for the required Total Chain Pull.

STEP NO. 13A — CHAIN PULL (Progressive Method)

For long lines of complicated conveyor paths with a large number of vertical curves or where more than one drive unit is required, it is necessary to make a Progressive chain pull

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analysis. On multi-drive conveyor systems, it is usually required to assume the approximate drive locations, and it might be necessary to run a chain pull analysis two or three times to determine the best drive locations.

In a Progressive chain pull analysis, friction factors or losses are progressively estimated and accumulated through the path of the conveyor, starting at the slack side of the drive unit, or where the chain pull is minimum.

A sample problem of Progressive chain pull analysis is given in Step No. 15.

STEP NO. 14 — SELECTION OF CONVEYOR DRIVE

Refer to Conveyor Drive Section for selection of either Caterpillar or Sprocket type drives and the type of controls available.

REFERENCE TABLES FOR USE WITH DESIGN GUIDE FOR OVERHEAD CONVEYORS

(Short Method Chain Pull Calculation)

TABLE NO. 1
APPROXIMATE ALLOWABLE SUSPENDED LOAD ON TWO-WHEEL TROLLEY

I-BEAM TRACK SIZE	MAXIMUM LOAD
3″ I @ 5.7#	200 Lbs.
4″ I @ 7.7#	400 Lbs.
6″ I @ 12.5#	1200 Lbs.

TABLE NO. 2
APPROXIMATE FRICTION FACTORS FOR VARIOUS TROLLEYS

CHAIN SIZE	TROLLEY AND TRACK SIZE	FRICTION FACTOR
X-348	3″	3 %
X-458	4″	2½%
X-678	6″	2 %

TABLE NO. 3
MINIMUM RECOMMENDED RADIUS AND DIAMETER TURNS FOR VARIOUS TROLLEY SPACINGS

CHAIN SIZE	TROLLEY SPACING	ROLLER TURN RADIUS	TRACTION WHEEL DIAMETER
X-348	UP TO 18 INCH	18 INCH	24 INCH
	24 INCH		30 INCH
	30 INCH		36 INCH
X-458	UP TO 24 INCH	24 INCH	30 INCH
	32 INCH		36 INCH
X-678	12 INCH	36 INCH	36 INCH
	24 INCH		42 INCH
	36 INCH		48 INCH

TABLE NO. 4
MINIMUM RADII FOR VERTICAL CURVE WITH DROP FORGED RIVETLESS CHAIN
(Radius Given to Centerline of I-Beam Track)

Chain Size	X-348		X-458		X-678	
Trolley Spacing	Min.	Rec.	Min.	Rec.	Min.	Rec.
8″			5′-0″	6′-6″		
12″	5′-0″	6′-6″			8′-0″	12′-0″
16″			6′-6″	8′-0″		
18″	6′-6″	8′-0″				
24″	8′-0″	10′-0″	8′-0″	10′-0″	12′-0″	15′-0″
30″	10′-0″	12′-0″				
32″			10′-0″	12′-0″		
36″					15′-0″	20′-0″

STEP NO. 15 — PROGRESSIVE CHAIN PULL ANALYSIS

Discussion of progressive chain pull analysis is given in Step No. 13A. The following example problem and tabulation is based on the typical overhead conveyor layout drawing preceding this section, and friction factors from Tables No. 5 and No. 6.

Assume that the following conditions are known:

Track size	:	4" I-beam	Product Load	:	120#/ft.
Chain	:	X-458	Empty Carriers	:	44#/ft.
Trolley spacing	:	2'-0"	Loaded Carriers	:	164#/ft.
Carrier spacing	:	2'-0"	Conveyor length	:	337 ft.

NOTE: Loaded and empty carrier figures include carrier, chain and trolley weight per foot.

EXAMPLE PROBLEM FOR ACCUMULATED CHAIN PULL ANALYSIS

WORK POINTS	TRACK LENGTH BETWEEN WORK POINTS	CALCULATIONS FOR CHAIN PULL AT INDIVIDUAL OPERATIONS	CHAIN PULL AT INDIVIDUAL OPERATION	CHAIN PULL AT END OF INDIVIDUAL WORK POINTS	TOTAL ACCUMULATED CHAIN PULL
A	0	Output end of caterpillar drive	0	0	0
A-B	18'	2% x 18' x 164# Traction wheel 180° = 3% x 59	59.0 1.8	60.8	60.8
B-C	71'	2% x 71' x 164# Traction wheel 90° = 2% x 293.7	232.9 5.9	238.8	299.6
* C-D	34'	2% x 34' x 164# Vertical bend 30° = 3% x 411.1 Declining load = 3' x 44	111.5 12.3 (−132)*	−8.2	291.4
D-E	4'	2% x 4' x 164# Roller turn 90° = 3% x 304.5	13.1 9.1	22.2	313.6
E-F	23'	2% x 23' x 164# Traction wheel 180° = 3% x 389	75.4 11.7	87.1	400.7
* F-G	46'	2% x 46' x 164# Vertical bend 30° = 3% x 551.6 Declining load = 3' x 44	150.9 16.6 (−132)*	35.5	436.2
G-H	6'	2% x 6' x 164# Roller turn 180° = 5% x 455.9	19.7 22.8	42.5	478.7
H-J	11'	2% x 11' x 164# Roller turn 90° = 3% x 514.8	36.1 15.4	51.5	530.2
J-K	12'	2% x 12' x 164# Roller turn 30° = 1.5% x 569.6	39.4 8.5	47.9	578.1

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EXAMPLE PROBLEM FOR ACCUMULATED CHAIN PULL ANALYSIS (CONT.)

WORK POINTS	TRACK LENGTH BETWEEN WORK POINTS	CALCULATIONS FOR CHAIN PULL AT INDIVIDUAL OPERATIONS	CHAIN PULL AT INDIVIDUAL OPERATION	CHAIN PULL AT END OF INDIVIDUAL WORK POINTS	TOTAL ACCUMULATED CHAIN PULL
K-L ▲	16′	2% x 16′ x 44# Vertical bend 30° = 3% x 592.2 Incline load = 3′ x 44	14.1 17.8 132.0	163.9	742.0
L-M ▲	3′	2% x 3′ x 44# Roller turn 30° = 1.5% x 744.6	2.6 11.2	13.8	755.8
M-N ▲	9′	2% x 9′ x 44# Traction wheel 90° = 2% x 763.7	7.9 15.3	23.2	779.0
N-P *▲	35′	2% x 35′ x 44# Vertical bend 30° = 3% x 809.8 Declining load = 3′ x 44	30.8 24.3 (−132)*	−76.9	702.1
P-Q	37′	2% x 37′ x 164# Vertical bend 30° = 3% x 823.5 Inclining load = 6′ x 164	121.4 24.7 984.0	1130.1	1832.2
Q-R	6′	2% x 6′ x 164#	19.7	19.7	1851.9
R-A	6′	2% x 6′ x 164# Friction thru drive = 5% x 1871.6	19.7 93.6	113.3	1965.2

TOTAL ACCUMULATED CHAIN PULL = 1965.2#

Based on these calculations, a 2000# caterpillar drive would be marginally adequate. Therefore, to provide a safety factor for unknown operating conditions, it would be advisable to select a 3000# drive.

*Declining product loads are not deleted from Accumulated Chain Pull total because conveyor may not be fully loaded at declines.

▲Indicates conveyor not loaded between work points.

REFERENCE TABLES FOR USE WITH DESIGN GUIDE FOR OVERHEAD CONVEYORS

(Progressive Chain Pull Analysis)

TABLE NO. 5
FRICTION FACTORS FOR STRAIGHT HORIZONTAL CONVEYOR
(Progressive Chain Pull Calculation)

CHAIN SIZE	TROLLEY AND TRACK SIZE	FRICTION FACTOR
X-348	3″	2½%
X-458	4″	2 %
X-678	6″	1½%

TABLE NO. 6
FRICTION FACTORS FOR TURNS AND VERTICAL CURVES
(Progressive Chain Pull Calculation)

DEGREE OF TURN	FRICTION FACTORS		
	ROLLER TURNS	TRACTION WHEELS	VERTICAL CURVES
30°	1½%	½%	3%
45°	2 %	1 %	5%
90°	3 %	2 %	——
180°	5 %	3 %	——

Note No. 1:

FRICTION THROUGH DRIVE UNIT
Add 5% of Total Accumulated Chain Pull for Efficiency Losses in Drive Unit.

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ALLOWABLE CHAIN PULLS FOR OVERHEAD CONVEYORS WITH VERTICAL DIPS

MAXIMUM ALLOWABLE CHAIN PULLS — X-348 CHAIN

MAXIMUM LIVE LOAD PLUS WT. OF CARRIER	MAXIMUM CHAIN PULL — POUNDS													
	HORI-ZONTAL CHAIN PULL	5′-0″ RAD. BEND		6′-6″ RAD. BEND			8′-0″ RAD. BEND				10′ OR LARGER BEND			
		TROLLEY SPAC.		TROLLEY SPACING			TROLLEY SPACING				TROLLEY SPACING			
		12″	18″	12″	18″	24″	12″	18″	24″	30″	12″	18″	24″	30″
20#	2500	1300	910	1630	1080	820	2210	1470	1120	890	2210	1840	1400	1120
30#	"	1280	880	1580	1050	790	2190	1420	1080	860	2210	1770	1350	1080
40#	"	1240	850	1510	1010	760	2100	1370	1050	830	2210	1700	1290	1050
50#	"	1190	820	1460	980	720	2020	1310	1010	790	2210	1640	1250	1010
75#	"	1070	740	1310	870	650	1810	1190	900	710	2210	1470	1120	900
100#	"	960	650	1170	780	580	1620	1050	810	630	1910	1310	1000	810
125#	"	840	580	1020	680	510	1420	910	700	560	1670	1150	870	710
150#	"	710	490	870	580	430	1210	790	600	470	1430	990	740	600
175#	"	600	410	720	480	370	1010	650	510	400	1190	820	620	500
200#	"	470	320	580	390	290	810	530	400	310	960	650	490	400
225#	"	360	240	410	290	220	600	390	290	240	710	450	370	290
250#	"	240	160	290	190	—	400	260	200	—	470	320	250	200

MAXIMUM ALLOWABLE CHAIN PULLS — X-458 CHAIN

MAXIMUM LIVE LOAD PLUS WT. OF CARRIER	MAXIMUM CHAIN PULL — POUNDS													
	HORI-ZONTAL CHAIN PULL	5′-0″ RAD. BEND		6′-6″ RAD. BEND		8′-0″ RAD. BEND			10′-0″ RAD. BEND			12′ OR LARGER BEND		
		TROLLEY SPAC.		TROLLEY SPAC.		TROLLEY SPACING			TROLLEY SPACING			TROLLEY SPACING		
		16″	24″	16″	24″	16″	24″	32″	16″	24″	32″	16″	24″	32″
20#	4000	1690	NOT RECOMMENDED	2530	1690	3390	2250	1690	4000	2910	2170	4000	3390	2650
30#	"	1660		2490	1660	3320	2210	1660	4000	2850	2140	4000	3320	2600
40#	"	1630		2440	1630	3260	2170	1630	4000	2800	2110	4000	3260	2560
50#	"	1610		2400	1600	3210	2140	1600	4000	2760	2060	4000	3210	2510
75#	"	1530		2290	1530	3070	2040	1530	3930	2630	1970	4000	3070	2400
100#	"	1460		2190	1460	2920	1950	1460	3720	2500	1870	4000	2920	2280
125#	"	1390		2070	1390	2780	1850	1390	3570	2380	1780	4000	2780	2170
150#	"	1310		1970	1310	2630	1750	1310	3380	2220	1680	3940	2630	2050
200#	"	1190		1740	1170	2340	1560	1170	3010	2000	1490	3480	2330	1830
250#	"	1020		1520	1020	2040	1360	1020	2630	1740	1310	3060	2040	1600
300#	"	880		1310	870	1740	1170	870	2250	1490	1120	2630	1740	1370
350#	"	730		1090	720	1460	970	720	1870	1250	930	2190	1460	1140
400#	"	580		870	580	1170	780	580	1500	1000	750	1740	1170	910
450#	"	430		650	430	870	580	430	1120	750	560	1310	870	680
500#	"	—		430	—	580	—	—	740	490	—	870	580	450

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