Selection and Engineering Information

	Chain Type	Materials		Specifications				Feature	Applications
		Chain/Pin	Top Plate	Max. Allowable Load lbs.	Suggested Max. Speed (ft./min.)		Ambient Temperature °F		
					Lubricated	Dry			
Linear Movement	TS-P	Carbon Steel	430 Stainless steel	660	390	200	15 ~350	Type P : Suitable for single strand operation Type SS: Suitable for multi-strand operation and corrosive environment Type CS: Suitable for heavy load operation	Assembly line for bottling or canning, and conveying cartons or other parts.
	TS-SS	304 Stainless steel	304 Stainless steel	231	230	150	–4 ~750		
	TS-CS	Hardened carbon steel	430 Stainless steel	1,100	390	200	15 ~350		
	TT-N	304 Stainless steel	430 Stainless steel	330	330	200	15 ~500	Simple construction, washable, clean handling, and anti-corrosive.	
	TT-SS	304 Stainless steel		484			–4 ~750		
	TP	304 stainless steel	Polyacetal resin	264	330	160	–4 ~170	Self-lubrication, quiet operation. Anti-corrosive, suitable for transportation of small size goods due to small clearance between top plates.	Conveying steel, cans, finished parts, paper-packages, etc.
	TTP			187					
	TN	Carbon steel	Polyacetal resin	1,628	390	200	15 ~170	Damage-free, quiet operation. Smooth transportation, easy removal of top plate. Easy repair.	
	TN-NP	Nickel-plated carbon steel							
	TN-S	304 Stainless steel		231	230	150	–4 ~170		
	RS-P	304 Stainless steel	Polyacetal resin	40P, 2040P: 100 60P: 200	200	200	–4 ~170	Quiet and trouble-free operation with anti-corrosive protection. Also available in “E,” “K,” “Y,” and “SY” series.	Conveying electronic parts and small items.
Curved Movement	TRU	Carbon steel	430 Stainless steel	902	330	200	15 ~350	Float-prevention tab allows high speed, complex, and curved transportation.	Curved operation for type TS and TT.
	TRU-SS	304 Stainless steel		231	230	150	–4 ~750		
	TKU	Carbon steel	430 Stainless steel	638	150	150	15 ~350	Easy removal of chain. Used for low speed and simple curved operation.	
	TTU	304 Stainless steel		484	260	160	–4 ~750	Same features as TT. Used for curved operation.	Curved operation for TT.
	TPU	304 Stainless steel	Polyacetal resin	220	260	160	–4 ~170	Same features as TP and TRU.	Curved operation for TP.
	TNU	Carbon steel	Polyacetal resin	902	330	200	15 ~170	Used for simple curved operation. TN type side bow feature.	Curved operation for TN.
	TNU-NP	Nickel-plated carbon steel							
	TO	Carbon steel	430 Stainless steel	660	200	200	15 ~350	Any horizontal curved operation is possible. Min. radius: 4.00 inches. Complex curved operation is available.	Suitable for horizontal curved operations.
	TU			220				Any return such as straight/curved line on horizontal and vertical route is available. Complex curved operation available.	

Top Plate Chain Selection

Follow the procedure below to select top chain and liner that are most economical and suitable for the application.

Step 1: Establish general conveyor conditions
Step 2: Select top plate material
Step 3: Select liner material
Step 4: Determine factors and coefficients
Step 5: Select top plate width
Step 6: Calculate chain tension
Step 7: Determine chain size

Step 1 Establish general conveyor conditions

A) Materials conveyed
   (1) Container material
   (2) Weight
   (3) Dimensions
B) Conveyor arrangement
   (1) Straight or curved movement
   (2) Conveyor length
   (3) Layout
   (4) Space limitations
C) Other conditions
   (1) Conveyor capacity
   (2) Interval
   (3) Conveyor speed
   (4) Lubrication requirements
   (5) Material conveyance regularity
D) Environment
   (1) Temperature
   (2) The presence of corrosive chemical substances (See page B-76, Table I)
   (3) Existence of wear-causing agents, such as glass, paint, metal, powder, or sand

Table I must be referred to when selecting chain and liner materials to be used with top chain. The table shows the results of lab tests at 68°F. It is to be used for reference only and does not state or imply any warranty conditions whatsoever. Humidity and other conditions must also be considered.

Table I: Corrosion Resistance to Various Fluids

Fluid	Steel	Polyacetal	Stainless Steel 304	Stainless Steel 430	Ultra-high Polymer Polyethylene
Acetone	×	○	○	○	○
Oils (vegetable and mineral)	○	○	○	○	○
Alcohol	○	○	○	○	○
Aqueous ammonia	Δ	○	○	○	○
Sodium chloride	×	○	Δ	Δ	○
Hydrochloric acid (2%)	×	×	×	×	×
Sea water	×	Δ	Δ	×	○
Hydrogen peroxide	×	×	○	○	○
Caustic soda (25%)	×	×	○	○	○
Gasoline	○	○	○	○	Δ
Formic acid	×	×	×	×	○
Formic acid aldehyde	○	○	○	○	○
Milk	○	○	○	○	○
Lactic acid	×	○	○	×	○
Citric acid	×	Δ	○	Δ	○
Acetic acid (5%)	×	×	○	○	○
Carbon tetrachloride	Δ	○	Δ	Δ	Δ
Nitric acid (5%)	×	×	○	○	Δ
Rice vinegar (5%)	×	○	Δ	Δ	○
Hypochlorite soda	×	×	×	×	○
Soapy water	Δ	○	○	○	○
Paraffin	○	○	○	○	○
Beer	○	○	○	○	○
Fruit juice	×	○	○	Δ	○
Wine	○	○	○	○	○
Whiskey	○	○	○	○	○
Benzene	○	○	○	○	Δ
Water	×	○	○	○	○
Vegetable juice	Δ	○	○	○	○
Iodine	×	×	×	×	×
Sulfuric acid	×	×	×	×	×
Phosphoric acid	×	×	Δ	×	○
Soft drinks	○	○	○	○	○

○ Totally resistant Δ Partially resistant × Not suggested

Step 2 Select top plate material
Top plate material must be selected according to the type of goods to be moved.

Table II: Plate Material Selection Guide

Material Conveyed	Top Plate Material	Dry – Abrasive Atmosphere No	Dry – Abrasive Atmosphere Yes	Lubricated – Abrasive Atmosphere No	Lubricated – Abrasive Atmosphere Yes
Tin cans, aluminum cans, and metal containers (beer cans, soft drink cans and other cans having metal tops and bottoms, and fiber sides). Industrial parts (machine parts, dies, castings, forgings, metals, bearings, bolts, nuts, etc.)	Polyacetal	◎	×	◎	
	Stainless Steel		◎		◎
Plastics and plastic covered containers and paper containers (for milk products such as milk, cheese, ice cream and confectionery, includes containers with paper boards and paper bottoms such as those for soap and cereal).	Polyacetal		×		
	Stainless Steel	◎	◎	◎	◎
Glass jars, glass products and ceramics (for spirits, foods, pharmaceuticals and cosmetics).	Polyacetal		×		×
	Stainless Steel	◎	◎	◎	◎

◎ Suggested Good Limited use × Not suggested

Step 3 Select liner material
The appropriate liner material must be selected from the top plate materials listed under Step 2.

Table III: Liner Material Selection Guide

Top Plate Material (chain type)	Liner Material	Dry – Abrasive Atmosphere No	Dry – Abrasive Atmosphere Yes	Lubricated – Abrasive Atmosphere No	Lubricated – Abrasive Atmosphere Yes
Stainless steel (TS and TT for straight running, TRU, TKU, TO and TU for curved movement).	Stainless Steel				
	Steel		◎		◎
	Super-high-polymer Polyethylene	◎	×	◎	
Polyacetal (TP, TTP, TN and RS-P for linear movement, TPU and TNU for curved movement).	Stainless Steel			◎	◎
	Steel	◎	◎		
	Super-high-polymer Polyethylene		×		

◎ Suggested Good Limited use × Not suggested

Step 4 Determine factors and coefficients (f_2, f_3, k_2, k_3)

Table IV: Coefficient of Friction (f_2) between Top Plate and Liner

Top Plate Material	Lubrication	Coefficient of Dynamic Friction of Liner Material		
		Stainless Steel	Steel	Ultra High Polymer Polyethylene
Stainless Steel	Dry	0.35	0.35	0.25
	Lubrication by soapy water	0.20	0.20	0.15
	Oil lubrication	0.20	0.20	0.15
Polyacetal	Dry	0.25	0.25	0.25
	Lubrication by soapy water	0.15	0.15	0.15

Table V: Coefficient of Friction (f_3) between Material Conveyed and Top Plate

Material Conveyed	Lubrication	Coefficient of Dynamic Friction of Top Plate Material	
		Stainless Steel	Polyacetal
Plastic and paper containers and film packages	Dry	0.30	0.25
	Lubrication by soapy water	0.20	0.10
Cans (with metal tops and bottoms)	Dry	0.35	0.25
	Lubrication by soapy water	0.20	0.15
Bottles and ceramics	Dry	0.30	0.40
	Lubrication by soapy water	0.20	0.20
Industrial parts (metal)	Dry	0.35	0.25
	Oil lubrication	0.20	0.15

Table VI: Angle Factor (k_2) and Length Factor (k_3)

Turning Angle	Length Factor (k_3)	Angle Factor (k_2)			
		TPU and TNU Chains		TRU and TKU Chains	
		Dry	Lubricated	Dry	Lubricated
30°	0.5	1.15	1.10	1.20	1.10
60°	1.0	1.30	1.15	1.45	1.25
90°	1.6	1.50	1.25	1.75	1.35
120°	2.1	1.70	1.35	2.10	1.50
150°	2.6	1.90	1.50	2.50	1.70
180°	3.1	2.20	1.60	3.00	1.85

k_2 and k_3 factors are to be used for curved movement except for TO and TU type.

$k_3 = \pi \cdot$ Turning Angle/180°

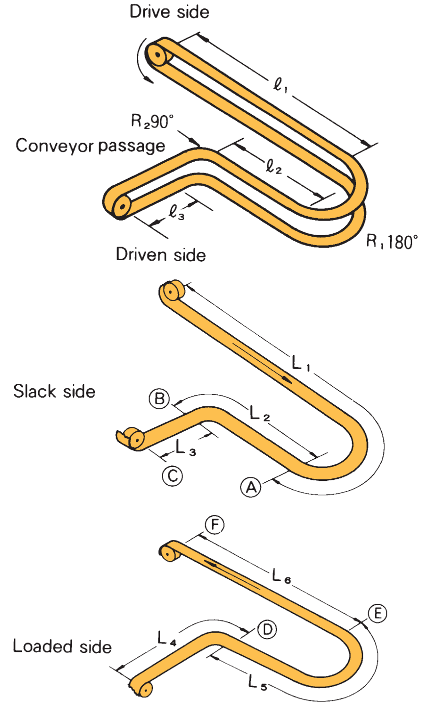
Step 5 Select top plate width

Generally, the top plate must be wider than the material conveyed. When materials are very wide and none of the top plate widths are satisfactory, top plates of the same width may be used in multi-strand arrangement. Top plates of different widths can be used together, but this is not desirable since the tension on the chains will be uneven.

Step 6 Calculate chain tension (T)

1) Linear movement
(TS, TT, TP, TN, TTP and RS-P chains)
$T = (M + 2.1\,w)\,Lf_2 + ML'f_3$ . . . . .Formula 1

2) Curved movement
(TRU, TKU, TPU, TNU and TTU chains)
The chain tension for curved movement is calculated similarly to that for linear movement. The tension at corners, however, is compensated for by angle factor (K_2) and length factor (K_3). Calculations are shown below for the illustrated examples.



The tension on the chain at each part ABC . . . F must be calculated. The tension at F is the greatest acting on the chain.

$T = T_{Ⓕ}$ ....Formula 2

Slack side:

Chain tension at Ⓐ : $T_{Ⓐ}$

$T_{Ⓐ} = L_1 w f_2 k_2$, $L_1 = \ell_1 + R_1 k_3$ (k_2 and k_3 at 180°)

Chain tension at Ⓑ : $T_{Ⓑ}$

$T_{Ⓑ} = \{T_{Ⓐ} + L_2 w f_2\}\,k_2$, $L_2 = \ell_2 + R_2 k_3$ (k_2 and k_3 at 90°)

Chain tension at Ⓒ : $T_{Ⓒ}$

$T_{Ⓒ} = T_{Ⓑ} + L_3 w f_2$, $L_3 + \ell_3$

Loaded side :

Chain tension at Ⓓ : $T_{Ⓓ}$

$T_{Ⓓ} = \{ T_{Ⓒ} + (M + w)\,L_4 f_2 + ML'_4 f_3\}\,k_2$, $L_4 = \ell_3 + R_2 k_3$ (k_2 and k_3 at 90°)

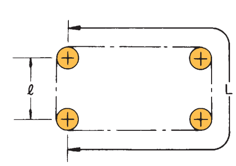
Chain tension at Ⓔ : $T_{Ⓔ}$

$T_{Ⓔ} = \{T_{Ⓓ} + (M + w)\,L_5 f_2 + ML'_5 f_3\}\,k_2$, $L_5 = \ell_2 + R_1 k_3$ (k_2 and k_3 at 180°)

Chain tension at Ⓕ : $T_{Ⓕ}$

$T_{Ⓕ} = T_{Ⓔ} + (M + w)\,L_6 f_2 + ML'_6 f_3$

3) TO and TU chains
Calculations for chain selection vary according to their usage and arrangement. A sample calculation is given below for the arrangement shown on the right.



$T = (M + w)\,Lf_2 + w\ell f_2 + ML'f_3$
...........................Formula 3

4) Calculation of power required

$$HP = \frac{TS}{33{,}000 \cdot \eta} \text{ ....Formula 4}$$

Step 7 Determine chain size

Multiply the maximum chain tension (T) by the speed coefficient (k_1) taken from Table VII and verify that the following equation is satisfied.

T X $k_1 \leq$ Chain maximum allowable load .... Formula 5

When the maximum allowable load is insufficient, it can be corrected by using top plates with narrower width and increasing the number of chain strands, or by splitting into many short conveyors.

Table VII: Speed Coefficient (k_1)

Chain Speed (ft./min.)	Speed Factor (k_1)
0 ~ 50	1.0
50 ~ 100	1.2
100 ~ 160	1.4
160 ~ 230	1.6
230 ~ 300	2.2
300 ~ 360	2.8
360 ~ 400	3.2

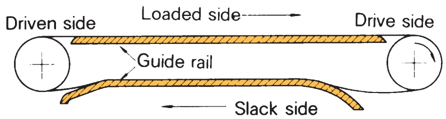
T : Chain tension (lbs.)
M : Weight of material conveyed per ft. (lbs./ft.)
w : Chain weight (lbs./ft.)
L : Center distance between sprockets (ft.)
ℓ : Distance not loaded (ft.)
L' : Distance of the material sliding on the chain for storage (L′=0 when items and chain are not slipping)
f_2 : Coefficient of friction between the top plate and liner (See page B-77, Table IV)
f_3 : Coefficient of friction between goods moved and top plate (See page B-77, Table V)
k_1 : Speed coefficient (See Table VII)
k_2 : Angle factor (See page B-77, Table VI)
k_3 : Length factor (See page B-77, Table VI)
R : Radius at corner (ft.)
S : Chain speed (ft./min.)
η : Mechanical transmission efficiency for drive unit
HP : Power required

Conveyor design

The layout of a conveyor varies with the type of chain used. A typical layout is shown below. Goods should be conveyed on the tension side of the chain, and the slack (return) side should be supported by guide rails with sloped ends to prevent chain vibration and conveyor pulsation.

2-1 **Guide rail**

The guide rail consists of the conveyor frame and liner. The liner sides with the top chain to minimize frictional resistance and wear so the chains are protected and driving power can be minimized.

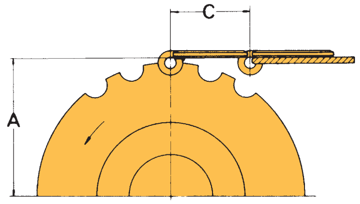


2-2 **Location of guide rails and sprocket**

When the chain engages with the sprocket, the chain itself moves up and down slightly due to the polygonal effect of the sprocket. Therefore, the guide rail on the loaded side must be positioned so that the chain is horizontal when at the highest level. Guide rail installation dimension (A) is determined from the following equation.

$$A = \frac{\text{pitch diameter of sprocket}}{2} + B \text{ (inch)}$$

Chain Type	B	C
TS • TRU • TKU • TN • TNU	.433	1.496
TT, TTU	.157	
TP-I	.197	
TP-II • TPU, TTP, TTPF	.157	



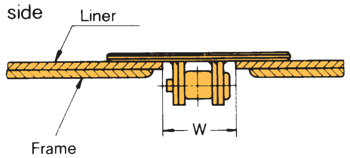
Note: Please refer to page B-73 for the RS Plastic chain

B - CONVEYOR CHAINS

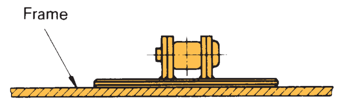
Guide Rail Inside Width

Linear Movement Chain

Loaded side



Slack-side (top plate sliding)



Note: TS-P type chains are shown in this illustration. Other chain types can also be used.

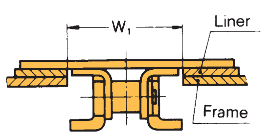
Chain Type	W
TS-P	1.300
TS-SS & CS	1.594
TT	1.772

Chain Type	W
TP	1.772
TTP	1.772
TN	1.496

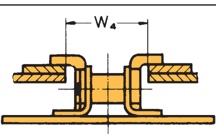
Curved Movement Chain

Linear Section

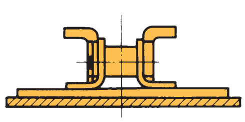
Loaded side



Slack side
Attachment sliding

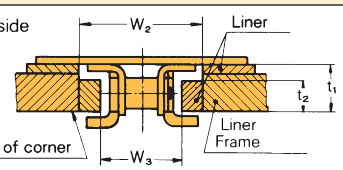


Slack side
Top plate sliding

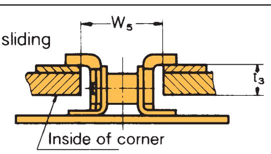


Curved Section

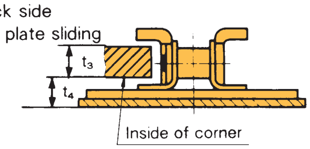
Loaded side



Slack side
Attachment sliding



Slack side
Top plate sliding

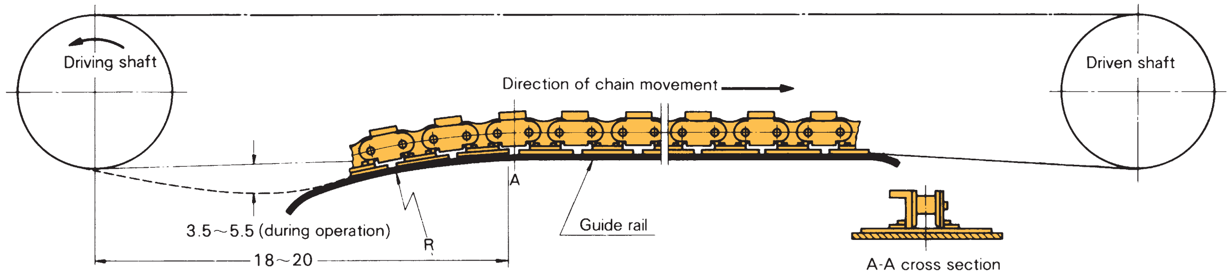


Note: TRU chains are shown in the illustration. Other chain types can also be used.

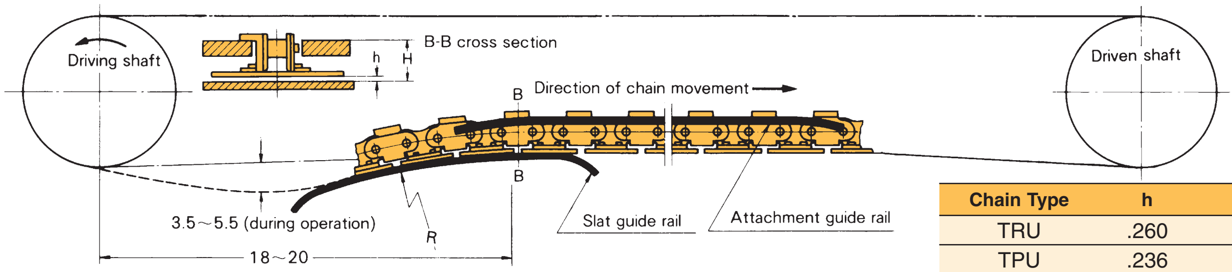
Chain Type	W_1	W_2	W_3	t_1	t_2	W_4	W_5	t_3
TRU	1.752	1.890	1.220	.689	.472	1.220	1.220	.472
TPU	1.772	1.772	1.772	.472	.472	1.890	1.890	.472
TNU	1.496	1.496	1.496	.709	.709	–	–	–
TO	1.752	–	–	–	–	–	–	–
TU	1.752	–	–	–	–	–	–	–
TKU	1.772	1.890	1.417	.748	.531	–	–	–
TTU	1.654	–	–	–	–	1.654	–	–

2-3 **Slack side guide rail arrangement**

Top plate sliding (applicable for all top chains)



Attachment sliding (TRU type)



Chain Type	h	H
TRU	.260	1.181
TPU	.236	1.024

(1) Slack of 3.5 ~ 5.5 inches (during operation) is needed under the drive sprocket.
(2) Engagement angle must be more than 150° between the drive sprocket and the chain.
(3) The radius R (inches) of the guide rail must be larger than the radius of chain back-bend given in the table below.

Radius of Chain Back-bend

(in.)

Type	Back-bend Radius
TS	13
TRU•TKU	12
TT	7
RS40P	5
RS60P	18

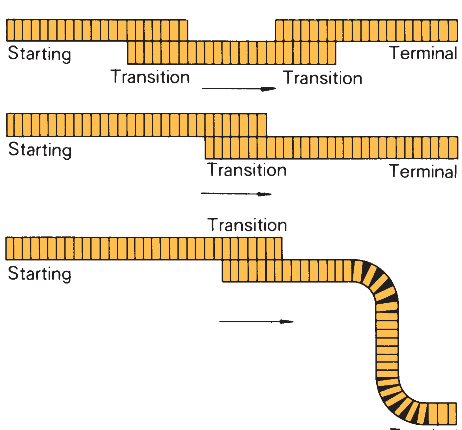
(in.)

Type	Back-bend Radius
RS2040P	18
TP•TTP•TPU	2
TN•TNU	4
TTU	2

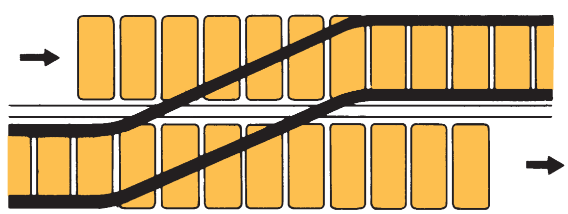
(4) Guide rails must have sloped ends to prevent interference with the chain.

2-4 **Connection of additional conveyors**

If a conveyor is too long, the chain tension will increase and chain strength will not be sufficient. In such cases, additional conveyors should be used.



Locations of the chain and the guide rail are very important for a smooth transition between conveyors. Two parallel chains must be positioned at the same height, or the output chain must be positioned slightly higher than the receiving chain. The guide rail must be shaped such that transition of goods can be accomplished smoothly.



B - CONVEYOR CHAINS