1

Flat and V-belts

1. FLAT BELTS

Speed ratio, neglecting slips :

$$\frac{N_2}{N_1} = \frac{D_1}{D_2} \qquad ...(1.1)$$

where, N = rpm, D = pulley dia.

Speed ratio, considering slip 's' and belt thickness 't' :

$$\frac{N_2}{N_1} = \left[\frac{D_1 + t}{D_2 + t}\right]\left[\frac{100 - s}{100}\right] \qquad ...(1.2)$$

Ratio of belt tensions, neglecting centrifugal tension (for v < 12 m/s) :

$$\frac{F_1}{F_2} = \exp(\mu\theta) \qquad ...(1.3)$$

where, F_1 = tight side tension, N

F_2 = slack side tension, N

θ = angle of contact, radians

Coefficient of friction for tanned leather belt and cast iron pulley combination :

$$\mu = 0.54 - \frac{0.7}{v + 2.5}, \quad v = \text{belt speed, m/s.} \qquad ...(1.4)$$

Refer to Table 1.13 for other belt-pulley combinations.

Angle of arc of contact :

$$\theta = \pi \pm 2 \sin^{-1}\left(\frac{D_2 - D_1}{2C}\right) \qquad ...(1.5)$$

Take + ve sign for bigger pulley.

where, C = centre distance.

Power transmitted :

$$P = \frac{F \cdot v \cdot K_j}{K_s \times 10^3} = \frac{T \cdot N_1 \cdot K_j}{9550 \times K_s} \text{ kW} \qquad ...(1.6)$$

where, $F = F_1 - F_2$, T = torque, N.m

Power transmitted per square mm of belt :

$$P_{11} = \frac{\sigma_1 v}{K_s \times 10^3}\left[\frac{\exp(\mu\theta) - 1}{\exp(\mu\theta)}\right] K_j \text{ kW} \qquad ...(1.7)$$

where, K_s = service factor (See Table 1.3)

K_j = joint factor (See Table 1.4)

$\sigma = \dfrac{F_1}{at}$, a = belt width, t = belt thickness.

$v = \pi D_1 N_1/60$ m/s

Ratio of belt tensions, considering centrifugal tension (For $v > 12$ m/s) :

$$\frac{F_1 - F_c}{F_2 - F_c} = \exp(\mu\theta) \qquad ...(1.8)$$

Power transmitted :

$$P = \frac{(F_1 - F_c)}{K_s \times 10^3}\left[\frac{\exp(\mu\theta) - 1}{\exp(\mu\theta)}\right] K_J \text{ kW} \qquad ...(1.9)$$

where, F_c = ρ at v^2 is the centrifugal tension per unit length of belt.

ρ = density of belt material.

Velocity of belt for maximim power transmission :

$$v = \sqrt{\frac{\sigma_w}{3\rho}} \qquad ...(1.10)$$

where, σ_w = working stress for belt material per unit width of belt.

Required belt area :

$$at = \frac{10^3 \times P}{v(\sigma_W - \rho v^2)K_j}\left[\frac{\exp(\mu\theta)}{\exp(\mu\theta) - 1}\right] K_s \qquad ...(1.11)$$

Initial tension,

$$F_i = \frac{1}{4}(\sqrt{F_1} + \sqrt{F_2}) \qquad ...(1.12)$$

Maximum stress in belt :

$$\sigma_{max} = \frac{F_1}{at} + \rho v^2 + \frac{Et}{D_1} \qquad ...(1.13)$$

where, E = modulus of elasticity for belt material

D_1 = diameter of smaller pulley.

Refer to Tables 1.5 to 1.12 for specifications of various types of belts.

Length of open belt :

$$L_0 = \frac{\pi}{2}(D_1 + D_2) + 2C + \frac{(D_2 - D_1)^2}{4C} \qquad ...(1.14)$$

Refer to Fig. 1.1 for nomograph for open type flat belt.

Length of cross belt :

$$L_c = \left(\frac{\pi}{2} + \phi\right)(D_1 + D_2) + \sqrt{4C^2 - (D_1 + D_2)^2} \qquad ...(1.15)$$

where, $\phi = \sin^{-1}\left[\dfrac{D_1 + D_2}{2C}\right]$

$$L_c \cong \frac{\pi}{2}(D_1 + D_2) + 2C + (D_1 + D_2)^2/4C \qquad ...(1.16)$$

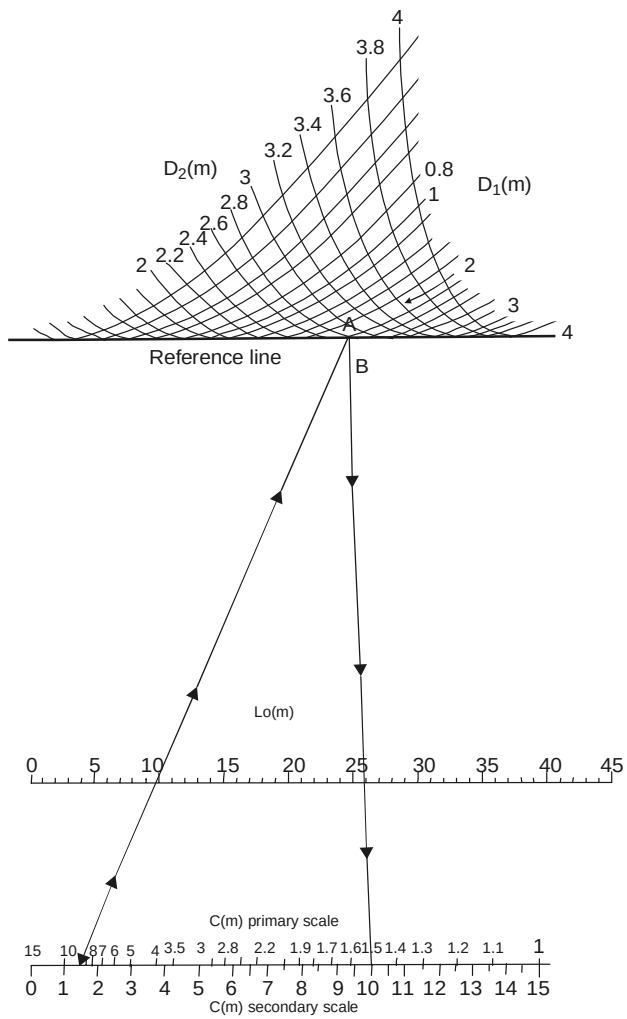


Fig. 1.1 Nomograph for calculating length of open type flat belt.

Refer to Fig. 1.2 for nomograph for cross type flat belt.

Centre distance:

$$C = \frac{L_o}{4} - 0.3925\,(D_1 + D_2) + \left[\left\{\frac{L_o}{4} - 0.3925(D_1 + D_2)\right\}^2 - \frac{(D_2 - D_1)^2}{8}\right]^{1/2} \quad ...(1.17)$$

Cast Iron Pully Dimensions (Fig. 1.3) :

Width of pully rim (Barth's formula)

$$a_1 = 1.19\,a + 10 \text{ mm for single belt} \quad ...(1.18a)$$

$$= 1.10\,a + 5 \text{ mm for double belt} \quad ...(1.18b)$$

Refer to Tables 1.17 and 1.18 for pulley widths.

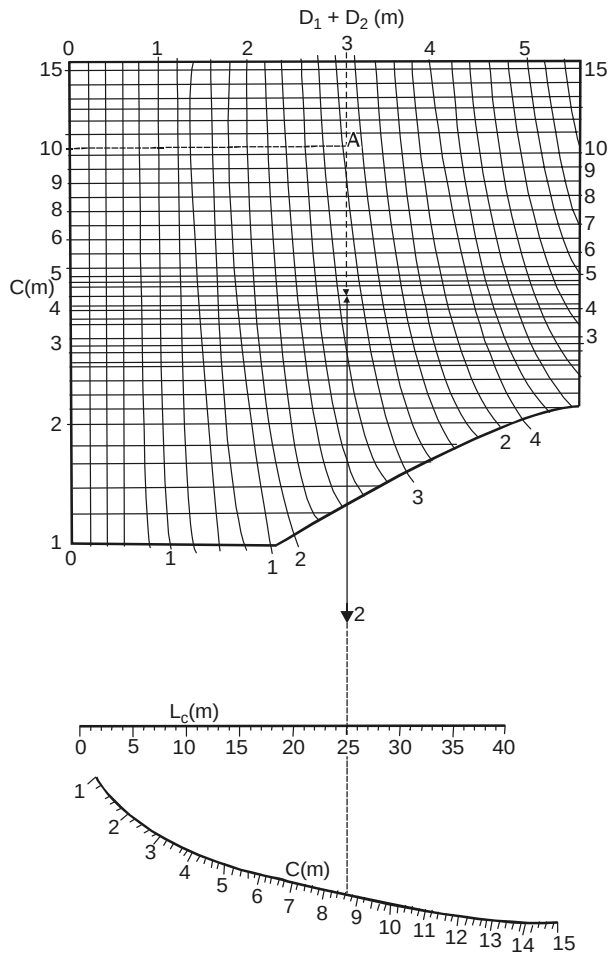


Fig. 1.2 Nomograph for calculating length of cross type belt.

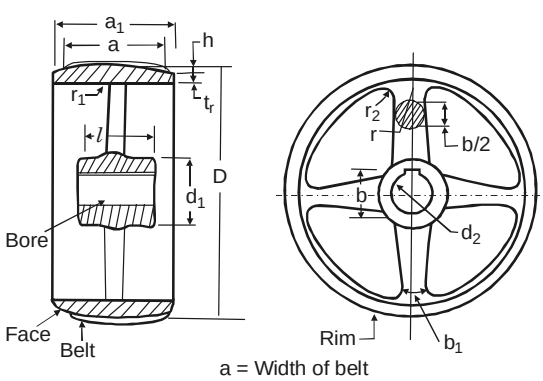
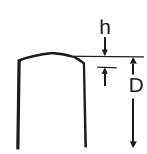


Fig. 1.3 Cast iron pulley.



Crown pulleys of diameters
From 40 to 355 mm inclusive.
(Crown is unrelated to the width
in this diameter range).

Fig. 1.4 Crown height.

Rim thickness (Barth's formula)

$$t_r = 0.25\sqrt{D} + 1.5 \text{ mm for light duty} \quad ...(1.19a)$$

$$= 0.375\sqrt{D} + 3.2 \text{ mm for heavy duty} \quad ...(1.19b)$$

Crown height (Fig. 1.4) :

$$h = \frac{a_1}{200} \text{ for well-aligned shafts} \quad ...(1.20a)$$

$$= \frac{a_1}{120} \text{ for poorly aligned shafts} \quad ...(1.20b)$$

Refer to Tables 1.15 for crown height.

Number of arms, n :

Use solid web upto 200 mm pulley dia.

$$n = 4 \text{ for } D = 200 \text{ to } 450 \text{ mm} \quad ...(1.21a)$$

$$n = 6 \text{ for } D \text{ above } 450 \text{ mm} \quad ...(1.21b)$$

Major axis of elliptical arms near boss :

$$b = 2.94\sqrt[3]{\frac{a_1 D}{4n}} \text{ for single belt} \quad ...(1.22a)$$

$$= 2.94\sqrt[3]{\frac{a_1 D}{2n}} \text{ for double belt} \quad ...(1.22b)$$

Minor axis $= b/2$ ...(1.23)

Cross-section of arms near rim $= \frac{2}{3}$ rd of that near boss ...(1.24)

Radius r_1 and r_2 near rim $= \frac{b}{2}$ ...(1.25)

Minimum length of bore, $l = \frac{2}{3}\, a_1$ ...(1.26)

Radius of cross-section of arms, $r = \frac{3}{4}\, b$ ...(1.27)

Size of boss : $\frac{d_1 - d_2}{2} = 0.412\sqrt[3]{a_1 D} + 6 \text{ mm for single belt}$ ...(1.28a)

$$= 0.529\sqrt[3]{a_1 D} + 6 \text{ mm for double belt} \quad ...(1.28b)$$

where, d_1 = boss dia, d_2 = shaft dia.

Maximum bending stress in arms :

$$\sigma = \frac{128M}{\pi n b^3}, \qquad M = (F_1 - F_2)\frac{D}{2} \quad ...(1.29)$$

Resultant pull on pulley due to belt tensions :

$$R = \frac{F}{k-1}\sqrt{k^2 + 1 + 2k\cos(180° - \theta)} \qquad ...(1.30)$$

where, $k = \dfrac{F_1 - F_C}{F_2 - F_C}$, $\quad F = F_1 - F_2$

Diameter of motor pully :

$$D_1 \cong (1200 \text{ to } 1400)\ \sqrt[3]{\frac{P}{N_1}}\ \text{mm}$$

where, P = power transmitted, kW and N_1 = rpm ...(1.31)

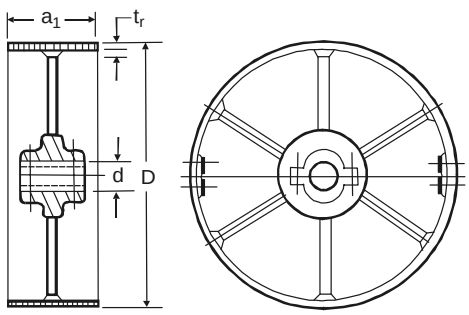


Fig. 1.5 Mild steel pulley.

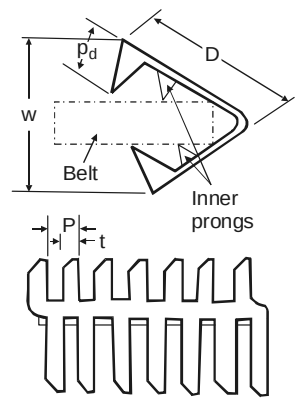


Fig. 1.6 Dimensions for belt fasteners (Alligator type)

Mild Steel Pulley (Fig. 1.5) :

Minimum length of boss : $l = a/2$

< 100 mm for 19 mm dia spokes. ...(1.32)

< 138 mm for 22 mm dia spokes

Refer to Table 1.19 for number of arms.

Rim thickness t_r = 5 mm for D = 400 to 2000 mm ...(1.33a)

$= \dfrac{D}{200}$ + 3 mm for single belt ...(1.33b)

$= \dfrac{D}{200}$ + 6 mm for double belt ...(1.33c)

Belt Fasteners (Fig. 1.6)

Refer to Tables 1.20 and 1.21 for diamensions of alligator type belt fasteners.

2. V-BELTS

(a) Industrial Belts.

Number of Belts : $$n = \frac{10^3 \times P \times K_a}{(F_1 - F_C)v}\left[\frac{\exp(\mu_e\theta)}{\exp(\mu_e\theta) - 1}\right] \qquad ...(1.34)$$

where, μ_e = $\mu/\sin\beta$, equivalent coefficient of friction (see Table 1.23).

β = semi groove angle of pulley (See Fig. 1.7)

K_a = service factor (see Table 1.25)

P = drive power, kW.

According to IS : 2494–1974, $n = \dfrac{P \times K_a}{kW \times K_b \times K_c}$ ...(1.35)

where, kW = ratings of V-belts. (See Table 1.24)

K_b = small dia factor (See Table 1.26)

K_c = correction factor for belt length (see Table 1.27).

Angle of arc of contact : $\theta = 2\cos^{-1}\left(\dfrac{D_2 - D_1}{2C}\right)$ ...(1.36)

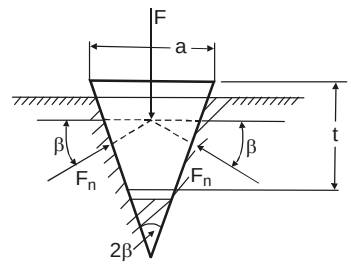


Fig. 1.7 V-belt groove.

Pitch length of belt : $L_p = 2C + 1.57\,(D_1 + D_2) + \dfrac{(D_2 - D_1)^2}{4C}$ ...(1.37)

Refer to Table 1.29 for nominal inside and pitch lengths.

Centre distance : $C = A + \sqrt{A^2 - B}$ ...(1.38)

where, $A = \dfrac{L_p}{4} - \dfrac{\pi(D_1 + D_2)}{8}$

$B = (D_2 - D_1)^2/8$

Maximum centre distance, $C_{max} = 2\,(D_1 + D_2)$ ...(1.39)

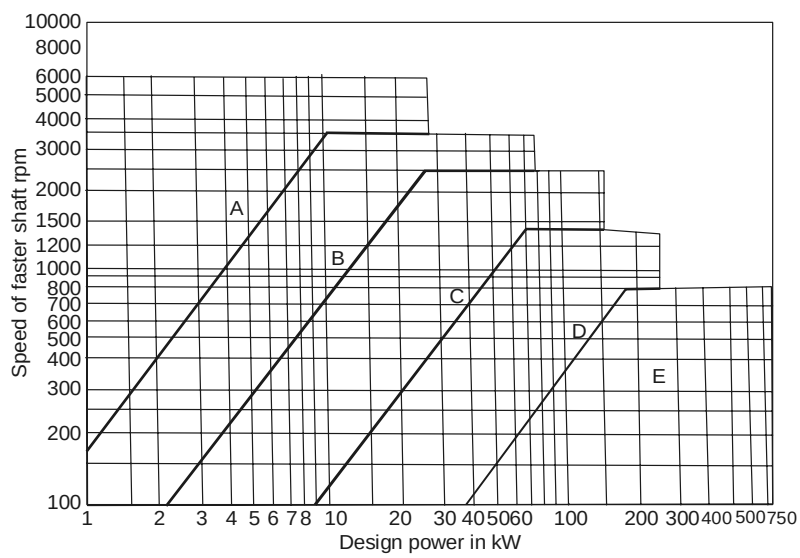


Fig. 1.8 Selection of V-belt cross-section.

Maximum centre distance, $C_{min} = 0.55\,(D_1 + D_2) + t$ ...(1.40)

Refer to Fig. 1.8 for selection of V belt cross-section.

V-Grooved Pulleys (Fig. 1.9).

Refer to Table 1.30 for Dimensions of Standard *V*-grooved pulleys and Table 1.31, for pulley pitch diameters.

(*b*) For Agricultural Machinery (Fig. 1.10)

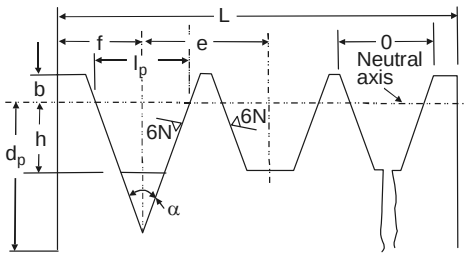


Fig. 1.9 Dimensions for Standard V-Grooved Pulley.

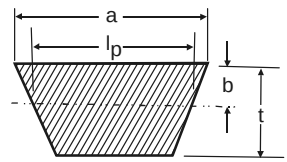


Fig. 1.10 Size of V-Belts for Agricultural Machinery

Refer to Table 1.32 for sizes of *V*-belts and pulleys.

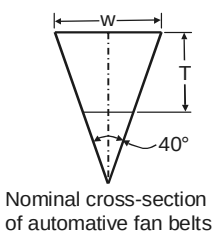


Fig. 1.11 V-belt for automotive fan.

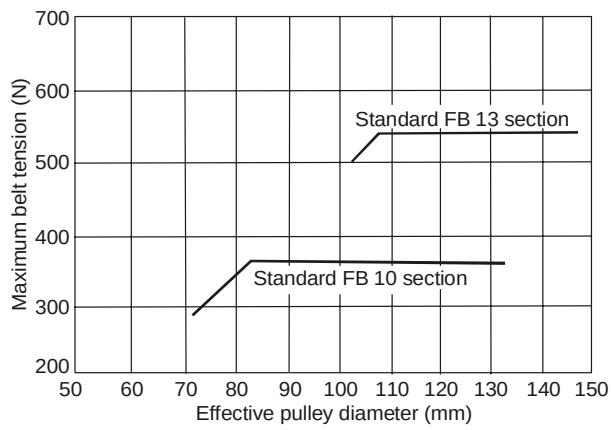


Fig. 1.12 Selection of fan belt.

(*c*) For automotive fan (Fig. 1.11)

Refer to Table 1.33 for dimensions of standard *V*-grooved pulleys. For selection of fan belt,refer to Fig. 1.12.

(*d*) Link V-belts.

Corrected power $= P.\,K_d\,.\,K_l$ ...(1.41)

where, K_d = correction factor for arc of contact (see Table 1.37)

K_l = load factor (see Table 1.38)

Dimensions of link V-belts (Fig. 1.13)

Refer to Tables 1.34 to 1.36.

(*e*) Train-lighting belting.

Refer to Table 1.40 for specifications of train lighting belting.

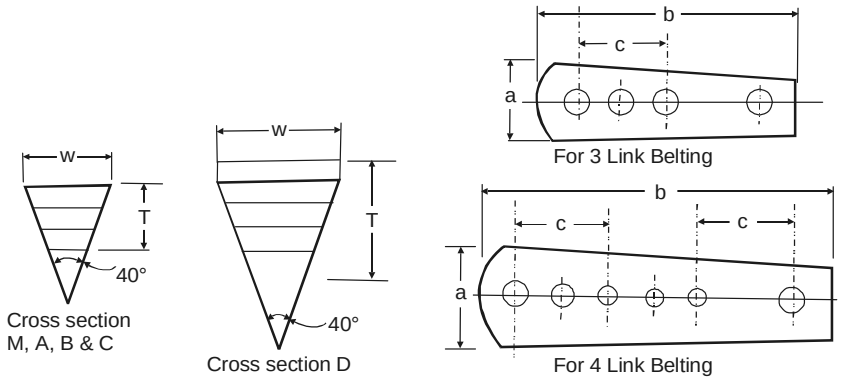


Fig. 1.13 Dimensions of Link V-Belts.

Table 1.1 Comparison of Mechanical Drives

Type of drive	*Centre distance*	*Speed ratio*	*Shifting*	*Maintenance cost*	*Initial cost*	*Power rating kW*	*Peripheral speed m/s*	*Efficiency per cent*
Flat belt	Long	4-10	Yes	Low	1	upto 100	5-30	92-98
V-belts	Short	7-15	No	Low	3	50	5-30	87-97
Roller chains	Short	6-10	No	Medium	5	3500	upto 25	94-98
Silent chains	Short	5-15	No	Medium	7	3000	upto 25	94-58
Ropes	Very long	5-10	No	Medium	10	2500	6-15	92-96
Spur gears	Short	upto 10	Yes	Medium	15	10000	25	92-99
Helical gears	Short	upto 10	Yes	Medium	25	35000	25	94-99
Bevel gears	Short	upto 20	No	Medium	30	30000	30	90-98
Worm grears	Short	8-100	No	High	35	100	upto 35	75-90

Table 1.2 Classification of Flat Belt Drives

Type of drive	*Belt speed, Max., M/s*	*Power transmitted, kW*
Light	Upto 12	7.5
Medium	12 to 24	7.5 to 15
Heavy	Above 24	Above 15

Table 1.3 Service Correction Factor, K_s

Service Conditions	K_s
Atmospheric condition :	
Clean, scheduled maintenance on large drives	1.2
Normal	1.0
Oily, wet or dusty	0.7
Angle of centre line :	
Horizontal to 60° from horizontal	1.0
60° to 75° from horizontal	0.9
75° to 90° from horizontal	0.8
Pulley material :	
Fiber on motor and small pulleys	1.2
Cast iron on steel	1.0
Service:	
Temporary or infrequent	1.2
Normal	1.0
Important or continuous	0.8
Peak loads :	
Steady belt loads as obtained with steam engines, turbines, diesel and multi-cylinder gas engines, fans centrifugal pumps, and steady line shaft loads.	1.0
Jerky belt loads as obtained with large induction motors ; compensator-started,shunt wound, diredt current motors ; single cylinder gas engines ; reciprocating machines ; and machines developing series of peak loads, such as compressors,rock crushers and punch presses etc.	0.8
Shock and reversing belt loads on all motor *10 hp*. and under, all cross the line start motors, wound-rotor (slip-ring) motor, synchronous motors, and reversing loads such as printing presses, elevator service and laundary washers etc.	06

Source : Design of Machine Elements by Vallance & Doughtie, p. 370, Table 86, 3rd ed.

Table 1.4 Correction Factors K_j for Belt Joints

Type of joint	K_j
Cemented by belt maker	1.00
Cemented	0.98
Wire laced by machine	0.90
Wire laced by hand	0.82
Raw hide faced	0.60
Metal belt hoops	0.35

Vallance & Doughtie, “Design of Machine Elements” 3rd ed ., p. 365, Table 82.

Table 1.5 Widths of Friction Surface Rubber Transmission Belting

Nominal belt width, mm	*Tolerance, mm*
25, 32, 40, 50, 63,	± 2.0
75, 80, 90, 100, 112, 125	± 3.0
140, 160, 180, 200, 224, 250	± 4.0
280, 315, 355, 400, 450, 500	± 5.0

IS : 1370-1976

Table 1.6 Thickness of Friction Surface Rubber Transmission Belting

Ply construction	*Nominal belt thickness, mm*	*Tolerance,mm*
3 ply	3.9	± 0.5
4 ply	5.1	± 0.7
5 ply	6.4	± 0.8
6 ply	7.7	± 0.9
7 ply	9.1	± 1.0
8 ply	10.4	± 1.1
9 ply	11.7	± 1.2
10 ply	13.0	± 1.3

IS : 1370—1976

Table 1.7 Weight and Tensile Strength of Rubber Transmission Belting

Type of duck		*Nominal mass g/m²*	*Tensile strength N/mm of width*	
			Warp	*Weft*
Soft	28	810	60.11	28.83
	32	915	67.37	31.77
Hard	31	910	60.11	33.73
	34	970	67.37	43.25

IS : 1370—1976

Table 1.8 Rating in Kilowatts per mm Width of Rubber Transmission Belting at 180° Arc of Contact

Type of duck		*Mass of fabric g/m²*	*Pulley dia mm*	*Belt speed m/s*	*Rating per mm width per ply in kW*
Soft					
	28	810	250	5	0.012
	32	915	250	5	0.015
Hard	31	910	250	5	0.012
	34	970	250	5	0.015

I.S. 1370-1976

Table 1.9 Dimensions for Solid Woven Impregnated Cotton* and Hair ** Belting for Power Transmission

Pulley width mm	*Nominal belt width mm*	*Tolernace on width mm*	*Nominal belt thickness, mm*				
			5+0.5 –0.0	*6.5 + 0.5 –0.3*	*8 + 0.6 –0.3*	*10 + 0.7 –0.5*	*12 + 0.8 –0.6*
32	25		*x*	-	-	-	-
40	32		*y*	-	-	-	-
50	40		*x*	-	-	-	-
63	50		*x*	*x*	-	-	-
71	63	± 1.6	*x*	*x*	-	-	-
80	71		-	*y*	-	-	-
90	80		-	*y*	-	-	-
100	90		-	*y*	*y*	-	-
112	100		-	*x*	*x*	-	-
125	112		-	*x*	*x*	-	-
140	125		-	*x*	*x*	-	-
160	140		-	*y*	*y*	*y*	-
180	160		-	-	*y*	*y*	-
200	180	± 2.4	-	-	*y*	*y*	-
224	200		-	-	*x*	*x*	-
250	224		-	-	*x*	*x*	-
280	250		-	-	-	*x*	*y*
315	280		-	-	-	*y*	*y*
355	315	± 3.2	-	-	-	*y*	*y*
400	355		-	-	-	*x*	*x*
450	400		-	-	-	*x*	*x*
500	450		-	-	-	-	*x*
600	500		-	-	-	-	*x*
675	600		-	-	-	-	*z*

x = preferred size, *y* = permissible size, *z* = discouraged size

*IS : 529—1976, **IS : 530—1976.

Table 1.10 Tensile Strength of Solid Woven Impregnated Cotton* and Hair Belting**

Type of belt	*Minimum tensile strength, N/mm²*
Cotton	51.68
Hair :	
Grade 1	37.04
Grade 2	28.86

*IS : 529-1976 ** IS : 530-1976

Table 1.11 Specifications for Vegetable Tanned Leather Belting

Type of belt	*Width of belt mm*	*Length of splice mm*	*Tensile strength N/mm^2*
Single	Upto and including 25	110	24.05
	Over 25 upto and including 40	115	
	Over 40 upto and including 50	125	
	Over 50 upto and including 71	140	
	Over 71 upto and including 80	150	
	Over 90 upto and including 140	180	
	160 and above	200	
Double	Upto and including 125	100	24.05
	Over 125	125	
Splices (single and double)	-		20.20

IS : 2240—1976

Table 1.12 Specifications of Round Leather Belting

Nominal size mm	*Width mm* ± 0.3	*Thickness mm* ± 0.5	*Minimum breaking Strength, (N)*
5 (Heavy)	5	5	441
6 (Regular)	6	5	667
6 (Heavy)	6	6	755

IS : 2241—1976

Table 1.13 Coefficient of Friction for Belts

Belt material	*Pulley material*						
	Cast iron, steel			*Wood*	*Compressed Paper*	*Leather face*	*Rubber face*
	Dry	*Wet*	*Greasy*				
Leather, Oak tanned	0.25	0.20	0.15	0.30	0.33	0.38	0.40
Leather, chrome tanned	0.35	0.32	0.22	0.40	0.45	0.48	0.50
Canvas, stiched	0.20	0.15	0.12	0.23	0.25	0.27	0.30
Cotton, woven	0.22	0.15	0.12	0.25	0.28	0.27	0.30
Camel hair, woven	0.35	0.25	0.20	0.40	0.45	0.45	0.45
Rubber	0.30	0.18	—	0.32	0.35	0.40	0.42
Balata	0.32	0.20	—	0.35	0.38	0.40	0.42

Vallance and Doughtie "Design of Machine Members", 3rd ed. p. 367, Table 83.

Table 1.14 Minimum Pulley Diameters for given Belt Speeds and Belt Plies in mm

No. of plies	*Maximum belt speed, m/s*				
	10	15	20	25	30
3	90	100	112	140	180
4	140	160	180	200	250
5	200	224	250	315	355
6	250	315	355	400	450
7	355	400	450	500	10
8	450	500	10	630	710
9	10	630	710	800	900
10	630	710	800	900	1000

IS : 1370—1976

Table 1.15 Crown of Cast Iron and Mild Steel Flat Pulleys of Diameters upto 355 mm

Nominal dia, D, mm	*Crown, h, mm*
40 to 112	0.3
125 & 140	0.4
160 & 180	0.5
200 & 224	0.6
250 & 280	0.8
315 & 355	1.0

IS : 1691—1980

Table 1.16 Crown of Cast Iron and Mild Steel Flat Pulleys of Diameters from 400 mm to 2000 mm

Nominal dia, D mm	*Crown h of pulleys of width*						
	125 and smaller	*140 & 160*	*180 & 200*	*224 & 250*	*280 & 315*	*355*	*400 & larger*
400	1	1.2	1.2	1.2	1.2	1.2	1.2
450	1	1.2	1.2	1.2	1.2	1.2	1.2
500	1	1.5	1.5	1.5	1.5	1.5	1.5
10	1	1.5	1.5	1.5	1.5	1.5	1.5
630	1	1.5	2	2	2	2	2
710	1	1.5	2	2	2	2	2
800	1	1.5	2	2.5	2.5	2.5	2.5
900	1	1.5	2	2.5	2.5	2.5	2.5
1000	1	1.5	2	2.5	3	3	3
1120	1.2	1.5	2	2.5	3	3	3.5
1250	1.2	1.5	2	2.5	3	3.5	4
1400	1.5	2	2.5	3	3.5	4	4
1600	1.5	2	2.5	3	3.5	4	5
1800	2	2.5	3	3.5	4	4.5	5
2000	2	2.5	3	3.5	4	4.5	6

All dimensions in mm IS : 1691—1980

Table 1.17 Width and Diameters of Flat Cast Iron and Mild Steel Pulleys

Width, mm	*Tolerance, mm*	*Nominal dia, mm*	*Tolerance, mm*
20, 25, 32, 40, 50, 63, 71	± 1	40 40, 50	± 0.5 ± 0.6
80, 90, 100, 112, 125, 140	± 1.5	1, 63 71, 140	± 0.8 ± 1.0
160, 180 200, 224, 250, 280, 315	± 2	90, 100, 112 125, 140	± 1.2 ± 1.9
355, 400, 450, 500, 10, 630	± 3	160, 180, 200 224, 250 280, 315, 355	± 2.0 ± 2.5 ± 3.0
Material of C.I. pulley : Grade FG 200 of IS : 210-1978		400, 450, 500 10, 630, 710 800, 900, 1000	± 4.0 ± 5.0 ± 6.3
Material for M.S. pulley : IS : 226-1975		1120, 1250, 1400 1600, 1800, 2000	± 8.0 ± 10.0

IS : 1691-1980

Table 1.18 Width of Flat Pulleys

Belt width mm	*Pulley to be wider than the belt width by mm*
Upto and including 125	13
From 125 upto and including 250	25
From 250 upto and including 375	38
From 375 upto and including 500	50

IS : 2122-1973

Table 1.19 Number of Arms in Mild Steel Pulley

Diameter of pulley, mm	*No. of arms*	*Dia. of arms, mm*
280 to 500	6	19
10 to 710	8	19
800 to 1000	10	22
1120	12	22
1250	14	22
1400	16	22
1600	18	22
1800	18	22
2000	22	22

IS : 1691—1980

Table 1.20 Dimensions for Belt Fasteners (Alligator Type)

(All dimensions in mm)

Fastener designation	*Thickness of belt*	*Metal Thickness (Sheet)*	*Point depth* P_d	*Approx. overall depth, D*	*Approx. overall width, W*	*Width of bar or Prong, t min.*	*Pitch of prongs P*
15	3 to 4	1.0	5.0	13	18	2.5	6
20	4 to 5	1.1	6.5	17	22	3	8
25	5 to 5.5	1.2	7.0	21	25	3	8
27	5.5 to7	1.2	8.0	24	29	3	8
35	7 to 8	1.8	9.5	30	32	4	10
45	8 to 9.5	1.8	11.0	31	38	5	12
55	9.5 to 11	2.0	14.0	40	48	6.5	16
65	11 to 13	2.0	16.0	41	54	6.5	16

IS : 5593—1980

Table 1.21 Dimensions of Hinge Pins and Rocker Pins for Belt Fasteners

Fastener designation	*Pin dimensions mm*
15	2.8 dia.
20	2 × 2.8
25	2 × 2.8
27	2 × 3.2
35	2.2 × 3.5
45	3.2 × 5
55	3.5 × 5
65	3.5 × 5

Table 1.22 Classification of V-Belts (Fig. 1.7)

Type of belt	*IS code No.*	*Cross-section symbol*	*Nominal top width a, mm*	*Nominal thickness t, mm*	*Angle of V-belt* 2β, *deg.*
Industrial purposes	IS : 2494-1974	A B C D E	13 17 22 32 38	8 11 14 19 23	40
Automotive fan	IS : 135-1970	FB10 FB13	10 13	8 11	40
Agricultural machinery	IS : 8777-1978	HI HJ HK HL HM	25.4 31.8 38.1 44.5 50.8	12.7 15.1 17.5 19.8 22.2	26

Table 1.23 Effective Coefficient of Friction for V-belts

Angle of groove 2β, *deg.*	*Effective coefficient of friction* μ_e
26	0.578
30	0.502
32	0.471
34	0.445
36	0.421
38	0.399
40	0.380

Table 1.24 Power Rating of V-belts in kW

Belt cross-section symbol	*Formula*	*Maximum value of d_e in formula, mm*
A	$P = 0.7355\left(0.61\,v^{-0.09} - \frac{26.68}{d_e} - 1.04\times10^{-4}v^2\right)v$	125
B	$P = 0.7355\left(1.08\,v^{-0.09} - \frac{69.8}{d_e} - 1.78\times10^{-4}v^2\right)v$	175
C	$P = 0.7355\left(2.01\,v^{-0.09} - \frac{194.8}{d_e} - 3.18\times10^{-4}v^2\right)v$	300
D	$P = 0.7355\left(4.29\,v^{-0.09} - \frac{690}{d_e} - 6.48\times10^{-4}v^2\right)v$	425
E	$P = 0.7355\left(6.22\,v^{-0.09} - \frac{1294}{d_e} - 9.59\times10^{-4}v^2\right)v$	700

where, P = power at 180° arc of contact for a belt of average length

v = belt speed in m/s.

d_e = equivalent pitch diameter = $d_p \times K_b$

d_p = pitch diameter of the smaller pulley

K_b = small diameter factor (see Table 1.26)

IS : 2494—1974

Table 1.25 Correction Factors for Industrial Service, K_a

Severity of service	*Type of driven machines*	*Type of driving unit* *A.C. motors, normal torque squirrel cage, synchronous and split phase. D.C. motors, shunt wound, multiple cylinder internal combustion engines over 600 rpm.*			*A.C. motors, high torque, high slip repulsion, induction, single phase, series wound and slip ring. D.C. motors, Series wound and compound wound, single and multi cylinder I.C. engines under 600 rpm. Line shaft, clutches, brakes*		
		Operational hours per day			*Operational hours per day*		
		Upto 10 hrs	*Over 10 to 16 hrs.*	*Over 16 hrs & continuous service*	*Brakes upto 10 hrs*	*Over 10 to 16 hrs*	*Over 16 hrs & continuous service*
Light duty	Agitators for liquids, blowers and exhausters, centrifugal pumps and compressors, fans upto 7.5 kW and light duty conveyors.	1.0	1.1	1.2	1.1	1.2	1.3
Medium duty	Belt conveyors for sand, grains etc, dough mixers, fans upto 7.5 kW, generators, line shafts, laundry machinery, machine tools, punches, presses and shears, printing machinery positive displacement rotary pumps, and revolving and vibration screens.	1.1	1.2	1.3	1.1	1.2	1.3
Heavy duty	Brick machinery, bucket elevators, conveyors (drag-pan-screw), hammer mills, paper mill beaters, pistion pumps, positive displacement blowers pulverizers, saw mill and wood working machinery and tectile machinery	1.2	1.3	1.4	1.4	1.5	1.6
Extra heavy duty	Crushers (gyratory jaw-roll), mills (ball-rod-tube), hoists	1.3	1.4	1.5	1.5	1.6	1.8

IS : 2494—1974

Table 1.26 Small Diameter Factor K_b

Speed ratio range	K_b
1.000 to 1.019	1.00
1.020 to 1.032	1.01
1.033 to 1.055	1.02
1.01 to 1.081	1.03
1.082 to 1.109	1.04
1.110 to 1.142	1.05
1.143 to 1.178	1.06
1.179 to 1.222	1.07
1.223 to 1.274	1.08
1.275 to 1.340	1.09
1.341 to 1.429	1.10
1.430 to 1.12	1.11
1.13 to 1.814	1.12
1.815 to 2.948	1.13
2.949 and over	1.14

IS : 2494-1974

Table 1.27 Correction Factors for Belt Length, K_c

Nominal inside length mm	*Belt cross-section symbol*				
	A	*B*	*C*	*D*	*E*
610	0.80				
660	0.81				
711	0.82				
787	0.84				
813	0.85				
889	0.87	0.81			
914	0.87				
965	0.88	0.83			
991	0.88				
1016	0.89	0.84			
1067	0.90	0.85			
1092	0.90				
1168	0.92	0.87			
1219	0.93	0.88			
1295	0.94	0.89	0.80		
1372		0.90			
1397	0.96	0.90			
1422	0.96	0.90			
1473	0.97				

(*Contd...*)

Nominal inside length mm	*Belt cross-section symbol*				
	A	*B*	*C*	*D*	*E*
1524	0.98	0.92	0.82		
1600	0.99				
1651	1.00	0.94			
1727	1.00	0.95	0.85		
1778	1.01	0.95			
1905	1.02	0.97	0.87		
1981	1.03	0.98			
2032	1.04				
2057	1.04	0.98	0.89		
2159	1.05	0.99	0.90		
2286	1.06	1.00	0.91		
2438	1.08		0.92		
2464		1.02			
2540		1.03			
2667	1.10	1.04	0.94		
2845	1.11	1.05	0.95		
3048	1.13	1.07	0.97	0.86	
3150			0.97		
3251	1.14	1.08	0.98	0.87	
3404			0.99		
3658		1.11	1.00	0.90	
4013		1.13	1.02	0.92	
4115		1.14	1.03	0.92	
4394		1.15	1.04	0.93	
4572		1.16	1.05	0.94	
4953		1.18	1.07	0.96	
5334		1.19	1.08	0.96	0.94
6045			1.11	1.00	0.96
6807			1.14	1.03	0.99
719			1.16	1.05	1.01
8331			1.19	1.07	1.03
9093			1.21	1.09	1.05
9855			1.23	1.11	1.07
10617			1.24	1.12	1.09
12141				1.16	1.12
13665				1.18	1.14
15189				1.20	1.17
16713				1.23	1.19

IS : 2494—1974

Table 1.28 Correction Factors for Arc of Contact, K_d

Arc of contact on small pulley deg		*Correction factor, K_d*	
		V-V.	*V-flat*
180		1.00	0.75
177		0.99	0.76
174		0.99	0.76
171		0.98	0.77
169		0.97	0.78
166		0.97	0.79
163		0.96	0.79
160		0.95	0.80
157		0.94	0.80
154		0.93	0.81
151		0.93	0.81
148		0.92	0.83
145		0.91	0.83
142		0.90	0.84
139		0.89	0.85
136		0.88	0.85
133		0.87	0.86
130		0.86	0.86
127		0.85	0.85
123		0.83	0.83
120		0.82	0.82
117	Discouraged range	0.81	0.81
113		0.80	0.80
110		0.78	0.78
106		0.77	0.77
103		0.75	0.75
99		0.73	0.73
95		0.72	0.72
91		0.70	0.70
87		0.68	0.68
83		0.65	0.65

IS : 2494—1974

Table 1.29 Dimensions for Standard V-grooved Pulleys (Fig. 1.9)

Groove section	*Pitch width l_p, mm*	*Minimum height of groove above pitch line, b, mm*	*Minimum depth of groove below pitch line, h, mm*	*Centre to centre distance of grooves, e, mm*	*Edge of pulley to first groove centre f, mm*
A	11	3.3	8.7	15 ± 0.3	10 + 2 – 1
B	14	4.2	10.1	19 ± 0.4	12.5 + 2 – 1
C	19	5.7	14.3	25.5 ± 0.5	17 + 2 – 1
D	27	8.1	19.9	37 ± 0.6	24 + 3 – 1
E	32	9.6	23.4	44.5 ± 0.7	29 + 4 – 1

IS : 3142—1965

Table 1.30 Nominal Inside Length, Pitch Length and Permissible Length Variations for V-V

Nominal inside length mm	*Nominal pitch length, mm for cross-section symbol*					*Pitch length **	*Variation ***
	A	*B*	*C*	*D*	*E*	*PLL*	*MVL*
610		645					
660		696				+ 11.4	
711		747				– 6.4	
787		823					
813		848				+ 12.5	
889		925	932			– 7.5	
914		950					2.5
965		1001	1008				
991		1026					
1016		1051	1059				
1067		1102	1110			+ 14.0	
1092		1128				– 8.9	
1168		1204	1212				
1219		1255	1262				
1295		1331	1339	1351		+ 16.0	
1372			1415			– 9.0	
1397		1433	1440				
1422		1451	1466				
1473		1509					
1524		1560	1567	1580			5.0

Nominal inside length mm	*Nominal pitch length, mm for cross-section symbol*					*Pitch length* *	*Variation* **
	A	*B*	*C*	*D*	*E*	*PLL*	*MVL*
1600		1636					
1626		1661				+ 17.8	
1626		1661				– 12.5	
1651		1687	1694				
1727		1763	1770	1783			
1778		1814	1821				
1905		1941	1948	1991			
1981		2017	2024				
2032		2068					
2057		2093	2101	2113		+30	
2159		2195	2202	2215		– 16	
2286		2322	2329	2342			7.5
2438		2474		2494			
2464	-	2507	-	-		+ 34	
2540	-	2583	-	-		– 18	
2667	2703	2710	2723	-			
2845	2880	2888	2901	-	-		
3048	3084	3091	3104	3127	-		
3150				3205			
3251		3287	3294	3307	3330	+ 38	
3404				3459		– 21	
3658		3693	3701	3736			
4013		401	4069	4092		+43	
4115		4158	4171	4194		–24	
4394		4437	4450	4473			
4572		4615	4658	4651			12.5
4953		4996	5009	5032	-	+49	
5334		5377	5390	5413	5426	–28	
6045			6101	6124	6137		
6807			6863	6880	6889	+1	
719			7625	7648	7661	–32	
8331			8387	8410	8423	+65	15
9093			9149	9172	9185		
9855				9934	9947	–37	
10617			10696	10709		+76	
12141			12220	12233		–43	17.5
13665			13744	13757		–89	
15189			15268	15281		–50	
16713			16792	16805		+105	
						–59	

*PL Pitch length limits, ** MVL maximum variation in length within a matched set. IS : 2494–1974

Table 1.31 Recommended Standard Pulley Pitch Diameters

Series of pitch diameters			*Degree of performance * for pitch diameters, according to groove section*				
Nominal value	*Pitch dia., Min.*	*Limits, Max.*					
mm	*mm*	*mm*	*A*	*B*	*C*	*D*	*E*
75	75	76.3	3				
80	80	81.3	3				
85	85	86.4	3				
90	90	91.4	1				
95	95	96.5	2				
100	100	101.6	1				
106	106	107.7	2				
112	112	113.8	1				
118	118	119.9	2				
125	125	127.0	1	2			
132	132	134.1	2	2			
140	140	142.2	1	1			
150	150	152.4	2	2			
160	160	162.6	1	1			
170	170	172.7	3	2			
180	180	182.9	1	1			
190	190	193.0	3	3			
200	200	202.3	1	1	1		
212	212	215.4			2		
224	224	227.6	2	2	1		
236	236	239.8			2		
250	250	254.0	1	1	1		
265	265	269.2			2		
280	280	284.5	2	2	1		
300	300	304.8	2	2	2		
315	315	320.0	1	1	1		
355	355	360.7	2	2	2	1	
375	375	381.0		2	2	2	
400	400	406.4	1	1	1	1	
425	425	431.8			2		
450	450	457.2	2	2	2	1	
475	475	482.6			2		
500	500	508.8	1	1	1	1	1
530	530	538.5		3	3	3	2
10	10	19.0	2	2	2	2	1
600	600	609.6		2	2	2	2
630	630	640.0	1	1	1	1	1

Series of pitch diameters			*Degree of performance * for pitch diameters, according to groove section*				
Nominal value	*Pitch dia., Min.*	*Limits, Max.*					
mm	*mm*	*mm*	*A*	*B*	*C*	*D*	*E*
670	670	680.7					2
710	710	721.4	2	2	2	2	1
750	750	762.0		2	2	2	3
800	800	812.8	3	1	1	1	1
900	900	914.4		2	2	2	2
1000	1000	1016.0		1	1	1	1
1060	1060	1077.0				2	
1120	1120	1137.9		3	2	2	2
1250	1250	1270.0			1	1	1
1400	1400	1422.4			2	2	2
1500	1500	1524.0				2	2
1600	1600	1625.6			1	1	1
1800	1800	1828.4				2	2
1900	1900	1930.4					2
2000	2000	2032.0				1	1
2240	2240	2275.8					2
2500	2500	2540.0					1

*1 = first preference, 2 = second preference, 3 = not recommended. IS : 3142—1965

Table 1.32 Size of V-belts and Pulleys Agricultural Machinery

(All dimensions in mm) (Fig. 1.10)

Designation	*Sympol*	*Profile*				
		HI	*HJ*	*HK*	*HL*	*HM*
Pitch width	I_p	23.6	29.6	35.5	41.4	47.3
Nominal top width	a	25.4	31.8	33.1	44.5	50.8
Nominal height	t	12.7	15.1	17.5	19.8	22.2
0.160 I_P	b	3.8	4.7	5.7	6.6	7.6

Angle of pulley groove = 26° ± 1°

Minimum pulley dia d_p = 3.55 1_p

Minimum depth of groove below pitch line h = 0.535 1_p

IS : 8777—1978

Table 1.33 Dimensions of Standard V-grooved Pulleys for Automotive Fan Belts

Cross-section symbol	*Nominal top width of belt a*	*pulley effective outside dia*	*Groove angle 2 β + 1/2° deg*	*Minimum groove depth h*	*Top width of groove g ± 0.13*	*Centre to centre of groove, e ± 0.25*
FB 10	10	76 and over	36	11.1	9.7	13.0
FB 13	13	90 and over	36	14.2	12.2	16.1

IS : 135—1970

Table 1.34 Dimensions of Link V-Belts

Cross-sectional Symbol	*Nominal Top Width, W*	*Nominal Thickness, T*
M	12	9.5
A	13.5	11
B	18	12.5
C	24	17.5
D	35	25.5

IS : 9515—1980

Note : The sections A, B, C and D may be used as replacement items for solid endless V-belts of section A, B, C and D conforming to IS : 2494—1974.

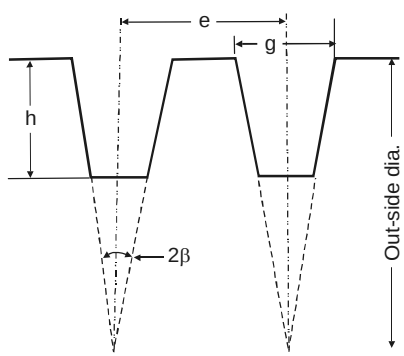


Fig. 1.14

Table 1.35 Dimensions of Links for Link-V-Belts
(All dimensions in milimetres)

Cross-section	*a*	*b*	*c*	*No. of Piles*	*Belting*
M	10	50	19	4	
A	13	55	20.5	5	
B	17	60	22	6	3 Link
C	22	73	25	7	
D	32	90	38	10	Belting
D	32	150	38	8	4 Link Belting

IS : 9515—1980

Table 1.36 Rated Power for Link V-belts

Nominal size of link Belt (mm)	*Small pulley Pitch dia. (mm)*	*Belt Speed in Metro per Minute*						
		150	*300*	*460*	*600*	*760*	*915*	*1070*
10	50	0.15	0.30	0.37	0.52	0.60	0.60	0.60
	63	0.15	0.30	0.45	0.60	0.75	0.75	0.75
	75(N)	0.15	0.37	0.60	0.75	0.92	0.90	0.90
	90 and over	0.22	0.45	0.67	0.90	0.97	0.97	1.05
12.5	63	0.22	0.37	0.60	0.75	0.75	-	-
	75	0.22	0.52	0.75	0.97	1.12	-	-
	90(N)	0.30	0.60	0.90	1.19	1.42	1.57	-
	100 and over	0.37	0.67	0.97	1.27	1.57	1.79	1.94
16	112	0.45	0.82	1.19	1.57	1.87	2.09	2.31
	125(N)	0.92	0.97	1.34	1.79	2.09	2.39	2.54
	150	0.67	1.12	1.64	2.09	2.54	2.90	3.21
	175 and over	0.75	1.34	1.87	2.39	2.91	3.36	3.66
19	175	0.82	1.49	2.16	2.76	3.36	-	-
	200(N)	1.05	1.87	2.69	3.50	4.25	4.85	-
	225	1.12	2.09	3.13	4.10	4.93	5.67	-
	250 and over	1.19	2.31	343	4.55	5.45	6.34	-
22	200	1.19	2.24	3.28	4.13	5.00	5.60	-
	225(N)	1.27	2.31	3.43	4.40	5.22	5.97	-
	250	1.34	2.46	3.58	4.70	5.60	6.49	7.24
	275 and over	1.42	2.54	3.66	4.78	5.67	6.57	7.31
25.5	225	1.34	2.39	3.66	4.63	5.52	-	-
	250 (N)	1.42	2.61	3.80	4.93	5.90	6.64	-
	275	1.49	2.76	4.03	5.22	6.19	6.87	-
	300 and over	1.64	3.13	4.48	5.67	6.57	7.24	-

Note–N = Recommended normal pulley sizes. IS : 9515—1980

Table 1.37 Correction Factors for Arc of Contact for Link V-belts, K_d

Are of Contact	180°	175°	170°	165°	160°	155°	150°	145°	140°	135°	130°	125°	120°
Correction factors for reducrion drives	1.0	1.01	1.02	1.04	1.05	1.07	1.08	1.1	1.12	1.14	1.16	1.18	1.2
Correction factors for speed-up driving	1.2	1.21	1.22	1.24	1.26	1.28	1.3	1.33	1.35	1.37	1.39	1.42	1.44

IS : 9515—1980

Note : Arc of contact = $180° \times \dfrac{60 \times (\text{Dia of large pulley} - \text{Dia of small pulley})}{\text{Centre distance}}$

Table 1.38 Load Factors for Link V-Belts, K_l

Type of Drive	*Load Factor, K_l*
Occasional full loads, lineshafts, normal industrial drives	1.0
Fans, pumps, hot atmospheres, very short centre	1.1 to 1.2
Heavy drives, compressors, pulsating loads, drives from steam or internal combustion engines	1.3 to 1.5

IS : 9515—1980

Table 1.39 Properties of V-belts for Industrial Purposes

Cross-sectional of belt symbol	*Area of cross-section, mm^2*	*Max. working load, F_1, N*	*Power* range kW*	*Min. groove pulley dia. mm*	*Weight per, mN*	*Density of belt material kg/m^3*	*Max.number of pully grooves*
A	80.7	200	upto 3.42	75	0.882	1115	6
B	143.0	300	0.5-6.61	137	1.628	1160.8	9
C	236.7	750	0.82-13	229	2.962	1275.8	14
D	476.6	1400	1.65-32.2	330	5.923	1267.3	14
E	681.4	1600	3.48-51.8	533	8.885	1329.6	20

*At 180° area of contact on smaller pulley. IS : 9515-1980

Table 1.40 Specification for Train Lighting Belting

	Threads per dm		*Nominal count of single yarn in Tex*		*Ply Folding*		*Minimum breaking load in 25×200 mm strips, N*		*Maximum elongation under 441 N percent*	
Requirement	Warp	Weft	Warp	Weft	Warp	Weft	Warp	Weft	Werp	Weft
	122	71	81.5	81.5	5	5	145	922	19	6
Tolerance	± 2.5	± 5	—	—	—-	—	—	—	—	—

IS : 6583—1972

Belt width, Nom = 75, 100, 125 mm ± 3 mm

Belt thickness, Nom = 5.1 ± 0.9 mm

Belt length in machine rolled coils, L = $0.01571\,(D + d)\,N$

where, L = length of belting in m.

D = out side dia of the rolled coil of belting, cm

d = dia of hole in the middle of the rolled coil, cm

N = number of laps in the coil

Fatigue life = 75000 cycles.

Fabric = head fabric of nominal weight 910 g/m^2

Tensile strength = 210 N/mm width in the warp direction.

= 122 N/ mm width in the weft direction.