20.3 Standard Pitch Lengths of V-belts

According to IS: 2494-1974, the V-belts are designated by its type and nominal inside length. For example, a *V*-belt of type *A* and inside length 914 mm is designated as *A* 914–IS: 2494. The standard inside lengths of *V*-belts in mm are as follows :

610, 660, 711, 787, 813, 889, 914, 965, 991, 1016, 1067, 1092, 1168, 1219, 1295, 1372, 1397, 1422, 1473, 1524, 1600, 1626, 1651, 1727, 1778, 1905, 1981, 2032, 2057, 2159, 2286, 2438, 2464, 2540, 2667, 2845, 3048, 3150, 3251, 3404, 3658, 4013, 4115, 4394, 4572, 4953, 5334, 6045, 6807, 7569, 8331, 9093, 9885, 10 617, 12 141, 13 665, 15 189, 16 713

Material handler.

According to IS: 2494-1974, the pitch length is defined as the circumferential length of the belt at the pitch width (*i.e.* the width at the neutral axis) of the belt. The value of the pitch width remains constant for each type of belt irrespective of the groove angle.

The pitch lengths are obtained by adding to inside length: 36 mm for type *A*, 43 mm for type *B*, 56 mm for type *C*, 79 mm for type *D* and 92 mm for type *E*. The following table shows the standard pitch lengths for the various types of belt.

Table 20.3. Standard pitch lengths of V-belts according to IS: 2494-1974.

Type of belt	*Standard pitch lengths of V-belts in mm*
A	645, 696, 747, 823, 848, 925, 950, 1001, 1026, 1051, 1102 1128, 1204, 1255, 1331, 1433, 1458, 1509, 1560, 1636, 1661, 1687, 1763, 1814, 1941, 2017, 2068, 2093, 2195, 2322, 2474, 2703, 2880, 3084, 3287, 3693.
B	932, 1008, 1059, 1110, 1212, 1262, 1339, 1415, 1440, 1466, 1567, 1694, 1770, 1821, 1948, 2024, 2101, 2202, 2329, 2507, 2583, 2710, 2888, 3091, 3294, 3701, 4056, 4158, 4437, 4615, 4996, 5377.
C	1275, 1351, 1453, 1580, 1681, 1783, 1834, 1961, 2088, 2113, 2215, 2342, 2494, 2723, 2901, 3104, 3205, 3307, 3459, 3713, 4069, 4171, 4450, 4628, 5009, 5390, 6101, 6863, 7625, 8387, 9149.
D	3127, 3330, 3736, 4092, 4194, 4473, 4651, 5032, 5413, 6124, 6886, 7648, 8410, 9172, 9934, 10 696, 12 220, 13 744, 15 268, 16 792.
E	5426, 6137, 6899, 7661, 8423, 9185, 9947, 10 709, 12 233, 13 757, 15 283, 16 805.

Note: The *V*-belts are also manufactured in non-standard pitch lengths (*i.e.* in oversize and undersize). The standard pitch length belt is designated by grade number 50. The oversize belts are designated by a grade

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number more than 50, while the undersize belts are designated by a grade number less than 50. It may be noted that one unit of a grade number represents 2.5 mm in length from nominal pitch length. For example, a *V*-belt marked *A* – 914 – 50 denotes a standard belt of inside length 914 mm and a pitch length 950 mm. A belt marked *A* – 914 – 52 denotes an oversize belt by an amount of (52 – 50) = 2 units of grade number. Since one unit of grade number represents 2.5 mm, therefore the pitch length of this belt will be 950 + 2 × 2.5 = 955 mm. Similarly, a belt marked *A* – 914 – 48 denotes an undersize belt, whose pitch length will be 950 – 2 × 2.5 = 945 mm.

20.4 Advantages and Disadvantages of V-belt Drive over Flat Belt Drive

Following are the advantages and disadvantages of the *V*-belt drive over flat belt drive :

Advantages

1. The *V*-belt drive gives compactness due to the small distance between centres of pulleys.
2. The drive is positive, because the slip between the belt and the pulley groove is negligible.
3. Since the *V*-belts are made endless and there is no joint trouble, therefore the drive is smooth.
4. It provides longer life, 3 to 5 years.
5. It can be easily installed and removed.
6. The operation of the belt and pulley is quiet.
7. The belts have the ability to cushion the shock when machines are started.
8. The high velocity ratio (maximum 10) may be obtained.
9. The wedging action of the belt in the groove gives high value of limiting *ratio of tensions. Therefore the power transmitted by *V*-belts is more than flat belts for the same coefficient of friction, arc of contact and allowable tension in the belts.
10. The *V*-belt may be operated in either direction, with tight side of the belt at the top or bottom. The centre line may be horizontal, vertical or inclined.

Disadvantages

1. The *V*-belt drive can not be used with large centre distances, because of larger weight per unit length.
2. The *V*-belts are not so durable as flat belts.
3. The construction of pulleys for V-belts is more complicated than pulleys of flat belts.
4. Since the *V*-belts are subjected to certain amount of creep, therefore these are not suitable for constant speed applications such as synchronous machines and timing devices.
5. The belt life is greatly influenced with temperature changes, improper belt tension and mismatching of belt lengths.
6. The centrifugal tension prevents the use of *V*-belts at speeds below 5 m / s and above 50 m / s.

20.5 Ratio of Driving Tensions for V-belt

A *V*-belt with a grooved pulley is shown in Fig. 20.2.

Let R_1 = Normal reactions between belts and sides of the groove.

R = Total reaction in the plane of the groove.

μ = Coefficient of friction between the belt and sides of the groove.

Resolving the reactions vertically to the groove, we have

$$R = R_1 \sin \beta + R_1 \sin \beta = 2R_1 \sin \beta$$

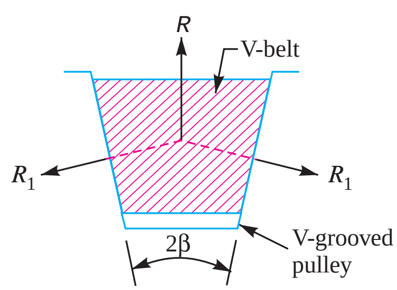

Fig. 20.2. V-belt with pulley.

* The ratio of tensions in *V*-belt drive is cosec β times the flat belt drive.

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or $$R_1 = \frac{R}{2 \sin \beta}$$

We know that the frictional force

$$= 2 \mu.R_1 = 2 \mu \times \frac{R}{2 \sin \beta} = \frac{\mu.R}{\sin \beta} = \mu.R.\text{cosec}\,\beta$$

Consider a small portion of the belt, as in Art. 18.19, subtending an angle $\delta\theta$ at the centre, the tension on one side will be T and on the other side ($T + \delta T$). Now proceeding in the same way as in Art. 18.19, we get the frictional resistance equal to μ R. cosec β against $\mu.R$. Thus the relation between T_1 and T_2 for the V-belt drive will be

$$2.3 \log (T_1 / T_2) = \mu.\theta \text{ cosec } \beta$$

20.6 V-flat Drives

In many cases, particularly, when a flat belt is replaced by V-belt, it is economical to use flat-faced pulley, instead of large grooved pulley, as shown in Fig. 20.3. The cost of cutting the grooves is thereby eliminated. Such a drive is known as ***V-flat drive.***

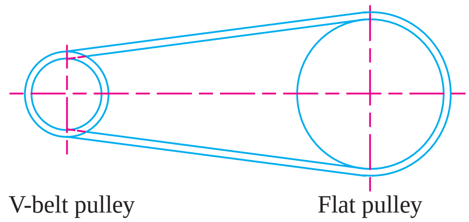

Fig. 20.3. V-flat drive.

5-tine clamps of a material handlesr

Example 20.1. *A compressor, requiring 90 kW, is to run at about 250 r.p.m. The drive is by V-belts from an electric motor running at 750 r.p.m. The diameter of the pulley on the compressor shaft must not be greater than 1 metre while the centre distance between the pulleys is limited to 1.75 metre. The belt speed should not exceed 1600 m / min.*

Determine the number of V-belts required to transmit the power if each belt has a cross-sectional area of 375 mm², density 1000 kg / m³ and an allowable tensile stress of 2.5 MPa. The groove angle of the pulleys is 35°. The coefficient of friction between the belt and the pulley is 0.25. Calculate also the length required of each belt.

Solution. Given : P = 90 kW = 90×10^3 W ; N_2 = 250 r.p.m. ; N_1 = 750 r.p.m. ; d_2 = 1 m ; x = 1.75 m ; v = 1600 m/min = 26.67 m/s ; a = 375 mm² = 375×10^{-6} m² ; ρ = 1000 kg / m³ ; σ = 2.5 MPa = 2.5 N/mm² ; 2β = 35° or β = 17.5° ; μ = 0.25

First of all, let us find the diameter of pulley on the motor shaft (d_1). We know that

$$\frac{N_1}{N_2} = \frac{d_2}{d_1} \quad \text{or} \quad d_1 = \frac{d_2 N_2}{N_1} = \frac{1 \times 250}{750} = 0.33 \text{ m}$$