Szent Istvan University

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V-BELT DRIVES TYPES, CHARACTERISTIC AND INDUSTRIAL APPLICATION

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1. V-BELT HISTORY

The V-belt has been in existence since the early 1920's. Through the years, vast improvements have been made in the materials used in V-belt construction and in cross sectional shape as well. Originally, V-belts came into being to replace the flat and round belts on automotive drives to ensure greater reliability. In 1930, Mr. Geist of Allis Chalmers, obtained patents on the use of V-belts in multiple for industrial usage, which led to a very broad application of V-belts on all types of industrial equipment. The use of V-belts in multiple, allowed drives with a much larger range of horsepower capacity than ever before obtainable using single belt drives. Originally, standardization of V-belts began under the technical committee of licensees under the Geist patent. This committee was replaced in 1940, by an industry committee, established by the Rubber Manufacturers Association on V-belt Standardization. The first RMA standard was established in 1949, on the A,B,C,D and E section belts. Today, the Rubber Manufacturers Association have established standards on all types of V-belts which are recognized internationally. These standards have been adopted by all standardizing bodies such as the API, ASAE, SAE and the International Standards Organization.

Originally, V-belts were manufactured using prime quality cotton cord as tensile members along with natural rubber compounds. These materials were used on V-belts up to and during most of World War II. Steel Cable was introduced as a V-belt reinforcing member during World War II. Later, high tenacity Rayons replaced cotton as tensile members because of their much greater strength capacity. In addition to this, the SBR synthetic type of rubbers which were also developed during the war, were incorporated into V belt constructions. Due to the deficiencies of both cotton and rayon tensile members, experimentation was carried on with Nylon fibers, however these never gained wide acceptance because of operational problems and today, polyester, fiberglass and aramid fibers are the predominant tensile members on all high capacity V-belts. In addition to polyester tensile members, the Neoprene type of elastomers have become widely used because of their much greater resistance to oil, heat, and ozone resistance.

In addition to changes in materials, changes in belt cross-sections have occured to obtain greater horsepower in less space. This was originally introduced with the "narrow" type belt on cars in 1950. This more efficient, space saving design was further refined for industrial use with the introduction of 3V,5V and 8V belts in 1959. This new cross section design featured a domed top with increased sidewall area, providing greater horsepower capacity in less space. More recently Joined, V-Ribbed and Raw Edge belting have gained widespread acceptance.

2. V-BELT DRIVE ADVANTAGES

Efficiency tests of Carlisle multiple V-belt drives have shown them to be 94 - 98% efficient. Because of the wide variety of belt sizes available, almost any type of drive application can be designed using stock standard items. This ensures availability and excellent delivery schedules and if necessary, special constructions are available for unusual applications. Carlisle V-belt drives also provide many advantages that help reduce equipment repairs and hold forced downtime to the lowest possible level. Other significant advantages include:

- Smooth starting and running.
- Permit a wide range of driven speeds, using standard electric motors.
- They're rugged and provide years of trouble-free performance with minimal attention . . . even under adverse conditions.
- Capable of transmitting power around corners or out of plane drives.
- Clean—require no lubrication.
- Highly efficient.
- Extremely wide horsepower ranges.
- Dampen vibration between driver and driven machines.
- Silent operation.
- Long service life.
- Easy installation.
- Can be used as an effective means of clutching.
- They act as a "safety fuse" refusing to transmit severe power overload, except for a very brief period.
- V-belts and sheaves wear gradually-making preventive corrective maintenance simple and easy.

3. DESIGNATION OF V-BELT

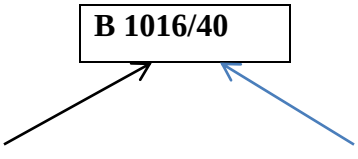
It has been mentioned that, the calculations for V-belt drives are based on pitch diameter. However, V-belts are designated with nominal inside length (this is easily measurable compared to pitch length). Therefore, to arrive at the inside length, the following relationship is useful.

Inside length + X = Pitch Length

Value Of X

	A	**B**	**C**	**D**
X (mm)	**36**	**43**	**56**	**79**

For example, a B- section belt with nominal inside length of 1016 mm or 40 inches (nearest value obtained from belt catalogue) is required for a V-belt drive. Then this belt is designated as,



(mm) (inches)

3.1. V belt design factors

3.1.1. Service Factor

A belt drive is designed based on the design power, which is the modified required power. The modification factor is called the service factor. The service factor depends on hours of running, type of shock load expected and nature of duty.

Hence,

Design Power ($\mathbf{P}_{dcs}$) = service factor ($\mathbf{C}_{sev}$)* Required Power (**P**)

C_{sev} = 1.1 to 1.8 for light to heavy shock.

3.1.2. Modification of kW rating

Power rating of a typical V-belt section requires modification, since, the ratings are given for the conditions other than operating conditions. The factors are as follows,

3.1.3. Equivalent smaller pulley diameter

In a belt drive, both the pulleys are not identical, hence to consider severity of flexing, equivalent smaller pulley diameter is calculated based on speed ratio. The power rating of V-belt is then estimated based on the equivalent smaller pulley diameter ($\mathbf{d_{ES}}$). $\mathbf{d_{ES}} = \mathbf{C_{SR}}\ \mathbf{d_S}$

where, $\mathbf{C_{SR}}$ is a factor dependent on the speed ratio.

3.1.4. Angle of wrap correction factor

The power rating of V-belts are based on angle of wrap, $\boldsymbol{\alpha} = 180^0$. Hence, Angle of wrap correction factor (C_{vw}) is incorporated when α is not equal to 180^o.

3.1.5. Belt length correction factor

There is an optimum belt length for which the power rating of a V-belt is given. Let, the belt length be small then, in a given time it is stressed more than that for the optimum belt length. Depending upon the amount of flexing in the belt in a given time a belt length correction factor (C_{vL}) is used in modifying power rating.

Therefore, incorporating the correction factors,

Modified power rating of a belt (kW) = Power rating of a belt (kW) x C_{vw} x C_{vl}

4. TYPES OF V-BELTS

A V-belt is a power transmission drive distinguishable by its trapezoidal, hexagonal, or triangular cross section shape. Because of their characteristic shapes, V-belts are versatile belts that come in a wide array of standard types, sizes, speed, and are fairly adaptable to practically all types of drive. The speed capacity of a V-belt ranges from 1,500 to 6,000 feet per minute. Most V-belts are oil and heat resistant, and static conductive.

4.1. Double-Sided V Belt

Like its name suggests, the double-sided V-belt has two Vs, one on each side. The double-sided belt is also characterized by its hexagonal cross-section shape. The shape of the double-sided V-belt allows the belt to be used in serpentine reverse bend drives where a transmission may need to drive in reverse to generate power.

4.2. Cogged V Belt

Cogged V-belts are distinguishable by their trapezoidal shape, which facilitates gripping during drives to allow a transmission to achieve a higher horsepower. A cogged V-belt can either be a conventional or narrow raw edge cogged V-belt. Conventional cogged V-belts are designed for high-tension drives, while narrow cogged V-belts can be used for all drives.

4.3. Variable Speed V-Belts

A variable speed V-belt is a wider, allowing for a greater range of speeds and better resistance to twisting while transitioning from one speed to another. This type of V-belt is recommended for variable-speed sheave drives that need to control speed to achieve a certain result.

4.4. V-Ribbed V-Belts

V-ribbed belts are combined variable speed V-belts that are banded together to achieve different speeds, strength and transmission capabilities. V-ribbed belts are recommended for multi-sheave drives.

4.5. Truly Endless V Belt

The truly endless V belt is manufactured as a closed loop and is not spliced, hence the name. Truly endless V belts are designed for conditions in which pulleys are nonparallel or in which the pulley rotation changes suddenly. Despite the frequency of twisting and flexing in the truly endless V belts, they have a moderately long service life.

4.6. Poly V Belt

The outside of the poly V belt is flat and has several V-shaped grooves along the inside. One poly V belt has as much traction power as several traditional V-belts working together. In effect, this V belt configuration combines the function of the flat belt and the V belt. The design is best suited for small sheaves and can be operated at high speeds.

4.7. Open-Ended V Belt

Open-ended V belts are useful where obstructions make access to the drive belt difficult. They are constructed the same as traditional V-belts, except that they are open-ended and do not need metal fasteners. This type of drive has a limited load capacity and tends to be expensive.

5. SPECIAL APPLICATION V-BELTS

5.1. Super II® V-Belt

Figure 5.1.

The advantage of Super II V-belt over conventional wrapped belts.

5.1.1. Greater strength

The innovative center placement of the specially treated, load carrying polyester cord gives the Super II belt better balance and greater strength. It also makes it more resistant to stretching (tension decay), resulting in less frequent retensioning.

5.1.2. Longer Life

The Super II V-belt was designed specifically for severe drives, and tests show that it lasts far longer than conventional V-belts in these types of applications.

5.1.3. Better Heat Dissipation

100% neoprene rubber compound loaded with Stiflex® fibers found previously only in higherpriced V-belts, dissipates heat more easily. Also, the lower cord placement allows the belt to run cooler with less internally generated heat (hysteresis).

5.1.4. Better grip/controlled slippage

Unique sidewall construction offers optimal gripping characteristics. Raw-edged construction provides improved grip during normal drive loads to enhance efficiency, and fabric layers give the belt controlled slippage for high load situations.

5.1.5. Greater flexibility

Multiple neoprene-impregnated fabric plies, top and bottom, support the load carrying center cord more evenly and resist flex fatigue for maximum flexibility even on small sheaves or backside idler drives.

The revolutionary Super II belt: the super problem solver.

- Solves high torque problems with a specially treated, more durable polyester cord that resists stretching.
- Solves extreme shock load problems with raw-edged sidewalls that allow for controlled slippage.
- Solves belt cracking problems due to heat build-up with a special 100% neoprene rubber compound that dissipates heat better and a central cord placement which reduces internally generated heat.
- Solves small sheave and backside idler drive problems with a center cord that flexes more easily in either direction and multiple fabric plies top and bottom.

A belt that beats the toughest problems. Many heavy-duty industrial machines demand more than conventional wrapped V-belts can stand. Their punishing drives make ordinary belts crack under pressure. The result: expensive and unnecessary downtime. Now there's a solution to the consistently costly problem of replacing and retensioning belts. The Super II belt was designed specifically for the most brutal applications. In heavy torque, high horsepower and extreme shock load comparisons, it's not even a contest. The Super II V-belt is stronger, more flexible and lasts far longer than conventional wrapped belts.

5.2. Blue Ribbon V-Belt Line

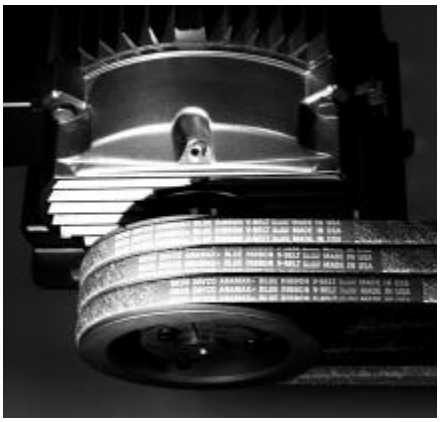


Figure 5.2.

5.2.1. Advantages

Carlisle ARAMAX Blue Ribbon V-belts are engineered for maximum service life on your most abusive classical (A,B,C) belt
drives. Utilizing a special Carlisle “bareback” cover fabric and high tensile strength aramid fiber (Kevlar) cord, ARAMAX Vbelts provide exceptional service in the harshest environments. Durable performance even when subjected to extreme temperatures, high humidity, moisture, grit, oil, and grease.

5.2.2. Eliminate Belt Stretch

Blue Ribbon V-belts won’t stretch like standard classical V-belts. Consequently they require less retensioning maintenance making them ideally suited for hard to reach drives or equipment in remote locations.

5.2.3. Tight Matching Tolerances

V-belts utilize “match numbers” on the belt allowing users to match belts within +/- 0.075”, assuring the best possible matching performance available in the industry.

5.2.4. Superior Shock Load Properties

Unique construction components make them an excellent choice for machines operating with frequent shock loads or drives requiring high tension.

5.2.5. Stronger Than Steel

Better than high priced and hard to find steel cable V-belts. ARAMAX V-belts are more flexible, operate more efficiently, and offer increased durability when compared to steel cable while still providing comparable strength characteristics.

5.2.6. Longer Belt Life

Carlisle's unique "bareback" cover fabric and lower cord position in Ribbon V-belts assures maximum service life on clutching drives and drives with backside idlers.

5.2.7. Ideal for Agricultural Drives

Ribbon V-belts are recommended for many agricultural drive applications as well as commercial outdoor power equipment where severe service life is the norm rather than the exception.

5.3. Chipper Drive Belt

Figure 5.3.

5.3.1. Introduction

The Forest Products industry contains many drive applications using banded wedge-type belts, such as Chipper drives which cut logs into lumber. When machines jam during cutting, or mulching, the belt engages the sheave grooves with great force
and begins to generate heat, causing belt breakage and a resulting drive failure. The new Carlisle Wedge-Band Chipper Drive Belt is designed to be less aggressive in this condition than conventional wrapped or raw edge belts. Laminated construction
allows belt slip and generates less heat buildup compared to wrapped or raw edge construction belts, giving the machine time to clear itself of the obstruction and extending belt life. The new Carlisle Wedge-Band Chipper Belt is specially designed and constructed to meet the unique demands of the Forest Products industry. Ideally suited for applications such as chipper saws, debarker drives, head rigs and hogs, the Carlisle Wedge-Band Chipper Drive Belt will outperform your present belt, last longer, and help you reduce replacements, emergency shutdowns and lost production time. Engineered with a Raw-Edge® laminated construction to provide the optimum balance between controlled transfer of power and slippage to satisfy the unique operating demands of the lumber industry. The Carlisle Wedge-Band Chipper Drive Belt is designed to slip during “overload” or drive stall conditions. In addition, by allowing the belt to have controlled slippage during “overload” situations, less heat is generated, resulting in longer belt life.

5.3.2. Construction and Design Features and Benefits

Double Fabric Ply Tie-Band - Instead of using sets of individual belts, this is a banded belt with a patented reinforced top permanently bonded to individual belts during the curing process. This assures pre-matched size and quality and enables all the belts to pull together for optimum performance. The Tie-Band prevents wood chips from being lodged in the drive. It also eliminates belt whip and turnover, dampens vibration and absorbs shock.

Extra Large Diameter Treated Poly-Cord - Over sized polyester cord provides added belt strength and stability during peak shock loads to minimize snub breaks. The cord is also chemically treated for maximum resistance to belt stretch.

Stiflex® and Graphite Loaded Neoprene Rubber Compounds - Specially prepared stiflex/graphite compounds provide crosswise rigidity and maximum cord support in the cushion section for smooth running belt operation. Neoprene rubber provides superior resistance to oils, grease, sap and other harmful environmental conditions. These compounds are also static dissipating.

Six Plies of Laminated Fabric and Rubber - Raw-Edge® laminated construction with six separate plies of rubber and fabric bonded together in the compression section of the belt make up the heart of the Wedge-Band Chipper Drive Belt. Raw-Edge laminated construction provides drive efficiency, while the plies in the lower section reduce belt aggressiveness, a combination that provides the key to controlled slippage under peak loads.

5.4. Connector Belting

Figure 5.4.

Connector Belting was especially designed for those industrial drives where endless V-belts cannot be utilized or for emergency situations when endless belts are not readily available. In the latter case, endless V-belts should be installed when the drive is normally down. Connector Belting is specially designed for use with connectors. Connector Belting is oil and heat resistant and meets RMA requirements for static conductivity. The internal construction offers flexibility, belt strength, and excellent resistance to connector pull-out.

5.5. Thoro-Link V-Belting

Figure 5.5.

Thoro-Link V-belting is a multi-plied polyester fabric polyurethane construction designed for industrial drives where standard endless V-belts are not physically suitable or use in emergency service when endless belts are not readily available.

Thoro-Link belting provides a high quality link type belting with excellent resistance to heat, oil and many chemicals. A necessity in any plant as an emergency replacement. Pre-stretched under controlled tension, Thoro-Link belting is strong yet flexible for easy assembly and efficient operation over small sheave diameters. Thoro-Link belting is sold in cartons of 100’ rolls. Available in supreme construction for maximum horsepower ratings, the Thoro-Link V-belt is available in O, A, B, and C sections with color coded studs for belt section identification. The table below lists some important application information for the Thoro-Link belt.

SUMMARY

A V-belt is a power transmission drive distinguishable by its trapezoidal, hexagonal, or triangular cross section shape. Because of their characteristic shapes, V-belts are versatile belts that come in a wide array of standard types, sizes, speed, and are fairly adaptable to practically all types of drive. The speed capacity of a V-belt ranges from 1,500 to 6,000 feet per minute. Most V-belts are oil and heat resistant, and static conductive.

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