

## SECTION 5 DIFFERENT BELT CONFIGURATIONS

### 5.1 Double-Sided Twin Power Belt Drives

Timing belts are also available in double-sided designs, which offer an infinite number of new design possibilities on computer equipment, business machines, office equipment, textile machines and similar light-duty applications. Belts with driving teeth on both sides make it possible to change the direction of rotation of one or more synchronized pulleys with only one belt. The inside and outside teeth are identical as to size and pitch and operate on standard pitch diameter pulleys.

If the belts have nylon facing on both sides, then the same design parameters can be used for the drives on both sides of the belt. In case the outside teeth do not have nylon facing, the horsepower rating of the outside teeth is only 45% of the total load.

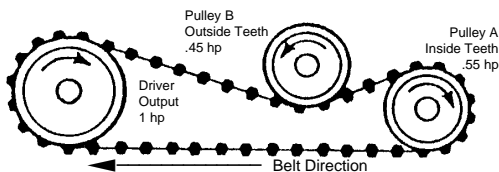


Fig. 11 Double-Sided Timing Belt

For example: assuming the drive pulley and belt are capable of transmitting 1 horsepower, 0.55 hp can be transmitted from the inside teeth of the pulley (A), and 0.45 hp can be transmitted by the outside teeth to pulley (B) for a total of 1 hp, the rated capacity of the driver pulley.

### 5.2 Long Length Timing Belt Stock

These belts are an excellent solution for drives that require belt lengths longer than those produced in conventional endless form. Long length belting has the same basic construction as conventional timing belts. These belts are usually produced by spiral cut of large diameter endless belts.

These belts are creatively used in:

- reciprocating carriage drives
- rack and pinion drives
- large plotters

An example of application is shown in **Figure 13**. A complete timing belt and a timing belt segment reduce vibration and chatter in this oscillating drive for a surface grinder.

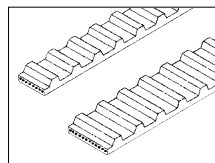


Fig. 12 Timing Belt Stock

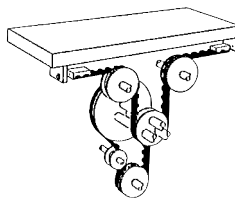


Fig. 13 Example of Timing Belt Stock Use

## SECTION 6 BELT CONSTRUCTION

The load-carrying elements of the belts are the tension members built into the belts (see **Figure 14**). These tension members can be made of:

1. Spirally wound steel wire.
2. Wound glass fibers.
3. Polyester cords.
4. Kevlar.



Trapezoidal



Curvilinear

Fig. 14 Belt Construction

The tension members are embedded in neoprene or polyurethane. The neoprene teeth are protected by a nylon fabric facing which makes them wear resistant.

The contributions of the construction members of these belts are as follows:

1. **Tensile Member** – Provides high strength, excellent flex life and high resistance to elongation.
2. **Neoprene Backing** – Strong neoprene bonded to the tensile member for protection against grime, oil and moisture. It also protects from frictional wear if idlers are used on the back of the belt.
3. **Neoprene Teeth** – Shear-resistant neoprene compound is molded integrally with the neoprene backing. They are precisely formed and accurately spaced to assure smooth meshing with the pulley grooves.
4. **Nylon Facing** – Tough nylon fabric with a low coefficient of friction covers the wearing surfaces of the belt. It protects the tooth surfaces and provides a durable wearing surface for long service.

### 6.1 Characteristics Of Reinforcing Fibers

#### Polyester

Tensile Strength	160,000 lbs/in <sup>2</sup>
Elongation at break	14.0%
Modulus (approx.)	2,000,000 lbs/in <sup>2</sup>

One of the main advantages of polyester cord over higher tensile cords is the lower modulus of polyester, enabling the belt to rotate smoothly over small diameter pulleys. Also, the elastic properties of the material enable it to absorb shock and dampen vibration.

In more and more equipment, stepping motors are being used. Polyester belts have proven far superior to fiberglass or Kevlar reinforced belts in these applications.

High-speed applications with small pulleys are best served by polyester belts under low load.

#### Kevlar

Tensile Strength	400,000 lbs/in <sup>2</sup>
Elongation at break	2.5%
Modulus	18,000,000 lbs/in <sup>2</sup>

High tensile strength and low elongation make this material very suitable for timing belt applications. Kevlar has excellent shock resistance and high load capacity.

#### Fiberglass

Tensile Strength	350,000 lbs/in <sup>2</sup>
Elongation at break	2.5 – 3.5%
Modulus	10,000,000 lbs/in <sup>2</sup>

The most important advantages are:

1. High strength.
2. Low elongation or stretch.
3. Excellent dimensional stability.
4. Excellent chemical resistance.
5. Absence of creep, 100% elongation recovery.

Disadvantages:

1. High modulus (difficult to bend).
2. Brittleness of glass. Improper handling or installation can cause permanent damage.
3. Poor shock resistance. No shock absorbing quality when used in timing belts.

**Steel**

Tensile Strength      360,000 lbs/in<sup>2</sup>  
 Elongation at break    2.5%  
 Modulus (approx.)    15,000,000 lbs/in<sup>2</sup>

Additional characteristics of tension members and their effect on the drive design are shown in tabulated form in **Table 1**.

**Table 1 Comparison of Different Tension Member Materials\***  
 E = Excellent    G = Good    F = Fair    P = Poor

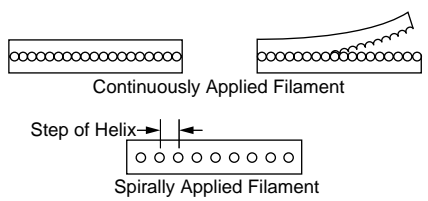
Belt Requirements	Nylon	Polyester Cont. Fil. Yarn	Polyester Spun Yarn	Kevlar-Polyester Mix	Kevlar Cont. Fil. Yarn	Kevlar Spun Yarn	Glass	Stainless Steel	Polyester Film Reinforcement
Operate Over Small Pulley	E	G	E	F	P	F	P	P	G
High Pulley Speed	E	E	E	F	P	F	P	P	G
High Intermittent Shock Loading	F	G	G	E	E	E	P	G	F
Vibration Absorption	E	G	E	G	F	F	P	P	F
High Torque Low Speed	P	P	P	F	G	F	E	E	F
Low Belt Stretch	P	P	P	P	G	F	E	E	G
Dimensional Stability	P	P	P	F	G	G	E	E	G
High Temperature 200° F	P	P	P	P	E	E	E	E	F
Low Temperature	F	G	G	G	G	E	E	E	G
Good Belt Tracking	E	G	E	G	F	G	F	P	E
Rapid Start/Stop Operation	F	G	E	G	P	G	P	E	G
Close Center-Distance Tolerance	P	P	P	P	G	F	E	E	G
Elasticity Required in Belt	E	G	E	G	P	P	P	P	P

\* Courtesy of Chemiflex, Inc.

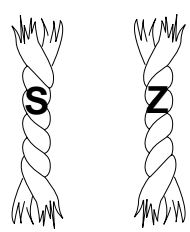
**6.2 Cord Twist And Its Effect On The Drive**

There is a specific reason for not applying the yarn directly in the form of untwisted filaments around the mold. If the filament would be applied continuously, the top and bottom of the belt body would be prevented from being properly joined, and separation could result. See **Figure 15**.

Two strands each composed of several filaments are twisted around each other, thus forming a cord which is subsequently wound in a helical spiral around the mold creating a space between subsequent layers, which corresponds to the step of the helix. The two strands, however, can be twisted two ways in order to create an "S" or a "Z" twist construction. See **Figure 16**.



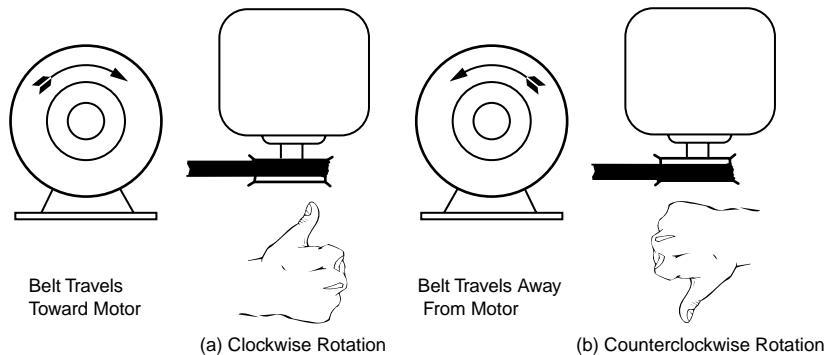
**Fig. 15 Belt Cross Section**



**Fig. 16 Cord Twist**

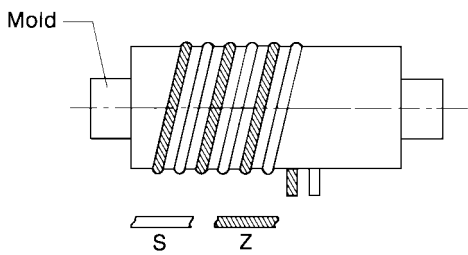
The "S" twist is obtained if we visualize the two strands being held stationary with our left hand on one end, while a clockwise rotation is imparted by our right hand to the two strands, thus creating a twisted cord. The "Z" twist is obtained similarly, if a counterclockwise rotation is imparted to the two strands.

Different types of cord twist will cause side thrust in opposite directions. The "S" twist will cause a lateral force direction which will obey the "Right-Hand" rule as shown in **Figure 17**.



**Fig. 17 Right-Hand Rule Applicable to "S" Twist**

A "Z" type cord twist will produce a direction of lateral force opposite to that of "S" cord. Therefore, in order to produce a belt with minimum lateral force, standard belts are usually made with "S" and "Z" twist construction, in which alternate cords composed of strands twisted in opposite directions are wound in the belt. This is illustrated in **Figure 18**.



**Fig. 18 "S" and "Z" Cord Lay of the Mold**

The lay of the cord is standard, as shown in **Figure 18**, and it is wound from left to right with the cord being fed under the mold. The smaller the mold diameter and the fewer the strands of cord per inch, the greater the helix angle will be, and the greater the tendency of the lay of the cord to make the belt move to one side.

In general, a standard belt of "S" and "Z" construction, as shown in **Figure 18**, will have a slight tendency to behave as a predominantly "S" twist belt, and will obey the "Right-Hand" rule accordingly.

**6.3 Factors Contributing To Side Travel**

The pulleys in a flat belt drive are crowned to keep the belt running true. Since crowned pulleys are not suitable for a timing belt, the belt will always track to one side. Factors contributing to this condition include:

- I. In the Drive
  1. Misalignment – A belt (any belt – any construction) will normally climb to the high end (or tight) side.
  2. Tensioning – In general, lateral travel can be altered or modified by changing tension.
  3. Location of plane – Vertical drives have a greater tendency to move laterally due to gravity.

4. Belt width greater than O.D. of pulley – This condition creates an abnormal degree of lateral travel.
5. Belt length – The greater the ratio of length/width of the belt, the less the tendency to move laterally.

**II. In the Belt**

1. Direction of the lay of the cords in the belt. See **Figure 18**.
2. Twist of the strands in the cord. See **Figure 16**.

**6.4 Characteristics Of Belt Body Materials**

Basic characteristics of the three most often used materials are shown in **Table 2**. The tabulated characteristics give rise to the following assessment of these materials:

**Natural Rubber**

- High resilience, excellent compression set, good molding properties
- High coefficient of friction; does not yield good ground finish
- High tear strength, low crack growth
- Can withstand low temperatures
- Poor oil and solvent resistance; unusable for ketones and alcohol
- Ozone attacks rubber, but retardants can be added

**Neoprene**

- High resilience
- Flame resistant
- Aging good with some natural ozone resistance
- Oil and solvent resistance fair

**Polyurethane**

- Excellent wear resistance, poor compression set
- Low coefficient of friction
- Oil and ozone resistance good
- Low-temperature flexibility good
- Not suitable for high temperatures

**Table 2 Comparison of Different Belt Body Materials\***

Common Name	Natural Rubber	Neoprene	Urethane, Polyurethane
Chemical Definition	Polyisoprene	Polychloroprene	Polyester/Polyether Urethane
Durometer Range (Shore A)	20 – 100	20 – 95	35 – 100
Tensile Range (p.s.i.)	500 – 3500	500 – 3000	500 – 6000
Elongation (Max. %)	700	600	750
Compression Set	Excellent	Good	Poor
Resilience – Rebound	Excellent	Excellent	Good
Abrasion Resistance	Excellent	Excellent	Excellent
Tear Resistance	Excellent	Good	Excellent
Solvent Resistance	Poor	Fair	Poor
Oil Resistance	Poor	Fair	Good
Low Temperature Usage (°F)	-20° to -60°	+10° to -50°	-10° to -30°
High Temperature Usage (°F)	to 175°	to 185°	to 175°
Aging Weather – Sunlight	Poor	Good	Excellent
Adhesion to Metals	Excellent	Good to Excellent	Fair to Good

\* Courtesy of Robinson Rubber Products