GatesFacts™ Technical Information Library
Gates Compass™ Power Transmission CD-ROM version 1.2
The Gates Rubber Company
Denver, Colorado USA

Timing Belt Selection And Troubleshooting

David E. Roos
Maintenance Technology
September 1989

Evenly spaced teeth on the bottom surface of synchronous or timing belts mesh with grooves on the pulleys for positive, no-slip transmission of power. Use of these belts has increased steadily since they were first developed and produced almost 40 years ago.

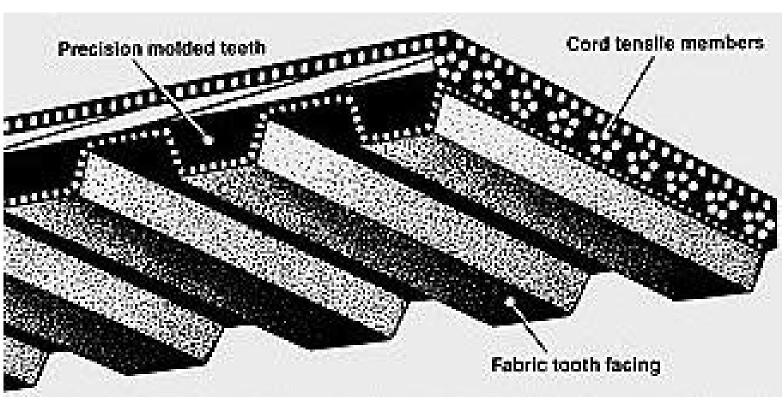
Timing belts are versatile and dependable. They are replacing chain as a positive drive transmission because they are quieter, need no lubrication, and are capable of higher speeds than chain. In some applications, they are replacing gears. The teeth on the belt enter and leave the pulley grooves in a smooth, rolling manner, with low friction.

Two other significant advantages leading to the increased use of timing belts involve lower maintenance and higher drive efficiency. Although drive maintenance is not totally eliminated, the positive tooth engagement and the high modulus tensile cords in these belts virtually eliminate retensioning. And the positive tooth engagement eliminates slip. Consequently, laboratory and field testing shows a 2 to 4 percent improvement in belt drive efficiency.

Four basic parts make up the standard timing belt:

- Tensile cord is the muscle of the belt, usually a high-tensile-strength fiber-glass cord that has a high resistance to elongation.
- Backing protects the tensile member from oil, grease, moisture, and other adverse environmental conditions.
- Teeth engage the grooves on the pulley. They are precisely formed and spaced and are made of a special high-modulus material.
- Facing is usually made of fabric to act as a wear surface, protecting the teeth. The facing also helps keep frictional losses to a minimum.

All four components are molded integrally to ensure that all work together as a unit .



The four basic parts of a timing belt are the tensile cord, the backing, the teeth, and the facing.

Conventional trapezoidal-tooth timing belts come in several cross sections, which really relate to the pitch of the belt. Pitch is the distance in inches from center to center of the teeth. The six basic cross sections or pitches are listed:

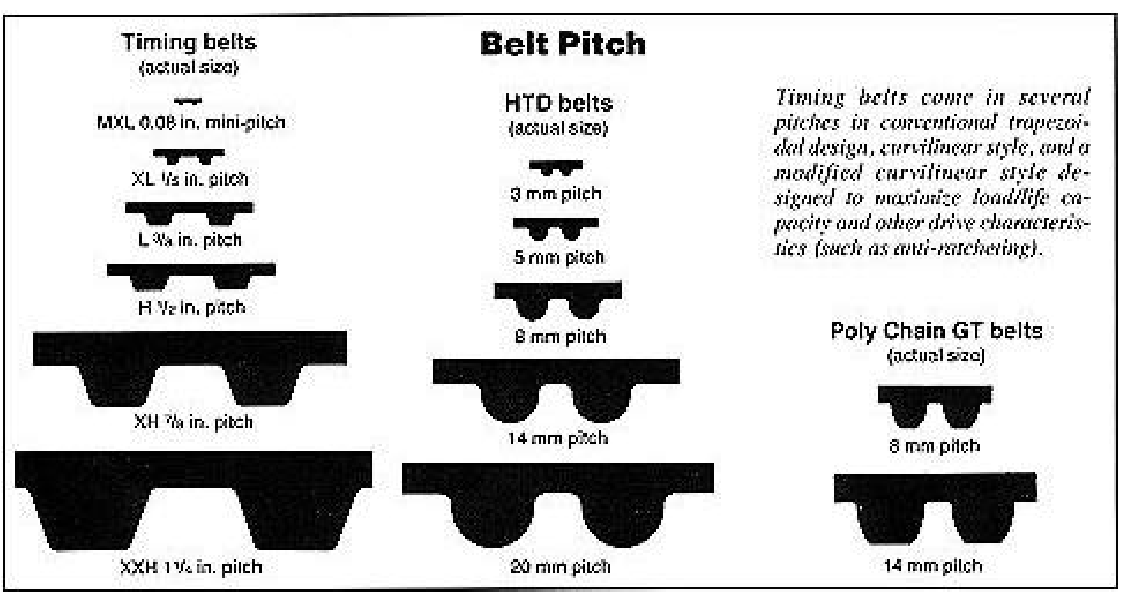
MXL =	mini extra light	$^{2}/_{25}$ in. pitch
XL =	extra light	$^{1}/_{5}$ in. pitch
L =	light	$^{3}/_{8}$ in. pitch
H =	heavy	$^{1}/_{2}$ in. pitch
XH =	extra heavy	$^{7}/_{8}$ in. pitch
XXH =	double extra heavy	1 $^{1}/_{4}$ in. pitch

Although the Rubber Manufacturers' Association (RMA) standards identify six basic pitches, the smaller-pitch belts are generally used only on very lightly loaded drives.

Curvilinear (round) tooth, tough high-torque-drive (HTD) belts also are available, but they are not yet part of the RMA standards. There are five basic cross sections or pitches.

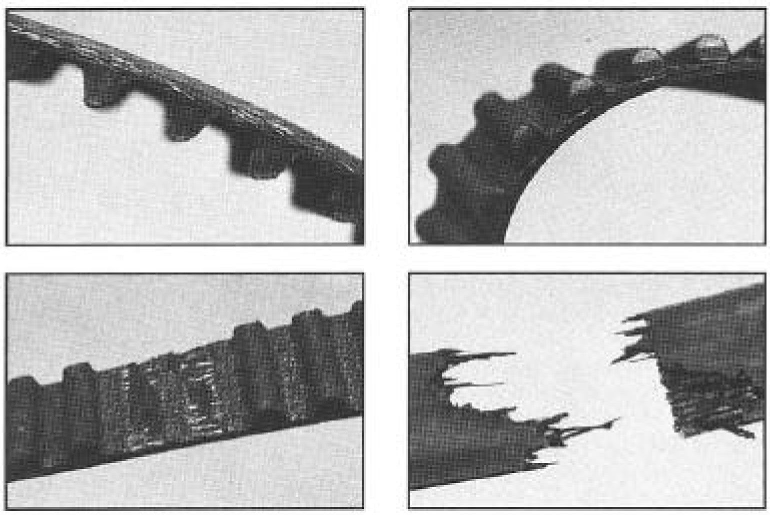
3M	3 mm (0.118 in.) pitch
5M	5 mm (0.197 in.) pitch
8M	8 mm (0.315 in.) pitch
14M	14 mm (0.551 in.) pitch
20M	20 mm (0.787 in.) pitch

The most recent development in high-capacity, curvilinear-style synchronous belts, the Poly Chain GT developed by the Gates Rubber Company has a tooth profile similar to that of other high-performance synchronous belts. However, its pressure angle, tooth depth, and materials (polyurethane and Kevlar) were optimized to maximize load/life capacity and other important drive characteristics (such as anti-ratcheting). These improved performance characteristics can result in more compact drive packages, or greater capacity from existing drive packages, or improved drive economies.

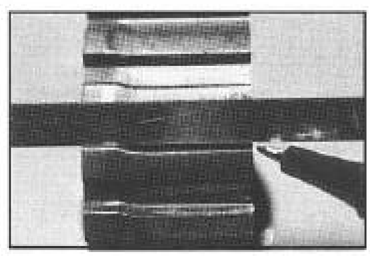


Selecting a timing belt is fairly straightforward for new drive designs. You must know the horsepower requirement of the drive, the speed of the driver machine, the speed of the driven machine, the approximate center distance for the drive, and length of operation.

Selecting a suitable belt drive is influenced by the type of equipment or machine, desired service life, and the available space for the drive.



Examples of belt failure include (left to right, top to bottom): Fabric wear on the leading tooth surface, indicated by pointed tooth shape, is one of the first signs of timing belt failure. Tooth cracking, possibly caused by repeated ratcheting, eventually leads to tooth separation. A belt with missing teeth should be replaced immediately. Tensile failure, leading to belt separation, can be caused by shock loads, foreign material in the drive, a damaged pulley, or improper installation.

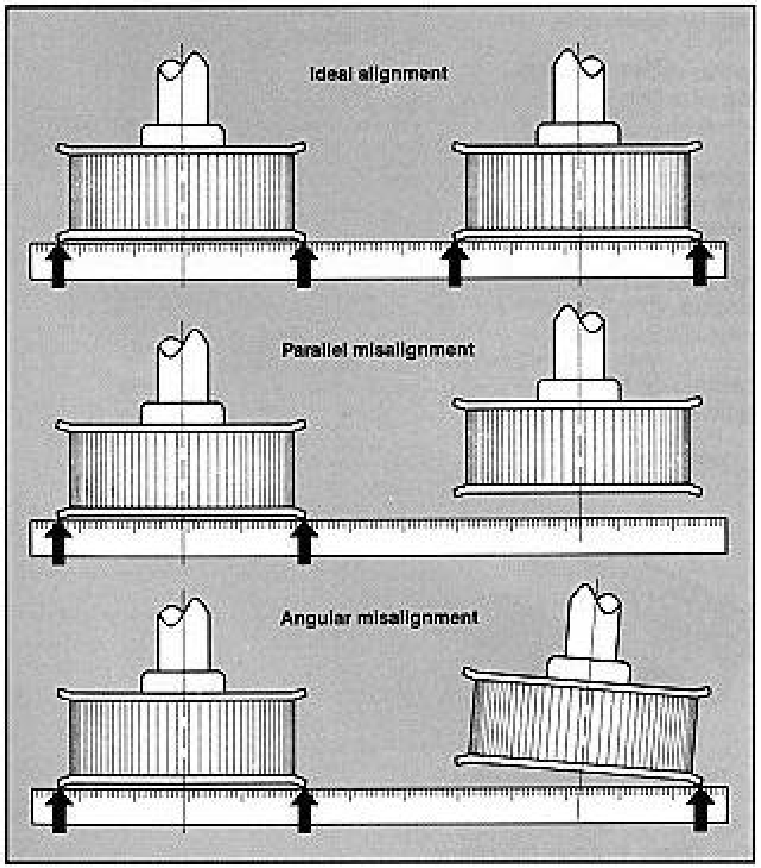


Pulley wear, shown by the gap between the ruler and tooth edge, results in premature wear and damage to belt teeth.

Engineers working on machinery equipped with synchronous drives should be aware of the following criteria:

- Pulleys must be aligned to within 1/4 deg (about 1/16 in. of maximum allowable misalignment per foot of center distance).
- At least one component of the drive should be adjustable to accommodate belt installation and drive tensioning. (Never force or pry a belt onto a drive during installation.)
- Belt idlers should be used to apply tension only when centers are not adjustable or when it is necessary to increase the number of teeth in mesh on the small pulley of a high-speed-ratio drive.
- Belt idlers should always be located on the slack side span.
- Idlers should be no smaller than the smallest loaded pulley or one-third larger if they are back-side idlers.
- All pulley dimensions must be kept within RMA Engineering Specifications (IP-24-1983), or manufacturer's standards where RMA standards do not exist.

Pulleys must be aligned to within 1/4 deg or 1/16 in. of maximum allowable misalignment per foot of center distance.



Here are four preventive maintenance tips designers should consider that can help save time and machinery wear and tear:

- Maintain a clean environment. Protect the drive from foreign objects that may be caught between the belt and pulley
- Check for unusual belt or pulley wear patterns. They can indicate other drive problems, such as misalignment, improper tension, foreign object in the drive, or pending failure.
- Keep the pulley free of corrosion to reduce rapid belt wear.

And the following troubleshooting tips can help determine what is causing a belt to fail:

- One side on the belt wears faster than the other, a tracking problem where the belt is riding against on pulley flange. This condition is often caused by misalignment. In the most severe cases with heavily loaded drives, side thrust forces can actually break off the pulley flanges.
- Cracks in back of belt. Belt is running of pulleys that are too small or operating in an ambient temperature that is higher or lower than recommended.
- Teeth cracked prematurely at base. Too small a back-side idler was used, or the drive is too small for the horsepower requirements.

- Ratcheting (belt skips teeth over the pulley), caused by improper tensioning or excessive load. Belts should be replaced after ratcheting because the tensile member and teeth have most likely been damaged. The drive should be retensioned according to the manufacturer's specifications. The drive design might also be reviewed.
- Belt breakage. Excessive or unusual shock loads or a foreign object caught in the drive is probably the cause.

When timing belts wear out from normal service life, it is typical for this wear and separation to start at the base of the tooth where it joins the belt on the forward side, in the direction of belt travel. All other belt failures are indicative of severe drive conditions, misuse, or abuse.

Timing belts are used in many kinds of machinery and equipment because they easily and efficiently synchronize one shaft speed to another. They are ideal for inaccessible drives that require no lubrication and minimal maintenance.