

Proper alignment can increase belt drive performance

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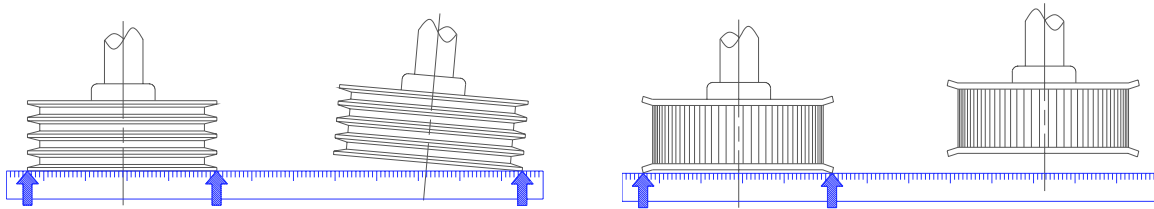
Introduction

Misalignment is one of the most common causes of premature belt failure. Depending on its severity, misalignment can gradually reduce belt performance by increasing wear and fatigue. Or, it can destroy a belt in a matter of hours or days.

While the forms of misalignment may be fairly well understood, accurate measurements and acceptable limits must be determined if maintenance personnel are to take corrective action.

Types of alignment

Basically, any degree of misalignment, angular or parallel, will decrease the normal service life of a belt drive



Angular Misalignment

Parallel Misalignment

Angular misalignment results in accelerated belt/sheave wear and potential belt stability problems with individual V-belts. A related problem, uneven belt and cord loading, results in unequal load sharing within multiple belt drives, and can lead to premature failure. Joined V-belts can suffer tie band separation when operating under misaligned conditions. Gates Corporation Power Transmission Product Application engineers caution that angular misalignment has a severe effect on the performance of synchronous belt drives.

Symptoms such as high belt tracking forces, uneven tooth/land wear, edge wear, high noise levels, and potential tensile failure due to uneven cord loading are typical indicators of misalignment. Also, wide synchronous belts are more sensitive to angular misalignment than narrow belts.

Parallel misalignment also results in accelerated belt/sheave wear and potential belt stability problems with individual V-belts. Uneven belt and cord loading is not as significant a concern as

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with angular misalignment. However, parallel misalignment is typically more of a concern with V-belts than with synchronous belts. This is because V-belts run in fixed grooves and cannot free float between flanges, as synchronous belts can, to a limited degree.

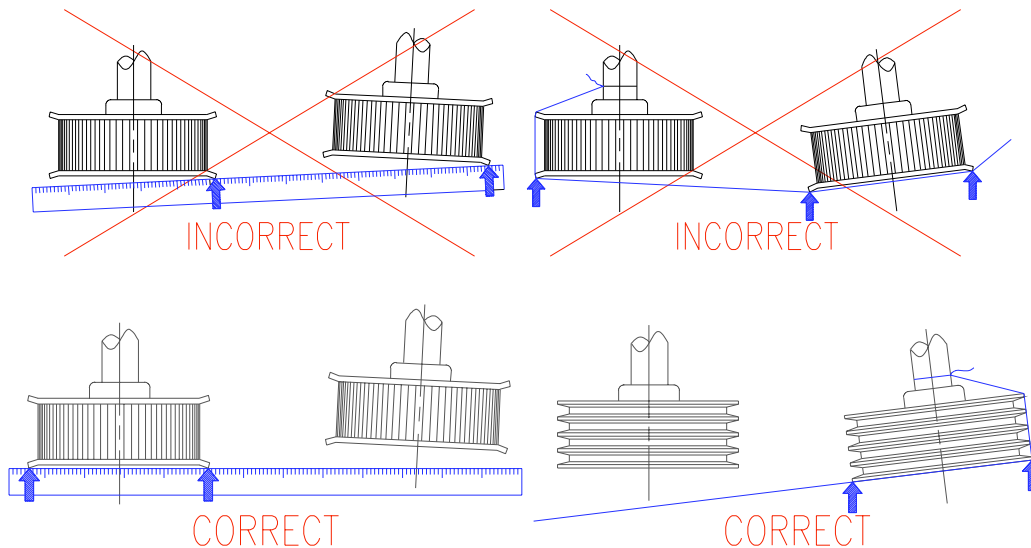
Parallel misalignment is generally not a critical concern with synchronous belt drives as long as the belt is not trapped or pinched between opposite flanges, and as long as the belt tracks completely on both sprockets.

Synchronous sprockets are designed with face widths greater than the belt widths to prevent problems associated with tolerance accumulation, and to allow for a small amount (fractions of an inch) of mounting offset.

As long as the width between opposite sprocket flanges exceeds the belt width, the belt will automatically align itself properly as it seeks a comfortable operating position on both sprockets. It is normal for a synchronous belt to lightly contact at least one of the sprocket flanges in the system while operating. Synchronous belts rarely run in the middle of the sprockets without contacting at least one flange.

Measuring misalignment

Gates engineers say the best tool for measuring misalignment is a laser alignment device. However, when one is unavailable, the next best tool is a straightedge such as a long level, a strip of extruded aluminum, or a ruler, depending on the center distance of the drive. The laser tool and straightedge are used to project the orientation of one sheave or sprocket face with respect to the other.



When preparing to measure parallel misalignment, the maintenance technician must first verify that the edges of both sheaves and sprockets are of equal thickness, or quantify the difference in thickness. It is important to align the sheave grooves or sprocket faces directly in line with one another, rather than just the outside surfaces of the sheaves or sprockets (flanges). It may be necessary to mount sheaves or sprockets with the outside surfaces offset with respect to one another in order to properly align the grooves or sprocket faces.

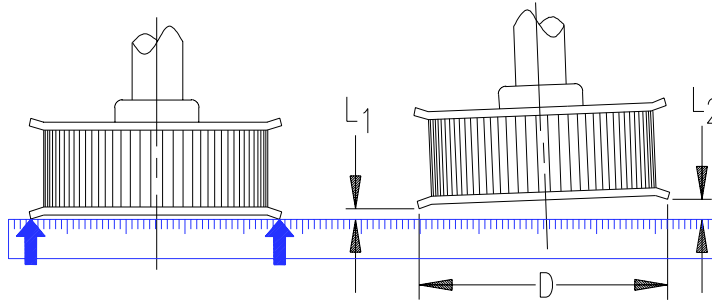
Sprocket flanges should also be inspected to be sure that they run true. A bent flange could result in erroneous measurements if the laser tool or straightedge rests against the outside edge of the damaged flange during the inspection process.

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To determine how much misalignment is acceptable and at what point it becomes excessive, the alignment must first be measured, quantified, and then compared to the belt manufacturer's recommendations for the particular type of belt. These recommendations can be found in drive design manuals.

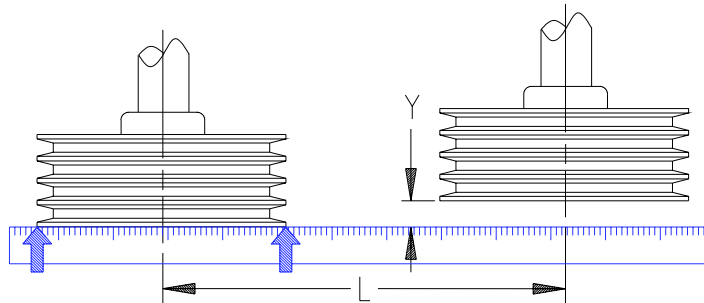
Quantifying misalignment

Misalignment can either be quantified mathematically, or be compared to some general rules of thumb for quicker and easier results. While using a straight edge to project the plane of the outside face of sheave or sprocket #1 with respect to sheave or sprocket #2, angular misalignment can be quantified as the difference in clearance between the straightedge and the outside surface of the sheave or sprocket #2 across the diameter.



$$\text{Misalignment} = \text{Arc Tan} \left[\frac{L_2 - L_1}{D} \right]$$

The angle of parallel misalignment can be quantified as the difference in clearance between the straightedge and the outer surfaces of the two sheaves or sprockets across the separation distance.



$$\text{Misalignment} = \text{Arc Tan} \left[\frac{Y}{L} \right]$$

The total allowable misalignment recommended for V-belts, in general, is 1/2-degree. While individual V-belts are known to be capable of handling greater amounts of misalignment before becoming unstable, maintaining the misalignment to within 1/2-degree will maximize belt life.

The total amount of misalignment recommended for synchronous, urethane 60-degree belts (Polyflex), and poly-V belts (Micro-V) is 1/4-degree. These drives are less tolerant of misalignment than conventional V-belt drives, and must be aligned more accurately.

When determining if a V-type drive system is aligned within these recommendations, the angular and parallel misalignment must both be measured and quantified individually, and then added together. The total sum of angular and parallel misalignment can then be compared to the belt manufacturer's recommendations for the particular type of drive.

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As discussed, sprockets for synchronous belts are made with face widths greater than the belt width to prevent belt fit problems from tolerance accumulations. This additional sprocket face width allows the belt to free float across the sprocket faces.

Because synchronous belts are particularly sensitive to being pinched or trapped between opposite sprocket flanges, sprockets must be installed so that there is clearance between the edge of the belt and the flanges, on both sides. If clearance between opposite sprocket flanges and the edges of the belt is present, parallel misalignment does not need to be quantified and added to the angular misalignment.

Rules of thumb

Maintenance technicians may not always find it practical or possible to accurately calculate the total misalignment in a system while determining if it is in acceptable alignment. It is also difficult to visualize small fractions of an angle such as $1/2$ and $1/4$ degrees. These can be more clearly illustrated with the following rules of thumb:

For V-belt drives:

$1/2$ -degree angle = approximately $1/10$ -inch per foot of distance traveled.

For synchronous, 60-degree angle, and V-ribbed drives:

$1/4$ -degree angle = approximately $1/16$ -inch per foot of distance traveled.

These rules can be used to estimate the amount of angular and parallel misalignment visually rather than having to calculate actual numerical values.

For example, in order for a synchronous belt drive to be within the belt manufacturer's recommendations for angular misalignment, the distance from the outside surface of the sprocket to the straightedge should not differ by more than $1/16$ -inch across a 12-inch diameter.

For a sprocket with a six-inch diameter this difference should not be more than $1/32$ -inch. If the difference is greater than this, or the calculated angle is in excess of the maximum recommended value of $1/4$ degree, the drive should be realigned.

Conclusion

Misalignment can be an obstacle for satisfactory synchronous and V-belt drive performance. In many cases, it is not easily detectable in complex drive applications. Maintenance technicians should also check related components, such as brackets and platforms, for proper design and placement. These parts must be strong enough to withstand the peak forces exerted by the belt drive without bending or flexing.

Additional resources

Gates Belt Preventive Maintenance and Safety program provides user tips ranging from inspection to installation of V-type and synchronous belt drives. Also included is information on reducing downtime, controlling parts replacement costs and increasing energy savings. To schedule a free belt preventive maintenance seminar at your facility, download a copy of Gates 48-page "Belt Drive Preventive Maintenance and Safety" manual, or sign up for Gates free weekly "Belt Tips" email service, go to www.gates.com/beltpm.

For additional information and a preventive maintenance manual on Gates clean running, Poly Chain® GT^{®2} synchronous belt drives for food handling systems, go to www.gates.com/stainless.

To locate a Gates power transmission distributor in your area, go to www.gates.com/distributors.

To schedule a visit with a Gates Industrial sales representative, call 1-800-777-6363.

For technical assistance from Gates Power Transmission Product Application engineers, call 303-744-5800, or email ptpasupport@gates.com.

