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PREVENTING DRIVE BELT ALIGNMENT PROBLEMS

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Amount of angular and parallel misalignment determines what action to take.

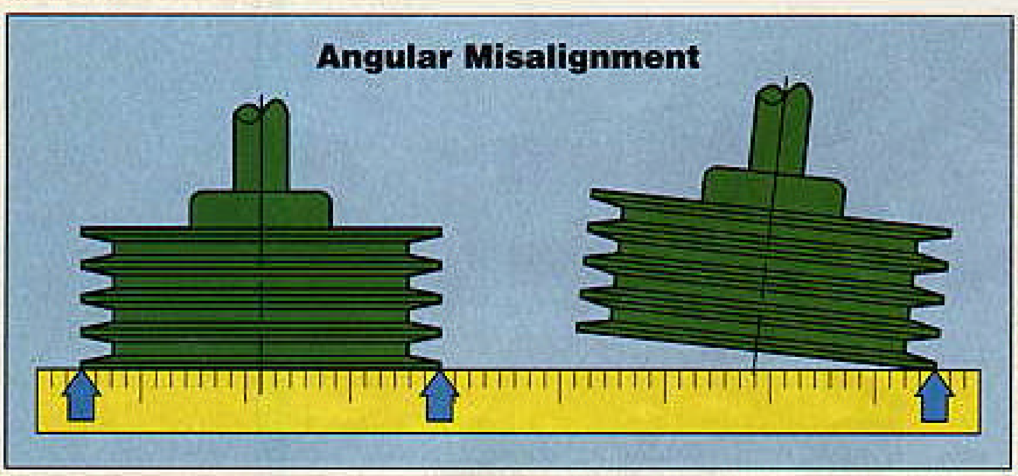
Misalignment is one of the most common causes of premature belt failure. The problem gradually reduces belt performance by increasing wear and fatigue. Depending on severity, misalignment can destroy a belt in a matter of hours or days.

While the basic forms of misalignment may be understood, accurate measurements and acceptable limits must be determined before corrective action is taken.

Types of Misalignment

Basically, any degree of misalignment, angular or parallel, decreases the normal service life of a belt drive. Angular misalignment (Fig. 1) results in accelerated belt/sheave wear and potential stability problems with individual V-belts. A related problem, uneven belt and cord loading, results in unequal load sharing with multiple belt drives and leads to premature failure.

***Fig. 1. Angular misalignment** causes excessive belt edge cord and sidewall wear and V-belt turnover in, or escape from, sheave grooves.*



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 possible. Also, wide belts are more sensitive to angular misalignment than narrow models.

Parallel misalignment (Fig. 2) also results in accelerated belt/sheave wear and potential stability problems with individual belts. Uneven belt and cord loading is not as significant a concern as with angular misalignment.

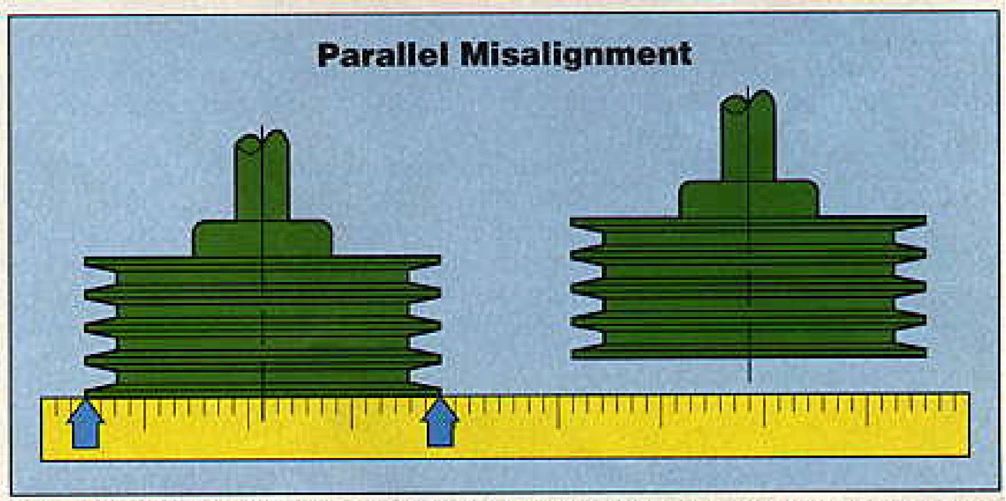


*Fig. 2. **Parallel misalignment** causes noise, tooth and sprocket wear, poor tracking, and excessive temperatures.*

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

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 the belt tracks completely on both sprockets.

Synchronous belt sprockets are designed with face widths greater than 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 automatically aligns 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 sprocket flange in the system while operating.

Measuring Misalignment

The most common tools for measuring misalignment are a straightedge and string. The improper use of either tool, especially a string, can result in erroneous conclusions (Fig. 3).

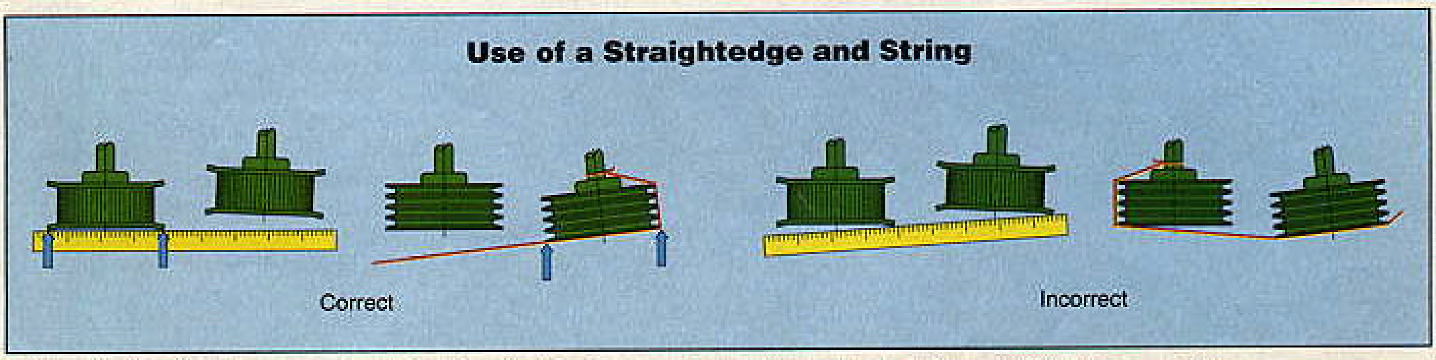


Fig. 3. Correct and incorrect ways to use a straigbtedge and string to cbeck for misalignment are sbown.

A straightedge should be used to project the orientation of one sheave or sprocket face with respect to the other. Orientation is also accomplished with a string, as long as it remains straight without any kinks or breaks.

When preparing to measure parallel misalignment, verify that edges of both sheaves or sprockets are of equal thickness, or quantify the difference in thickness. Align sheave grooves or sprocket faces directly with respect to one another, rather than the outside surfaces of the sheaves or sprockets. It may be necessary to mount sheaves or sprockets with the outside surfaces offset with respect to one another in order to properly align grooves or surfaces on which belts operate.

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

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

Quantifying Misalignment

Misalignment is quantified mathematically or compared to some general rules of thumb for quick and easy results.

Angular misalignment is quantified into a real value by taking measurements (Fig. 4).

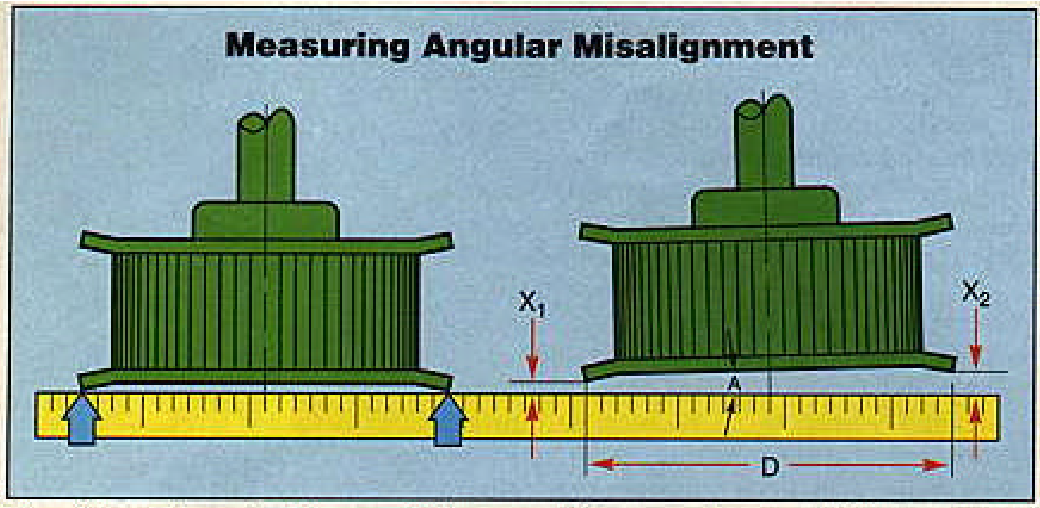


***Fig. 4. Angular misalignment** is corrected by moving one of the members in a drive train, usually the driver or motor.*

The actual angle of misalignment is defined by the difference in clearance between the straightedge or string and the outside surface of the sheave or sprocket across the diameter. The mathematical relationship is:

$A = \text{ArcTan}\,[(X_2 - X_1)/D]$
where
A = angular misalignment, deg.
D = diameter of sheave or sprocket, in.
X = distance from straight edge to sheave flange, in.

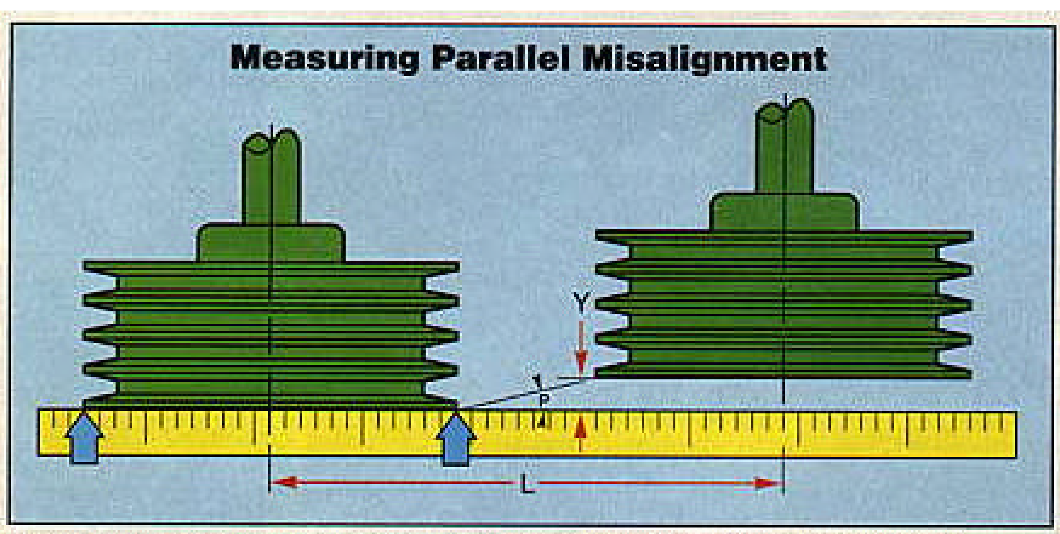


***Fig. 5. Parallel misalignment** is corrected by adjusting sheaves and sprockets on one or both shafts in a drive train.*

The angle of parallel misalignment is defined by the difference in clearance between the straightedge or string, and the outer surfaces of the two sheaves or sprockets across the span length of the belt (Fig. 5).

The mathematical relationship is:

P = ArcTan (Y/L)
where
P = parallel misalignment, deg.
Y = distance from straightedge to sheaves, in.
L = center distance between sheaves, in.

The total allowable misalignment recommended for V-belts is 1/2 deg. While individual V-belts are capable of handling misalignment up to 6 deg before becoming unstable, maintaining the misalignment to within 1/2 deg maximizes belt life. Joined V-belts tolerate misalignment up to 3 deg before significant tieband damage occurs.

The total amount of misalignment recommended for synchronous, 60-deg, and V-ribbed belts is 1/4 deg. These drives are less tolerant of misalignment than conventional V-belt drives, and must be installed accurately.

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

Since synchronous belts are particularly sensitive to being pinched or trapped between opposite sprocket flanges, sprockets must be installed so there is clearance between the belt and both flanges. This installation eliminates parallel misalignment, and does not have to be quantified and added to angular misalignment for a total value.

Rules of Thumb

Maintenance technicians may not find it practical or possible to accurately calculate 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 1/4 or 1/2 deg. These angles are illustrated with the following rules of thumb:

- For V-belt drives: 1/2 deg = approximately 1/10-in. offset per foot.
- For synchronous, 60-deg angle, and V-ribbed drives: 1/4 deg = approximately 1/16-in offset per foot.

These rules are used to estimate the amount of angular and parallel misalignment visually rather than by calculating numerical values.

Tips for Aligning Drives

Dual plane drive alignment. The processes described above permit alignment checking in one plane only. Shafts may be misaligned in either of two different planes, or both. For example, a drive with horizontal shafts is aligned in one plane using the techniques described above, then lined up in the second plane using a bubble level. The bubble level is used to see that both shafts are parallel with respect to the ground. If a drive has vertical shafts, the bubble level is used to make certain both shafts are perpendicular to the ground.

Parallel alignment. Parallel misalignment is difficult to determine since an accurate common reference plane is not always available. Synchronous belt drives are checked by making sure the belt is not pinched between opposite flanges or does not track off any unflanged sprockets. If the shafts are horizontal, and one is located vertically above the other, a plumb bob or bubble level is used to determine if the sheaves or sprockets are in line with each other. A single V-belt could also be hung in an outside sheave groove from the upper shaft to indicate the proper position of the lower sheave.

Angular alignment. After alignment and tension of a synchronous belt drive are set as accurately as possible, a simple test is used to make sure the system is lined up properly.

Carefully turn the drive over by hand and observe which direction and how fast the belt tracks toward one flange. The belt should move slowly enough that several revolutions are required for the belt to move from one sprocket flange to the other. The more rotations required, the better the system is aligned.

The drive should then be stopped and the rotation reversed. The belt should track in the opposite direction at about the same speed as before. If the belt continues to track in the same direction as before, the system in angularly misaligned and needs adjustment.

When adjusting angular alignment of synchronous belt drives, it is helpful to know what effect small adjustments have on the direction of belt tracking. Since synchronous belts tend to track “downhill” to a state of lower tension, or toward a shorter center distance, this fact determines the direction shafts need not be adjusted.

Related components, such as brackets and platforms, should also be checked for proper design and placement. These parts must be strong enough to withstand peak forces exerted by drives without bending or flexing.