

# Chain & Sprocket Systems and Maintenance

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**Chain and sprocket drives of one form or another have been driving machines and conveying materials for over a thousand years.** The chain manufacturing industry has developed numerous types and sizes of drive chains. Although it is a mature form of power transmission, there are still many industrial applications for which drive chain is suited. It is economical, resistant to shock loads, easy to install, has the ability to transmit high torque, operates in hostile environments, and is efficient. Chain and sprocket drives are highly engineered and manufactured within close tolerances.

## Chain Function

Chain can be grouped into two functions: material handling and power transmission. Some chains are used for both purposes. If the chain is transferring or conveying raw material or finished products, it is considered a material handling chain. If the chain's primary purpose is transferring power from one shaft to another, it is for power transmission. In some applications, special attachments — for moving materials — are part of a power transmitting chain's construction.

The chain drive system consists of a driving sprocket, one or more driven sprockets, and a loop of chain. A sprocket is a wheel that on the outside diameter has evenly spaced, uniformly shaped teeth, which provide positive engagement with the chain. Because the chain is hinged at every link, it is able to wrap around the sprockets' teeth, connecting the driver and driven units.

Power and torque are transmitted from the drive sprocket mounted on the shaft of the prime mover, and then connected to one or more driven sprockets by the chain. As the chain drive system operates, every link in the chain undergoes "cycle loading."

The working or tight side of the chain is under full tension, while the slack side is under minimum tension. The sprockets, turning on their respective shafts and connected by a chain, deliver the power or transfer the load to accomplish work.

During operation, a phenomenon known as "chordal action" occurs in a chain drive system resulting from the fact that chain link is a straight-line segment trying to follow the circular path of the sprocket pitch diameter. Because the line of approach of the chain is not tangent to the pitch circle, it is lifted to the top of the circle and then dropped down. There is a surge of force in the chain caused by the change in speed as it makes this rise and fall. An increase in chain velocity can aggravate this event, resulting in vibration and pulse loading in the system. Excessively worn parts may amplify this effect.

Standard roller chain is the most common type of drive chain used in industry. ANSI & ISO maintain standards for design, dimensions, and interchangeability. Pitch, distance from center of pin-to-pin, roller diameters, width, and load ratings are defined. Standard roller chain is made up of alternating roller links and pin links. Each link is constructed by placing rollers onto bushings and pressing roller link plates onto the bushings. The side plates into which two pins are pressed, hold the rollers and bushings in place. The assembly is secured by the press fit between the pins and the plates (often accompanied with a rivet on the end of the pins), spring clips, or cotter pins through holes in the end of the pins.

## Chain & Sprocket Alignment

Proper alignment within the recommended tolerances prevents premature component wear. It also reduces



Figure 1 A simple go-no-go gauge set is a great tool for determining when to change the chain (image courtesy of US Tsubaki).

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the loads that are applied to the supporting shafts and bearings.

A simple straight edge, wire, or laser system can be used to align the sprockets. Sprocket shafts should be parallel. The offset of sprocket faces should be  $< .0625$ "/foot of shaft centerline distance. Angularity should be  $< \frac{1}{2}$  degree. Axial run-out (wobble) of sprockets should be  $< .001$ "/inch of diameter.

### Chain and Sprocket Inspection

Check the condition of the drive components. The articulation of chain as it enters and leaves the sprockets causes the pins and bushings to wear, and the chain will gradually elongate. This is sometimes referred to as "chain stretch." The wear of a chain may be minimized by proper lubrication and maintenance procedures. Some wear is inevitable and normal. Measure the chain and if elongation is greater than 2% (.24" in one foot), replace the entire chain. Operating beyond the 2% elongation maximum recommendation

will cause the sprockets not to engage properly and may cause damage to the other components in the system. A simple go-no-go gauge set with machined steps (see Figure #1) is a great tool for determining when to change the chain. Do not join a new section of chain to a worn section because it may not operate correctly. Check the side plates for wear due to misalignment or cracks from fatigue. Make sure all chain joints are free to articulate and not stiff or frozen. Inspect carefully for signs of corrosion.

### Sprocket Wear

Sprockets should be closely examined for wear. Loose or wobbly sprockets on the shaft can indicate a worn bore, key, or shaft, and this improper fit could result in catastrophic failure. Light interference fits or the use of a tapered bushing system are recommended for most normally loaded applications. Wear on one side of the sprocket plate usually indicates misalignment. Wear

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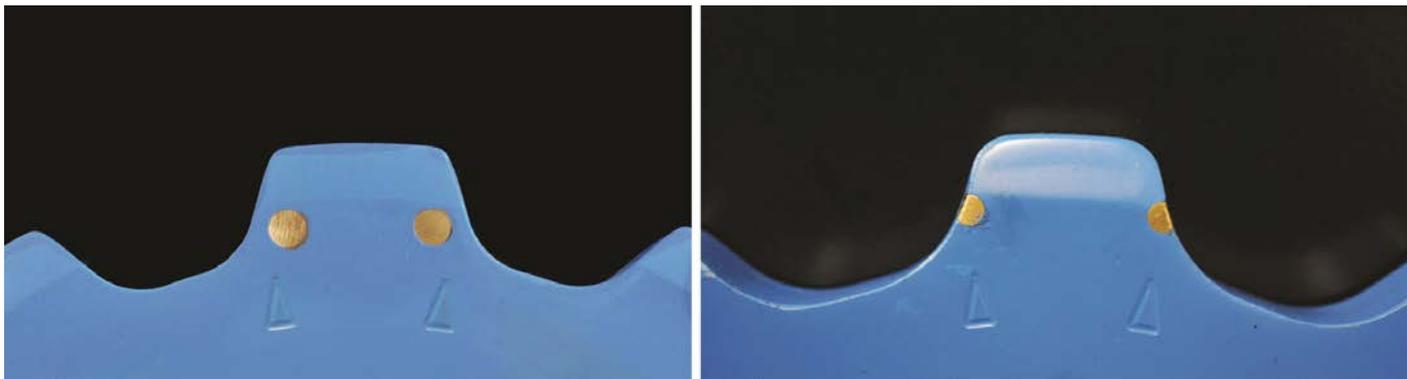


Figure 2 Wear indicator sprockets provide a maintenance technician with a visual warning of excessive wear (image courtesy of US Tsubaki).

on the working faces of the sprocket teeth may indicate a problem of inadequate lubrication. Watch for scratches, galls, grooves, or visible changes in the tooth form such as hooked or shark-fin shapes. Replace all worn and broken parts. Running a new chain on old sprockets will result in early failure of the chain. Worn sprockets damage associated equipment and will create vibration in the system.

The use of indicator-type sprockets in recent years is a major breakthrough in determining the point when a sprocket should be replaced. (See Figure #2.) By using a sprocket with strategically placed wear pins on the thrust faces of the tooth, the maintenance technician has a visual warning of excessive wear. It allows for the scheduling of maintenance rather than run-to-failure. (These sprockets are available in a wide range of sizes and types.)

Without a wear indicator, it was anybody's guess as to what was acceptable. When a chain would jump, the usual course of action was to treat the symptoms by shortening the number of links, and not deal with the cause, worn sprockets. This may keep the chain from coming off but increases the load on the bearings and doesn't eliminate vibration.

### Lubrication

Roller chain is a series of interconnected plain bearings that requires lubrication to resist wear, cushion impact, dissipate heat, flush away contaminants, hinder corrosion, and provide a film between chain & sprocket contact surfaces. There are special lubricants formulated for use with chain drives that are designed for sliding friction and

don't leave a varnish or gummy deposits. Heavy oils and greases that are too stiff will not flow to the needed areas. The important point is for the lubricant to be clean and applied properly, based on the application. There are four basic methods to apply oil to the chain drive. Manual/ spray can, drip or brush, static oil bath, continuous circulating oil system that is filtered. The application, speed, and horse-power determine the best method to use.

For operations wherein conveyed materials must be free from contact with oil, lube-free chains are an option. This type of chain does not require additional lubrication, as it uses oil-impregnated sintered bushings. The use of this chain decreases maintenance costs and reduces product contamination, which is ideal for food and beverage applications and operations where lubrication is not possible.

### Chain Tension

Proper tension for drive chain is extremely important. When chain is too tight, the additional load results in excessive wear on the chain joints and sprockets. Extreme tension also imposes additional loads on the bearings and shaft. When chain is too slack, vibration, noise, wear, shock loading occurs on the system. If the chain is excessively loose, it may jump off the sprockets. A good rule of thumb is a 1/2" of slack or mid-span movement for every 10" of drive center distance. If the drive orientation is vertical, then the allowable amount is one-half of that recommendation.

### Conclusion

The sum of parts is equal to the whole when it comes to a roller chain drive system. Worn parts that are not replaced correctly in a timely manner will cause a 'chain-reaction' resulting in ancillary damage to connected components, increased labor, higher maintenance costs, more unscheduled downtime, and potentially an inferior manufactured product. Check your chain & sprocket drives often. **PTE**

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