

UNDERSTANDING WEAR LIFE

Why Choosing a Quality Roller Chain will Maximize Your Drive's Service Life and Minimize Costs

ABSTRACT

Roller chain drives are one of the primary systems used in industry to transmit power and convey products. Since roller chain drives are widely used, productivity is highly dependent on the performance of roller chain. Roller chain that suffers from premature elongation ("stretch") due to wear and needs to be replaced on a frequent basis will negatively impact productivity and increase the cost of the operation.

This white paper will provide information that will go beyond the obvious factors, such as lubrication and general maintenance that prolong roller chain wear life, to other factors such as roller chain component parts fabrication, preparation and assembly. Factors that are essential to achieving maximum wear life. Diamond's strict specifications and quality control of these other factors are key to maximizing your drive's service life and minimizing operational costs.

LUBRICATION AND MAINTENANCE

The importance of proper lubrication and maintenance of roller chain during operation can not be overstated. Close adherence to lubrication type and method, based on the drive's specifications will not only reduce wear, but will produce other benefits such as cushion impact loads and heat dissipation. But lubrication is only part of the process that is necessary to maximize your drive's service life. Selecting a quality chain will be just as important.

CHAIN WEAR

A roller chain is a series of connected journal bearings that articulate as they enter and leave the sprockets. This articulation results in wear on the pins and bushings. As material is worn away from these surfaces the roller chain will gradually elongate (Fig. 1).

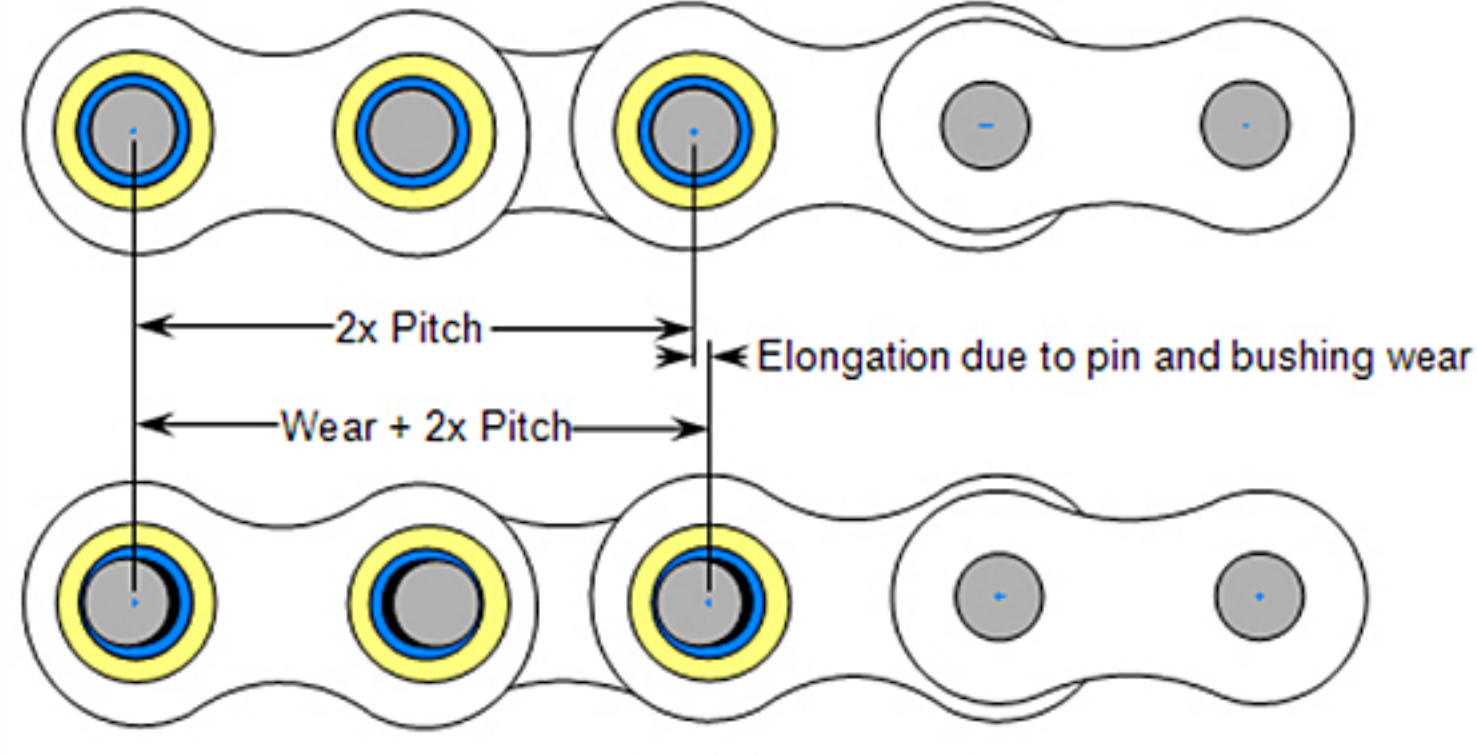


Fig. 1: Wear Diagram

Elongation due to wear is a normal phenomena during drive operation. The rate of wear is dependent on several factors; these include: proper lubrication, load, and the frequency and degree of articulation between pins and bushings. The manufacturing of the critical wear components, the pins and bushings, requires the strictest attention to detail. Starting with the proper selection of raw material, the part fabrication, and part preparation prior to and including assembly. All of these are critical elements in achieving maximum performance. If the wear components are not of the highest quality, the wear life of the roller chain will suffer regardless of other factors.

WEAR ELONGATION MEASUREMENT

Wear measurements can be made to determine if the chain has elongated to a length where replacement is necessary. To ensure accurate results, length measurements on roller chain must be done when the chain is in tension. If the chain is measured while still on the sprockets, the system must be turned off and all safety procedures must be followed. The tight span of the chain is the section that should be measured. If the chain has been removed from the sprockets, the ANSI specified measuring load should be applied to the chain so that the slack has been removed.

Measure as closely as possible from the center of pin to the center of another. The more pitches (pins) contained within the measurement increase the accuracy. If the measured value exceeds the nominal by more than the allowable percentage the chain should be replaced. The maximum allowable wear elongation is approximately 3% for most industrial applications, based upon sprocket design. The allowable chain wear in percent for large sprockets with 68 teeth or greater can be calculated using the relationship: $200/N$, where N is the number of teeth in the large sprocket. This relationship is often useful since the normal maximum allowable chain wear elongation of 3% is valid only up to 67 teeth in the large sprocket. In drives having fixed center distances, chains running in parallel or where smoother operation is required, wear should be limited to approximately 1.5%.

Example: if 12 pitches (12 pins) of a #80 chain were measured and result was 12.360" or greater (using 3% as the maximum allowable wear), the chain should be replaced. Anything less than 12.360" would still be acceptable by most industrial standards.

RAW MATERIAL

The raw material used by Diamond in making the wear components is not any "off-the-shelf" steel. Chemical composition and mechanical properties of the raw material must meet Diamond's unique specifications. This attention to detail is essential in the fabrication and heat treatment of the components. It is because of these unique specifications that Diamond requires all raw material suppliers to certify their product prior to delivery. Any shipment that does not have the certification documents will not be accepted into Diamond's inventory.

FABRICATION

Fabrication of the wear components must be done so that the desired assembly and performance is obtained per Diamond's specifications. Pins are "cold drawn" through a die to create a diameter with very close dimensional tolerances. The pins then go through a "centerless" grinding process that removes any surface imperfections, leaving the pins surface with a "mirror-like" finish. This finish gives the surface a uniform bearing area which distributes the load, bearing pressure, evenly across the entire length of the pin. Ultimately, the wear on the pin is evenly distributed across the length of the pin prolonging chain life.

The bushings also go through a grinding process to ensure a uniform bearing surface. Tight tolerances on the bushing's inside and outside diameters are specified to ensure roundness. Roundness of the bushing is critical, providing the maximum contact area between the pin and bushing. Any irregular surface within the contact area would lead to accelerated wear and a shortened chain life. Each step of Diamond's fabrication processes are designed to impart onto the wear components characteristics that collectively maximize the wear performance of the chain.

HEAT TREATMENT

Proper heat treatment of the wear components is a critical aspect to optimum wear life. Mechanical and physical properties of the wear components can be altered so much by heat treatment, that if done improperly, more harm than good could result. Therefore, heat treatment must be understood and closely controlled to obtain the most effective results. With these criteria in mind, Diamond employs its own metallurgist and lab personnel to closely monitor and maintain the highest quality standards.

Standard pins and bushings are carburized or case hardened. This process transforms the outside of the parts into a hard, wear-resistant surface but allows the inner core to remain tough and ductile to absorb normal shock loads.

The two key elements of heat treatment of the wear components are case hardness and case depth. Case hardness and case depth must be within the range that allows for maximum wear resistance and durability. If the depth of the case hardness is too deep, the part becomes brittle and can break during operation. If the depth of the case hardness is too shallow, the case hardness will wear away prematurely followed by rapid elongation.

In Fig. 2 a microscopic photo shows the case depth of a Diamond pin. The case depth can be seen as the lighter gray ring indicated by the red arrows. In Fig. 3 a microscopic photo shows the case depth of a competitor's pin, also indicated by red arrows. The case depth of the competitor's pin is far less compared to Diamond's. This shallow case depth would be detrimental to the wear life of the chain, causing it to elongate rapidly after the shallow case hardness has worn away.

Because of the fine line between a wear component that has been properly heat treated and one that has not, Diamond operates its own heat treatment department to ensure that all aspects of the process is closely controlled.

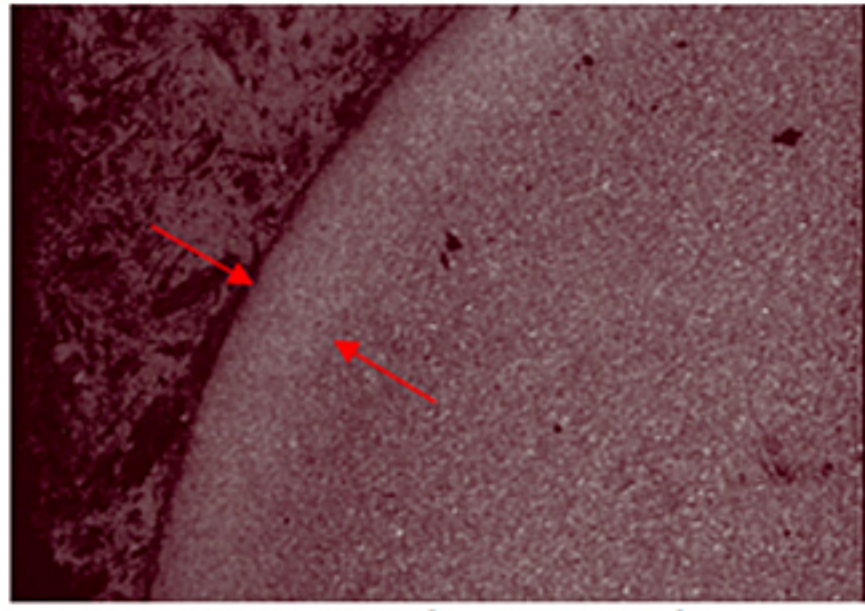


Fig. 2: Diamond Pin Case Depth

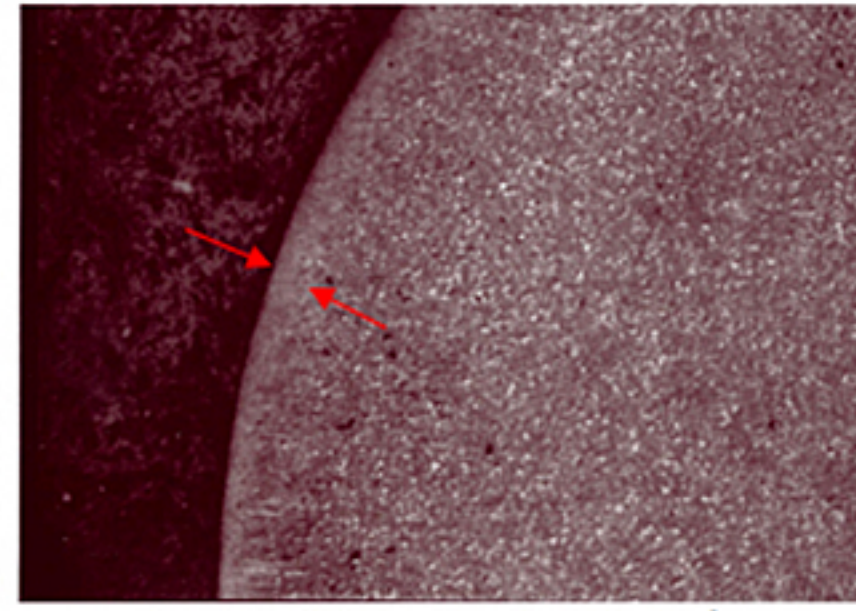


Fig. 3: Competitor Pin Case Depth

PRELOAD

After assembly, Diamond applies an initial load to the chains, called preload. This preloading approximates the recommended maximum loading in service. Preloading can be done either statically or dynamically. Preloading is done as a final alignment of the various chain components such as pins, bushings and link plates.

Preload Applied Preloading helps to greatly eliminate the initial elongation often found in lower quality chains. Elimination of this initial elongation can increase usable service life. The Preload chart (Fig. 4) illustrates the benefits of preloading by gaining additional wear life. The chain that has no or little preload applied will experience a significant amount of elongation during initial start-up of the drive before leveling off. The chain will then elongate at a steady rate until the case hardness on the wear components is gone and the chain experiences rapid elongation. The Diamond chain that has been properly preloaded has very little elongation during initial start-up, which ultimately results in additional wear life.

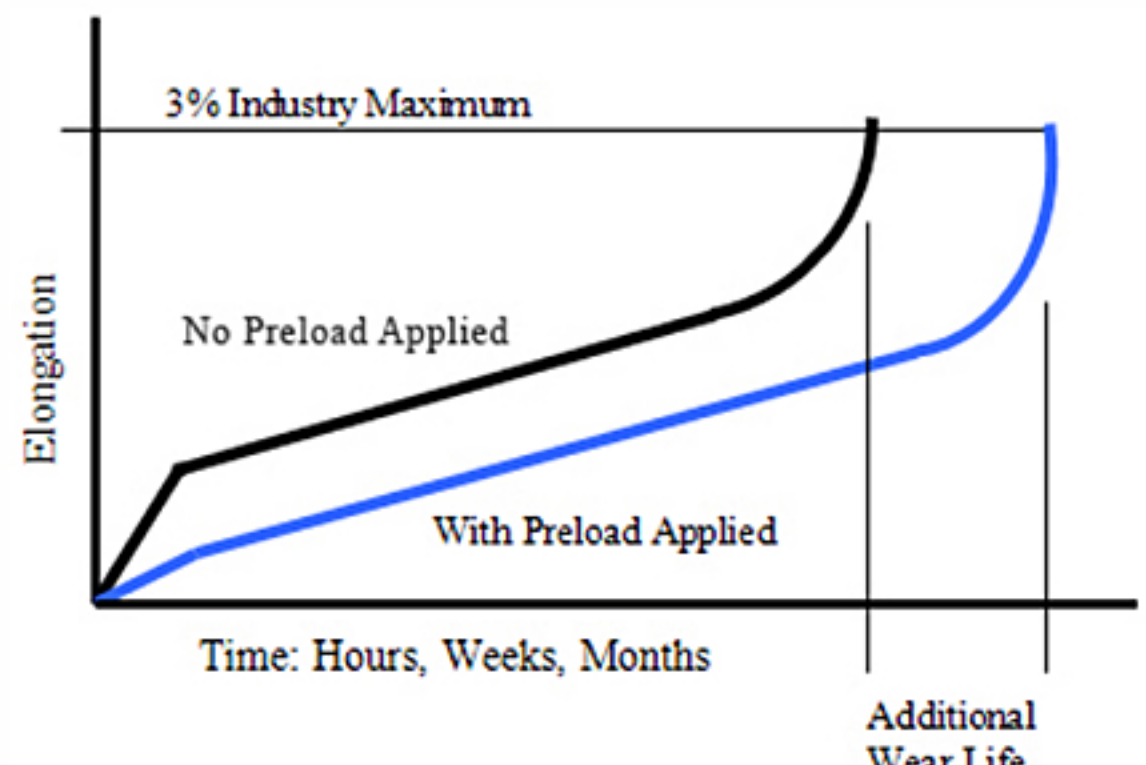


Fig. 4: Preload Chart

CONCLUSION

This white paper has provided information that explained the importance of selecting a high performance, high quality roller chain and also explained the steps Diamond takes to provide the customer with such a product.

Visual inspection of two different brands of roller chain may not yield any clues as to which one is the better product. Trial and error of the different brand names would be time consuming and costly, so selecting the right roller chain the first time is essential in achieving maximum productivity in your application. Selecting Diamond roller chain will without a doubt, improve your drive's service life and reduce long term costs.

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