



Stress Corrosion

Stress Corrosion and Hydrogen Embrittlement

These closely related failures are similar in appearance and nature. They appear as cracks which initiate at the point of highest stress and tend to extend in an arc-like path parallel to the rolling grain of the material. Often, more than one crack will appear on a side plate.

This type of failure can be caused by operating in an acidic or caustic medium or atmosphere. Carbon steel and certain grades of stainless steel are subject to stress corrosion cracking when exposed to a corrosive environment. Also, exposure of carbon steel chain to moisture can lead to rusting and stress corrosion cracking.

The reactions of many chemical agents with metals liberate hydrogen, which attacks and weakens the metal grain structure.

If stress corrosion failure occurs, check the installation to see if the chain is exposed to chemicals, gases, moisture, or other possible causes. If the chain has been cleaned with a detergent solution, the detergent could be at fault. For cleaning purposes, use only detergent-free fluids. Never use acids, such as in acid bath degreasing.



Fatigue Failure



Bushing Fatigue

Fatigue Failure

Fatigue failures are a result of repeated cyclic loading beyond the chain's endurance limit, or rated capacity. Extent of the overload and frequency of its occurrence are factors which determine when fatigue will occur. The overloading can be continuous or intermittent.

Continuous overloading may be caused by worn teeth or pocket buildup, imposing overloads with each cycle. Impulse overloads can be from motor overload torque, dynamic overloading due to sudden stops, or impact loading on conveyors.

Generally, a fatigue crack starts at the point of highest stress, which is the aperture of the pin or bushing plate. Repeated cyclic stresses cause the crack to extend approximately perpendicular to the pitch line of the chain until the plate breaks. Unlike a pure tension failure, there is no noticeable yielding (stretch) of the material.

When fatigue failure occurs, the application should be examined for continuous or impulse overloading conditions. Determine the cause of the overload and eliminate it if possible. (Be sure to check sprockets for worn teeth or pocket buildup.) If the cause cannot be eliminated, determine the extent of the overload and increase chain size (capacity) to accommodate the operating conditions.

Bushing fatigue is another type of fatigue failure. Such fatigue manifests itself as circumferential cracks near the bushing link plate or longitudinally along the length of the bushing. Both types of cracks may also appear in the same bushing. If bushing cracks are evident, do not try to repair the chain. Determine and correct the cause of the failure, then replace the entire chain.

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CHAIN CARE & TROUBLE SHOOTING

Tension Failure

This type of failure occurs when the ultimate tensile strength of a chain is exceeded (when the chain is subjected to a one-time load greater than it can withstand). Normally, tension failure can be identified by fractured side plates showing a definite yield in the metal itself.

Pin fracture, either near the center of the pin or a pin shear failure between the side plates, can also be a result of tension failure. When a chain breaks because of shocks or overloads, all of its components are affected, even though the unbroken parts may appear sound. To avoid repetitive failures, the entire chain should be replaced.

Tension failures can result from any condition which creates improper engagement between links and sprockets, characterized by the chain riding up on the sprocket teeth.

In addition, dirt and foreign matter buildup in the sprocket tooth pockets will prevent proper seating of the chain, creating an overload condition between link and tooth. Sprockets should be checked periodically; if any foreign material has accumulated, it should be promptly removed.

Another variation of tension failure is cracked bushings. In applications contaminated by dirt or grit, abrasive material may penetrate the links. When it reaches the inside and outside bushing surfaces, this material literally grinds into the bushings during articulation, reducing their wall thickness and lowering chain tensile strength. Eventually the bushings crack under load.

Galling (Abnormal Wear)

Galling, or the tearing away of metal particles from the load-bearing surfaces, occurs as a result of inadequate lubrication or excessive operating speed. The mating surfaces of the pins and bushings actually weld together, then break away as the joints flex over the sprockets. Once started, galling accelerates rapidly and is highly destructive.

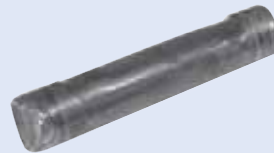
Galling can occur at high speed (within allowable speed limits) if lubrication is inadequate or misdirected. Check lubrication system to be sure that: a) proper type of lubricant is being used; b) lubricant flow is not obstructed; c) lubricant is penetrating chain joints.

Galling at speeds beyond allowable limits cannot be solved by lubrication changes. It can be prevented only by making necessary design changes to comply with speed limitations.

Importance of Lubrication

One of the most important, but overlooked, factors affecting chain life is proper lubrication. Besides minimizing metal-to-metal contact, lubrication provides cooling and impact damping at high speeds. It also reduces corrosion and carries away foreign matter, which is vital in abrasive environments.

Pin Galling



Side Plate Fracture Due to Tension Failure



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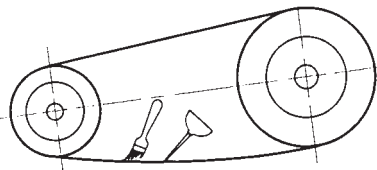
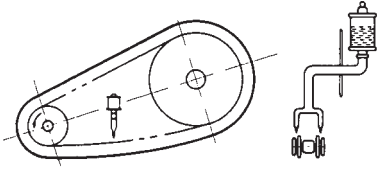
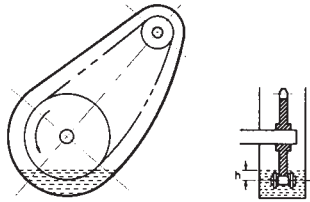
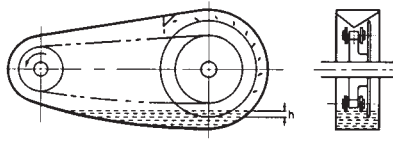
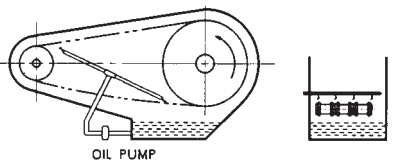
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CHAIN CARE & TROUBLE SHOOTING



Lubrication plays an important role for chain life because chain wear and its stretch results from friction in the area between pin and bushing. Proper lubrication is necessary to reduce metal to metal contact and interference at chain joints.

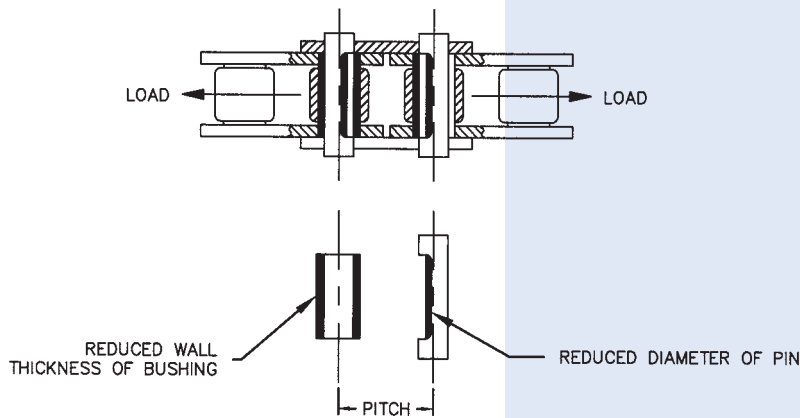
Method and amount of lubrication

Type	Method	Amount
A	 <p>Apply oil with a brush or spout can aiming at clearance between pins and roller links on the slack side of chain in operation.</p>	<p>periodically to keep chain joints from drying (generally about every 8 hours)</p> <p>at a rate of 5 to 20 drops per minute for each strand of chain, the higher the speed the more the drops per minute.</p>
	 <p>Drip lubrication Use simple casing and apply oil drops from a drip cup.</p>	
B	 <p>Oil bath lubrication Chain runs through an oil reservoir kept in leak-proof casing.</p>	<p>too much oil kept in reservoir (if h dimension is too high) can generate heat in oil and deteriorate its quality, therefore oil level should be kept in such a way as to maintain h dimension to be about 6 to 12mm.</p> <p>Oil level should be kept lower than chain lowest point to maintain h dimension to be about 12 to 25mm</p>
	 <p>Slinger disc lubrication Oil disc mounted on lower sprocket picks up oil from the oil reservoir kept in leak-proof casing and splashes it on chain. Disc should run at rim speed of more than 200 meters per minute. If chain width exceeds 125mm, oil disc should be used on both sides of chain.</p>	
C	 <p>OIL PUMP</p> <p>Forced lubrication Oil pump is used to force continuous spray of oil after cooling to chain within a leak-proof casing. No. of spray oil holes should be $N+1$ if the number of chain strand is N.</p>	

In all types of lubrication, roller chain should be cleaned periodically using light oil or gasoline. In order to see if lubrication is performed satisfactorily, remove chain from drive and check its pin and bushing. If pin and bushing show flaking or being colored to red or dark brown, poor lubrication generally exists.



CHAIN CARE & TROUBLE SHOOTING



Bushing and Pin Wear Surfaces

Excessive Wear

If the load-bearing surfaces show discoloration (brown-red oxide), lubrication is insufficient. Fretting corrosion has set in, and the abrasive oxide produced will greatly increase the wear rate. Among other causes of excessive wear are:

- **Tight Chain**—insufficient sag in the slack strand. Lessen idler tension or distance between sprockets until slack is 2% to 3% of the sprocket center-to-center distance.
- **Excessive Slack**—chain whips and creates noise. Adjust idlers or sprocket distances for proper slack.
- **Worn or Misaligned Sprockets**—can cause chain overloads and accelerate the wear rate. Replace sprockets when teeth show excessive wear or are hook-shaped.

Proper sprocket size is also important to minimize the wear rate. Use sprockets with a minimum of fifteen teeth for smoothest operation and longest life. The fewer teeth there are in a sprocket, the greater the wear rate because of the high angle of articulation.

Normal Wear

Wear normally takes place in the pin and bushing load-bearing areas. As they wear, the chain gradually elongates. The rate of chain wear is greatly affected by lubrication. When properly lubricated, load-bearing surfaces of the pin and bushing will look shiny and smooth.

Tips on Trouble Shooting Chain Life Expectancy

Chain life expectancy can be expressed as a maximum percent of elongation. When using up to 67-tooth sprockets, normal life expectancy is approximately 3% elongation. Thus, to avoid sudden tension failure, chain should be replaced when its length increases 0.36" per foot on the average. When using sprockets with over 67 teeth, life expectancy is reduced in relationship to the following formula: permissible chain elongation = $\frac{200}{N}$

where N is the number of teeth in the larger sprocket.

$$\text{Example } \frac{200}{N} = 1.8\%$$

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CHAIN CARE & TROUBLE SHOOTING



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Problem	Possible Causes	What To Do
Excessive noise	<ul style="list-style-type: none"> ■ Misalignment of sprocket ■ Loose casings or bearings ■ Too little or too much slack ■ Chain and/or sprocket wear ■ Inadequate lubrication or no lubrication ■ Chain pitch size too large 	<ul style="list-style-type: none"> ■ Realign sprockets and shafts ■ Tighten set-bolts ■ Adjust center or idler take-up ■ Replace chain and/or sprocket ■ Lubricate properly ■ Check chain drive recommendation
Chain vibration	<ul style="list-style-type: none"> ■ Resonance to the vibration cycle of machine to be installed ■ High load fluctuation 	<ul style="list-style-type: none"> ■ Change vibration cycle of chain or machine ■ Use torque converter or fluid coupling
Wear on inside of link plate and one side of sprocket teeth	<ul style="list-style-type: none"> ■ Misalignment 	<ul style="list-style-type: none"> ■ Realign sprockets and shafts
Chain climbs sprockets	<ul style="list-style-type: none"> ■ Excessive chain slack ■ Heavy overload 	<ul style="list-style-type: none"> ■ Adjust center or idler take-up ■ Reduce load or install stronger chain
Broken pins, bushings or rollers	<ul style="list-style-type: none"> ■ Chain speed too high for pitch and sprocket size ■ Heavy shock or suddenly applied loads ■ Material build-up in sprocket tooth pockets ■ Inadequate lubrication ■ Chain or sprocket corrosion 	<ul style="list-style-type: none"> ■ Use shorter pitch chain or install larger diameter sprockets ■ Reduce shock load or install stronger chain ■ Remove material build-up or install side gashed sprockets ■ Lubricate properly ■ Install anti-corrosive chain or sprockets
Chain clings to sprocket	<ul style="list-style-type: none"> ■ Center distance too big or high load fluctuation ■ Excessive chain slack 	<ul style="list-style-type: none"> ■ Adjust the center distance or install idler take-up ■ Same as above
Chain gets stiff	<ul style="list-style-type: none"> ■ Misalignment ■ Inadequate lubrication ■ Corrosion ■ Excessive load ■ Material build-up in chain joint ■ Peening of link plate edges 	<ul style="list-style-type: none"> ■ Realign sprockets and shafts ■ Lubricate properly ■ Replace with anti-corrosive chain ■ Reduce load or replace with chain of suitable strength ■ Shield drive from foreign matter ■ Check for chain interference
Breakage of link plate	<ul style="list-style-type: none"> ■ Subjected to shock load ■ Vibration ■ Moment of load inertia is too big 	<ul style="list-style-type: none"> ■ Reduce shock (e.g., install a shock absorber) ■ Install a device to absorb vibration (e.g., tightener, idler wheel) ■ Chain section should be checked (increase number of strands or select next larger size chain)