

Module 3 - Chain Failure Modes

Transmission chain

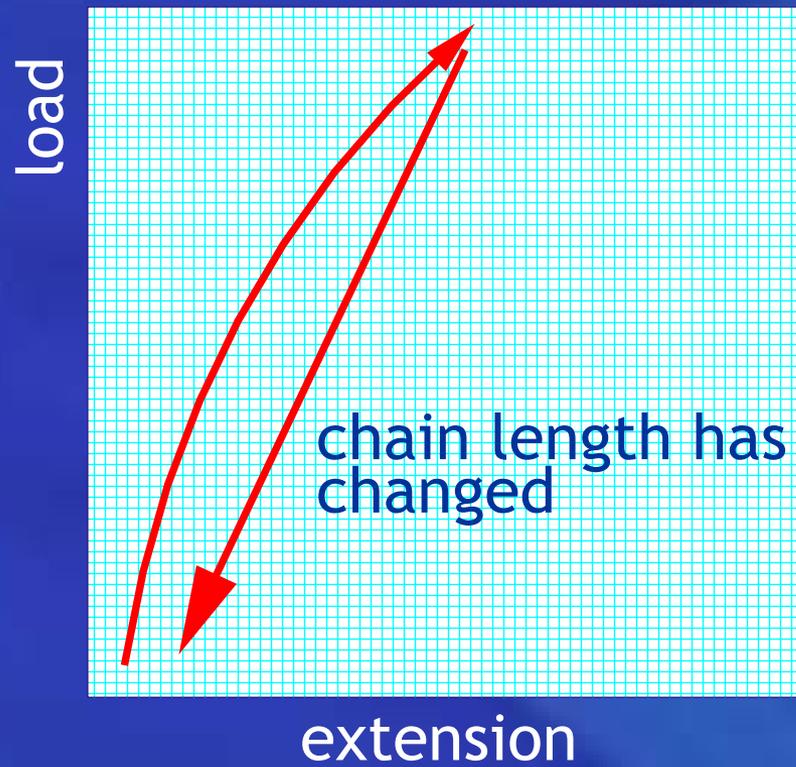
Key Chain Failure Types

- Overload- chain subjected to excessive one-off load which causes permanent deformation of material and leads to very short chain life.
- Fatigue- chain subjected to repetitive high load beyond the endurance limit, causing it to eventually fracture.
- Wear- Load normally between pin and bush eventually wears away material such that the chain stretches beyond its usable limit. Most chain are designed to fail due to wear.



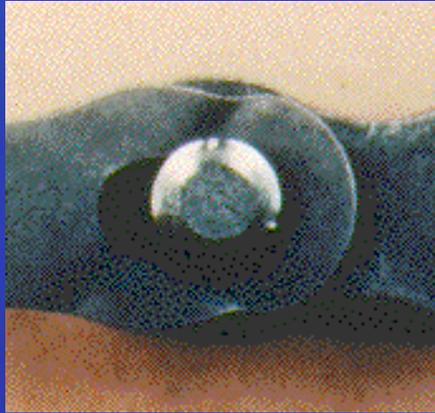
Overload Mechanism

Load vs Extension



- In normal operation chain returns to its original length when a load is applied and released.
- At very high loads (Above 65% of breaking load) material does not return to its former condition- it goes 'plastic'
- Each load 'stretches' the chain until it breaks.

How to Identify Overload



Look for evidence of deformed material.
The chain plate in the top image has failed in overload

- Stretching of the side plates can be seen

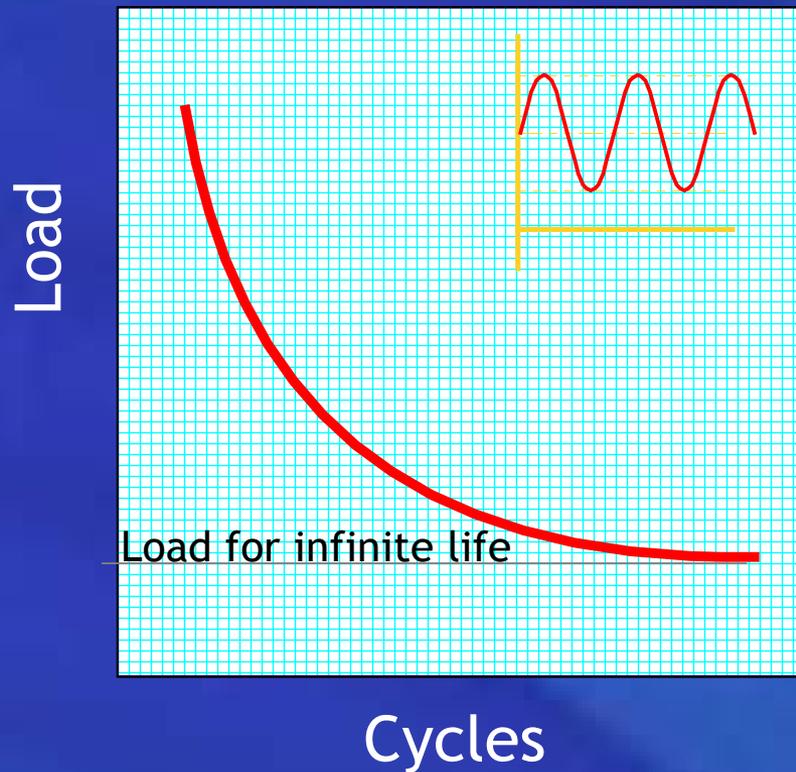


Overload failure can also cause the pin to break

- Outer plates then bend outward
- The chain literally unzips

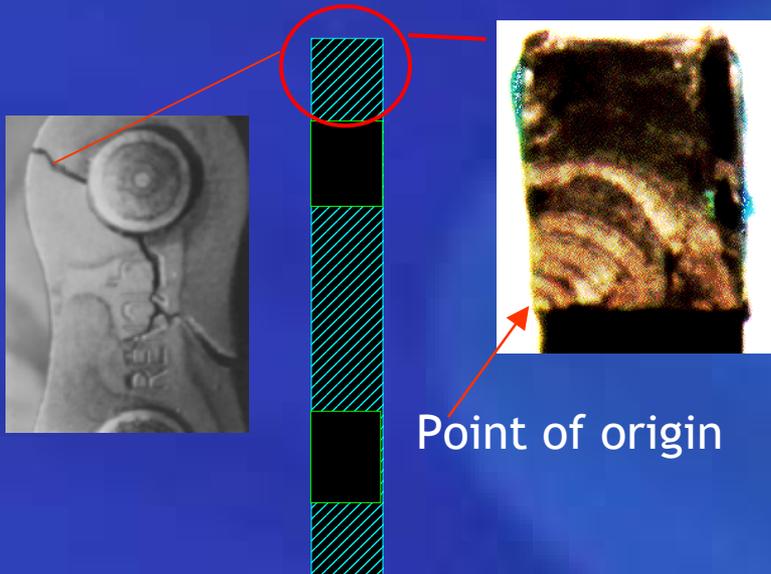
Fatigue - Mechanism

S-N Curve



- Applying a repeated load to a chain will eventually cause it to fail. The lower the load, the higher the life.
- Results can be plotted on a curve.
- At loads before the bottom of the curve, the life is infinite. The failure mode then becomes wear.

How to Identify Fatigue



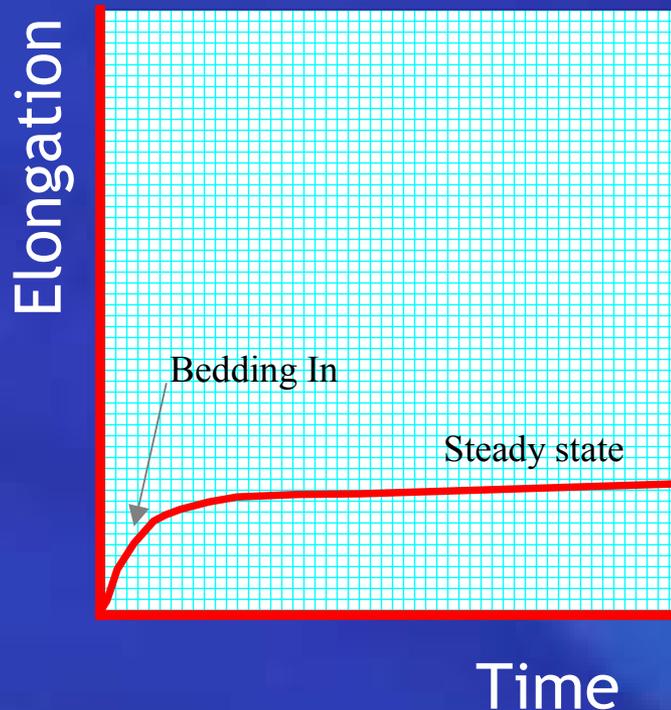
- Components fail without deformation
- Look for hairline cracks (can be very small)

The picture shows a fatigue failure in an advanced state

- Origin can be seen when the plate is removed.
- Classic “beach rings” show progressive failure.

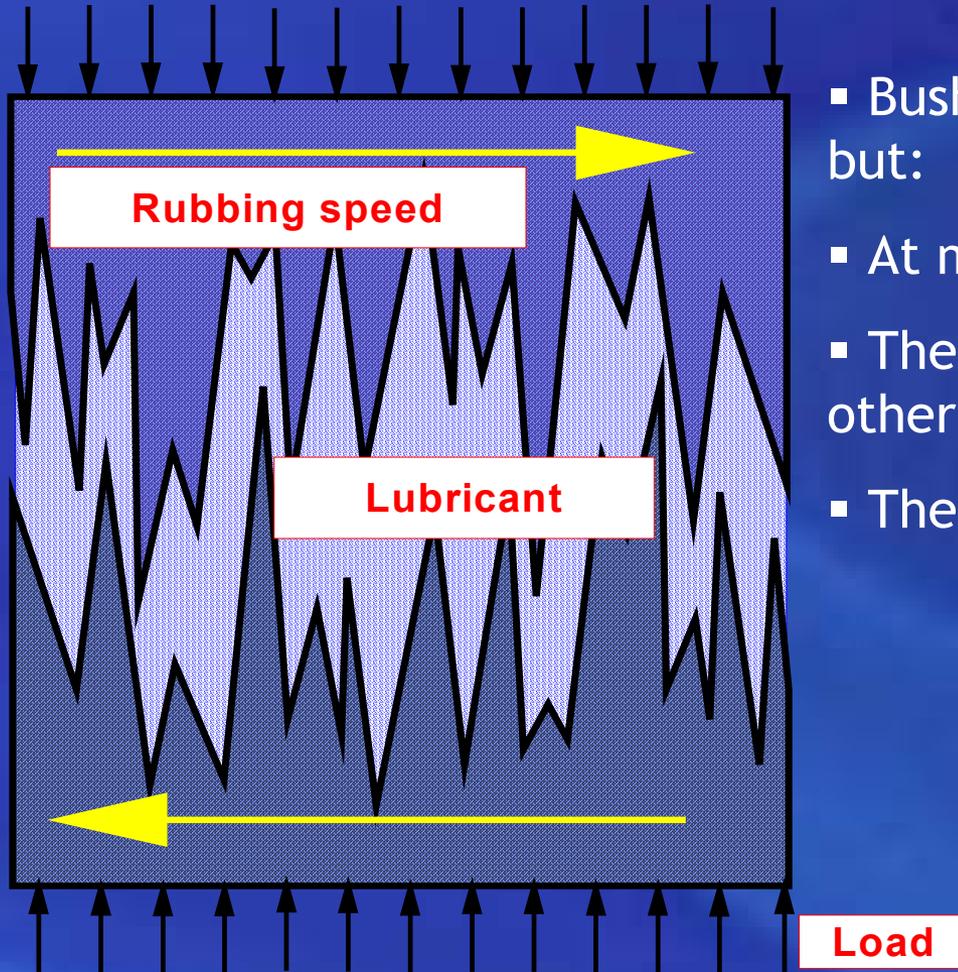
Wear - Mechanism

Wear Curve



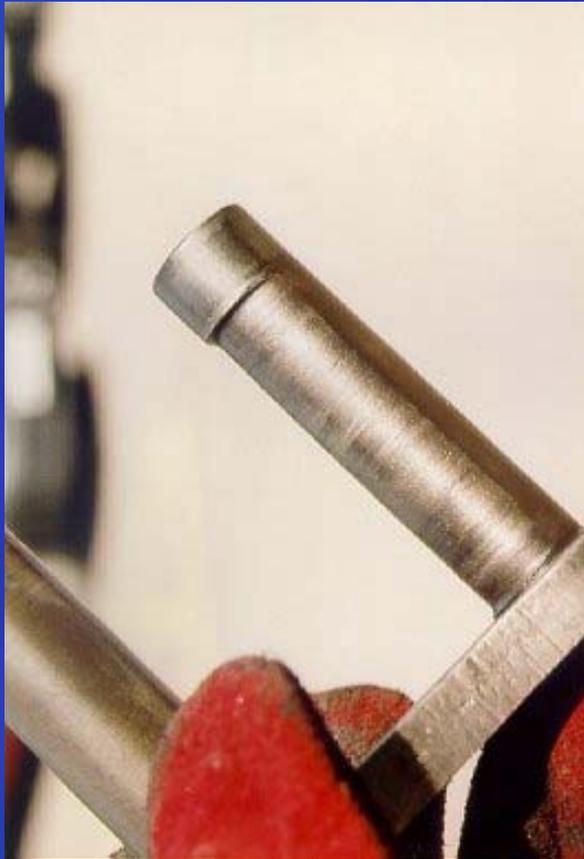
- Running a chain results in the chain extending in length.
- This is due to the pin wearing against the bush when it engages with the sprocket.
- Initial wear is high, it then settles down to a very low level.
- Correctly selected chain will result in 15,000 hours life for a 2% chain extension.
- The first few hours of running are shown on the curve.

Why does Wear Happen ?



- Bush and pin surfaces may look smooth but:
- At microscopic level they are jagged
- The jagged parts rub against each other and produce debris
- The amount of wear depends on:
 - Load
 - Speed of rubbing
 - Lubricant
 - Environment

How to Identify Wear



- Wear takes place between the pin and the bush.
- Generally the pin wears more.
- Most chain will run satisfactorily up to 2% elongation
- Measure the distance between say 10 chain pins and compare with the original catalogue pitch.

Other Chain Failure Modes

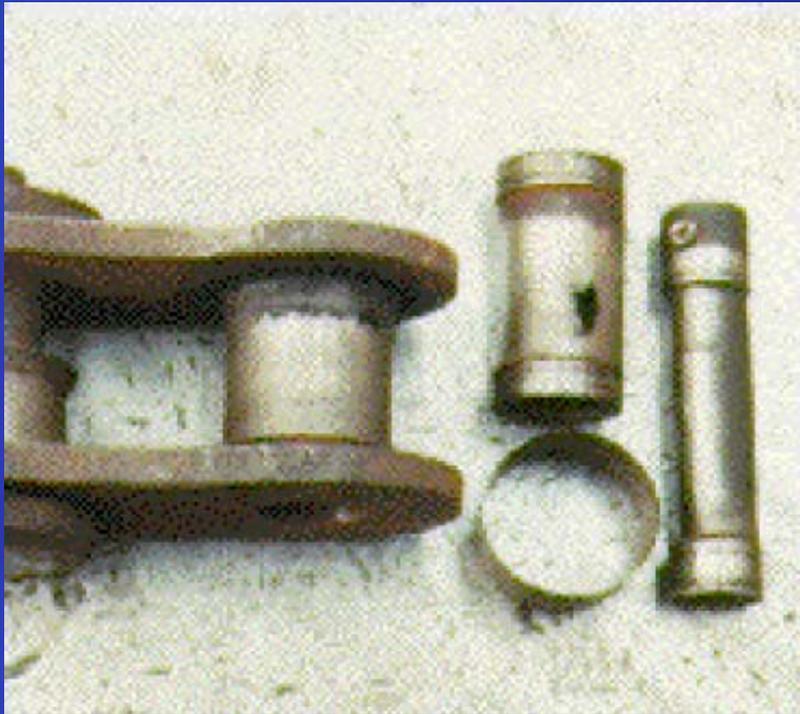
There are many other less common ways in which a chain can fail. Some examples follow.

Galling



- Lack of lubrication or excessively high running loads
- Metal to metal welding
- Smeared and grooved surface
- This pin is also corroded.

Corrosive Environment



- In very harsh conditions a combination of water and corrosive chemicals can cause havoc.
- This is an extreme example

Abrasive Conditions



- This sprocket has run with poor lubrication in a dusty environment.

Summary

- Chain can fail mechanically in the following ways:
 - Overload- should never happen
 - Fatigue- should try to design around this
 - Wear- the normal mode
- The bush/pin is the critical area
- Normal wear life is 15 000 hours
- Other modes of failure are possible but less frequent

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