



## Training notes from the woods & the classroom

March 2011

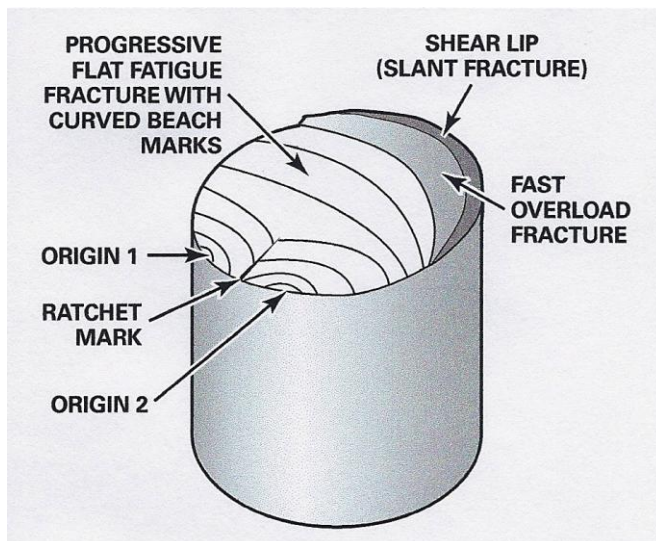
---

# Parts Failure Analysis

Have you ever wondered how a mechanic or an engineer can look at a failure and determine what caused it? The ability to determine the cause of a failure is very valuable for many reasons not least of which is to prevent the failure from happening again. Meaning, that a correct diagnosis could lead to some decision making which could lead to saving a lot of money and hassle and possibly even an accident.

A positive way to conduct a failure analysis inspection is to use an investigative approach because a common inspection error is to assume that the first damaged component you find is the cause of the failure but it might actually be the result of a failure!

For example, the axle shaft in the figure below shows beach marks that resulted from a fatigue fracture. Beach marks represent fatigue cycles that occurred before the part failed completely. They appear as irregular curved rings that radiate from one or more origins and usually result from periodic or prolonged stress from load applications.



Types of Wear are normal and premature. Normal Wear: Components that are operated correctly, and inspected and maintained at recommended intervals, will eventually wear under normal operating conditions. This is called “normal” wear.

Premature Wear: Components can wear prematurely and fail when a vehicle was not operated correctly or it was operated abusively. When a driver doesn't operate a vehicle correctly or

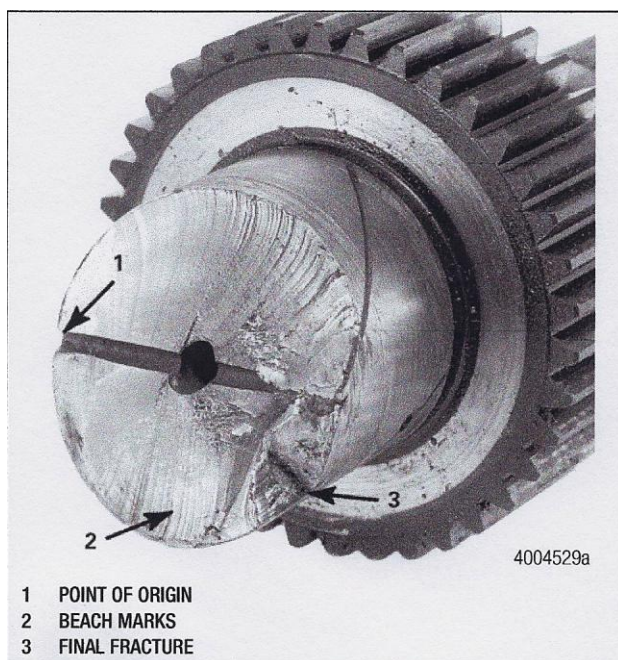
operates it abusively, components can fail immediately. Often, however, damaged components will continue to operate, but fail at a later time — even under normal operating conditions.

For example, when a driver speeds up the engine and rapidly releases the clutch (“popping the clutch”) or allows a vehicle’s spinning wheel to hit dry pavement, it causes an immediate load, or force to the driveline. Component failure can occur immediately or at a later time.

Premature wear is also caused when a vehicle is operated outside its application, equipment or load limits and when a vehicle is not properly maintained.

Most of the time, you can find the answers you need by visually inspecting a failed component. Sometimes, however, this process may require specialized knowledge or equipment.

Bending is a type of fatigue fracture that occurs when a shaft is subjected to both torsional and bending fatigue at the same time. Beach marks form and usually point toward the origin of the fracture, which represents fatigue fracture cycles that occurred before the component failed completely. The figure below shows beach marks on an axle shaft that indicate it fractured as a result of bending fatigue.

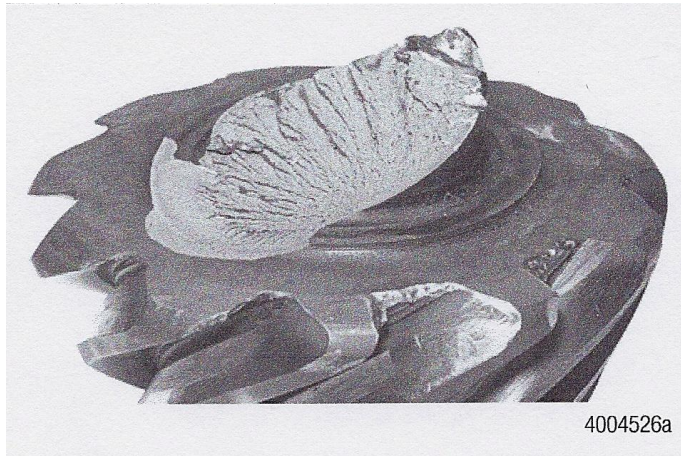


Shock load, also called an “impact fracture,” is a sudden and powerful force applied against a component. Shock load can destroy or damage a component immediately. Often, however, a component damaged by shock load will continue to operate, but it will wear prematurely or fail soon after the initial shock load has occurred.

Shock load causes components to crack and separate from each other. Look for a rough, crystalline finish on the separated parts. Torsional shock load results when a rapidly-applied twisting motion occurs; for example, when an excessive amount of torque is delivered to an axle shaft. Some Causes of Shock Load are: 1) An operator backs under a trailer with excessive force and the vehicle’s spinning wheel hits dry pavement. 2) An operator misses a shift. 3) An operator speeds up the engine and rapidly releases the clutch (“popping the clutch”), which causes an immediate force, or load, to the driveline.

4) An operator locks the differential when the wheels are spinning, which can damage the clutch collar and mating shaft splines and other carrier components.

The figure below shows a pinion gear damaged by a shock load. The fracture has a rough, crystalline appearance and is broken at a 45-degree angle.



These are just a few examples to show a bit of the art and science involved to help determine the cause of a part failure. There's a couple hundred more examples which goes well beyond the scope of this article but what I would like to do is provide you the ability to do a little bit of investigating on your own should you ever want to.

The following link is 121 page ArvinMeritor document complete with hundreds of photos that provides a process to help determine why parts failed during operation, what to look for when you inspect parts, and how to help prevent failures from occurring again:

<http://www.winningwithemail.com/content/6490/images/TP0445.PDF>

Paul Schultz, Schultz Equipment & Parts Co., Inc.  
Iron Mountain & Escanaba, MI 49801  
(906) 774-8900, [www.schultzequipment.com](http://www.schultzequipment.com)

(Content courtesy of the Great Lakes Timber Professionals Association – March 2011– *Great Lakes TPA Magazine*)

---

Minnesota Logger Education Program  
Dave Chura, Executive Director  
301 W 1<sup>st</sup> Street; Suite 510  
Duluth, MN 55802  
218-722-5442 · [dchura@mlep.org](mailto:dchura@mlep.org) · [www.mlep.org](http://www.mlep.org)