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Common Causes of Tire Coupling Failures

INFORMATIONAL BULLETIN

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Abstract

This publication is intended to provide users with a general overview of the most common causes of failure with elastomeric Tire couplings and their causes.

Foreword

This Foreword is provided for informational purposes only and is not to be construed to be part of any technical specification. It is intended for informational purposes only.

Suggestions for the improvement of or comments on this publication are welcome. They should be mailed to Mechanical Power Transmission Association, 6724 Lone Oak Blvd., Naples, FL 34109 on your company letterhead.

Scope

This informational bulletin is intended to provide users with a general overview of the most common failure modes with Elastomeric Tire Couplings.

1. INTRODUCTION

1.1. The primary modes of tire-coupling failure is narrowed to the following categories:

- Fatigue
- Overload/Shock
- Misalignment
- Hysteresis
- Hydrolysis and Environmental Attack
- Improper Installation

The two primary tire-couplings differ by elastomer material. The material differences are typically rubber-based elements or urethane-based elements (thermoset or thermoplastic elastomers). The general geometry and design of each coupling varies due to the influences from the material type and therefore the failure modes are not identical. The failure modes explained below are separated, when appropriate, based upon the differences from modal evidence.

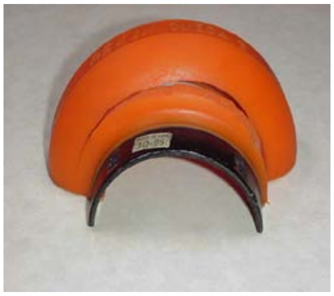
It is important to note that combinations of these failure modes are common and often related. For the purpose of this document, the following modes and examples are autonomous and exclusive.

2. FATIGUE

Fatigue is a component's natural weakening as a reaction to cyclic stresses. The primary mode of failure for tire couplings is fatigue. As stresses from torsion, alignment, start/stop, overloads and/or centrifugal forces act on the tire element, the element weakens. Over the period of operation the element will fail.

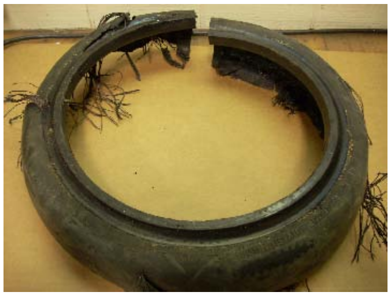
2.1 Fatigue in Urethane

Fatigue in urethane-based elastomers is evidenced by a tear of the element thru the sidewall just above the bonded area. This tear is typically gradual. The failure propagates from the end of the element thru the stress relief depressions at the split. These failures can be detected early with visual inspection by observing the initial crack/tear of the coupling ends. The most common cause of fatigue failure is influenced by misalignment.



2.2 Fatigue in Rubber

Fatigue in rubber-based elastomers is evidenced by cracks in the region of the element split. However, the primary fatigue damage is evidenced by large cracks located slightly above the clamp circle. These cracks extend completely through the element and often radially over the outside diameter of the element. As the cracks propagate, rubber debris, often similar to coffee grounds, will be evident beneath the coupling. Replacement is recommended when cracks extend for 20% or more of the element circumference. If the element is not replaced the cracks will continue to propagate and the reinforcement fabric will become torn and exposed. The fabric strands are often extended and bare.

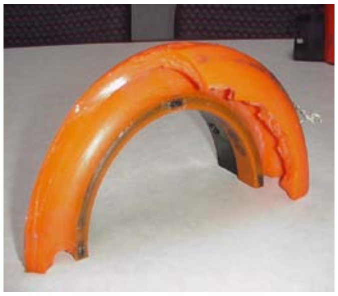


3. OVERLOAD/SHOCK LOADS

Overload is a condition where load is placed on a system in excess of design capacity. Shock loads are intermittent force impact or demand spikes that typically exceed normal steady state conditions. If not accounted for through proper service factoring, both conditions will lead to premature, and often sudden, element failure. Both urethane-based and rubber-based tire couplings are subject to these types of failures when loads exceed 400% of the actual rating.

3.1 Overload/Shock load in Urethane

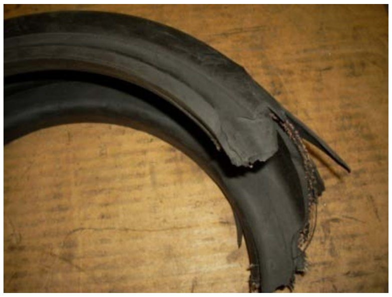
Evidence of a jagged tear starting in the sidewall and propagating toward the OD reflects overload and/or shock loading conditions. The shock loads cause the jagged tears in the sidewall. When the failure cuts upward into the top section of the element, the coupling is in pure overload. In pure overload, the element tears down the center; the elements thinnest section with the highest stresses. Extreme overload failures exceeding 500% of the coupling rating is reflected by a glassy, smooth surface.



3.2 Overload/Shock load on Rubber

Overload and shock load conditions with rubber-based elements are also evidenced with jagged wear patterns with the rubber. The cording that is exposed is typically torn relatively close to the edge of the rubber; shorter fabric length exposure than with a fatigue failure. 45° tear propagation from the shaft centerline is also evidenced from the initial jagged tears.

Overloads will often cause the element to slip between the hub and clamp ring, however, this condition is also representative of improper installation.

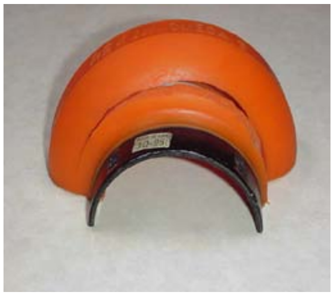
 

4. MISALIGNMENT

Tire couplings typically have the greatest capacity for misalignment than other coupling designs available. However, when the misalignment capacity is exceeded, the coupling undergoes stress reactions that fatigue the element. This fatigue is often similar to torsional fatigue but the crack propagation direction can differ based upon the type of misalignment; angular, parallel or end-float.

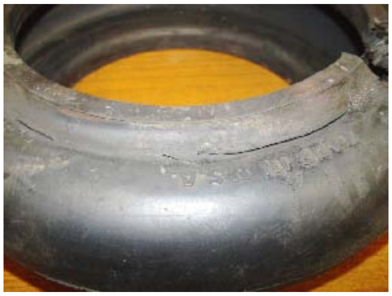
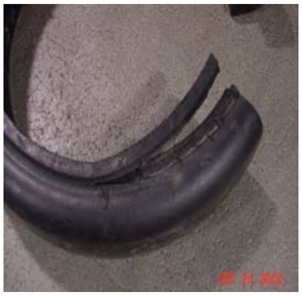
4.1 Misalignment in Urethane

Misalignment in urethane-based elements is often evidenced by a bond failure of the element to the hub. Cracks may also form on the element sidewall. Evidence of failure from misalignment is often equivalent to that of fatigue failure.



4.2 Misalignment in Rubber

Angular misalignment in rubber is usually represented by cracks above the clamp ring. These cracks and tears on the exterior sidewall that do not propagate angularly are indications of angular misalignment. Cracks that propagate radially, similar to early onset fatigue failure, represent parallel misalignment. Cracks on the interior surface of the element above the internal clamp ring are indicative of excessive end float.

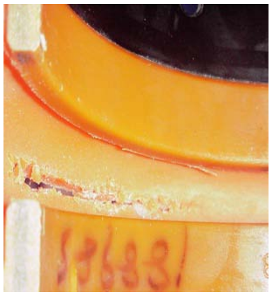
 

5. HYSTERESIS

Hysteresis in elastomeric couplings is the internal buildup of heat within the elastomer due to absorption of energy through mechanical power transference. An elastomeric coupling fails as hysteresis-influenced temperatures rise within the element and exceed the operating temperature limit of the material.

5.1 Hysteresis in Urethane

Hysteresis in urethane occurs when the urethane absorbs torsional vibration from high frequency pulsations. In dampening these vibrations, it converts the energy to heat. If the frequency is high enough the urethane cannot dissipate the heat fast enough and the urethane temperature continues to rise until it melts. The urethane temperature rises until it melts and liquefies. The failure usually occurs in the center of the coupling where there is less conductive surface to dissipate the heat. The shape of the tear is usually serrated and will be accompanied by molten urethane that appears in the underside of the coupling similar to a melted candle wax.



5.2 Hysteresis in Rubber

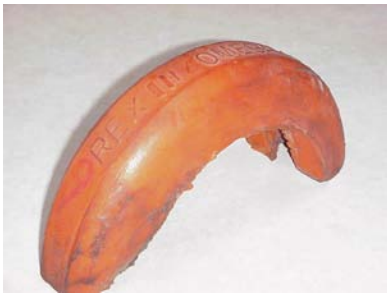
Hysteresis in rubber-based elements is less common due to its higher levels of conductivity and temperature capability. However, when the effects of vibration are high enough, the rubber will begin to locally revert toward its initial natural rubber properties prior to vulcanization. This results in extremely soft and/or tacky rubber.

6. HYDROLYSIS AND ENVIRONMENTAL ATTACK

Hydrolysis is a chemical decomposition that occurs in the presence of elevated pressure and moisture.

6.1 Hydrolysis in Urethane

Hydrolysis in urethane occurs as degradation at the bond where fatigue stresses are the highest. The mode of failure can be verified by an awl test or sliver test. Both tests identify basic degradation in the element's elasticity of the urethane. Contact the element manufacturer for details.



6.2 Chemical Attack in Urethane

Chemical attack in urethane is characterized by discoloration, increased stiffness, brittleness and cracking in the urethane or corrosion of the metal. Striated layered cracking or "alligator skinning" of the urethane is a conclusive sign of chemical attack. If unsure of the chemical resistance of the urethane, consult the manufacturer for a detailed listing of urethane chemical compatibility. Althernative urethanes may be available to improve performance.

6.3 Chemical Attack in Rubber

Chemical attack in rubber is evidenced by degradation in geometry, finish and/or surface hardness of the rubber. The effect is related to the type and concentration of the chemical. Contact the coupling manufacturer for information regarding the chemical resistance of the rubber. Alternative elastomers may be available to improve performance.

7. Improper Installation and Selection

The modes of failure from improper installation and selection are common and wide-ranging. Both urethane and rubber designs have different failure modes from improper installation and improper selection. The scope of those failures is too broad to discuss in this document. For details and examples evidencing improper installation contact the coupling manufacturer.