Friction Materials and Bonding Basics

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Outline

• Selecting the right material for the application.
• Becoming familiar with common friction materials.
• Understanding failure modes of friction materials.
• Preventing bond concerns.
Selecting The Right Material for The Application

- **Type of Vehicle**
  - Heavy Duty
  - Passenger Car
  - High Performance

- **Driving Conditions**
  - City
  - Highway
  - Wide Open

- **Vehicle Lock up Strategy**
  - On/Off
  - PWM
  - Continuous Slip
Becoming Familiar with Friction Materials

- **Tan**
  - Typical On/Off Strategy.
  - Medium-High Friction Coefficient.
  - Low-Medium Temperature Resistance.
  - Specified by the OEs.

- **Kevlar®**
  - Typical On/Off and PWM Strategy.
  - Medium Friction Coefficient.
  - Medium-High Temperature Resistance.
Becoming Familiar with Friction Materials

• **PowerTorque™**
  - Typical On/Off & PWM Strategy.
  - High Friction Coefficient.
  - Medium-High Temperature Resistance.

• **Carbon Fibre**
  - Continuous Slip Strategy.
  - Low Friction Coefficient.
  - High Temperature Resistance.
  - Manufactured from high strength Carbon Fibre strands.
  - Not a mixture of Carbon Fibres and wet-laid paper, commonly known as “Carbon Impregnated Paper”.

[Images of friction materials]
Understanding Failure Modes of Friction Materials

- Glazing
- Erosion
- Burning/Discoloration
- Rapid Wear
- Water Intrusion
- Delamination
- Debond
Glazing

• Phenomena
  • Shiny friction surface.

• Symptoms
  • Slipping as a result of low clamping forces.

• Common Causes
  • Oil additives break down and deposit onto friction surfaces.
  • Voids in the material become plugged.
  • Reduction in coefficient of friction.
Erosion

• Phenomena
  • Rough or “pitted” surface.

• Symptoms
  • Chatter, shutter, erratic engagement feel.

• Common Causes
  • Surface deterioration due to oil, cover to piston clearance.
  • Insufficient material compression.

• Results
  • Decrease in friction to reaction surface contact.
Burning/Discoloration

• Phenomena
  • Burnt, degraded friction surface.
  • Fractures/cracks across material surface.

• Symptoms
  • Delayed Engagement – Slipping.

• Common Causes
  • Insufficient Clutch Capacity.
  • Hydraulic Malfunction.
Rapid Wear

- **Phenomena**
  - Measurable thickness loss.

- **Symptoms**
  - Usually not observed until catastrophic failure.

- **Common Causes**
  - Aggressive reaction surface.
  - Reaction surface flatness.
  - Insufficient material compression during manufacturing or bonding.
Water Intrusion

• **Phenomena**
  • Material separation from piston/dampener at bond line.
  • Rust deposits on piston surface.

• **Symptoms**
  • Lock up shudder.

• **Common Causes**
  • Radiator to cooler leak.
  • Defective fill tube or bulkhead seal
  • Vehicle either flooded or driven through deep water.
Water Intrusion

• Friction materials are hygroscopic (they like to absorb moisture).

• Since water will displace ATF, the material can be waterlogged quickly under high pressure.

• Since the fibres are weakened from being waterlogged, the surface shear between the fluid and material interface can pull fibres from the material matrix.
Water Intrusion

• Water does not need to reach the adhesive line to cause a material failure.

• Example: Heat generated during an engagement can turn the water to steam and blow out material fragments.

• Water is known to cause cellulose to swell and weaken.
Delamination

• General Description
  • Friction material fails at a certain thickness.
  • Bond remains intact.
  • Typically occurs across the entire radius of material.

• Symptoms
  • Shutter as result of uneven loading.

• Common Causes
  • Incorrect material for the application.
  • Improper compression.
Debond

- **General Description**
  - Failure of adhesive to properly adhere to the bond surface.
  - One of the most common causes of lock up failure.

- **Symptoms**
  - Shutter as result of uneven loading.
  - No lock up engagement.
Debond

• Common Causes
  • Oil, residue, or other contaminate remaining on the piston/dampener bond surface.
  • Bond cycle settings.
    • Time
    • Temperature
    • Pressure
    • Fixture Flatness
    • Piston/Dampener Flatness
  • Adhesive cures but does not bond with the piston/dampener surface.
  • Improper surface finish on the bond surface.
Preventing Bond Concerns

Piston Preparation

• Surface Finish
• Flatness
• Cleanliness

Is this a good Bond?

• Bend Test
• Scrape Test
Surface Finish

- Typical surface finish range is 80-150 microinches.

- Most common surface in the reman industry is lathe cut.
  - By controlling feed depth and speed, an acceptable surface finish can be had.

- Be careful when making Deep or Fast Lathe Cuts
  - Allows adhesive flow into “valleys”, and reduces bond strength at interface.
  - Reduces contact points between the material and bond surface.
Surface Finish

• A more accurate and consistent finish is possible by media blasting the bond surface with an 80 grit aluminum oxide.

• A combination of lathe cutting and media blasting is also acceptable.
Flatness

- Bond surface flatness and fixture flatness are both critical in distributing equal pressure during a bond or in application.

- Recommended method for accurately finishing the bond surface is to lathe cut the surface while clamped to the lower bond fixture.
Cleanliness

- After the proper surface finish and flatness has been complete, cleaning and handling of the piston/dampener assembly prior to bond is critical in preventing a debond.

- Thoroughly wash the piston/dampener assembly.

- Follow up by thoroughly drying and wiping down bond piston/dampener surface with solvent such as MEK.
Confirming a Satisfactory Bond

- Two methods for confirming a successful bond.
  - Chisel Test
  - Bend Test

- Chisel Test
  - Simplest and fastest way to confirm if the bond is good.
  - Should be able to scrape material down to adhesive without lifting the adhesive from the bond surface.
  - Chiseling multiple sections is recommended.
Confirming a Satisfactory Bond

- **Bend Test**
  - More scientific than the chisel test.
  - Subjects part to most extreme conditions.

Excellent Bond

Marginal Bond
Confirming a Satisfactory Bond

The bonded specimens are soaked in ATF

Parts are then placed in boiling water for 10 minutes.

Parts are removed from water and allowed to sit for 10 minutes with the friction side facing up.

A 12mm rod is anchored in place

The test piece is placed on the rod over the diameter of the sample piece.

Within 15 minutes of removing the test piece from the water, pressure is exerted on the plate until the bend reaches a 90° angle.

The delaminated or debonded material is carefully removed from the bend area.

The bond is considered satisfactory if a minimum of 50% of the friction material remains in the bend radius.
Summary

• Become familiar with the application.
• Select the material that best fits the driving conditions and system strategy.
• Recognize failure modes.
• Control piston preparation and bonding variables.
Thank You for Your Attention

Have questions later on?

Contact Chris Horbach or Dave Perry

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