

# **MICROBIAL DEGRADATION OF PAVEMENT**

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# MOISTURE DAMAGE

- One of the major forms of failure in asphalt pavements
- Causes of moisture damage are usually considered to be:
  - adhesive and/or cohesive failure
- Failure in the pavement is manifested in several different forms (e.g. rutting, fatigue cracking, raveling, and/or stripping). This implies that there are several mechanisms that result in moisture damage.

# MOISTURE DAMAGE - Mechanisms

## 1. Adhesive Failure

- stripping (displacement of asphalt from the aggregate surface by water)
- hydraulic scouring (traffic)
- freeze-thaw cycling (environmental effect)

## 2. Cohesive Failure

- disruption of asphalt structuring by water
- emulsification (production of surfactants)

# BUT

- **An accurate prediction of moisture damage caused by one mechanism does not preclude the need to predict damage caused by other mechanisms as well.**

**IS BIODEGRADATION A VALID MECHANISM  
THAT NEEDS TO BE CONSIDERED?**

# WHY CLASSIFY BIODEGRADATION AS A MECHANISM THAT CAUSES MOISTURE DAMAGE?

- The transport of microbes to the asphalt-aggregate interface and the utilization of the asphalt at that location can appear as STRIPPING.
- Biodegradation of asphalt results in the production of surfactants or EMULSIFICATION.

# Damage Attributed to Microbes (Kansas)

- Deteriorated asphalt coatings on pipelines were correlated with elevated numbers of microbes in the vicinity (10-100 fold) demonstrating that they were using the asphalt as a food source.
- Anaerobic sulfate-reducing micro-organisms contributed to the damage through the production of corrosive acids.

(Harris, Corrosion, 1960 & 1964)

# Damage Attributed to Microbes (Western Australia)

- Failure (i.e. stripping, blistering) of three new asphalt pavements correlated with the presence of microbes.
- Hydrogen sulfide was detected indicating the presence of sulfate-reducing bacteria.
- 15 to 20% of the damage was attributed to microbial activity.
- Conclusions were validated in laboratory studies.

(Blankley, reports to the Central Laboratory, 1966 - 1968)

# Damage Attributed to Microbes (Mississippi)

- Microbial degradation was considered to be the cause of blistering and cracking of asphalt overlays.
- Blistering was due to the production of carbon dioxide and methane. Butyric acid and hydrogen sulfide were also present indicating the occurrence of anaerobic metabolism.

(Brown and Darnell, Asphalt Paving Technology, 56, 1987)

# Damage Attributed to Microbes (Minnesota)

- Stripped pavements at five field sites correlated with elevated numbers of microbes in the vicinity of the pavements.
- Severity of damage was correlated with nitrogen and phosphorous in the soil.
- Asphalt content was reduced in damaged cores.

(Chang, report to the Legislative Commission on Minnesota Resources, 1996)

**For our model of moisture damage to be complete we need to consider all possible mechanisms that lead to this form of failure.**

**IS BIODEGRADATION A VALID MECHANISM THAT NEEDS TO BE CONSIDERED?**

**WHAT DO YOU THINK?**

# Mitigation of Damage Attributed to Microbes

- There is some evidence that the use of lime mitigates this mechanism, apparently by increasing the pH of the system. Optimal pH for microbial growth is about 6 to 8.5.
- The calcium ion can also tie up nutrients, such as phosphorous, thus limiting microbial growth.