Moisture Damage? What is "Scouring"

Modeling ETG

Tampa

February - 2008

Kringos/Scarpas AAPT

Moisture Damage Mechanisms

- Adhesion
- Cohesion
- Mechanical Working
- Scouring/Scrubbing/Emulsification

Adhesion/Cohesion

- *Fundamental tests*
  - *Pull test*
  - *Surface Energy*
- *Specification Tests*
  - *TSR*
  - *Static Immersion Tests*

Adhesion + Cohesion + Mechanical Working

- ***Specification tests***
  - ***–TSR with freeze thaw cycles***
  - ***–Environmental Conditioning System***
    - ***75% accurate is not good enough***

"Premature overlay failures are expensive"

- ***Colorado -*** *'90 - Interstate stripping - $20M*
  - *Hamburg - "disintegrator mixes"*
- ***Texas -*** *Five early Superpave projects underperform expectations*
  - *Hamburg - "all problem mixes"*
- ***Oklahoma -*** *Superpave - 9 Mo failure*
  - *Hamburg - "disintegrator mix"*
- ***Nebraska -*** *Superpave - 8 Mo failure*
  - *Hamburg - "disintegrator mix"*
- *Indiana AE-60 Sand Mix – Failure on Interstates*

Adhesion + Cohesion + Mechanical Working + Scouring

- ***Hamburg Wheel-Tracking***
  - ***–Led by CO DOT & TXDOT***
- ***APA***
  - ***–Led by GA DOT***

Hamburg - TXDOT findings

- ***Better correlation to field than***
  - *Hveem Stability*
  - *Static Creep*
  - *Tex-531C (Lottman)*
- ***Identifies potential "bad actors"***
- ***Selects best antistrip***
  - ***Amines with limestone (usually)***
  - ***Lime with gravel***

Scouring

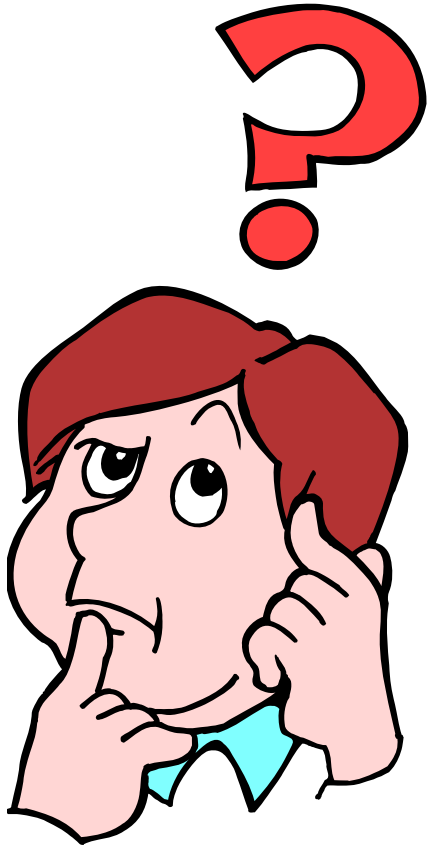
A failure of the asphalt mastic caused by high pressure water flow across its surface – pore pressure.

Cause: moisture sensitive binder or P-200

Research Need

- ***Fundamental Test to Define Scouring***
  - ***High pressure water flow through fine pores in mastic or binder***
  - ***Generates data for stripping models***
  - ***No aggregate or standard non-stripping aggregate***
  - ***Controlled temperature and pressure***
  - ***Capture/indentify displaced materials***

Can binder chemistry impact moisture damage?



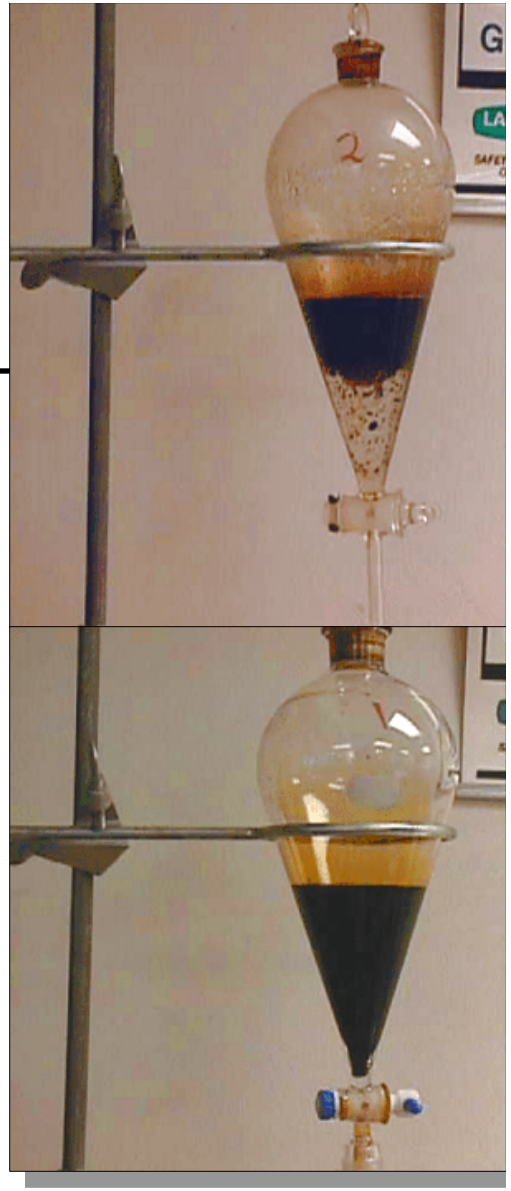
Binder Induced Stripping

Examples

- ***Emulsion residues – high emulsifier***
- ***Crude source***
- ***Excessive acid to boost PG***
- ***Asphalts with high salt content***
  - *Refinery caustic wash - no desalter*
  - *NaOH additive as PG booster*
  - *Acid/amine co-additives*
- ***Emulsion residues – high emulsifier***

Asian Experience

- ***Cheap Ven-like asphalt***
- ***Hamburg***
  - ***disintegrator mix - worst ever!***
- ***Investigation***
  - ***AC source responsible for early pavement failures***
    - *< 2 years to rehab*
- ***Hypothesis?***
  - ***Heavy-crude emulsion residue - Orimulsion***

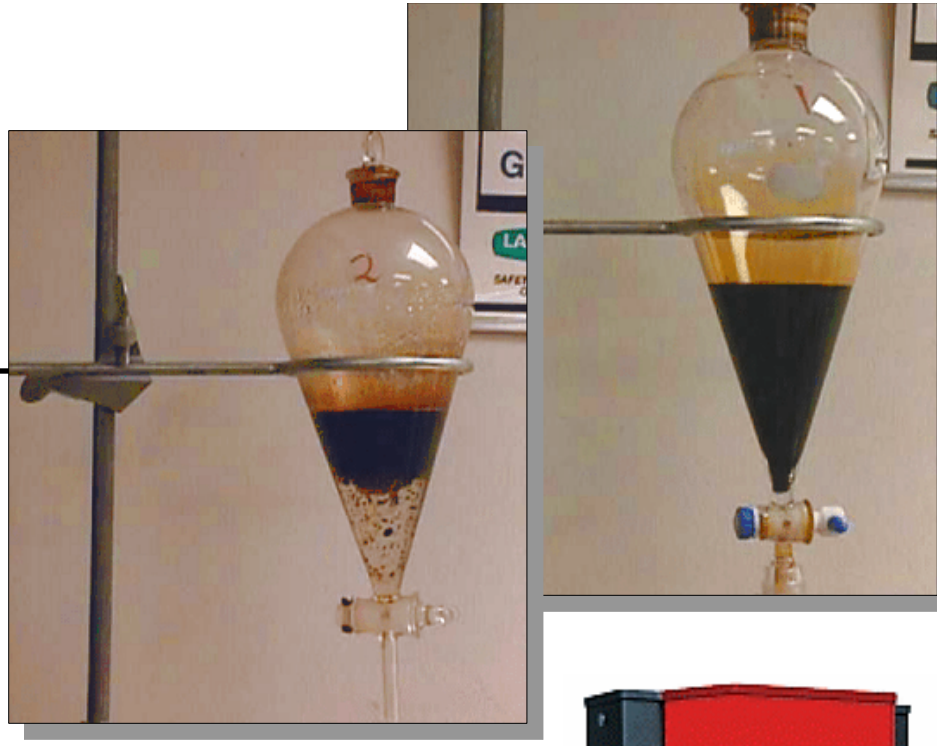


1999 - Oklahoma
Overlay failure <1 year

Forensics

- Mix satisfied SuperPave criteria
- Hamburg - disintegrator mix
- Polymer/Acid modified AC
- Contractor adds amine antistrip
- Additional amine reduces TSR

KDOT Study - H_3PO_4 + amine



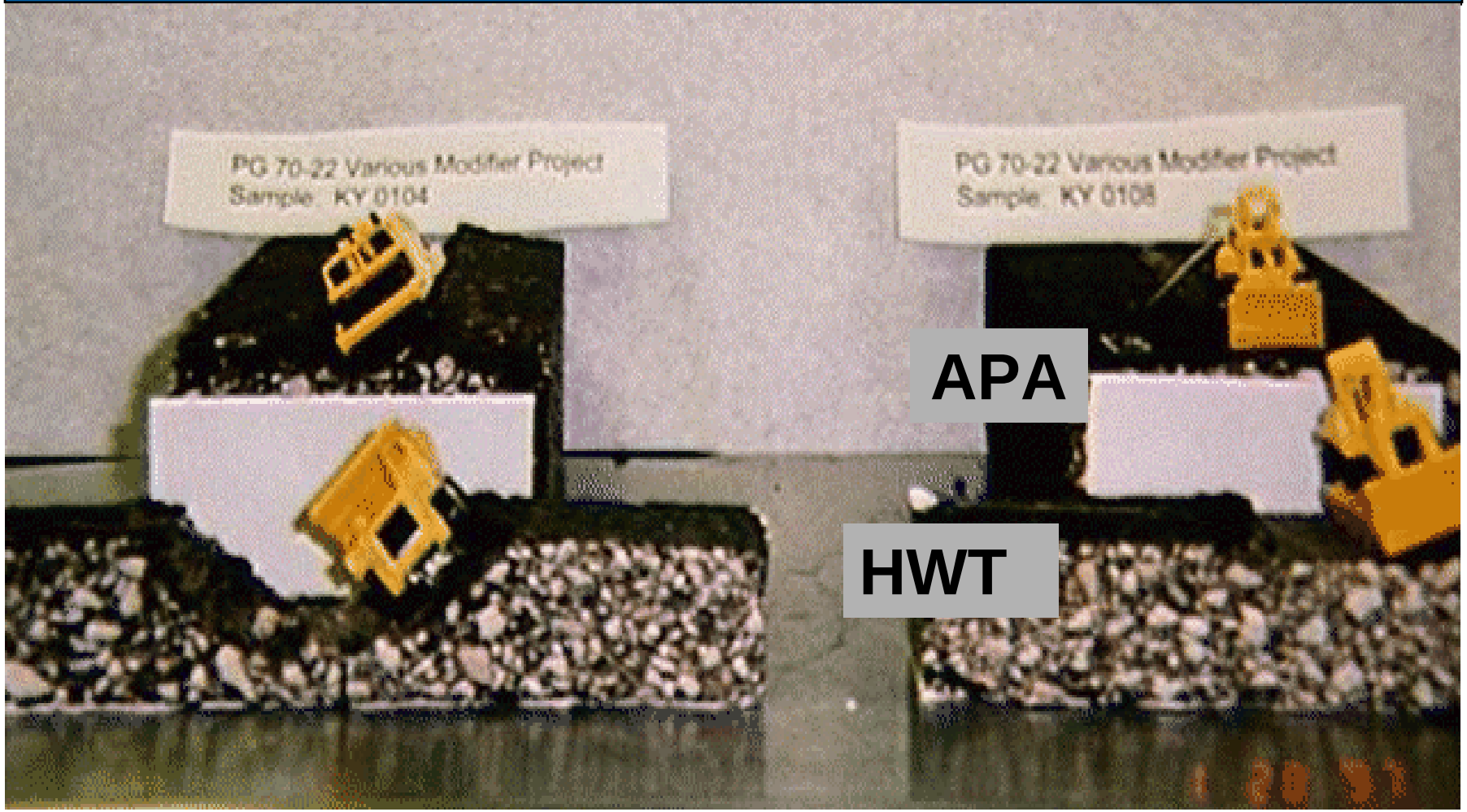
- Branthaver's 'Separatory Funnel' Test
  - pH
  - emulsification / affinity for water
- Superpave Performance Grading
  - DSR
  - BBR

- Bishara, et. al., TRB, 2001
- Fager, et. al., AAPT, 2002

I-70 - Copper Mountain

- ***Fall '92: CDOT placed 70k tons - $4M***
- ***Winter: Moisture-induced raveling***
- ***Hamburg forensic study:***
  - *Problem with one source of AC-10*
  - *Antistrip solutions don't help*
  - *Mix good with four other sources of AC-10*
- ***Project finished with AC-10 from same supplier, but different refinery & crude***
  - *Performance OK*

KY I-64
Are PG 70-22's the same?

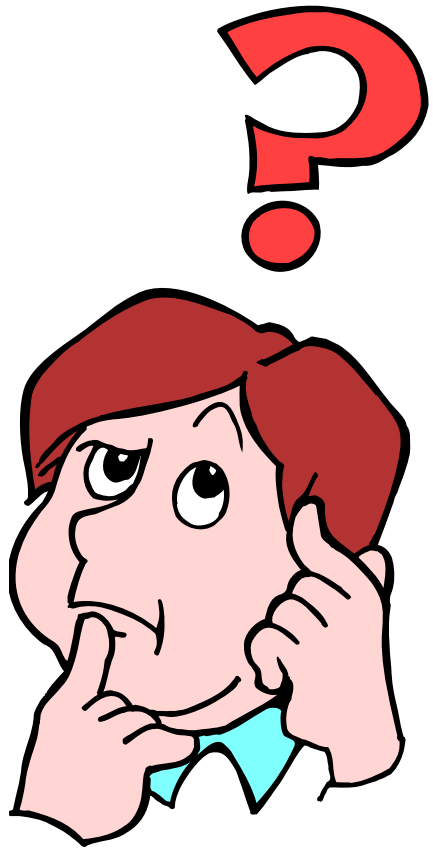


Blankenship/Myers - AAPT - 1998

Filler surface chemistry matters too!

Carbon black

Dust



P-200

Clay

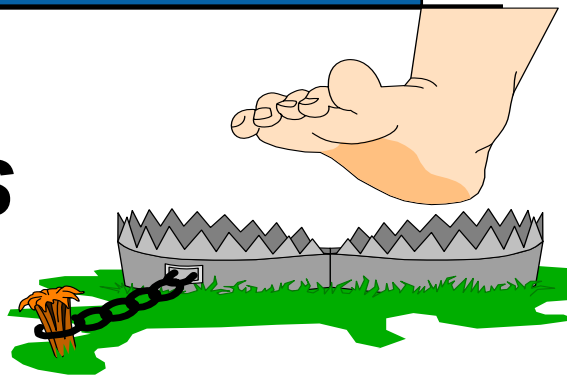
Sawdust

Lime

Baghouse fines

TLA

CLAY
Moisture enemy #1



- ***Moisture trap - Swells***
- ***Asphalt emulsifier***
  - *Stable even to freeze-thaw*
  - *Heat, water, AC, clay, shear*
  - *Immersion-compression tests do not predict damage severity*

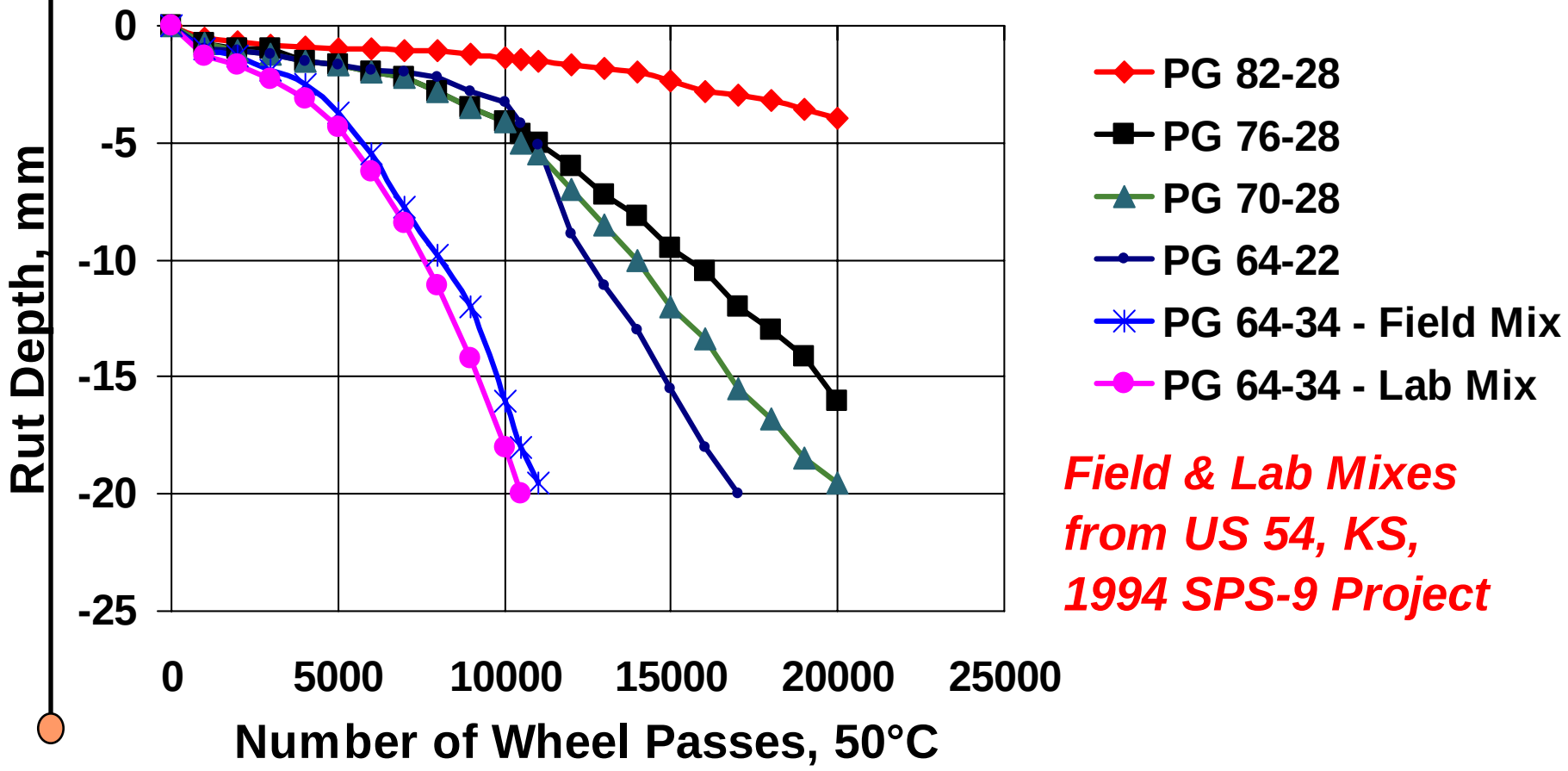
Quantifying surface activity

- ***Sand Equivalent***
  - *Poor Sensitivity?*
  - *Limits too low?*
- ***Methylene Blue***
  - *Quantitative!*
  - *Identify surface active fines*
    - *Aschenbrenner, Kandhal*

Surface activity in other fines!

Rand:
When
in doubt!

Hamburg Wheel Tracking Resistance to Rutting of PGAB's



Field & Lab Mixes from US 54, KS, 1994 SPS-9 Project

Thanks!