

# Moisture Sensitivity Testing

Changes to PENNDOT testing  
requirements

# Stripping





# Stripping



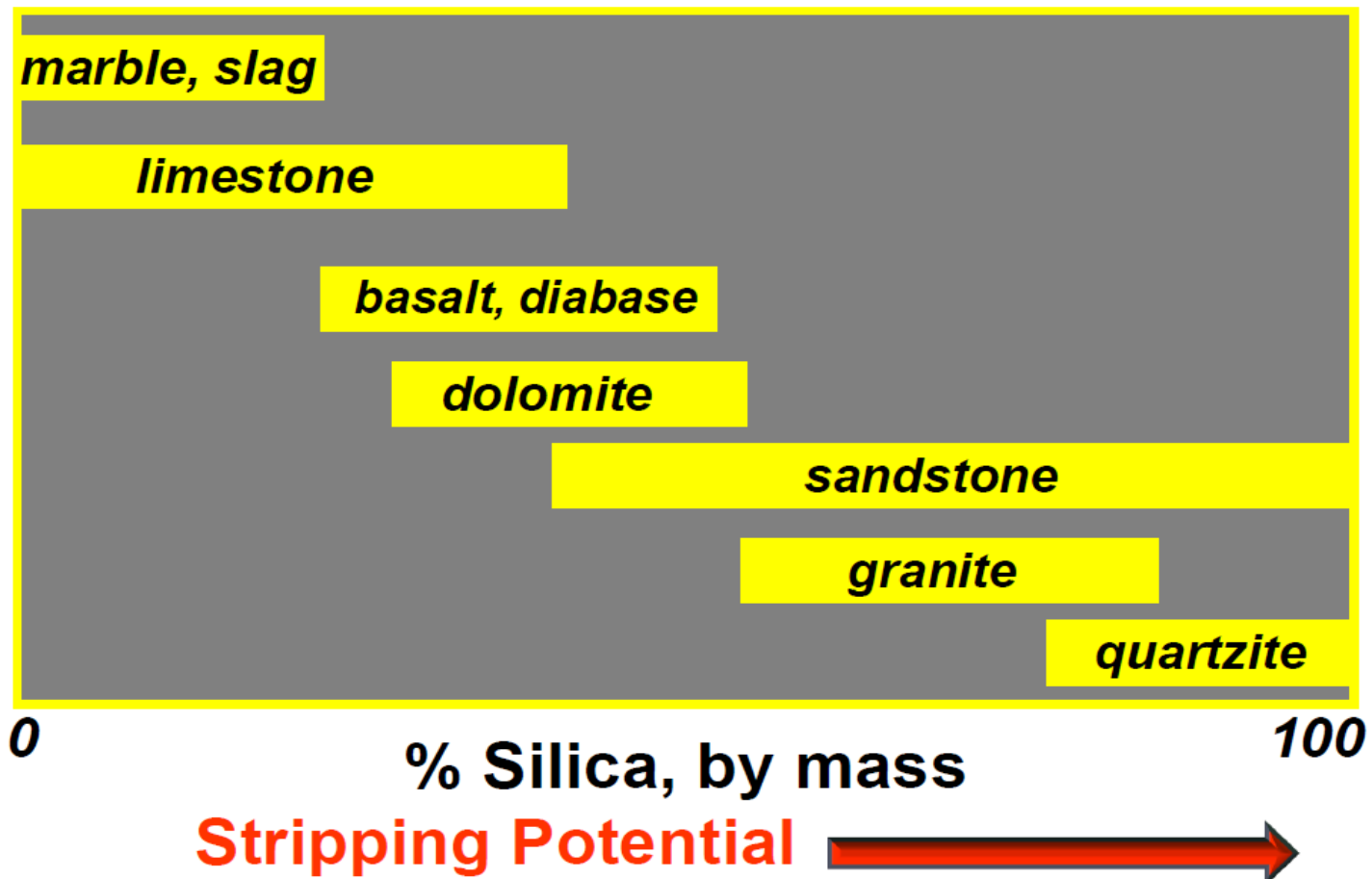
# Chemical Stripping Theory

- Water migrates into asphalt and gets into the asphalt / aggregate interface causing a negative charge to develop on both aggregate and asphalt surface over time.
- The asphalt strips from the aggregate because of this repulsive force.

# Role of Silicates in Stripping

- Most abundant mineral in the earth 's crust.
- Occur in almost all construction aggregates including most limestone and dolomite.
- Silica in the aggregate reacts with water yielding a negatively charged aggregate surface.

**Aggregates Rich in Silica Have More Propensity to Strip**



# Asphalt roll in stripping

- When water comes in contact with carboxylic acid groups in asphalts a reaction occurs yielding a negative charge.
- Asphalts with high asphaltenes resist this reaction (hydrophobic properties)
- Asphalts with high acidity and low asphaltenes can have poor performance even with low silica percentage aggregates.
  - This is why we need to retest mixes when we change asphalt sources.

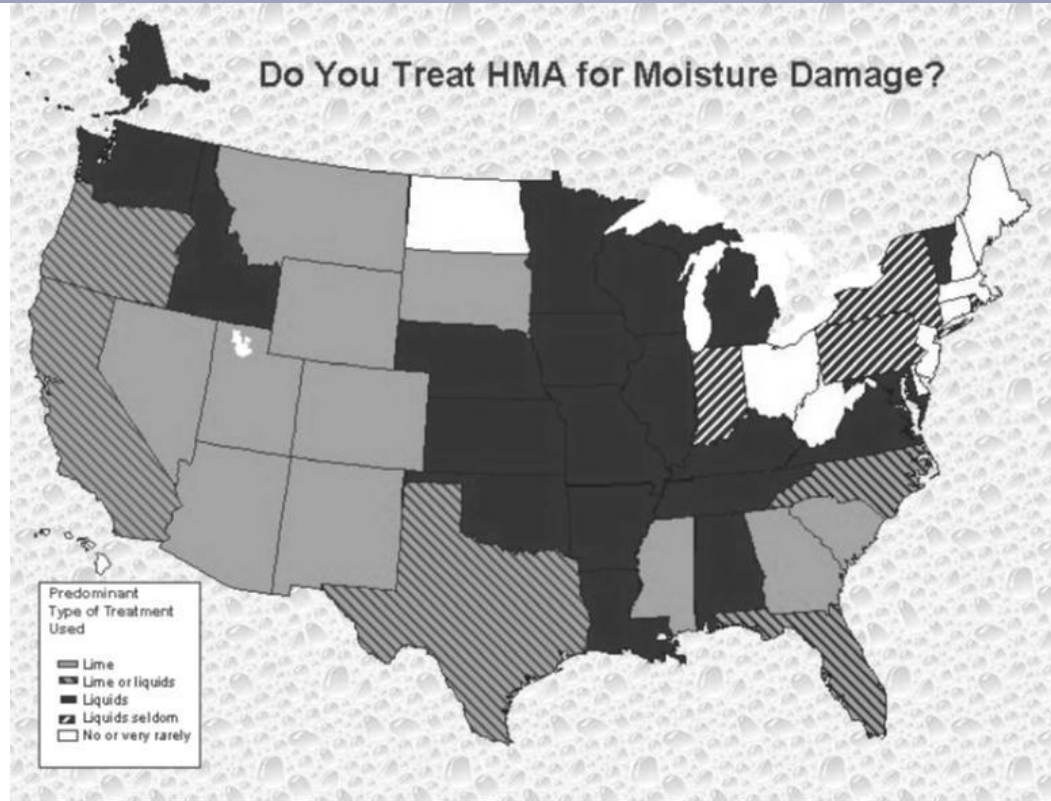


# Factors Affecting Stripping

- Aggregate composition (Silicate content)
- Asphalt Chemical Characteristics
- Effective Asphalt ( $P_{be}$ )
- Density of pavement ( $V_a$ )
- Pavement Drainage
- Aggregate Cleanliness



# Anti-Strip use



Use of Anti-strip Additives in the United States (Hicks et al., 2003).

# History

- The procedure for Moisture Susceptibility testing in PA prior to Oct 20, 2014 had several large differences from the AASHTO T 283 specification.
  - Loose mix is conditioned for 4 hours at 145° C instead of 16 hours at 60° C.
  - Vacuum was applied to conditioned specimens at 254 mm (10 in.) of mercury, for 30 minutes regardless of the degree of saturation.
  - Did not allow any field mixed material to be used for testing. (foamed WMA not testable)

# Indications of a Problem

- Had severe and obvious problems with the premature deterioration of some asphalt mix designs with certain aggregates.
- Districts with moisture damage issues were forced to **require** minimum amounts of liquid anti-strip additives to mitigate moisture damage problems.
- No mix designs ever seemed to fail PA modified AASHTO T283 testing needing anti-strip.
- Mix designs in border areas with other states needed anti-strip when used in other states but not in PA.

# Research Project Started

- COST BENEFIT ANALYSIS OF ANTISTRIP-ADDITIVES IN HOT MIX ASPHALT WITH VARIOUS AGGREGATES research started 2011.
- Final report due May 2015.
- Unexpected results during the material testing phase of the project demanded action.

# Test result that told us we had a problem

Test Result	Moisture Resistance of Aggregates in Mix		
	Good	Moderate	Poor
Passed	3	1	5
Failed	0	0	0
Error Rates	Type I	Type II	
	0 %	100 %	100 %



# Overall Accuracy of Modified Lottman Procedure, Level 2 Severity as Reported in Literature

Test Result	Stripping Potential of Aggregates in Mix		
	Low	Moderate	High
Passed	18	8	5.5
Failed	1	5	17.5
Error Rates	Type I	Type II	
	5 %	61 %	25 %

# Action Taken

- Letter to all producers of bituminous mixtures dated October 20, 2014.
  - Requires all **SRL – E and H, 12.5 mm and smaller NMAS** mixes must be reevaluated before being used in the 2015 construction season.
  - Any new mix design submitted must also be evaluated under the new requirements.
  - Districts that currently require minimum anti-strip amounts for certain aggregate types will continue to require them.

# Highlights of Revised Testing Requirements

- Allows plant mixed lab compacted mixture to be used for T 283 testing.
  - Gradation and asphalt content for plant mixed material must meet multiple sample ( $n \geq 3$ ) tolerances.
  - Foamed warm mix can be tested.
- Mixture curing times revert to the T 283 curing time of  $16 \pm 1$  hour at  $60 \pm 3^\circ\text{C}$ . ( $140 \pm 5^\circ\text{F}$ )
  - Curing times do not apply to field mixed specimens.
- The conditioned specimens must reach a degree of saturation of between 70 and 80 percent.

# Highlights of Revised Testing Requirements

- If the DME/DMM determines that moisture susceptibility results are suspect or inconsistent with historical data or field performance , a specified level of anti-strip additive may be required in a mixture at no additional cost to the Department prior to approval.
- **Contact your DME before starting any testing. All testing is required to be witnessed unless approved by the DME.**

# 2016 Requirements

- **All mixes approved in 2016** must be reevaluated using the revised moisture susceptibility criteria in order to be approved in 2016.



# Sources

- C, Ivan Harnish, ArrMaz Custom Chemicals, 2/3/2010 PowerPoint
- Kevin Gnegy P.E., District 9-0
- Don Christensen, Advanced Asphalt Technologies, LLC
- Dennis Morian, Quality Engineering Solutions, Inc.

# Questions?

You miss 100% of the shots you don't take.

-Wayne Gretzky-