# Slurry Seal and Micro Surfacing Systems

# Definition of an emulsion

An emulsion is a homogeneous mixture of two immiscible liquids.

- Immiscible liquids:
  - Liquids that normally don’t mix
    - Oil (or, in our case, asphalt) and water
- Homogeneous:
  - Mixture must have the same composition, throughout
  - No layering

# Example: Salad dressing

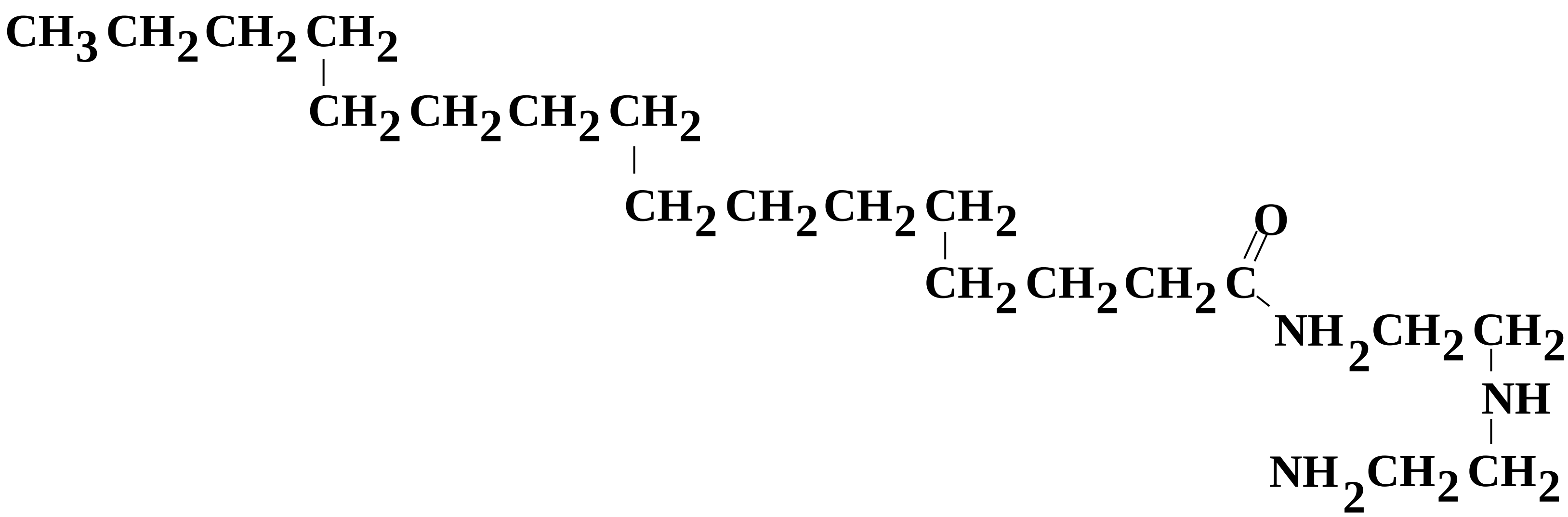
**Not an emulsion**

**Unstable emulsion**

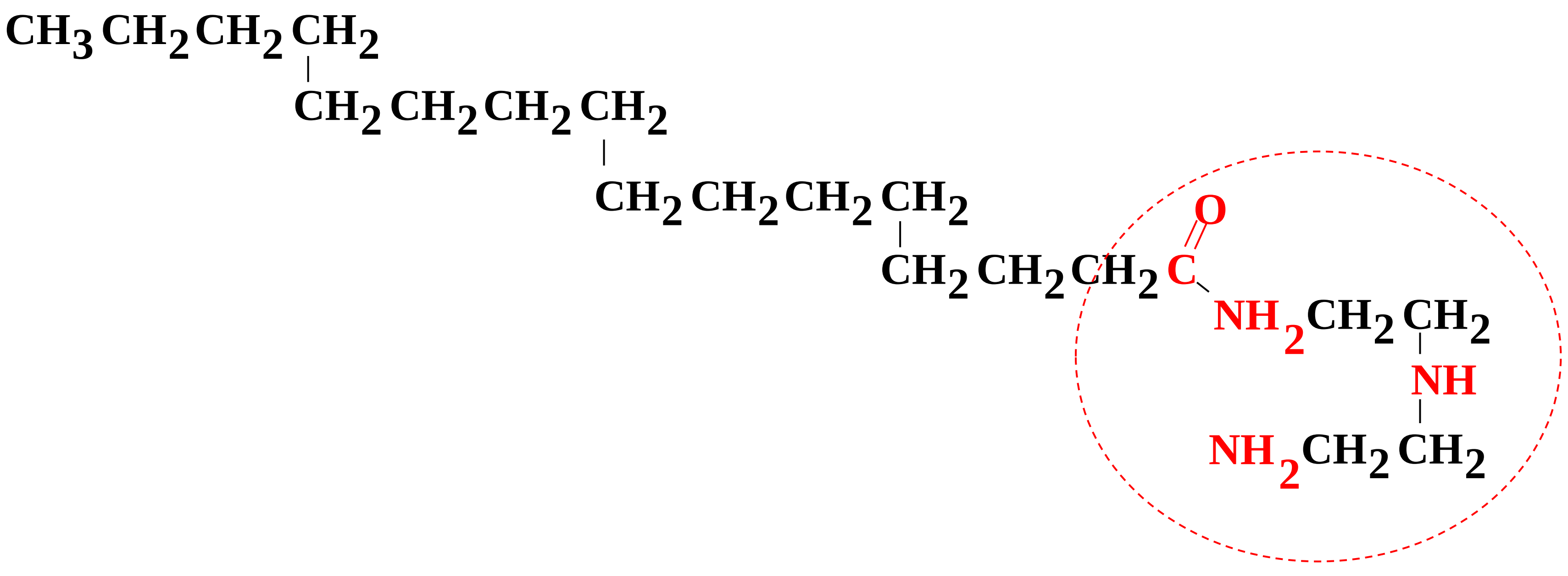
# Roles of the emulsifier

- Imparts stability
  - Prevents layers from forming
- Imparts charge
  - Cationic vs. Anionic (Positive vs. Negative)
- Imparts mixing and curing characteristics
  - Slow Set vs. Quick Set

# Cationic emulsifier structure

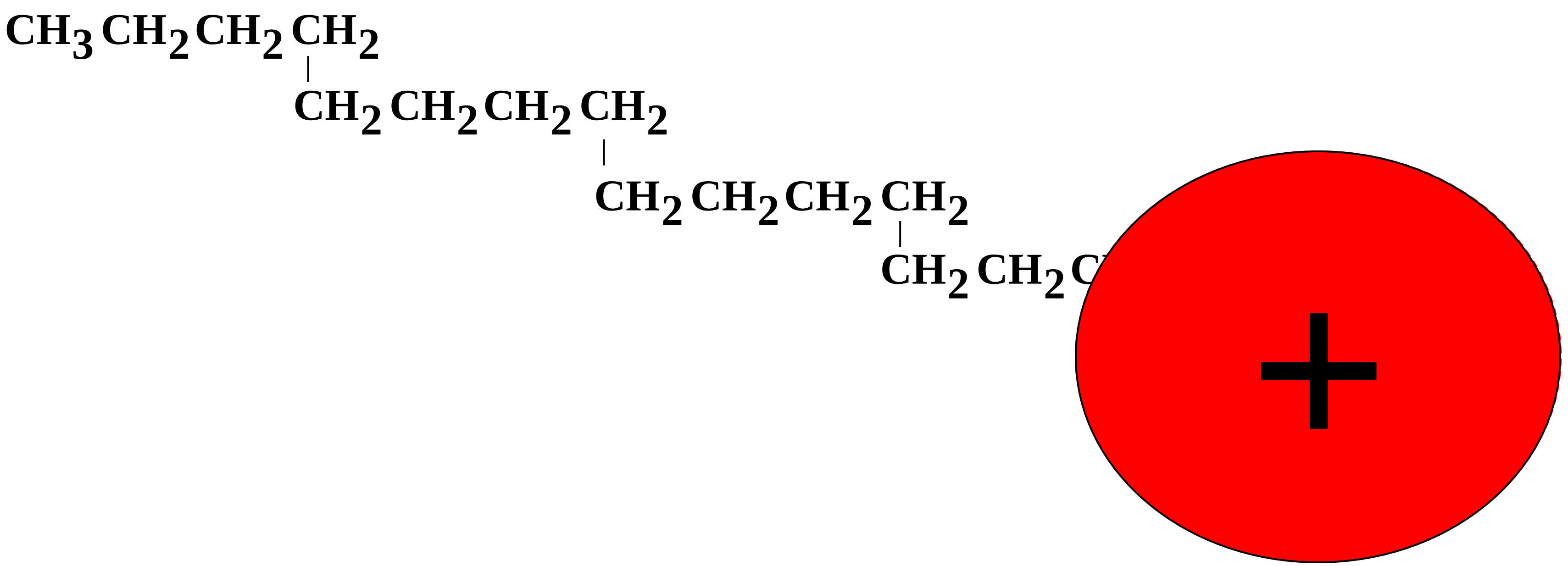


# Cationic emulsifier structure




**Head group: Polar, water loving (or hydrophilic)**

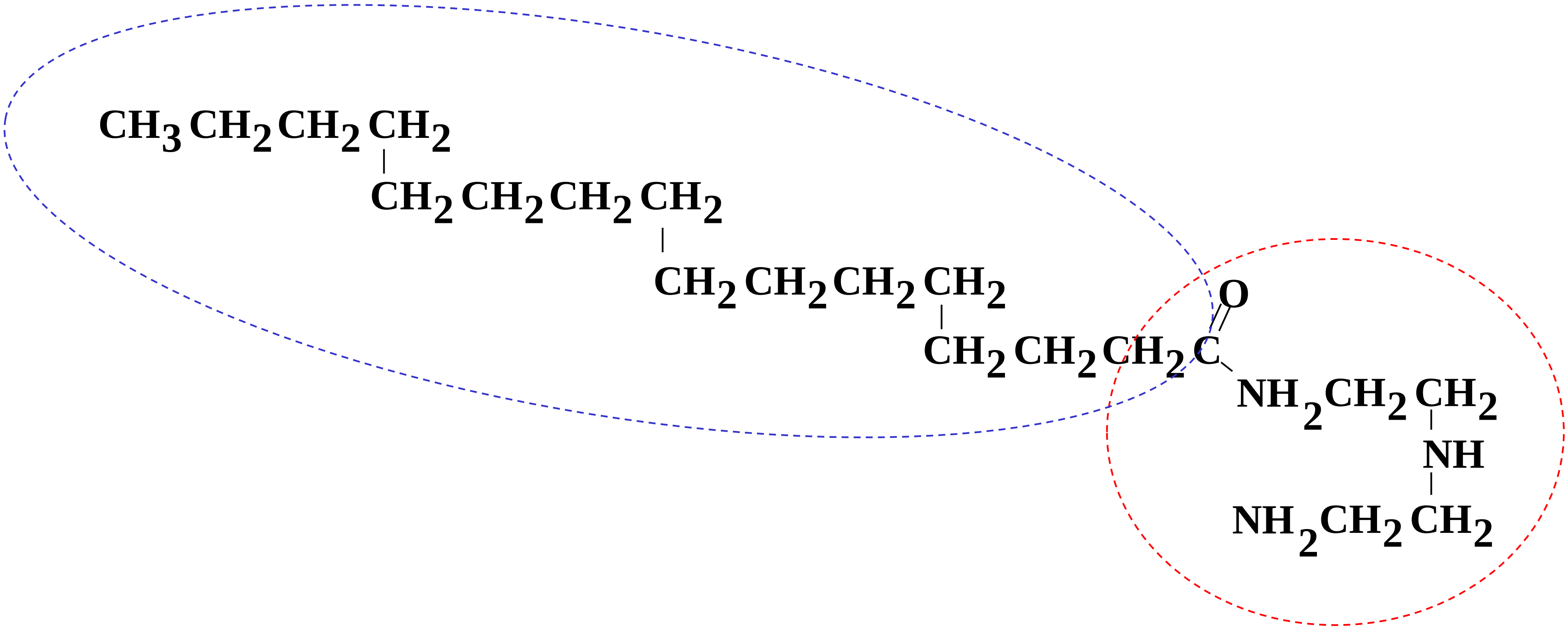
# Cationic emulsifier structure




**Head group: Polar, water loving (or hydrophilic)**

# Cationic emulsifier structure

**Tail group: Hydrocarbon, oil loving (or lipophilic)**

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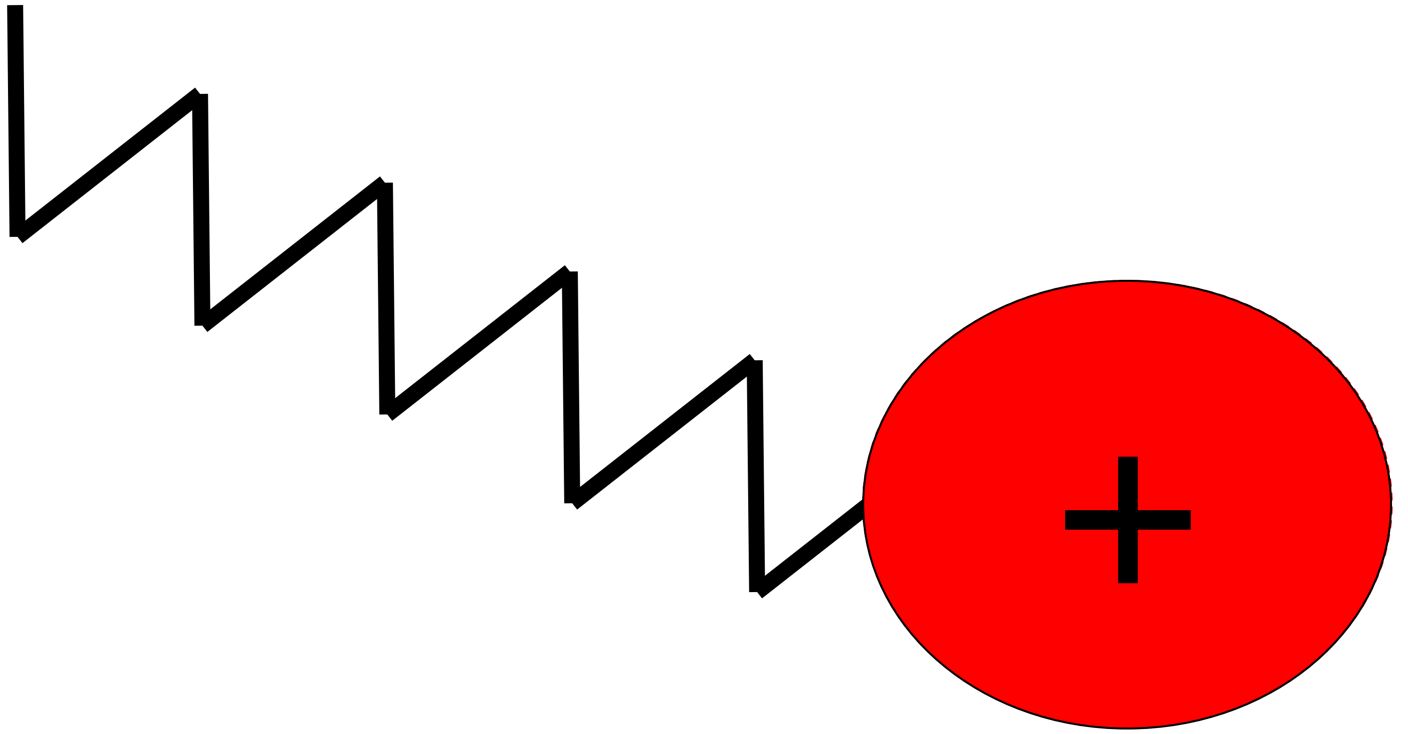
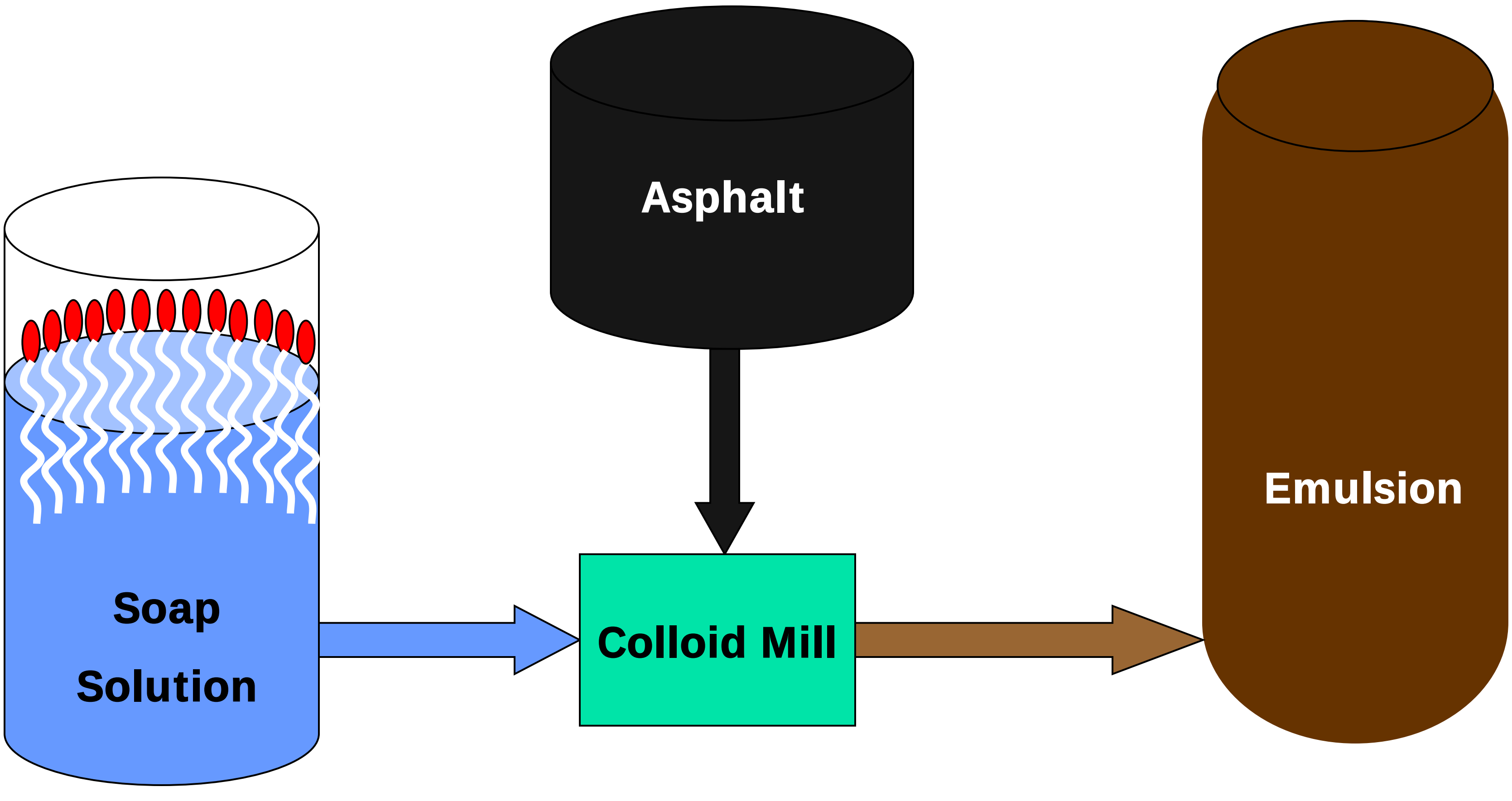
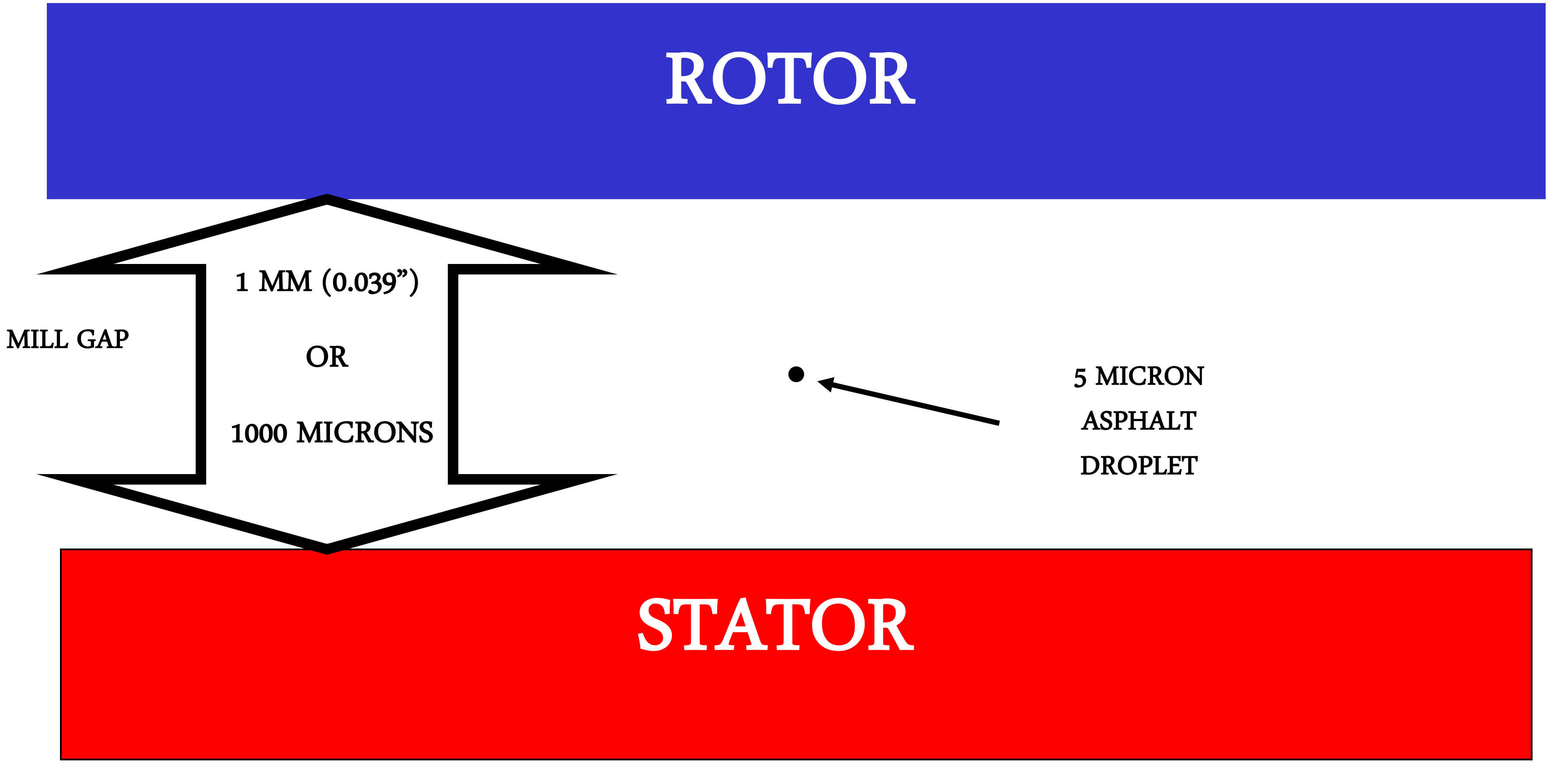



**Head group: Polar, water loving (or hydrophilic)**

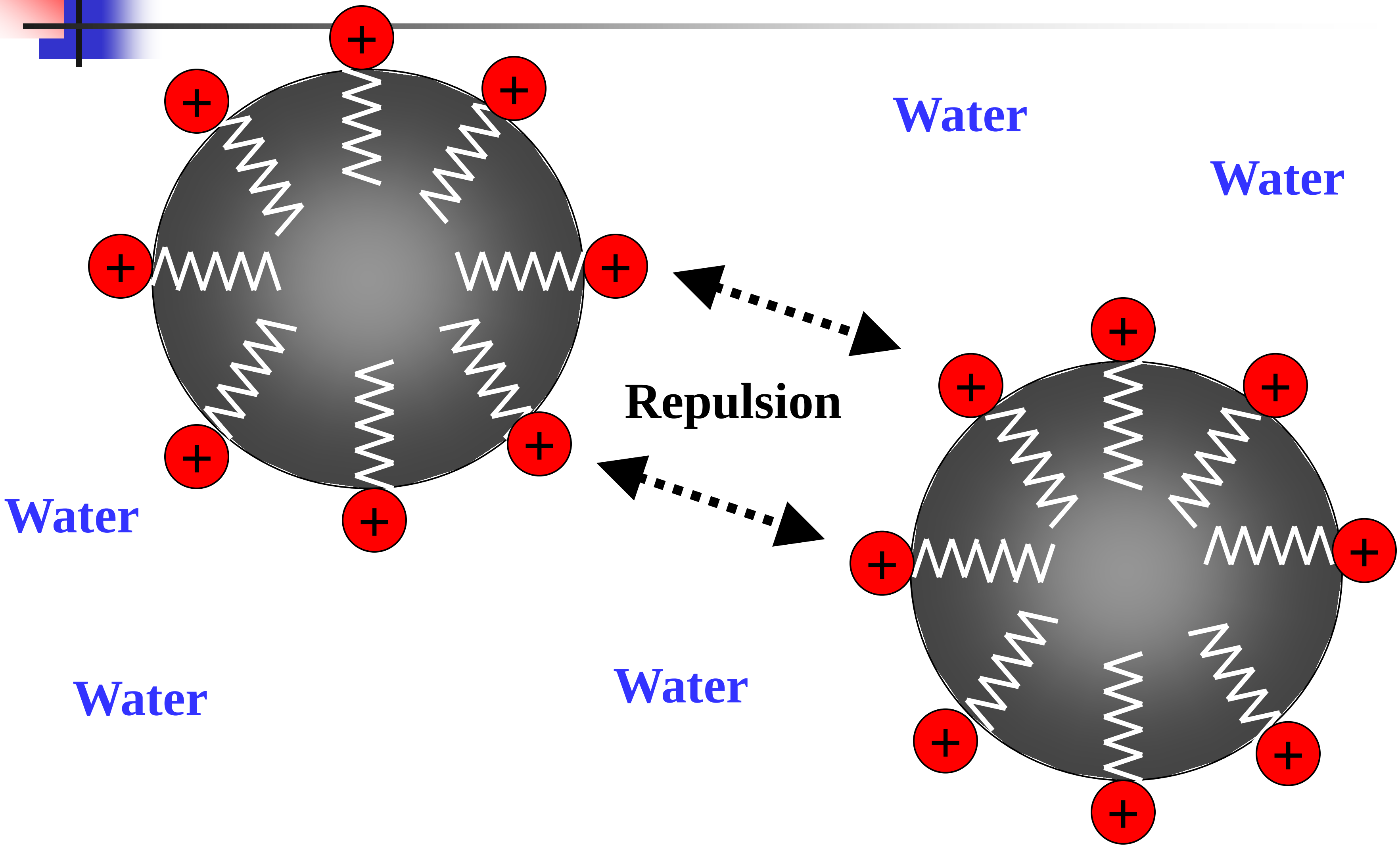
# Emulsion production



# Inside the colloid mill

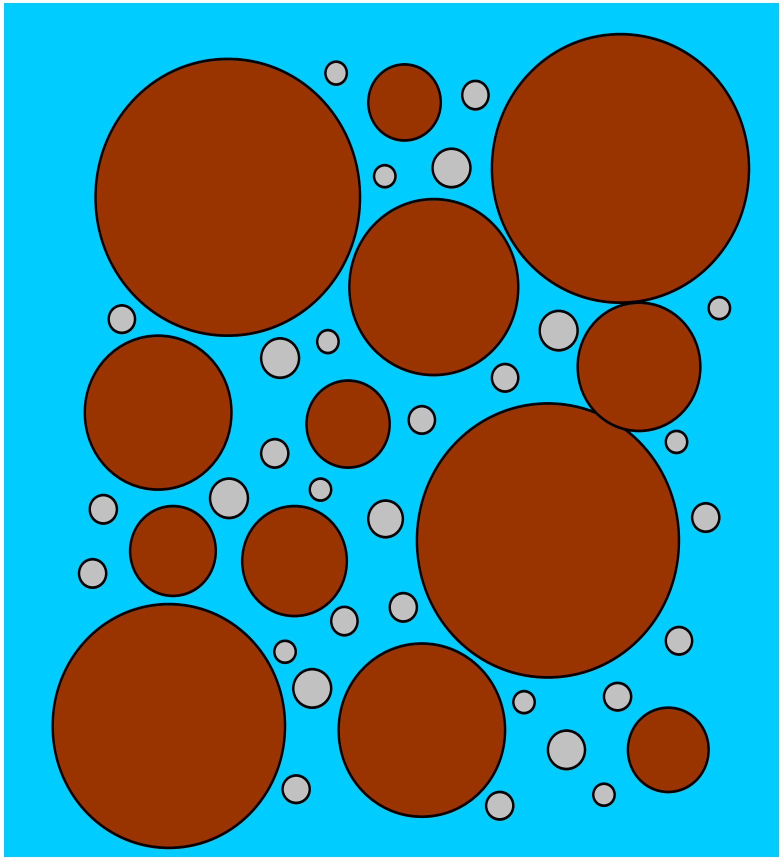


# Stabilized asphalt droplets



# Polymer in micro emulsions: Latex

- **Add latex external to asphalt**
  - Methods
    - Add to soap batch
    - Co-milling – soap line
    - Co-milling – asphalt line
  - Polymers – SBR, natural latex
  - Lower asphalt process temp.
  - No special mill, handling
- **Polymer in water phase**
- **Continuous polymer film formation on curing**

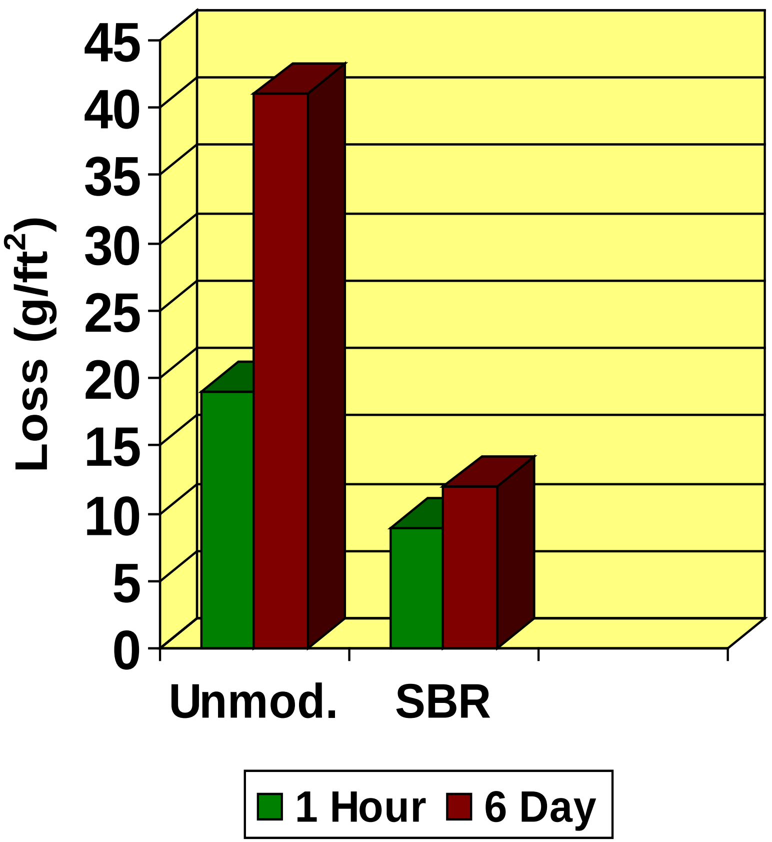


# Polymer in micro emulsions: SBS

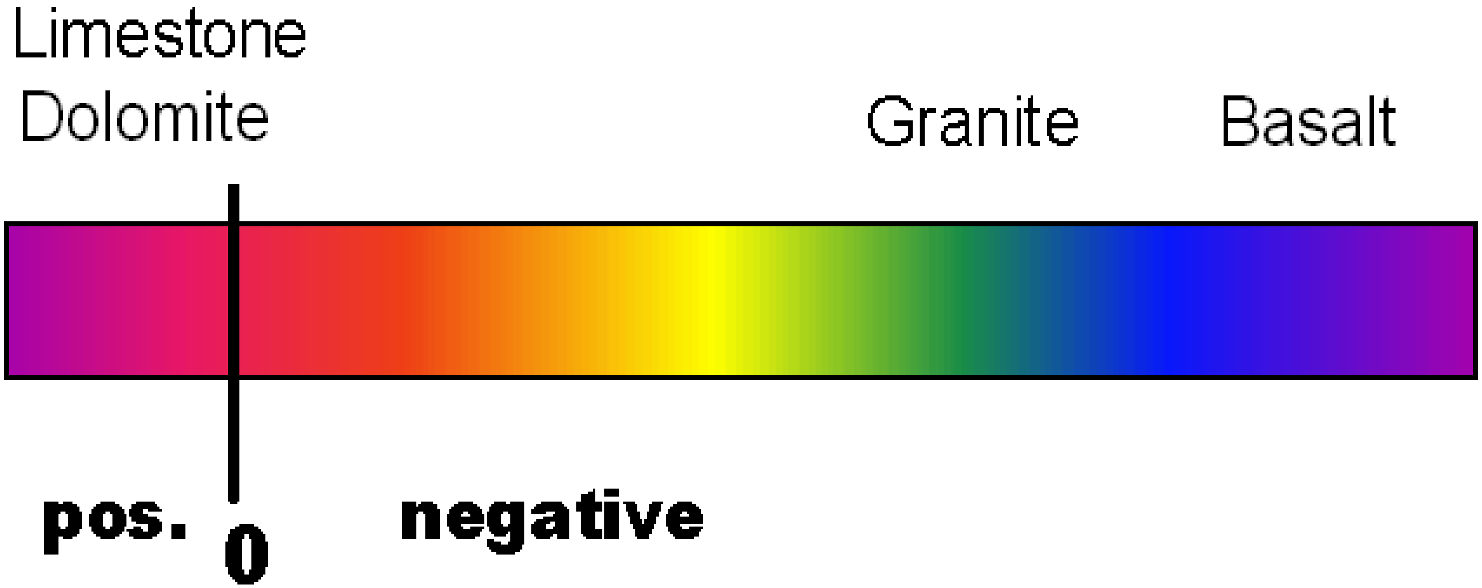
- **Add SBS to the asphalt before milling (produce the emulsion with PMA base)**
  - Polymers – SBS
  - PMA production requires special mill for production
  - PMA requires high process temperature
    - Emulsion plant needs a heat exchanger
- **Polymer in asphalt phase**
  - Stiffer residue may lead to slower film formation/curing
  - Softer starting base may mitigate that issue

# Benefits of adding latex

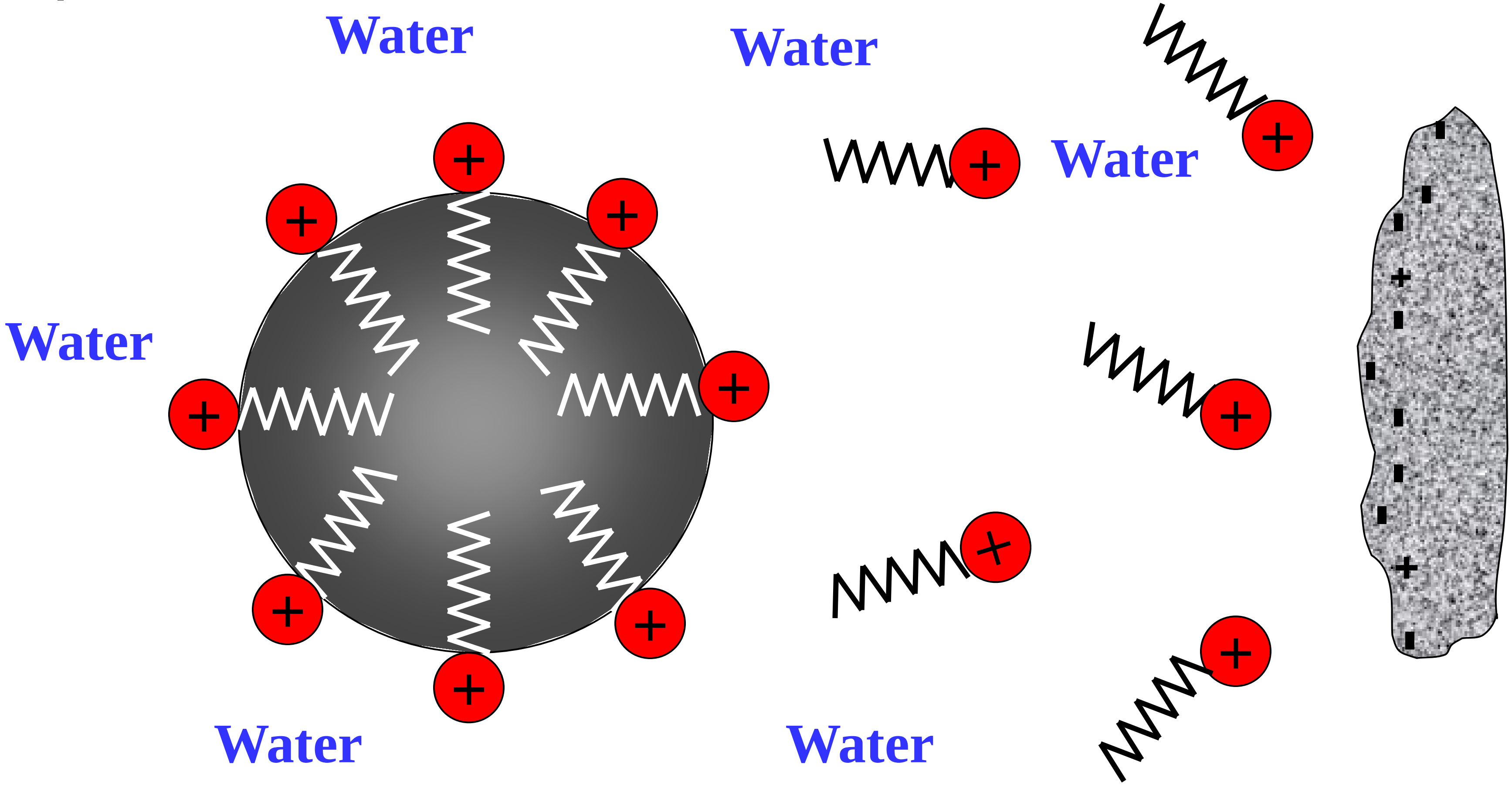
- SBR latex polymer
  - Mixture
    - Tougher surface
    - More resistant to abrasion
    - Improved adhesion and water resistance
  - Data
    - One-hour soak
      - 50% reduction in loss
    - Six-day soak
      - 67% reduction in loss



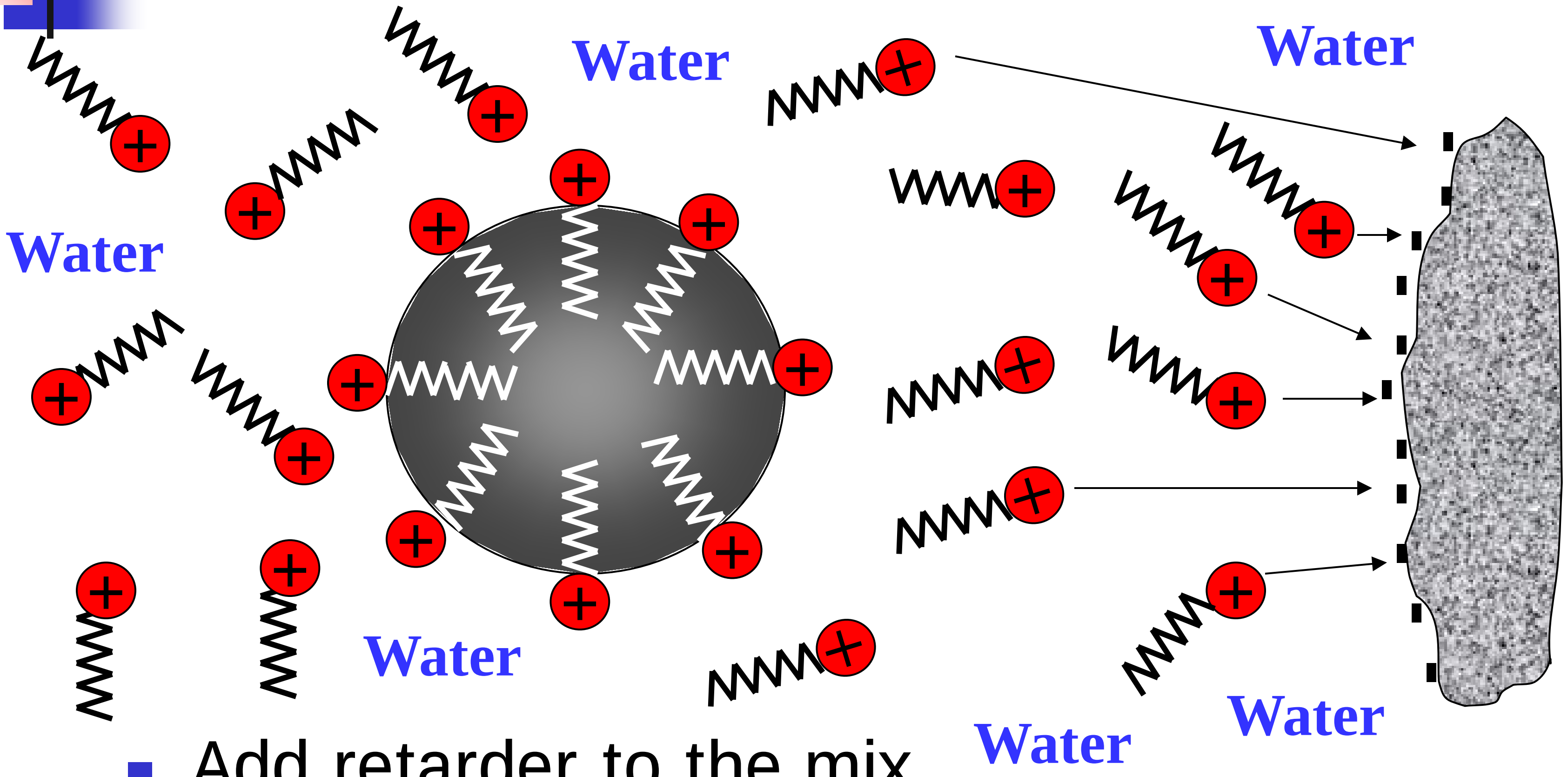
# Aggregate charge



# The chemistry of mix time

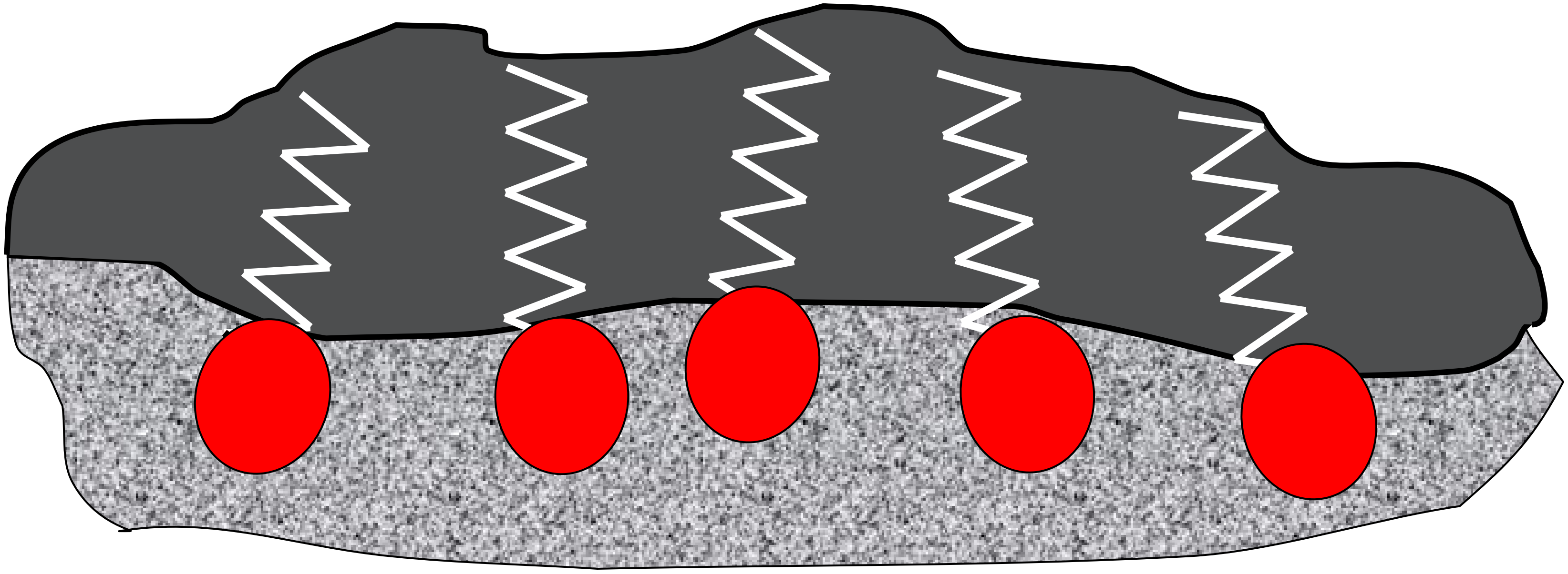


# Increasing mix time




- Add retarder to the mix
- Increase emulsifier dosage in the emulsion

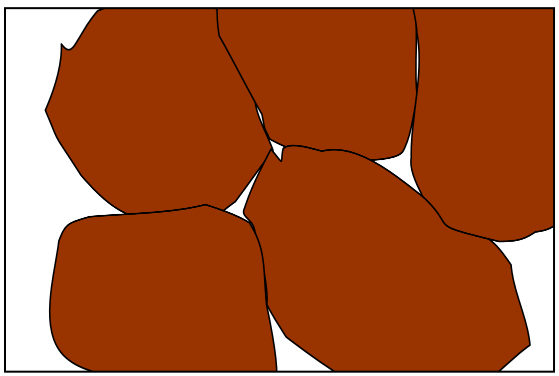
# Chemical break



# Residue – Latex modified vs. polymer modified

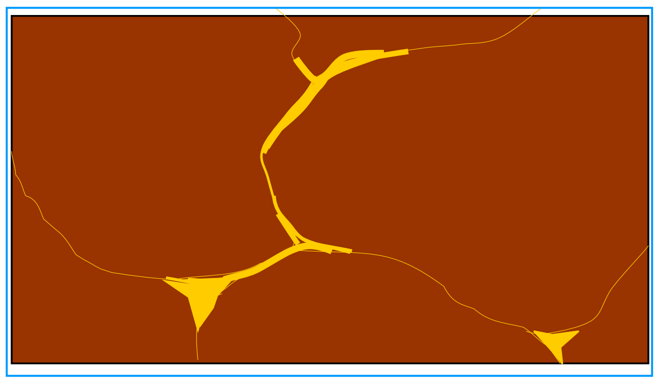
**Dried emulsion residues (coalesced asphalt particles)**

**Neat asphalt**



**Asphalt rheology only**

**Latex modified emulsion**

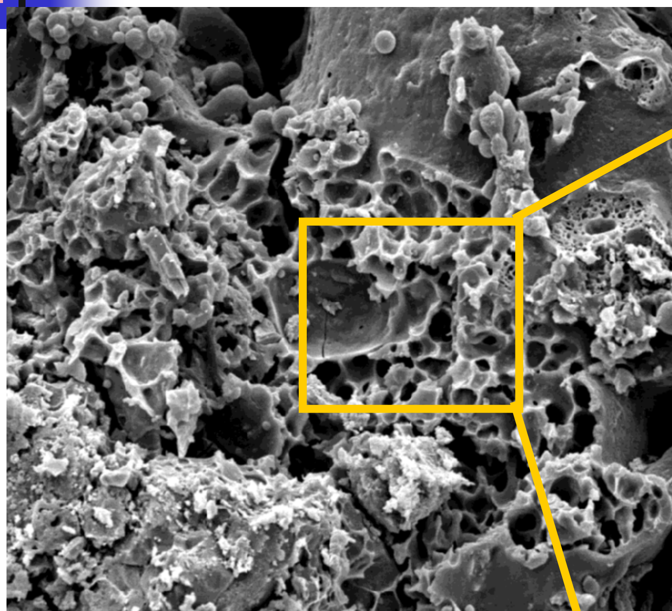


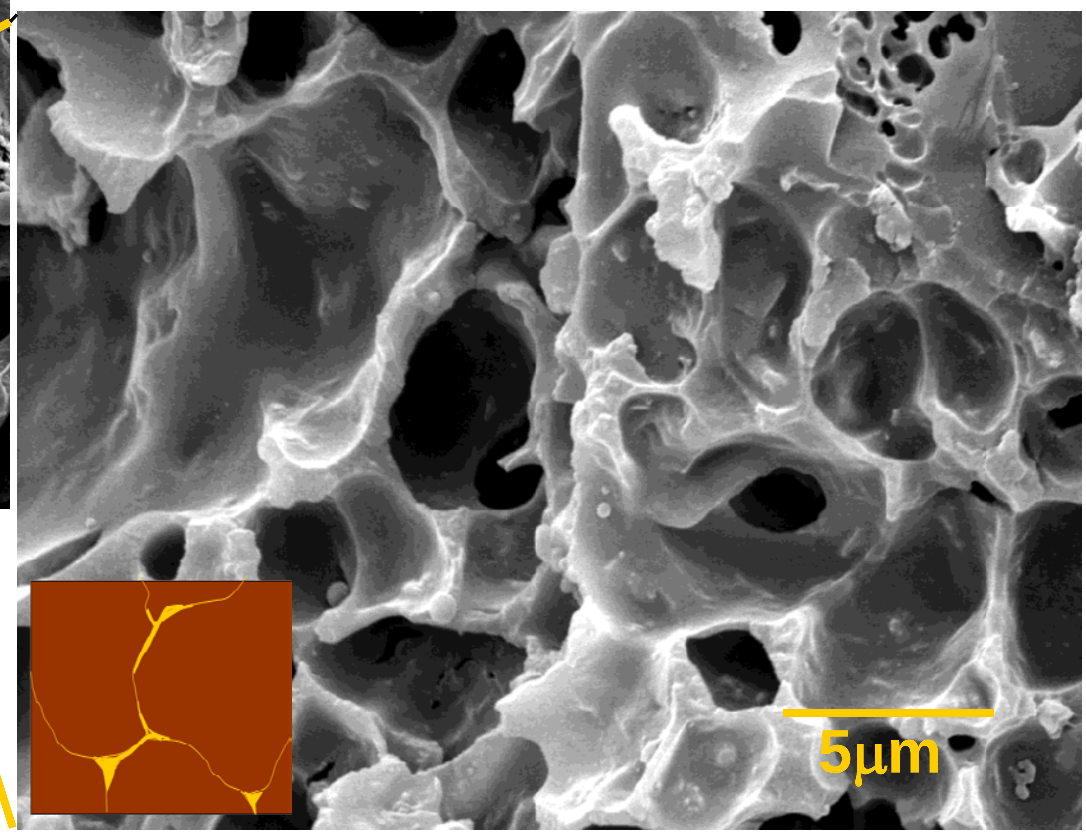
**Emulsion of polymer modified asphalt**

**Improved binder properties**

- **Improved low temperature fatigue properties**
- **Reduced rutting at high temperature**
- **Improved early strength development**

# Latex morphology






**Texas State Highway 84**

Near Waco,TX

- Paved in 1998
- Samples taken in 2001

# Mineral filler chemistry

## Two Competing Reactions

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

**Cement (or lime) reacts with acidic emulsion**

**$CaCl_2$ is formed – Calcium ions stabilize the system**

**More stable system mixes longer**

## The Other Reaction = Chemical Break

**Cement (or lime) has high pH - When combined with acidic emulsion having a low pH - System is destabilized**

**Destabilized systems break**

# Factors that affect curing

- Water content
  - More in → More out → Longer cure time
- Mix time
  - More stable emulsion → More mix time → Longer cure time
- Emulsion pH
- Particle size of the emulsion

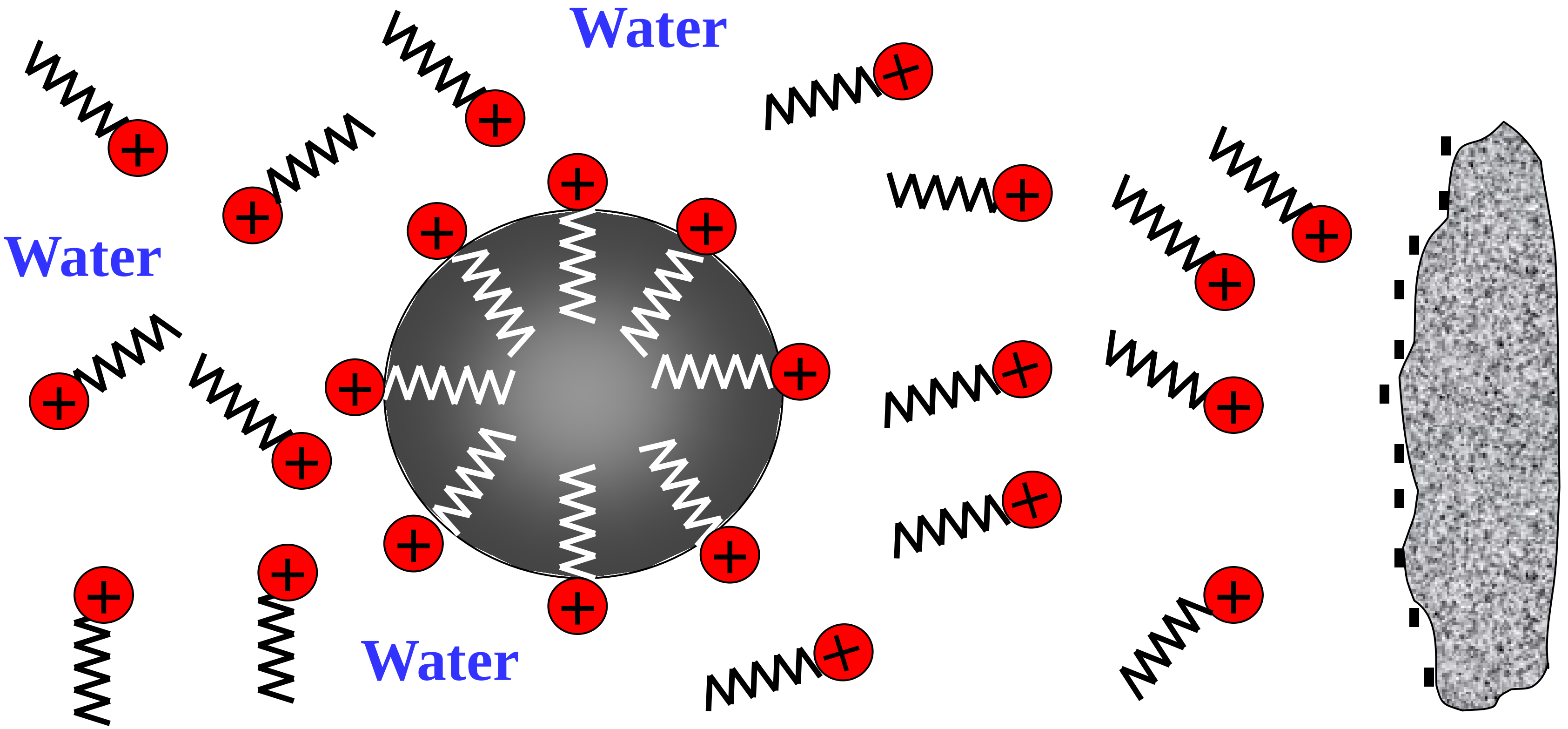
# Emulsion pH and curing

- Siliceous aggregate systems
  - Negatively charged aggregates
    - Granite, trap rock, basalt

↓ Emulsion pH → Faster cure rates

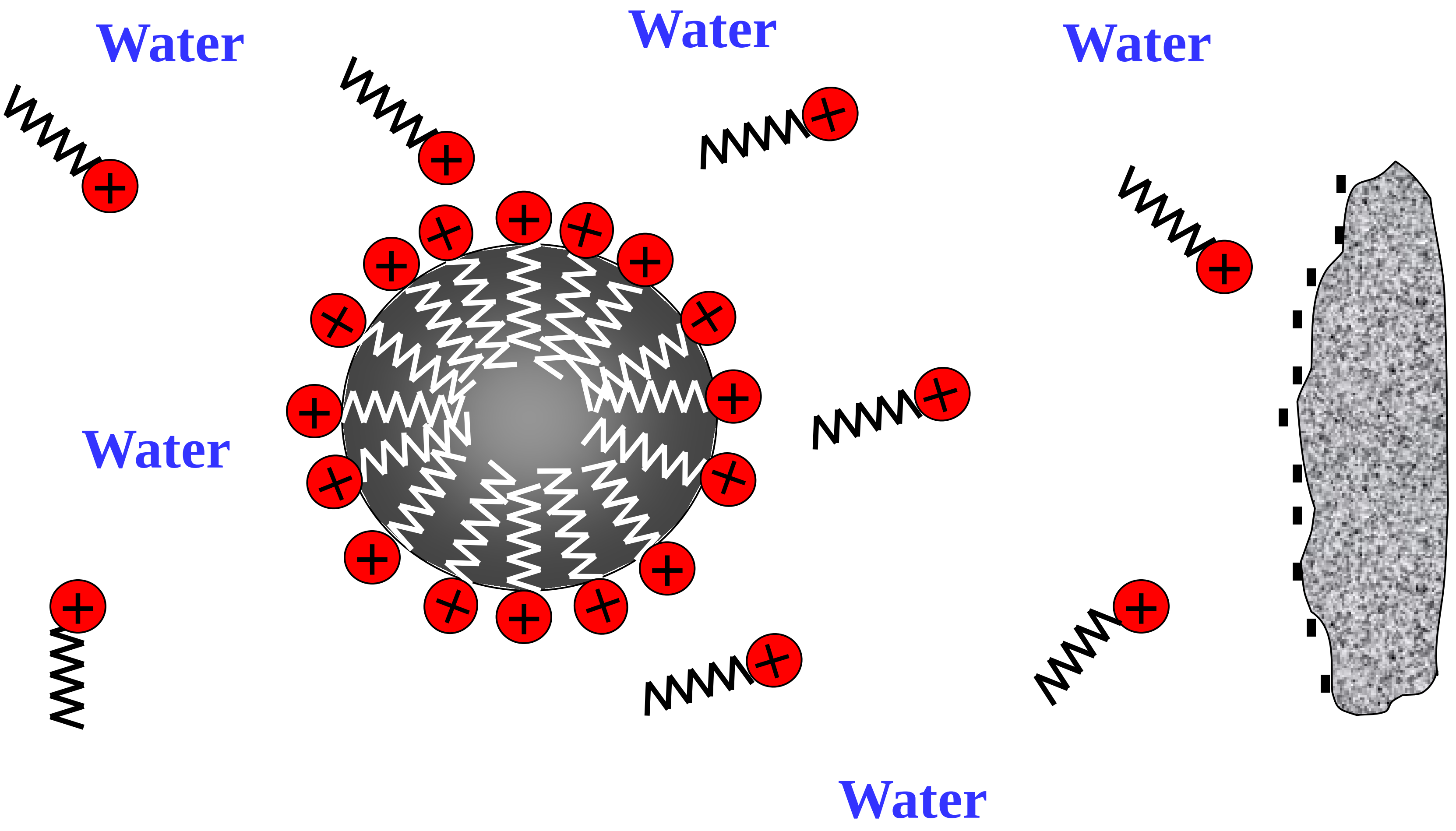
# Siliceous aggregates:

## Lower emulsion pH ➡ Faster cure rate



# Siliceous aggregates:

## Lower emulsion pH ➡ Faster cure rate



# Emulsion pH and curing

- Calcareous aggregate systems
  - Positively charged aggregates
    - Limestone, dolomite

↑ Emulsion pH → Faster cure rates

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

**Limestone reacts with acidic emulsion**

**$CaCl_2$ is formed – Calcium ions stabilize the system**

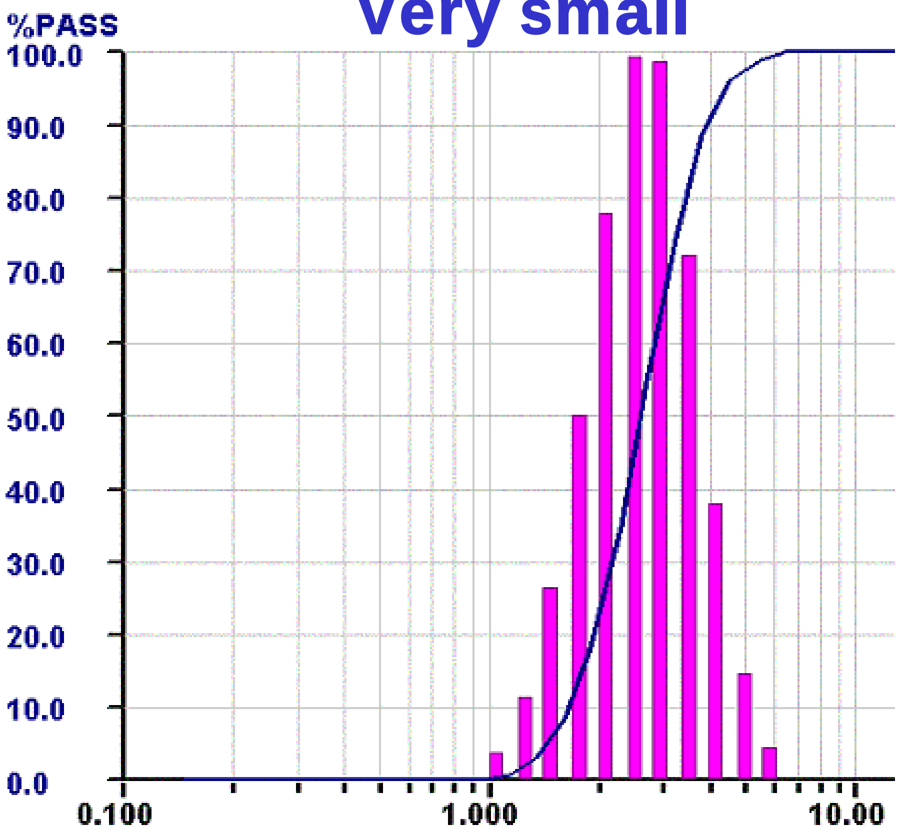
**Reducing the acid, reduces the stabilizing effect – Speeds the cure rate**

# Emulsion particle size and curing

- Smaller particle size emulsions
  - Faster cure time
- Target particle sizes
  - Average ~ 4-6 microns
  - 90% less than 7-8 microns
- Tight particle size distribution
  - Narrow bell-shaped curve

# Particle size distributions

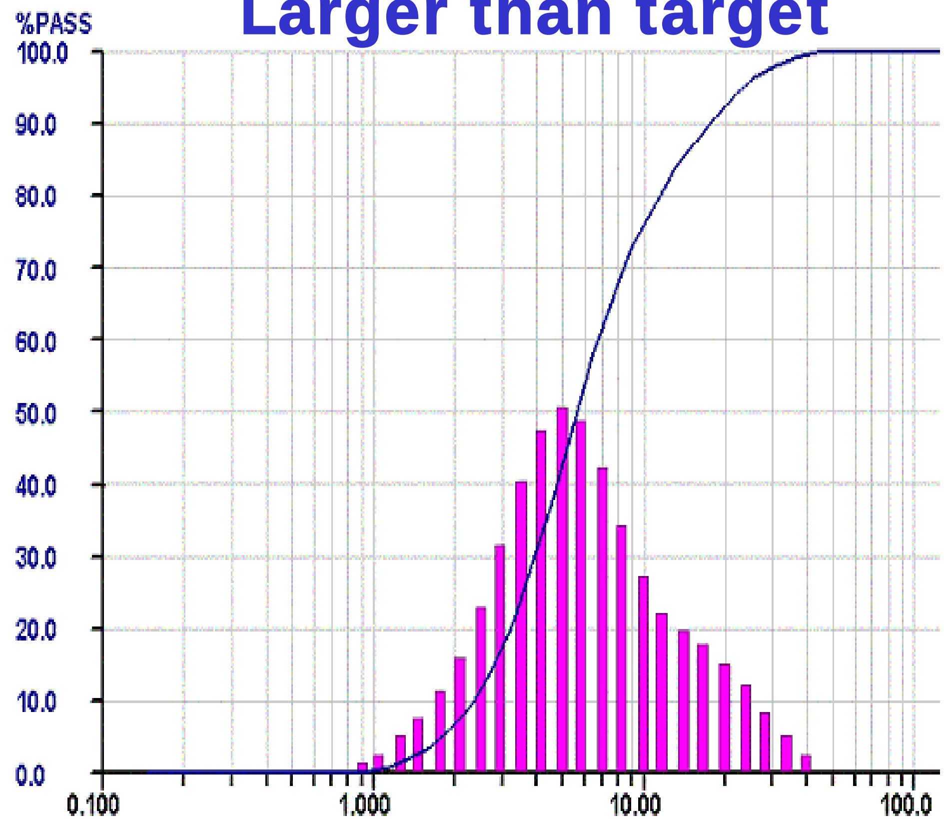
## Very small




**mv = 2.8**

**90% < 4.0**

## Larger than target




**mv = 8.1**

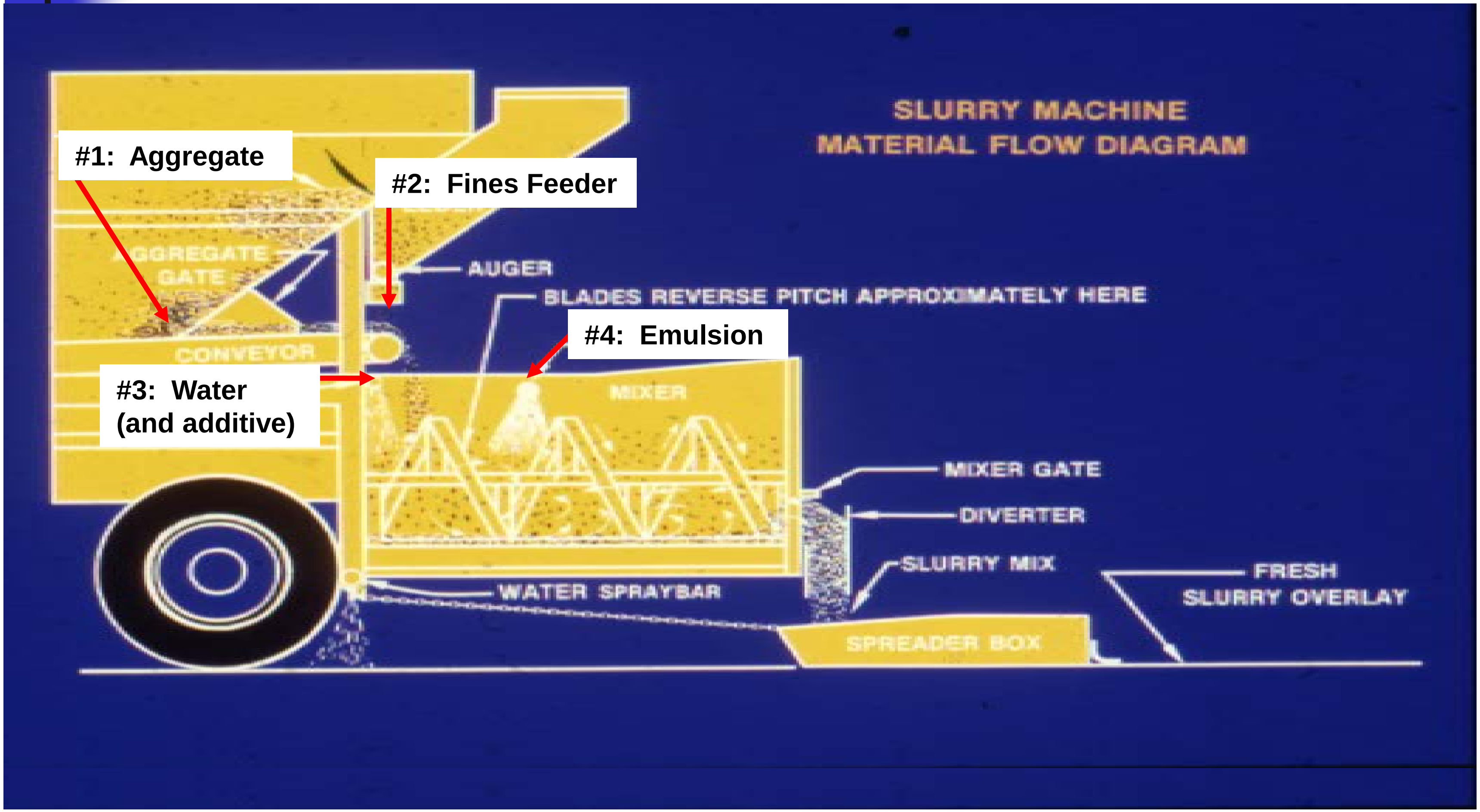
**90% < 17.7**

**Size (microns)**

# Micro surfacing testing summary

| Test | ISSA TB No. | Specification |
|---|---|---|
| Mix Time @ 77°F, seconds | 113 | 120 minimum |
| Wet Cohesion, kg-cm<br>@ 30 minutes (Set)<br>@ 60 minutes (Traffic) | 139 | 12 minimum<br>20 minimum or Near Spin |
| Wet Stripping, % | 114 | Pass (90% minimum) |
| Wet-Track Abrasion Loss, g/ft$^2$<br>One-hour soak<br>Six-day soak | 100 | 50 maximum<br>75 maximum |
| Lateral Displacement, %<br>Specific gravity after 1,000 Cycles of 125 lb. | 147 | 5 maximum<br>2.10 maximum |
| Excess Asphalt by LWT Sand Adhesion, g/ft$^2$ | 109 | 50 maximum |
| Classification Compatibility, Grade Points | 144 | 11 minimum |

# Application equipment



# Mix time test – ISSA TB 113

- **Purpose**

  To measure the amount of time a specific combination of materials will mix before breaking

- **Importance**

  Sufficient mix time will ensure the contractor has the time needed to apply the mixture and complete hand work before the mix breaks.

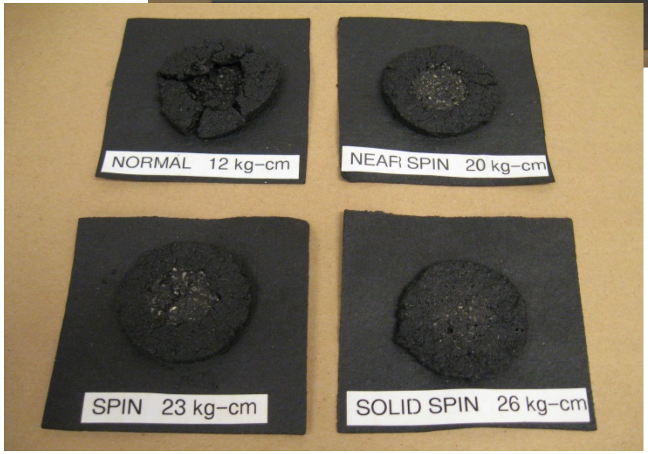
# Cohesion test – ISSA TB 139

- **Purpose**

  To determine initial set and cure development of slurry surfacing systems as a function of torque over time

- **Importance**

  This test will give the buyer agency an idea of when traffic may be returned to the pavement under given curing conditions.



# Wet track abrasion test ISSA TB 100

- **Purpose**

  To measure the wearing qualities of slurry surfacing systems under wet abrasion conditions

- **Importance**

  This test is used to determine the minimum residual binder content needed to hold the system together.

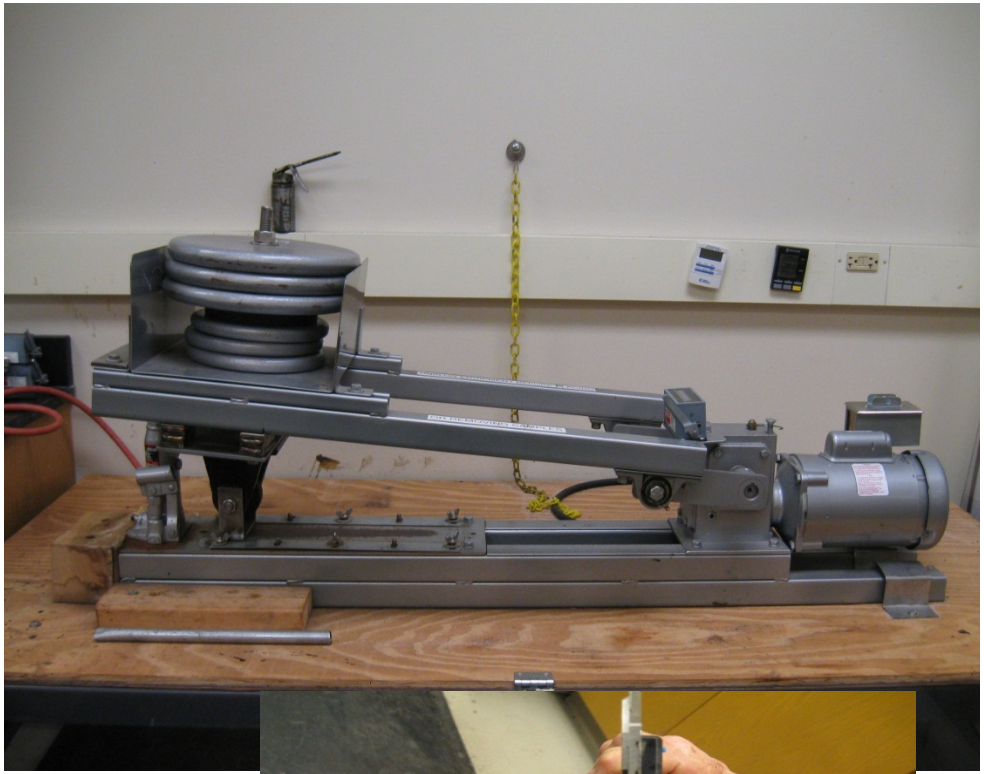

# Lateral displacement & Sand adhesion - ISSA TB 147 & 109

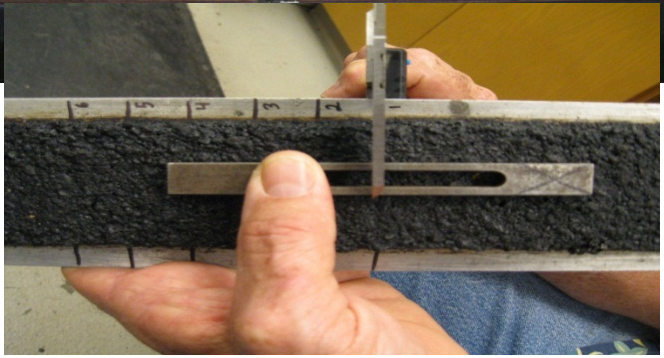
- **Purpose**

  To measure the rut resistance and/or flushing potential of slurry surfacing systems under simulated rolling traffic

- **Importance**

  This test is used to determine the maximum residual binder content a slurry surfacing system can support without rutting and/or bleeding.





# Thank you!

## Contact Information

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