NCHRP 9-53 PROPERTIES OF FOAMED ASPHALT FOR WARM MIX ASPHALT APPLICATIONS

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Foaming

- Will water affect strength and durability?
- How long will the effect of the foam last?
- How do different asphalts foam?
- How much temperature reduction can be achieved?
- Do foaming techniques produce the same quality and quantity of foam?
- What is the effect of anti-foaming agents?
- How will polymer modified binders behave?
- How will other additives interact with foaming?
- Will mix design need to be modified?

Scope

- Characterize foamed asphalt and the effects of foam on binders and mixtures
- Make testing as practical as possible by:
  - Minimizing complexity
  - Making tests applicable to lab and field
  - Simplifying equipment and making it as rugged as possible while detecting sensible differences in measurements
  - Minimizing cost of equipment and testing

Objectives

- Determine what properties of foamed asphalt binders relate to asphalt mixture performance and
- Develop laboratory foaming and mixing protocols that may be used to design asphalt mixtures

Asphalt Foaming

- Most Popular Method for Producing WMA
- Improves Particle Coating by:
  - Increasing Volume
  - Reducing Mass Viscosity
- Methods
  - Zeolite
  - Wet Sand
  - Plant Foaming Systems

Factors Affecting Asphalt Foaming

- Source of Asphalt
- Grade of Asphalt
- Presence of Anti-Foaming Chemicals
- Water Content
- Presence of Polymers
- Presence of Anti-Strip Additives
- Other Factors
  - Water Pressure?
  - Atmospheric Conditions?
  - Water Chemistry?

Foaming Methods

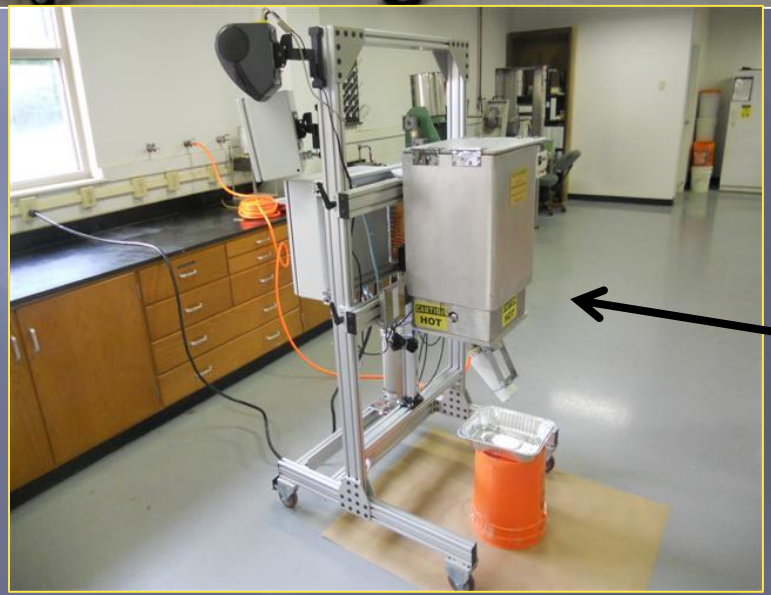
- Field
  - Mechanical Mixing
  - Venturi Mixing
  - Expansion Chamber
  - Shear/Colloid Mixer
  - Air Atomized Water
  - Atomized Water
- Lab
  - Expansion Chamber
  - Air Atomized Water

Field Foaming

A Few Available Devices

Field Foaming HP

Laboratory Foamers



Wirtgen

Instrotek

PTI

Laboratory Foaming

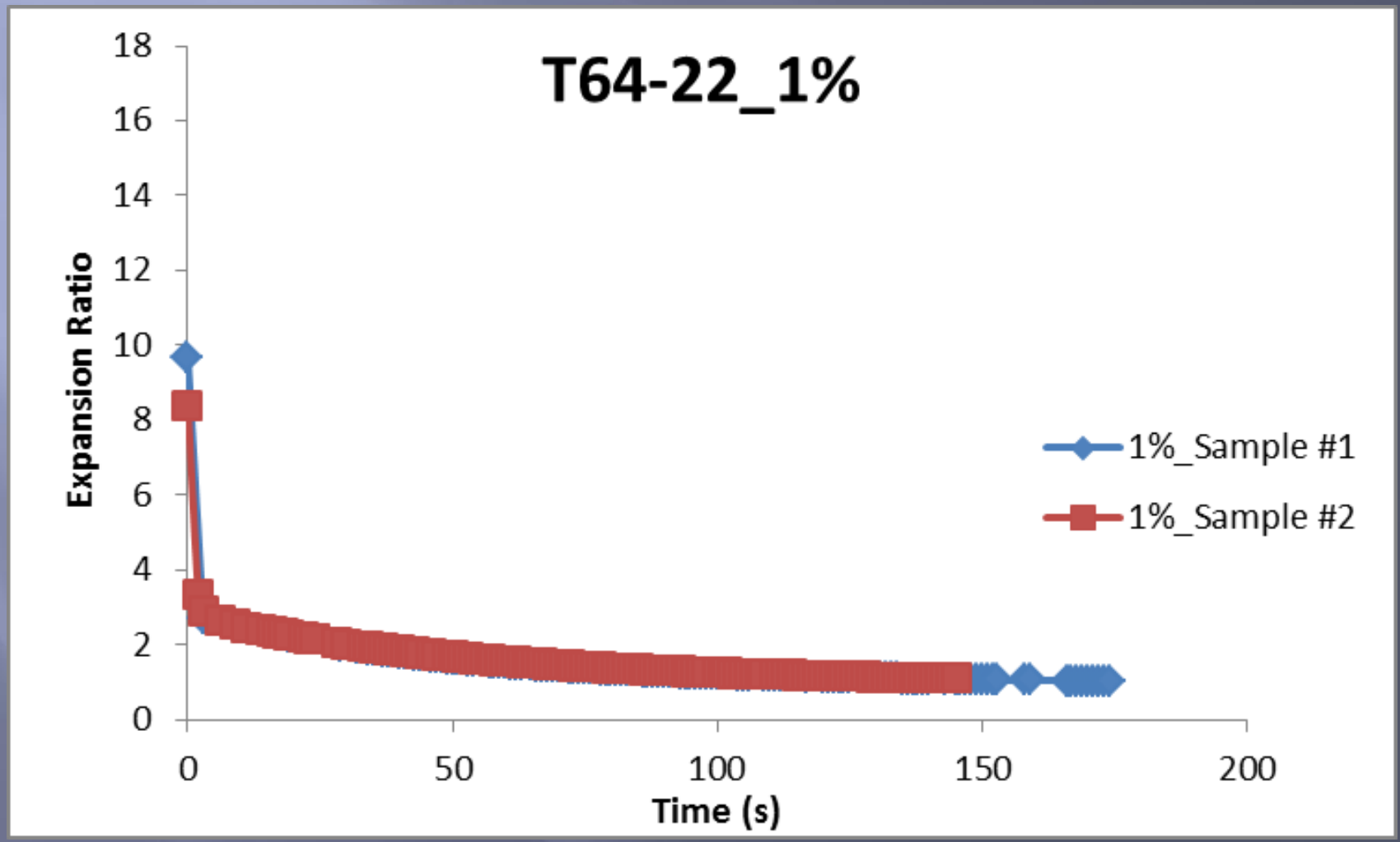
Foaming Measurements

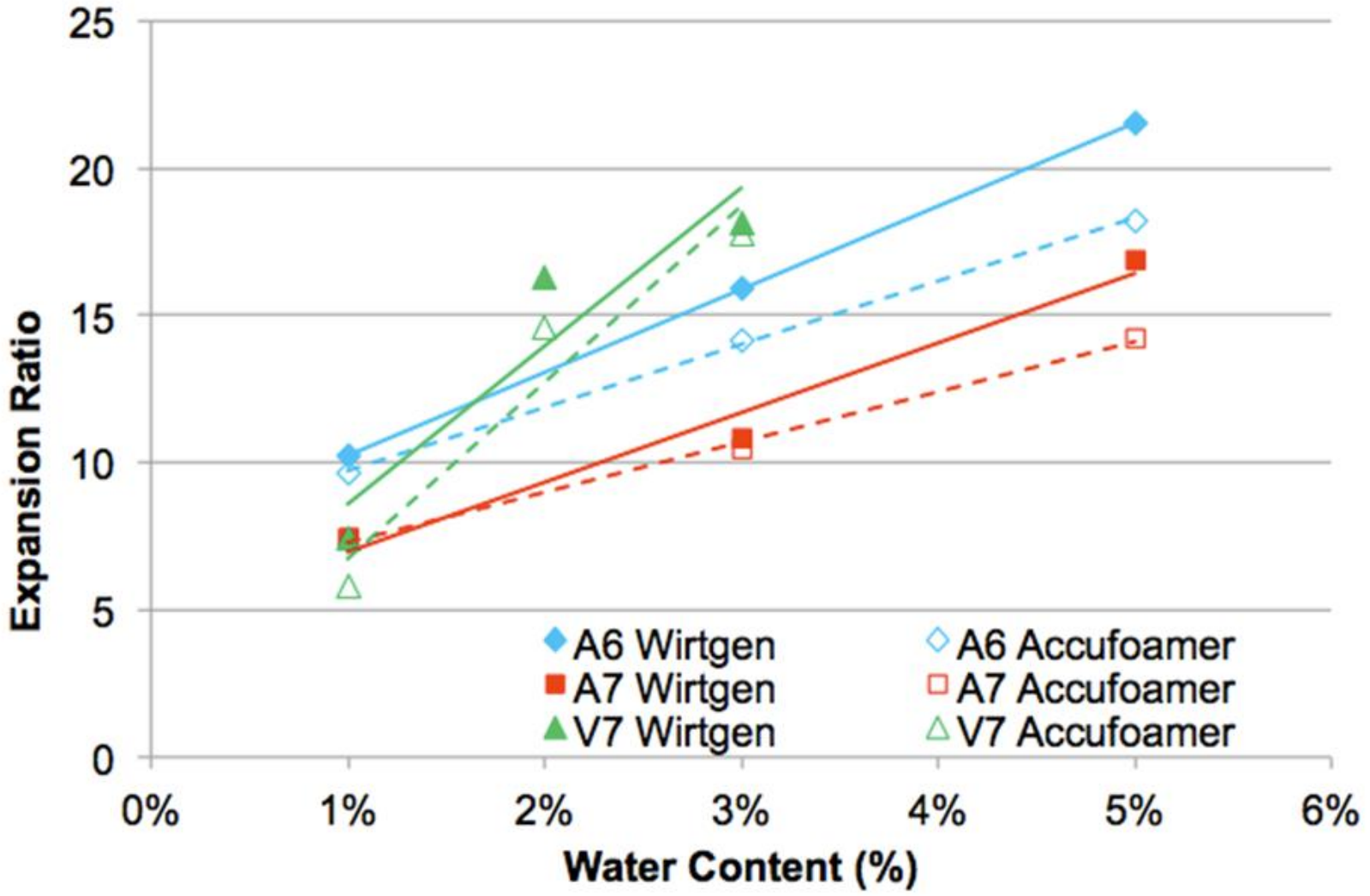
- Expansion Ratio
  - $ER = Vol_{max}/Vol_{final}$
- Half Life
  - $HL = t_{vmax} - t_{vhalf}$
- Rate of Decay
- Bubble Size Distribution

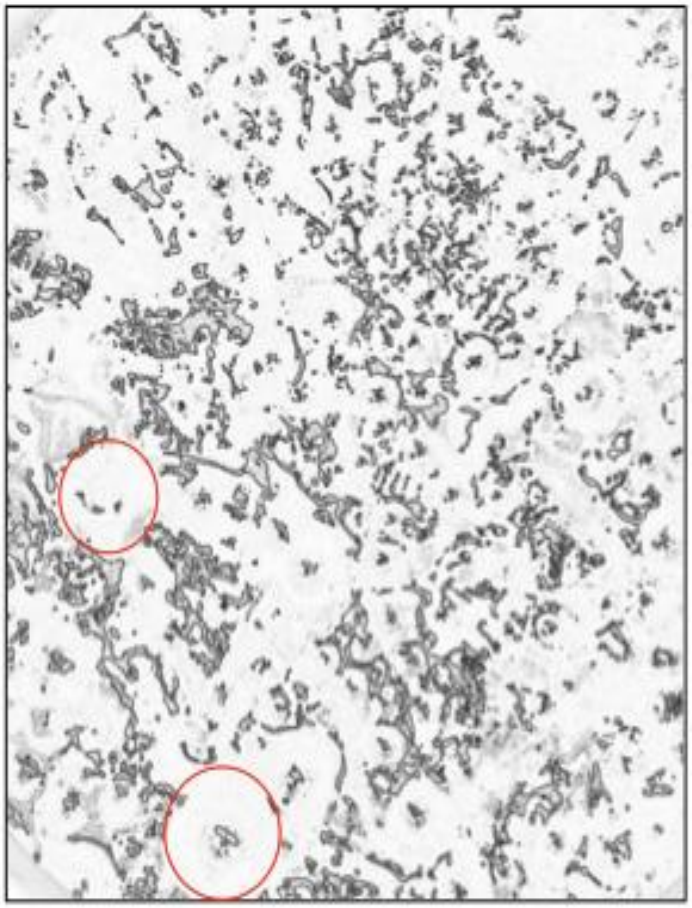
Uses of Tests

- Evaluate foamability of binders
- Optimize moisture content
  - Lab
  - Field
- Mix design for performance testing
- Relate to coatability
- Relate to workability

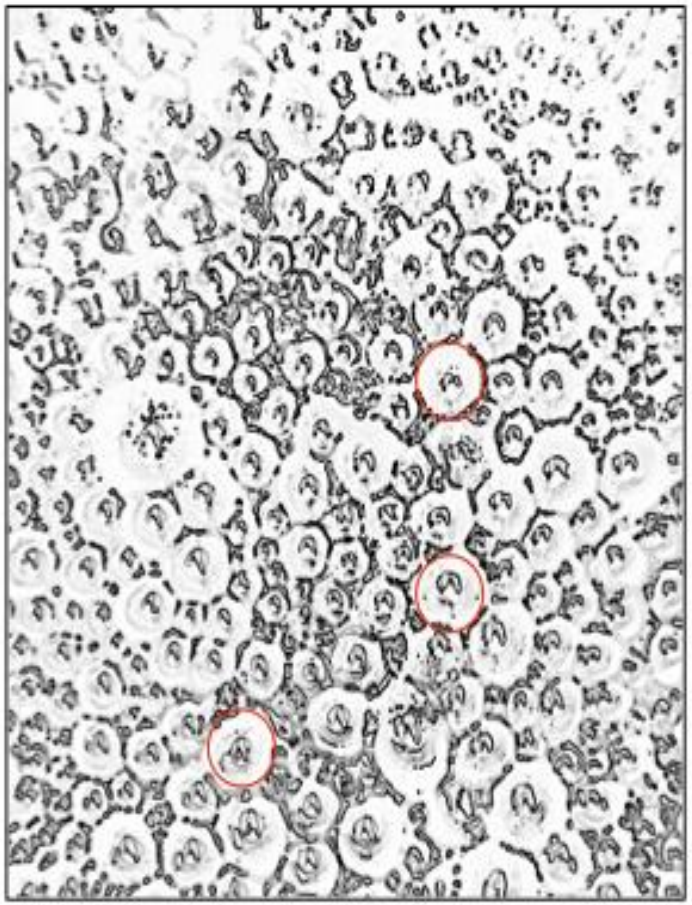
Expansion Ratio and Decay




25
20
15
10
5
0
Expansion Ratio
0%
1%
2%
3%
4%
5%
6%
Water Content (%)
A6 Wirtgen
A7 Wirtgen
V7 Wirtgen
A6 Accufoamer
A7 Accufoamer
V7 Accufoamer

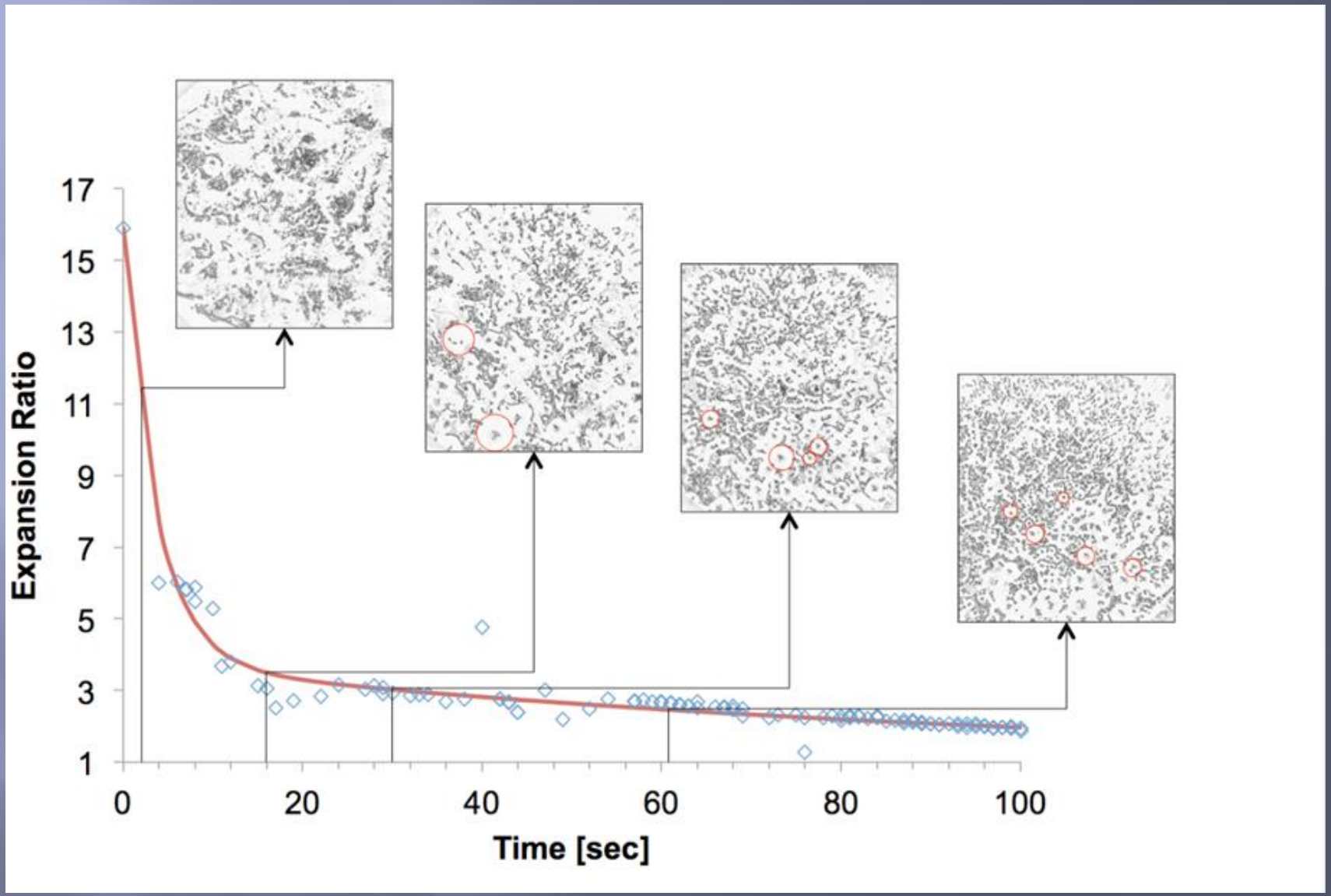


After
30 sec.



3% Moisture

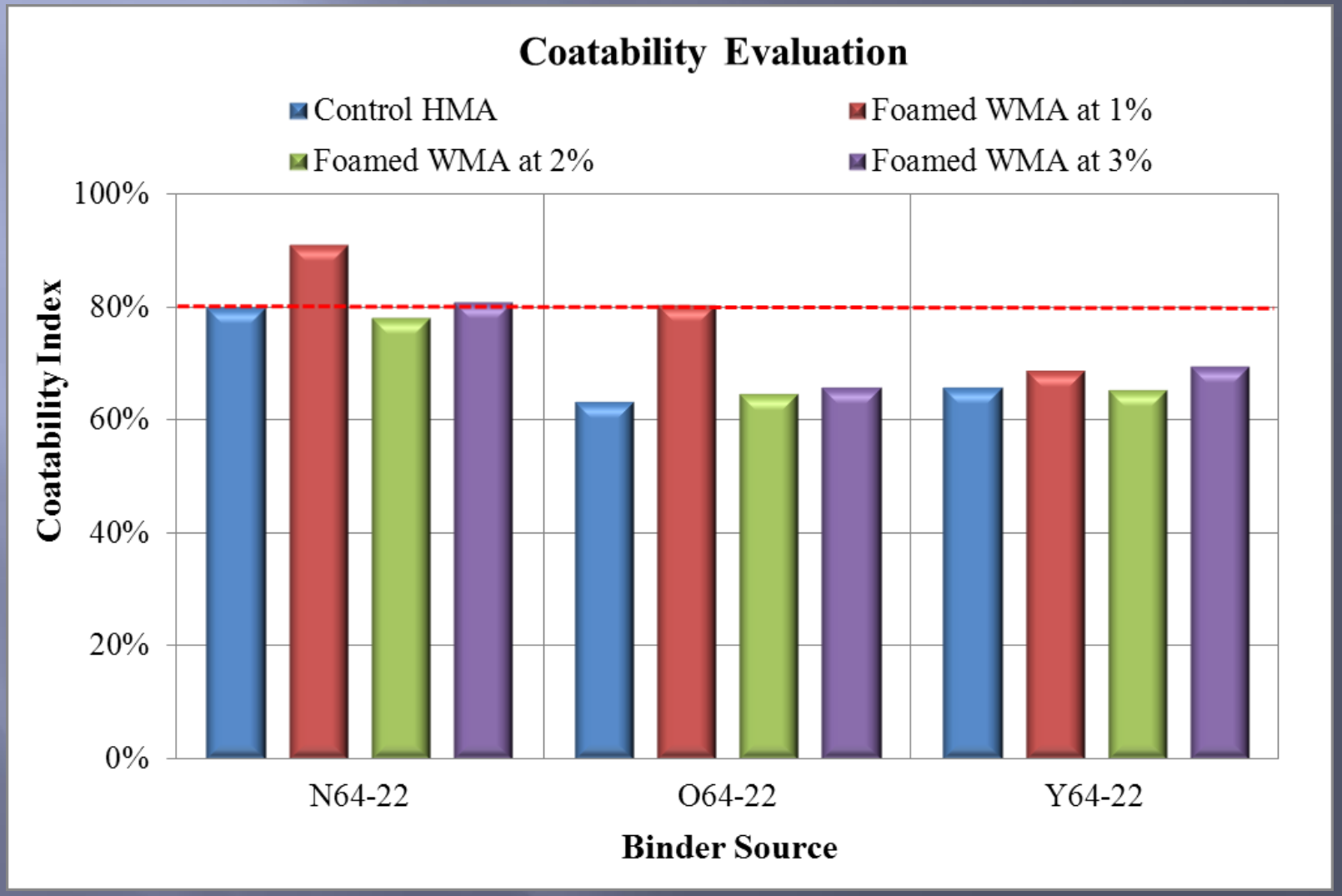
1% Moisture


Expansion Ratio
17
15
13
11
9
7
5
3
1
0
20
40
60
80
100
Time [sec]

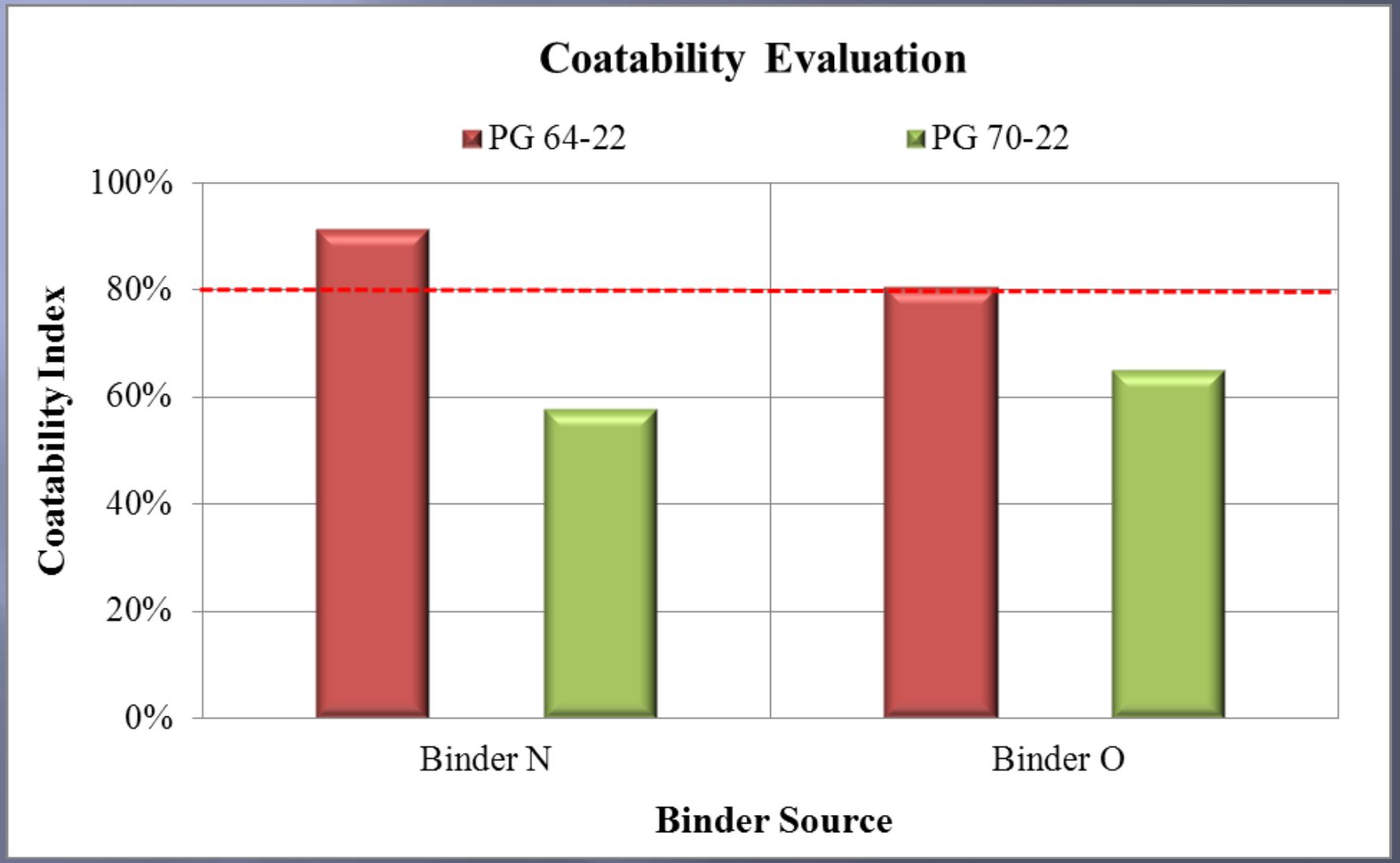
Coatability

- 4000 g aggregate retained on 3/8” sieve.
- Determine moisture absorption
- Use laboratory foamer to produce binder
- Add amount of asphalt according to surface area requirement.
- Mix for 90 sec.
- Condition in oven at 275°F (HMA) or 240°F (WMA)
- Determine moisture absorption
- Coatability is %difference in aggr and mix water absorption

Coatability



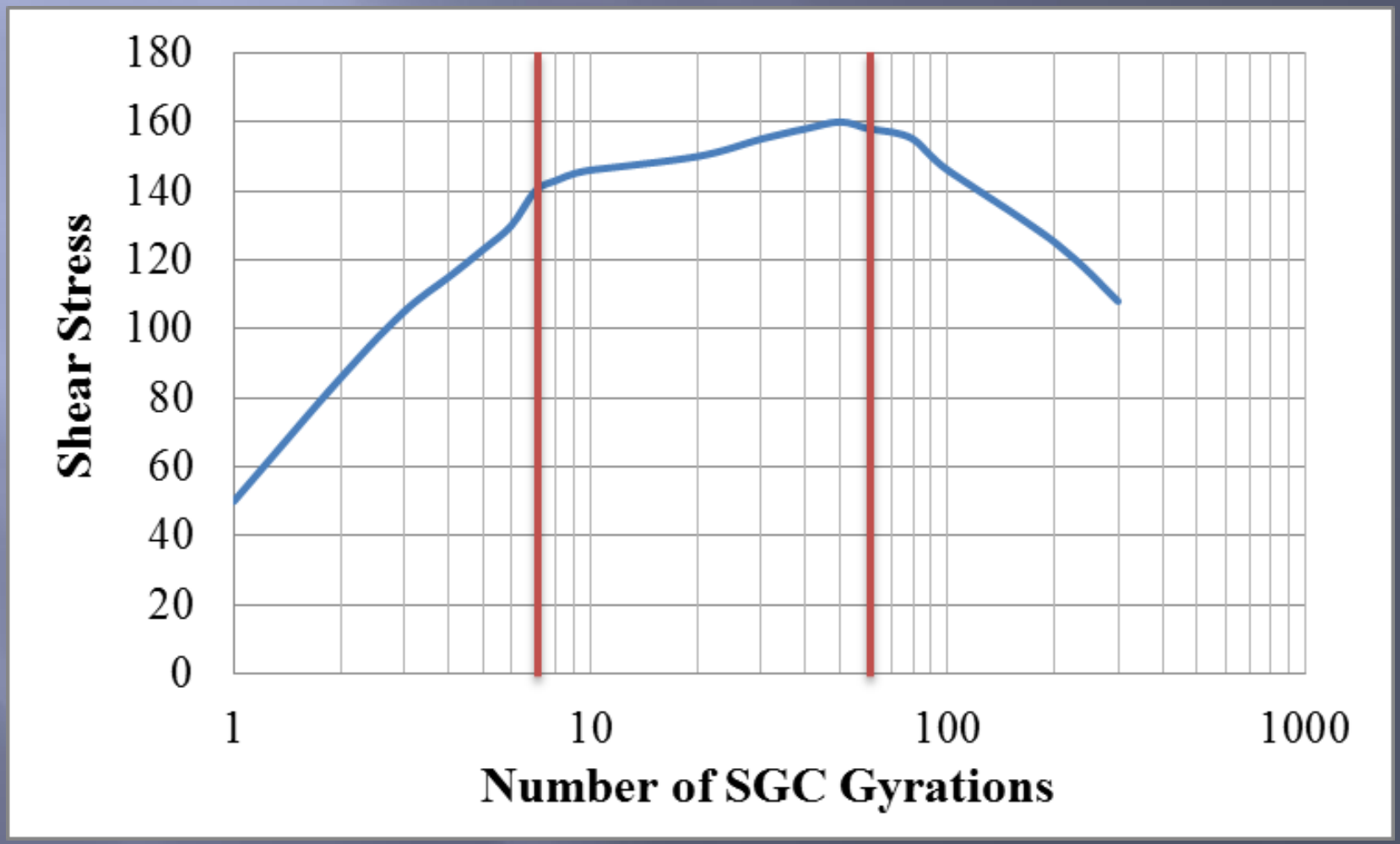
Effect of Polymers and Asphalt Source



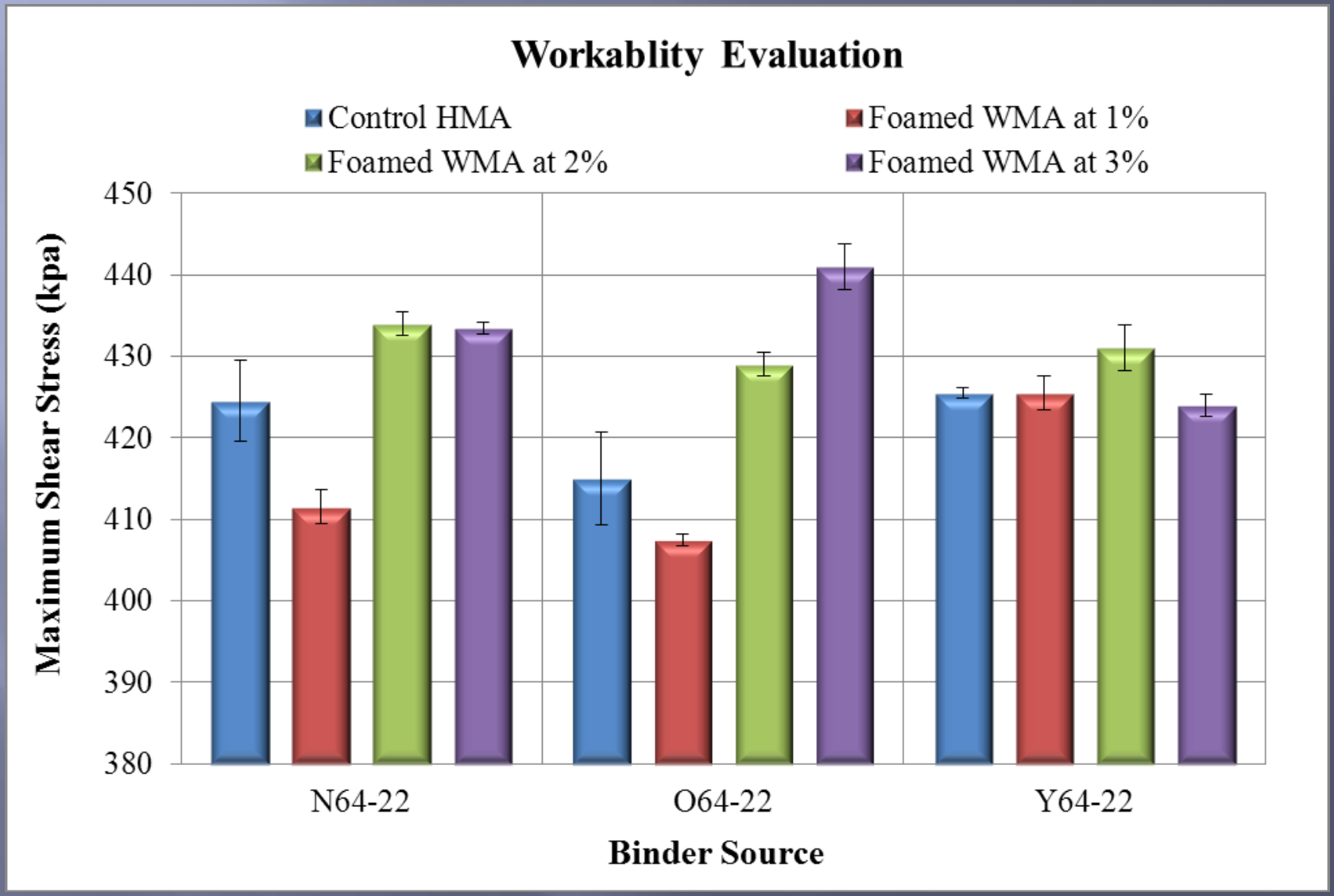
Workability

- Set foamer to desired water content
- Add foam to aggregate at design asphalt content
- Mix for 90 sec
- Condition for 2 hrs at 275 (HMA) or 240 (WMA)
- Compact in SGC capable of monitoring shear stress
- Compact to maximum shear stress and record

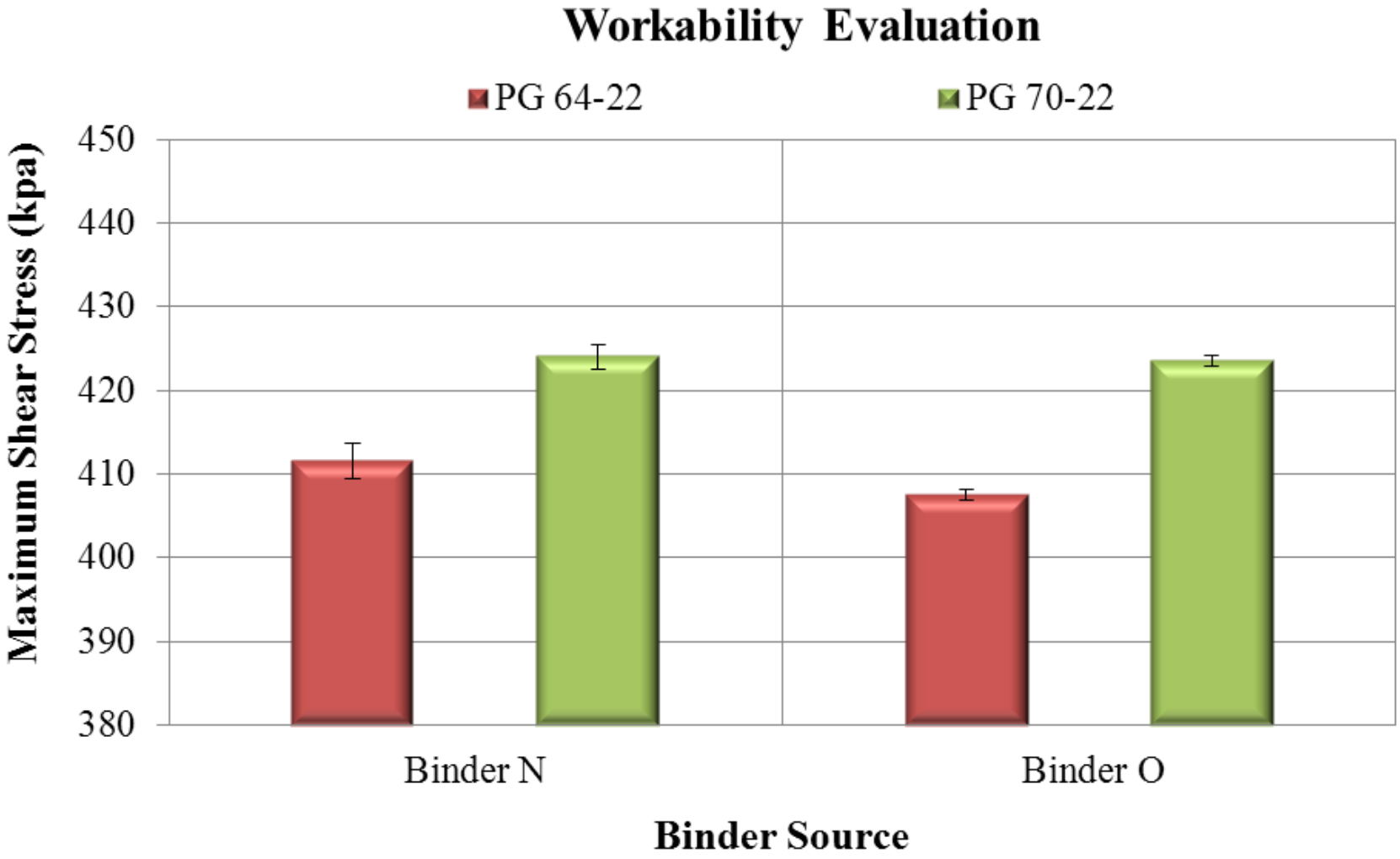
Workability



Workability



Effect of Polymers and Binder Source



What's Next?

- Currently Testing Field Materials
  - Foaming Characteristics
  - Workability
  - Coatability
- Prepare AASHTO Style Methods
  - Foaming
  - Mix Design
- Training and Training Materials