Ground Tire Rubber: ETG - DSR Concentric Cylinder Task Force

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Asphalt Binder ETG meeting - May 3, 2017

U.S. Department of Transportation
Federal Highway Administration

Task Force members

Matthew Corrigan: Task Force Lead

Industry & Academia

- Zia Alavi
- John D'Angelo
- John Casola
- Darin Hunter
- Andreas Lutz
- Bharath Rajaram
- Codrin Daranga
- Bill Buttlar (recently joined)
- James Meister (recently joined)

State DOTs & FHWA

- David Mensching
- Amir Golalipour
- Joe Devol
- Steve Landers
- Steve Davis
- Al Vasquez
- Tim Ramirez
- Troy Lehigh
- Jay Sengoz

Their efforts for this task force are greatly appreciated.

Outline

- Task Group Objective
- Work Items
- Summary of Activities & Findings
- Future Steps

Task Group Objective

"This Task Force created on ground tire rubber(GTR) modified asphalt testing standard development with a goal to develop a draft provisional AASHTO standard using the **Concentric Cylinder** (cup & bob)."

Work Items

- Geometry fixture & details
  - **Cup & Bob size**
  - **Temperature Control**
- Equilibrium time needed for Concentric Cylinder geometry
- Calibration of Concentric Cylinder for CSS and CSR factors
- Draft of Standard

I) Questioner Results Summary

- Vendors make Concentric Cylinder geometry based on DIN EN 1302 & ISO 3219 standard
  - **Range of the ratio of cup radius over bob radius: 1 to 2**
  - **Ratio above 1.085 -> relative measurement (wide gap)**
  - **Amount of material needed for testing: 20-30 ml**
  - **Type of heating/cooling system: Peltier technology**
  - **Temperature calibration kit is available**
  - **Procedures used to calibrate & verify the geometry:**
    - Cannon standard
    - FE simulations – Oil/binder sample only to verify

II) Equilibrium time

- Provide documentations on an established procedure for equilibrium time in DSR testing
  - **Document from Dr. Anderson was shared with members**
- Test few binders following provided procedures and report the results (three labs participated)

Determination of Thermal Equilibrium

Criterion:

- For each measurement time, except for the first two and last two measurement times, calculate the criterion for specimen thermal equilibrium, CSE as:

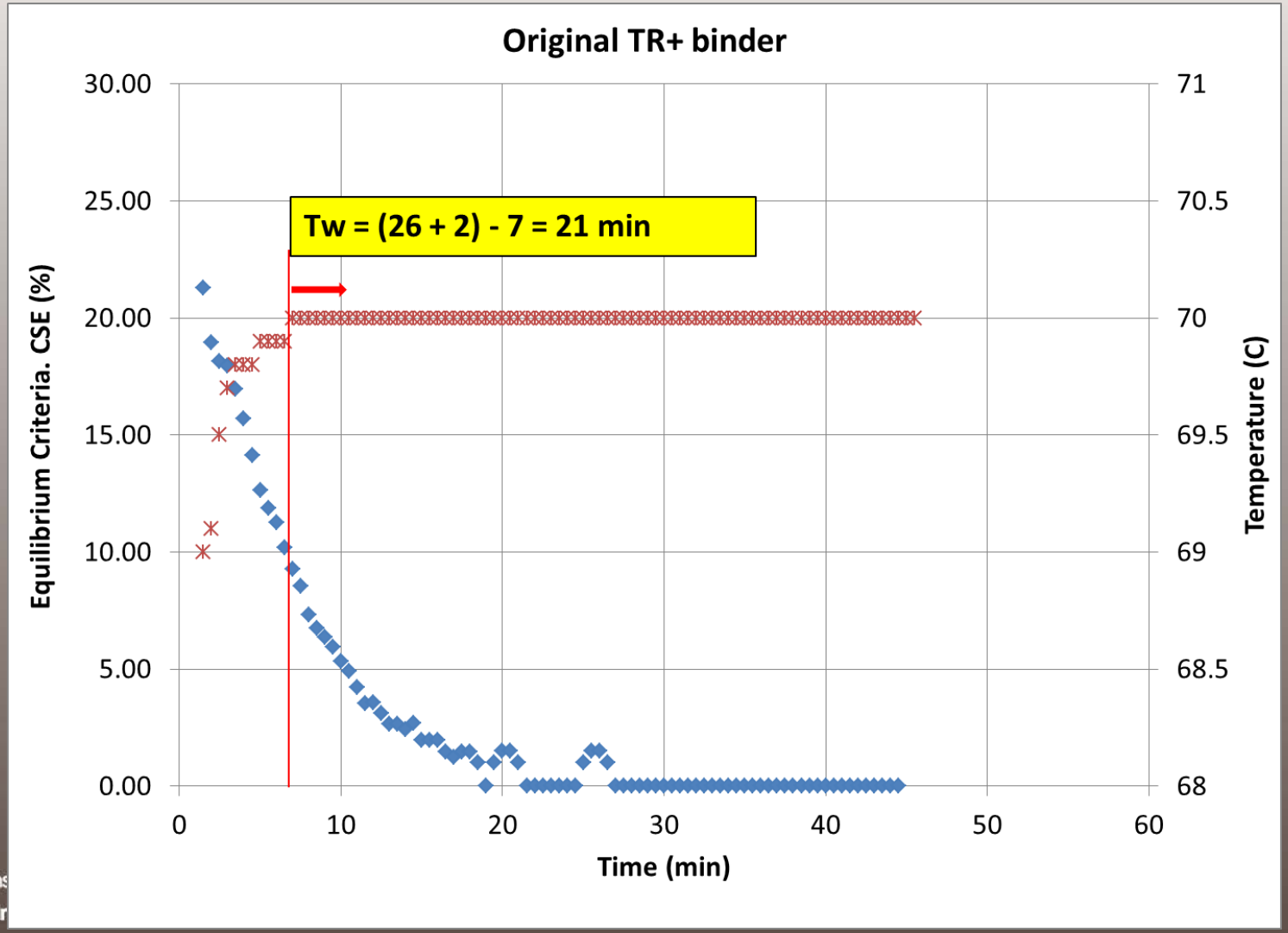
$$C_{SE} = 100 \left\{ \sum_{t-2}^{t+2} |G^*_{AVG} - G^*_i| \right\} / G^*_{AVG}$$

where G^*_{AVG} is the average of five measurements between t_i -2 and t_i +2 and $\sum_{t-2}^{t+2} \left| G^*_{AVG} - G^*_i \right|$ is the sum of absolute differences of the five measurements from the average.

- Calculate the time to specimen thermal equilibrium, t_{SE} as the first time, t_i when CSE is ≤ 1.0% minus t0 and the DSR temperature remains within ± 0.1° of the target test temperature. Report t_{SE} in minutes rounded upward to the nearest whole number.
  - **The wait time, t_w is equal to t_{SE} + 2 minutes where the added 2 minutes may be considered as a cushion or factor of safety**

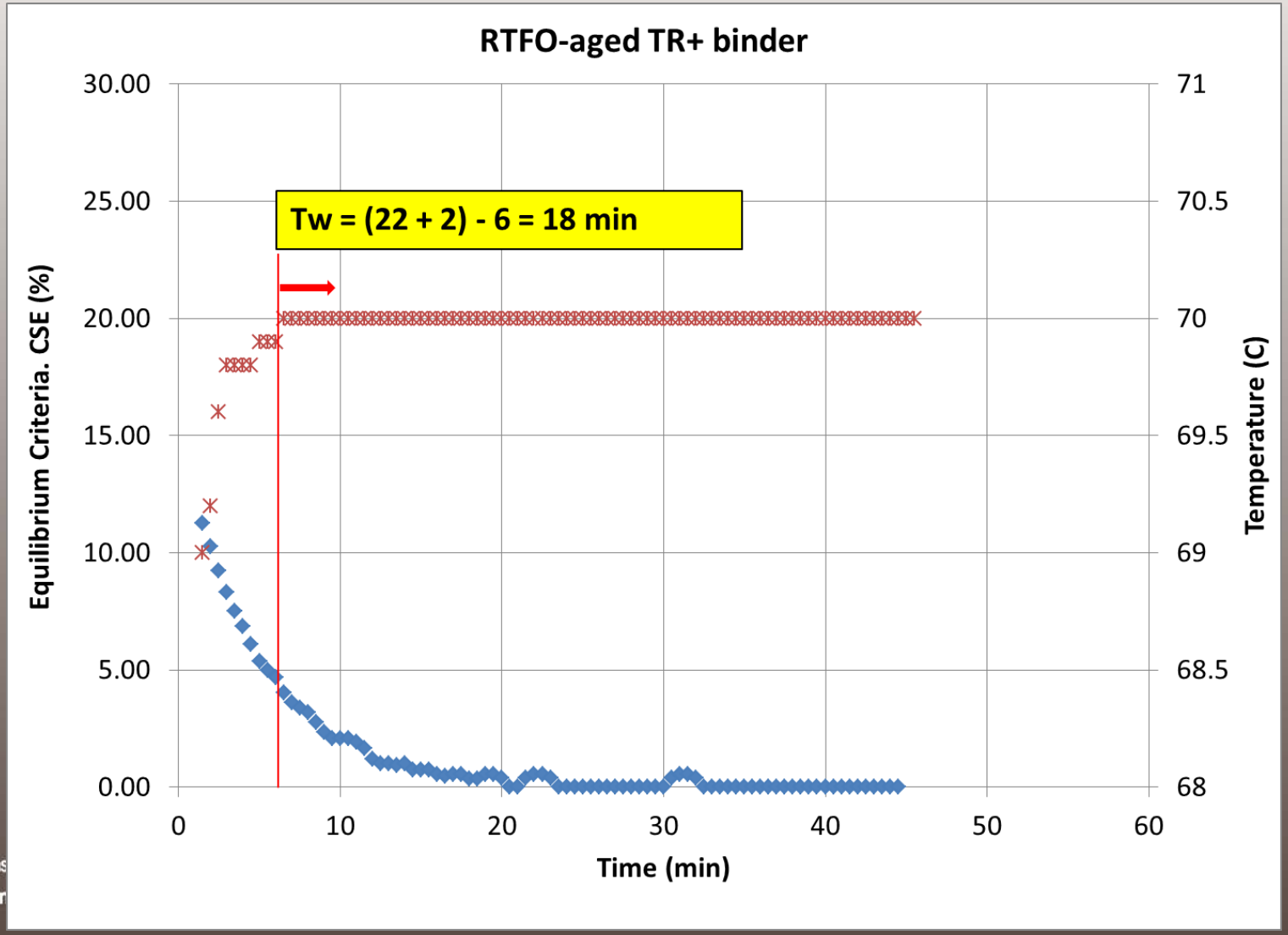
Example 1

Original binder



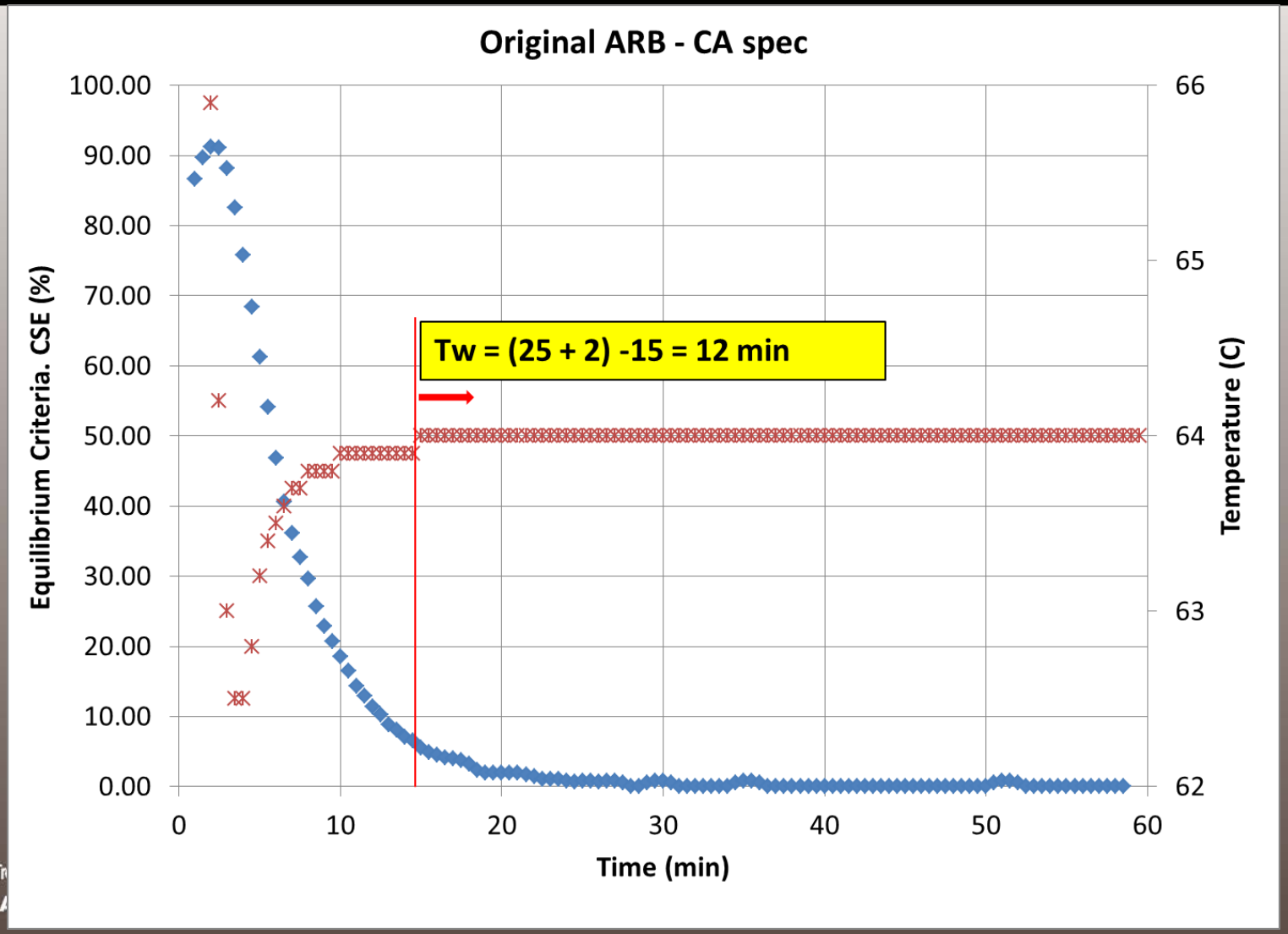
Example 1

RTFO-aged binder



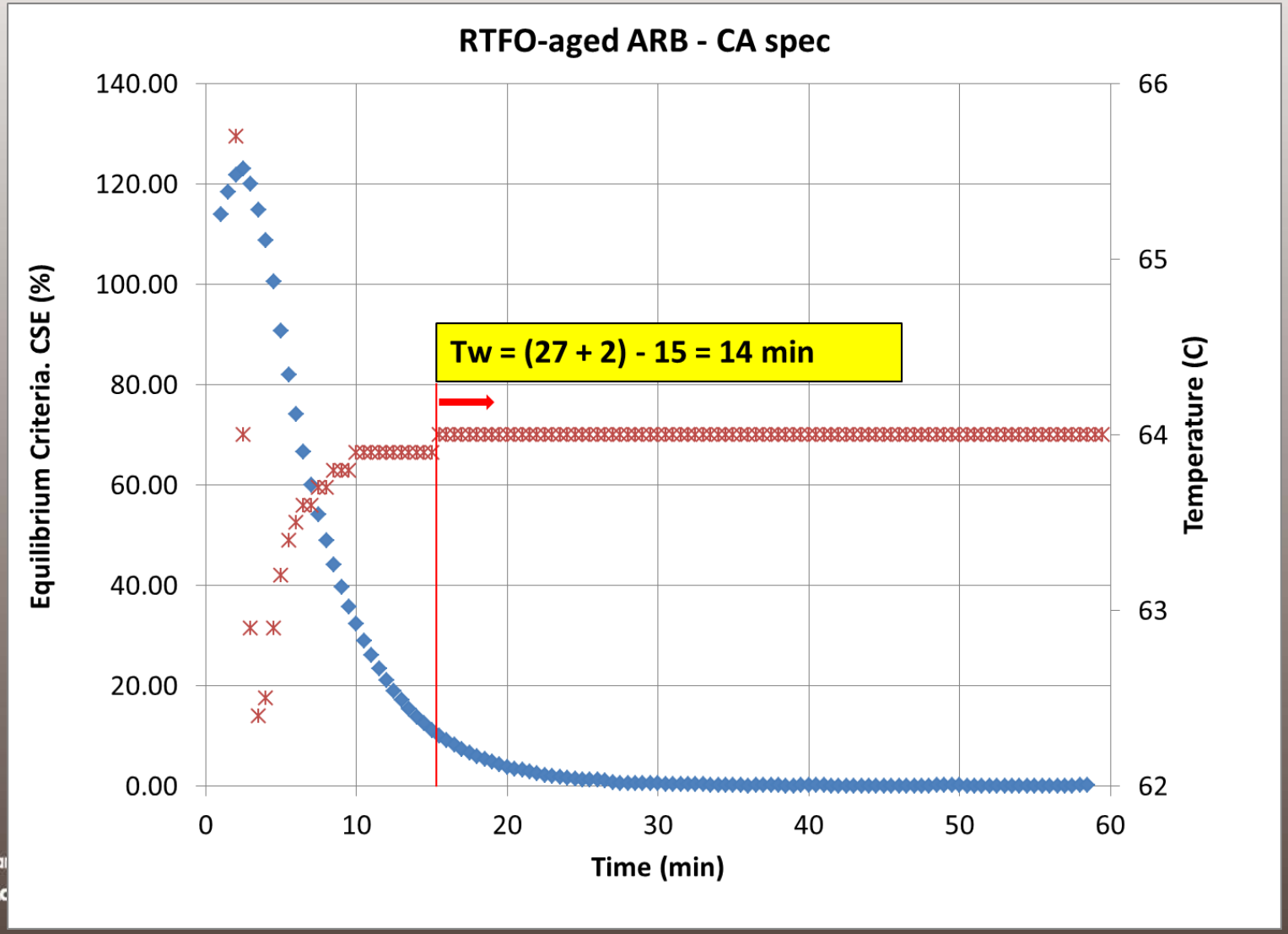
Example 2

Original binder



Example 2

RTFO-aged binder



Summary of Results

- Five binders tested – Three labs
  - **Original Binder**
    - **Total soaking time: 20min to 30min**
    - **Conservative selected equilibrium time: 30min**
  - **RTFO-aged Binder**
    - **Total soaking time: 18min to 30min**
    - **Conservative selected equilibrium time: 30min**

III) Calibration of Concentric Cylinder

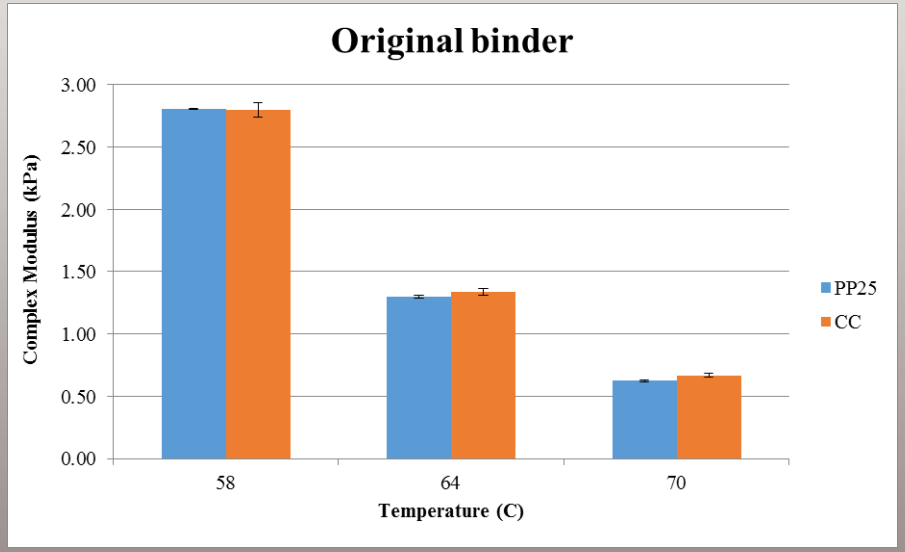
- Objective:
  - **Validation of geometry factors (CSS & CSR) for concentric cylinder.**
- Provide some documentations on few established procedures
- Representative from each vendor to work on this item and provide suggestions

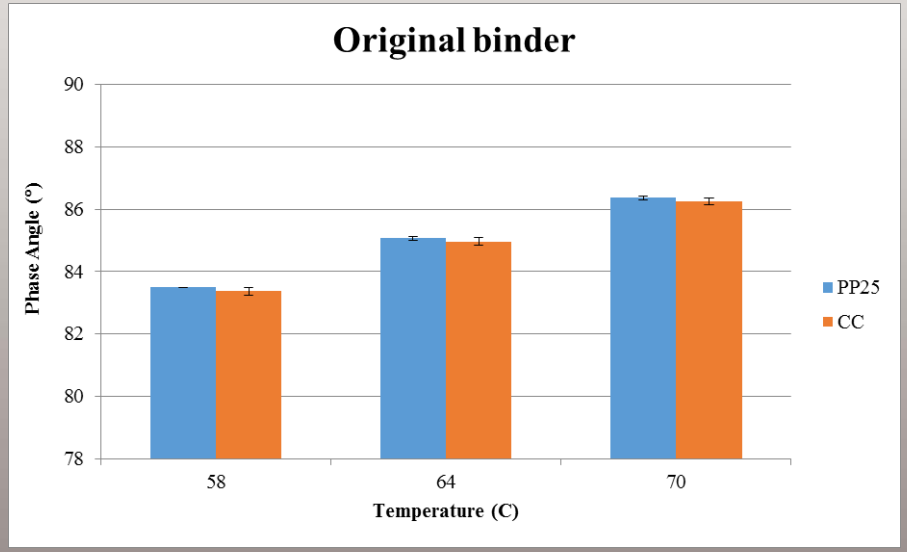
Preliminarily Testing

- Materials:
  - **One un-modified PG64-XX and one modified binder (either polymer- or terminal blend rubber-modified) with PG 64-XX or PG70-XX grade**
- Testing:
  - **Test using both concentric cylinder and parallel plates (25-mm) with 1.0 mm gap setting**

Test Results: PP vs. CB

Neat Binder – Original binder

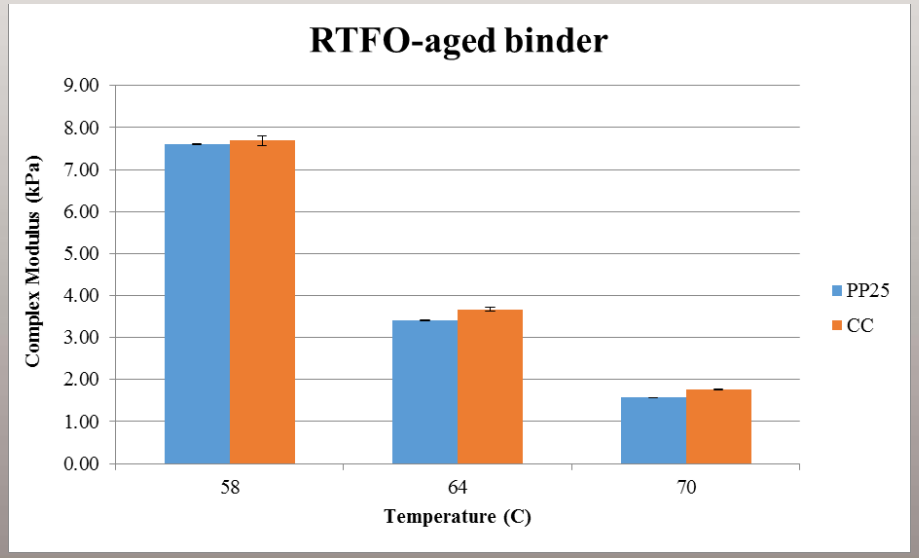


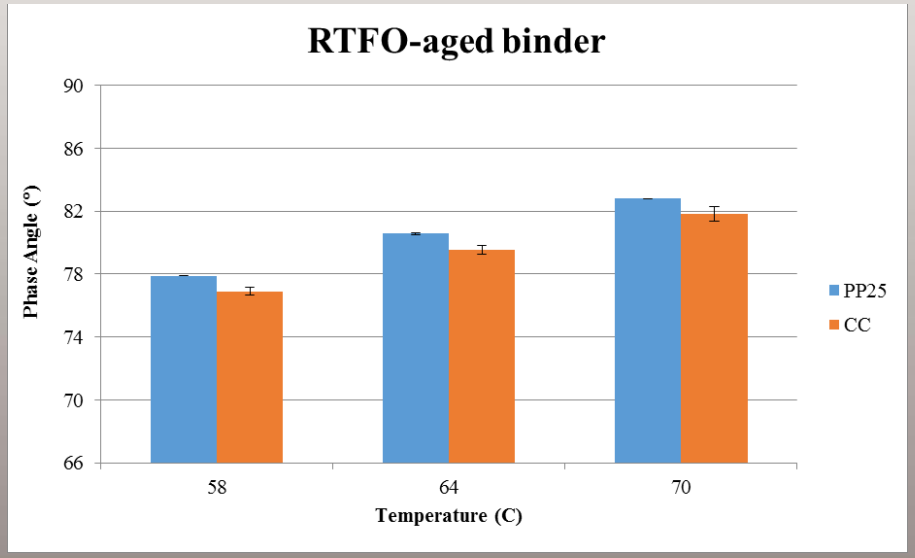


- Same PG grade
- Percent differences are between %0.5 to %8
- Similar results at multiple temperatures

Test Results: PP vs. CB

Neat Binder – RTFO-aged binder





- Same PG grade
- Percent differences are between %0.5 to %9.5
- Similar results overall

Summary of Observations

- Three labs: each lab tested at least two binders.
- Not any significant differences between two geometries was observed.
- Factors contributing to some differences:
  - **Trimming**
  - **CSS & CSR factors**

Next Action Item

- Provide a highly polymer modified binder to all participating labs by UC-Davis
- Frequency Sweep Testing:
  - **Test using both concentric cylinder and parallel plates (25-mm) with 1.0 mm gap setting**
  - **Frequencies ranges from 0.01 to 10 Hz. Must have 1.59 Hz (10 rad/sec) in the list of measured frequencies.**
  - **Tests should be performed at 46, 58 and 70 C.**
- Master Curve:
  - **Compare rheological parameters such as R-value, cross over frequency and etc.**

IV) Draft of Standard

Standard Method of Test for

Determining the Rheological Properties of Asphalt Binder Containing Ground Tire Rubber Particulates Using Concentric Cylinder Geometry in the Dynamic Shear Rheometer (DSR)

AASHTO Designation: TP XX-XX

AASHTO
American Association of State Highway and Transportation Officials
444 North Capitol Street N.W., Suite 249
Washington, D.C. 20001

Topics of Discussion

- Title:
  - **Focus on GTR modified asphalt binder**
  - **Just a note for neat and polymer modified binders**
  - **Name designation can be addressed in the scope plus rubber percentage**
- Test Temperature Range:
  - **Reference M 320**
  - **Leave it open for higher temperatures**
  - **Note: for higher percentage.**

FHWA Field Support
Mobile Asphalt Testing Trailer (MATT)

- Mobile Asphalt Pavement Materials Lab
  - Site Visits
  - Field Data/Testing/Evaluation
  - Use/Demo Emerging Test Devices
  - POC: Matthew Corrigan

Thank You!!

Discussion / Comments / Questions

FHWA's Mobile Asphalt Testing Trailer
Office of Asset Management, Pavement, and Construction

U.S. Department of Transportation
Federal Highway Administration

www.fhwa.dot.gov/pavement/asphalt