REOB update from FHWA$_{TFHRC}$

Binder Expert Task Group

Oklahoma City, Oklahoma

September 15th, 2015

Pavement Materials Team, TFHRC

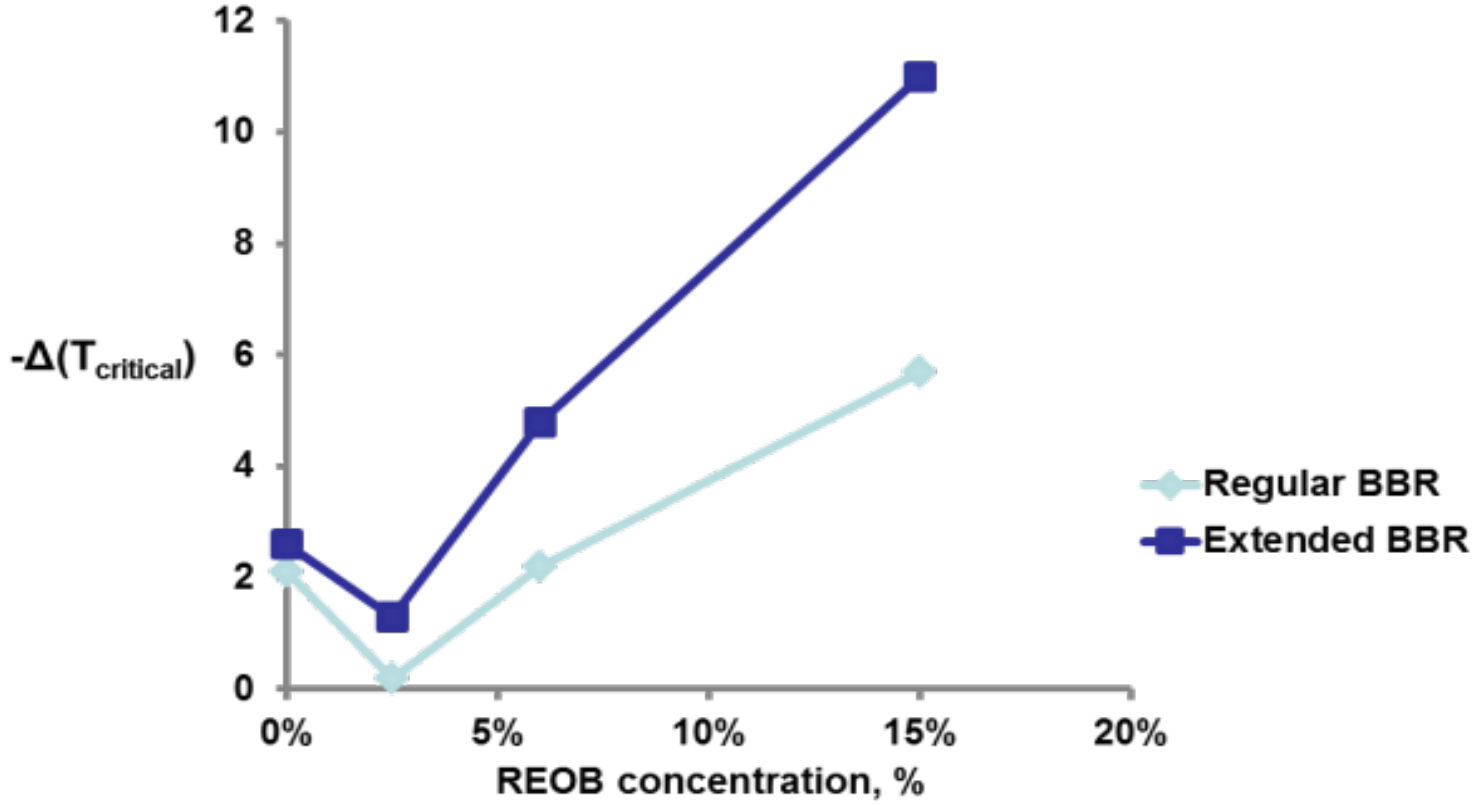
Last ETG Presented…

- X-ray Fluorescence
- Case study of real field aging to justify 2XPAV
- Binder
  - Blending and softening efficiency
  - m&S $\Delta T_{CRITICAL}$
  - Extended BBR
  - Linear Amplitude Sweep
  - Double Edge Notch Tension
  - ABCD
- Short-term and long-term oven aged mixtures
  - Hamburg & TSR
  - E*
  - AMPT Cyclic Fatigue
  - TSRST

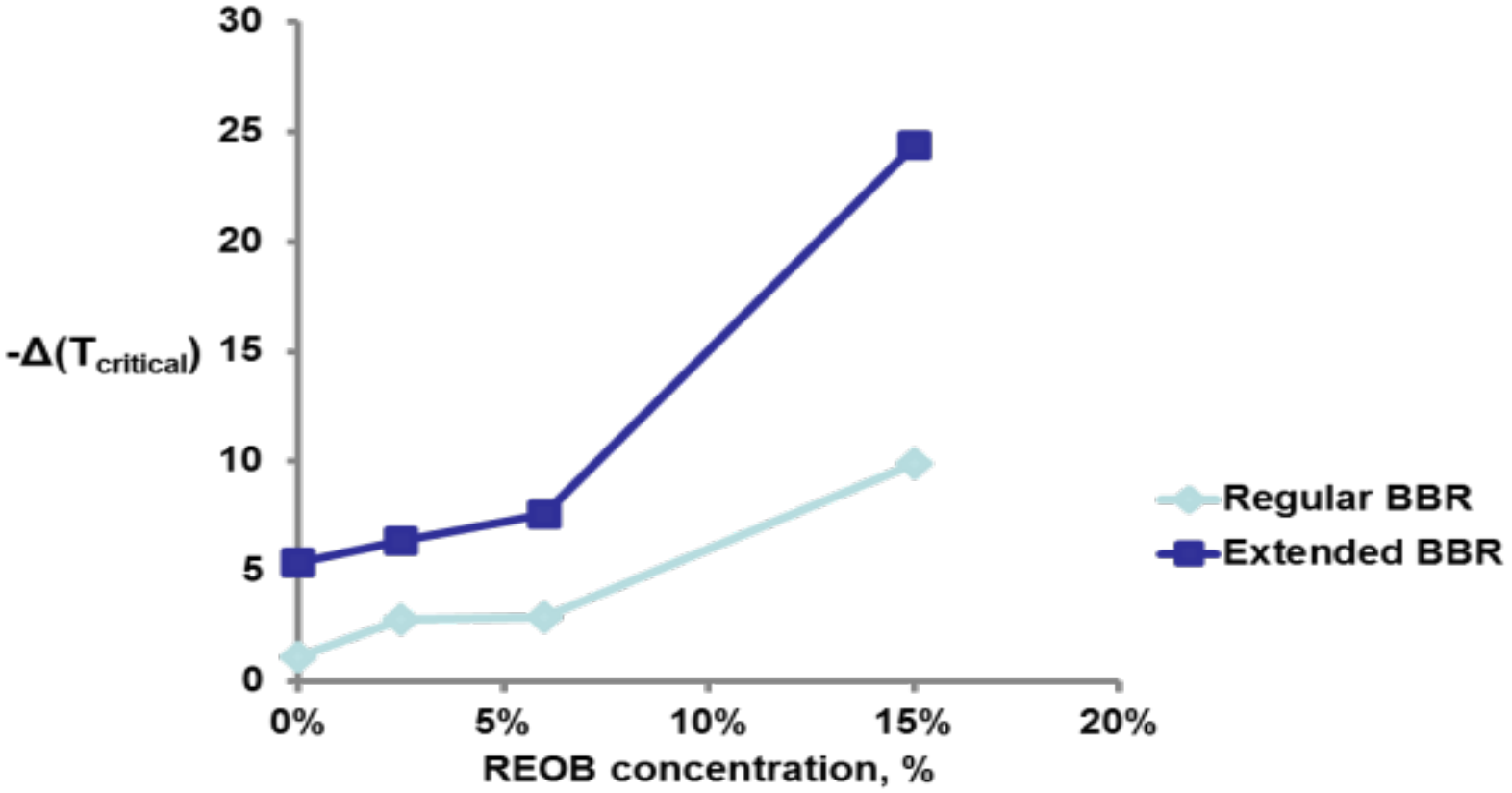
	Base		+REOB Source 3	
	PAV	2X PAV	PAV	2X PAV
PG 58-28	-2.0°C $\Delta T_{critical}$ PG60-30 *0% PG100-0 + 0% REOB*	-1.1°C $\Delta T_{critical}$ PGxx-29	-5.7°C $\Delta T_{critical}$ PG58-33 *20% PG100-0 + 15% REOB*	-10°C $\Delta T_{critical}$ PGxx-26
			-5.1°C $\Delta T_{critical}$ PG51-40 *0% PG100-0 + 15% REOB*	-10°C $\Delta T_{critical}$ PGxx-34
			-0.8°C $\Delta T_{critical}$ PG69-24 *20% PG100-0 + 0% REOB*	2X PAV Not tested
			-0.2°C $\Delta T_{critical}$ PG59-33 *0% PG100-0 + 2.5% REOB*	-2.8°C $\Delta T_{critical}$ PGxx-29
PG64-22	+0.8°C $\Delta T_{critical}$ PG67-27 *0% PG100-0 + 0% REOB*	-1.9°C $\Delta T_{critical}$ PGxx-23	-2.2°C $\Delta T_{critical}$ PG61-28 *0% PG100-0 + 6% REOB*	-2.9°C $\Delta T_{critical}$ PGxx-23

xx – indicates the high temperature grade of the 2X PAV material was not tested

BBR $\Delta T_{critical}$ Spread: $PG_{(S)tiffness}$ – $PG_{(m)\text{-}creep,}$ 1XPAV



BBR $\Delta T_{critical}$ Spread: $PG_{(S)tiffness}$ – $PG_{(m)\text{-}creep,}$ 2X PAV



Findings (1 of 5)

1. You can readily detect REOB presence
2. You can tell that it is there; but you *cannot* tell *exactly* how much is there.
   - Round Robin XRF results may shed more light on this.
3. Effect of REOB depends on base binder (like PPA)
4. Variation between REOB suppliers & their samples
   - Same concentration can produce different PG grades

Findings (2 of 5)

5. **2 X PAV is a reasonable approximation of 5 years - *where anecdotal concerns lie* (ALF Data)**

6. **REOB softens and reduces tensile strength**
   - **Binder notched tension (DENT)**
   - **Decreases mix wet and dry IDT strength**
   - **Also seen in TSRST**

7. **In 2 of 3 cases, REOB improved *binder* intermediate temperature parameters for fatigue / strain tolerance**
   - **6% and 2.5% REOB blends**
   - **CTOD and LAST**

Findings (3 of 5)

8. **Rheological "disruption" occurred w/ highest %REOB**
   - **Differences in Low Temperature m&S**
   - **Did Not occur in blend with PG100-0 by itself**
   - **Did occur in blends with high-REOB + PG100-0**
   - **Made worse by extended aging**
   - **Alludes to performance deterioration**
   - **Corroborated by DENT CTOD & LAST & Stripping**
   - **Forces the issue of compatibility** (extenders, rejuvenators, RAP / RAS, WMA…)

Findings (4 of 5)

9. REOB effects on Moisture Sensitivity

- TSR ratio, strength and Hamburg performance decreases with increasing REOB when no anti-strip is added
- REOB did not interfere with liquid anti-strip which improved TSR and Hamburg performance
- Liquid anti-strip (0.4%) alters IDT strength and Hamburg deterioration more than REOB (2.5%-15%)

Findings (5 of 5)

10. Conclusions

- Low concentrations of REOB did not appear to adversely affect binder and mixture properties
- High concentration of REOB consistent with loss of strength in different binder and mix test methods

11. Recommendations

- Further examination of m & S as “flag” is warranted.
- Minimum value for S should be reexamined

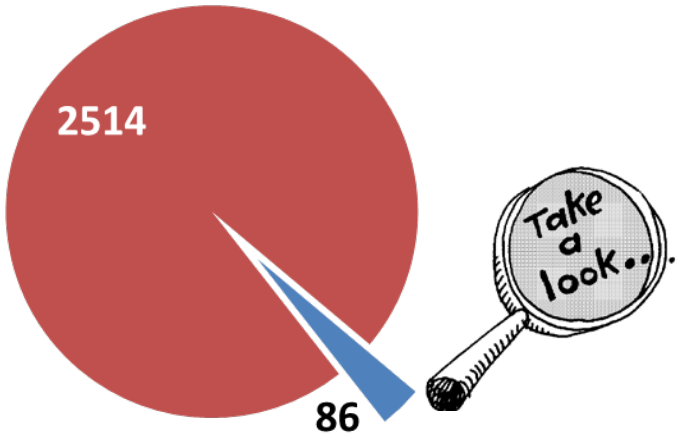
New Updates

New Updates

- Focus on m & S
- Standard test methodology
- What is the ability of ΔTc to discriminate binders with different levels of REOB?
- Conduct rheological tests on XRF samples sent in by the State DOTs

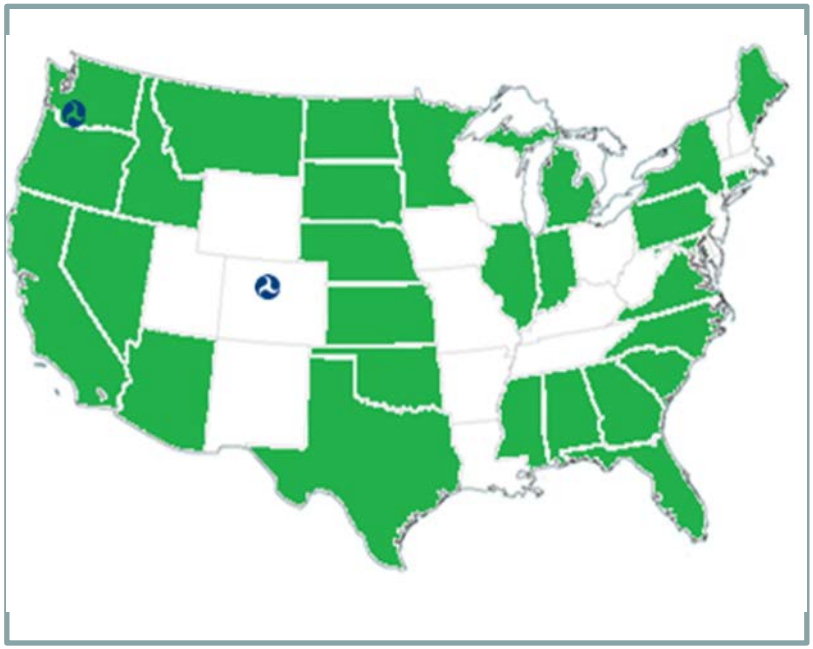
TURNER-FAIRBANK HIGHWAY RESEARCH CENTER

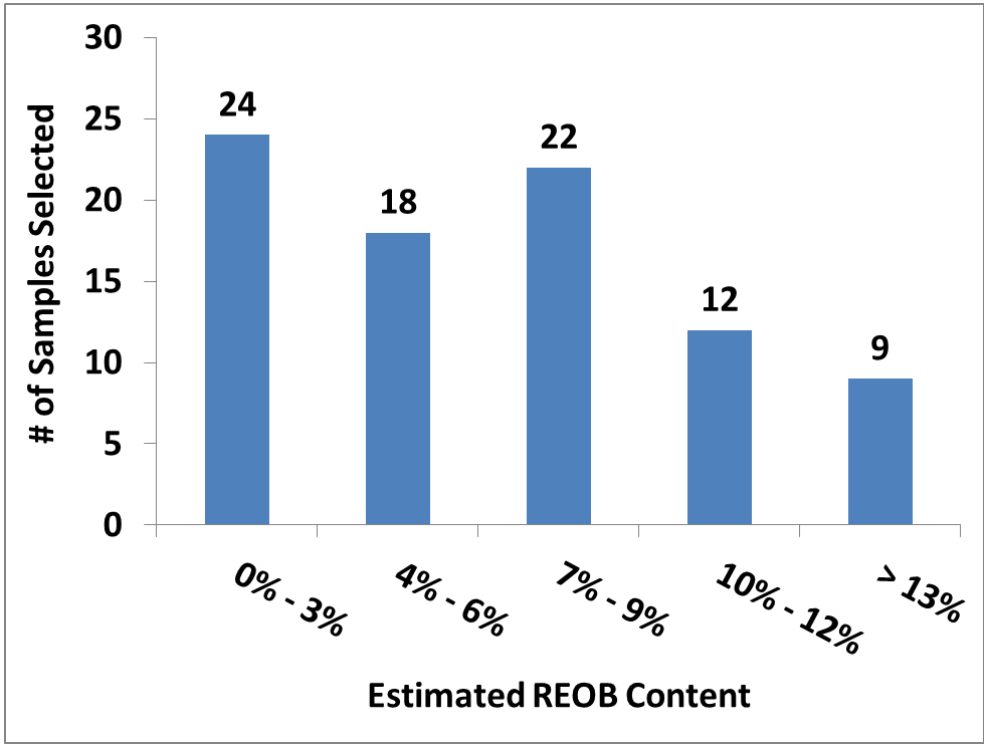
FHWA has tested 2,600 samples in XRF

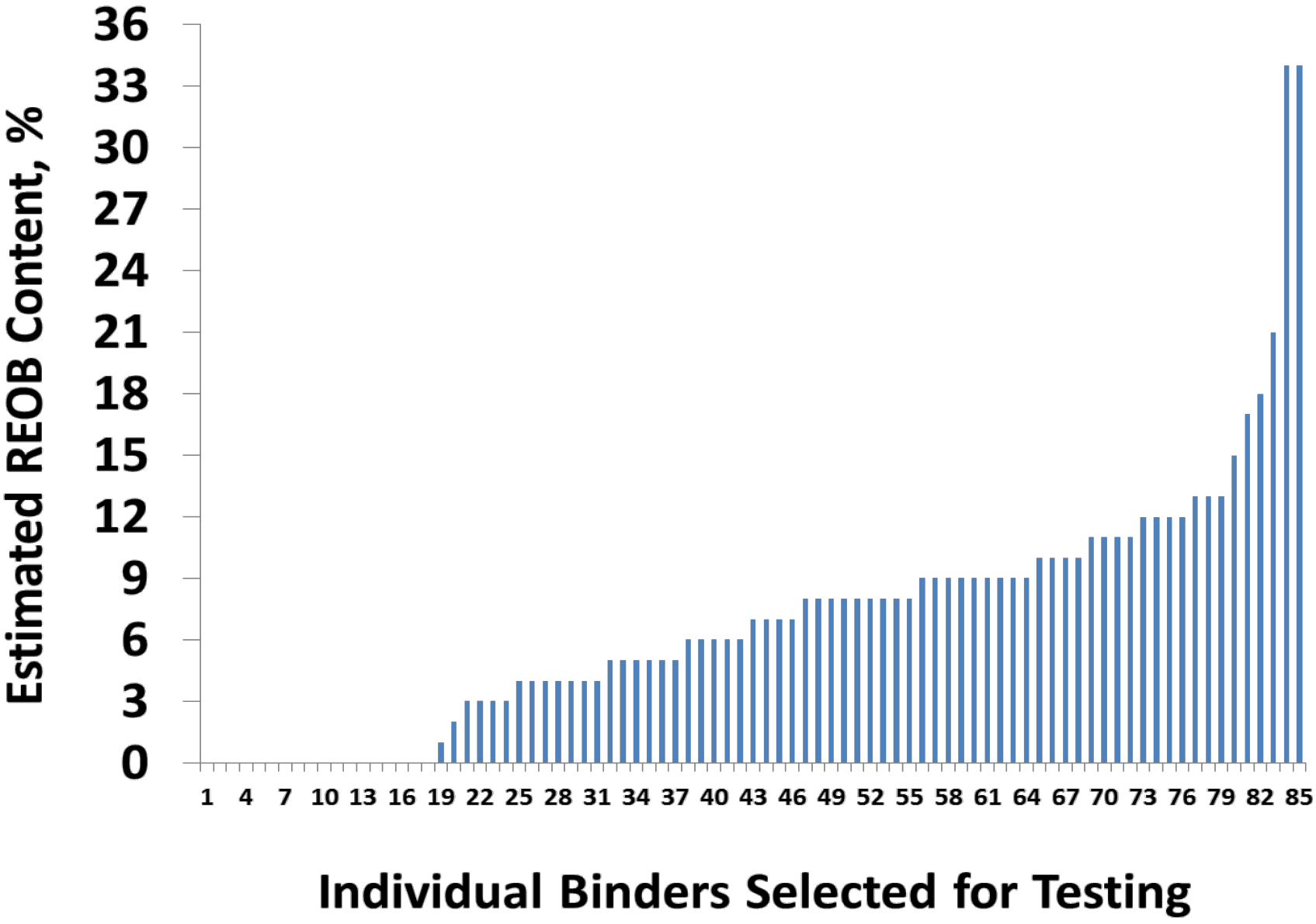


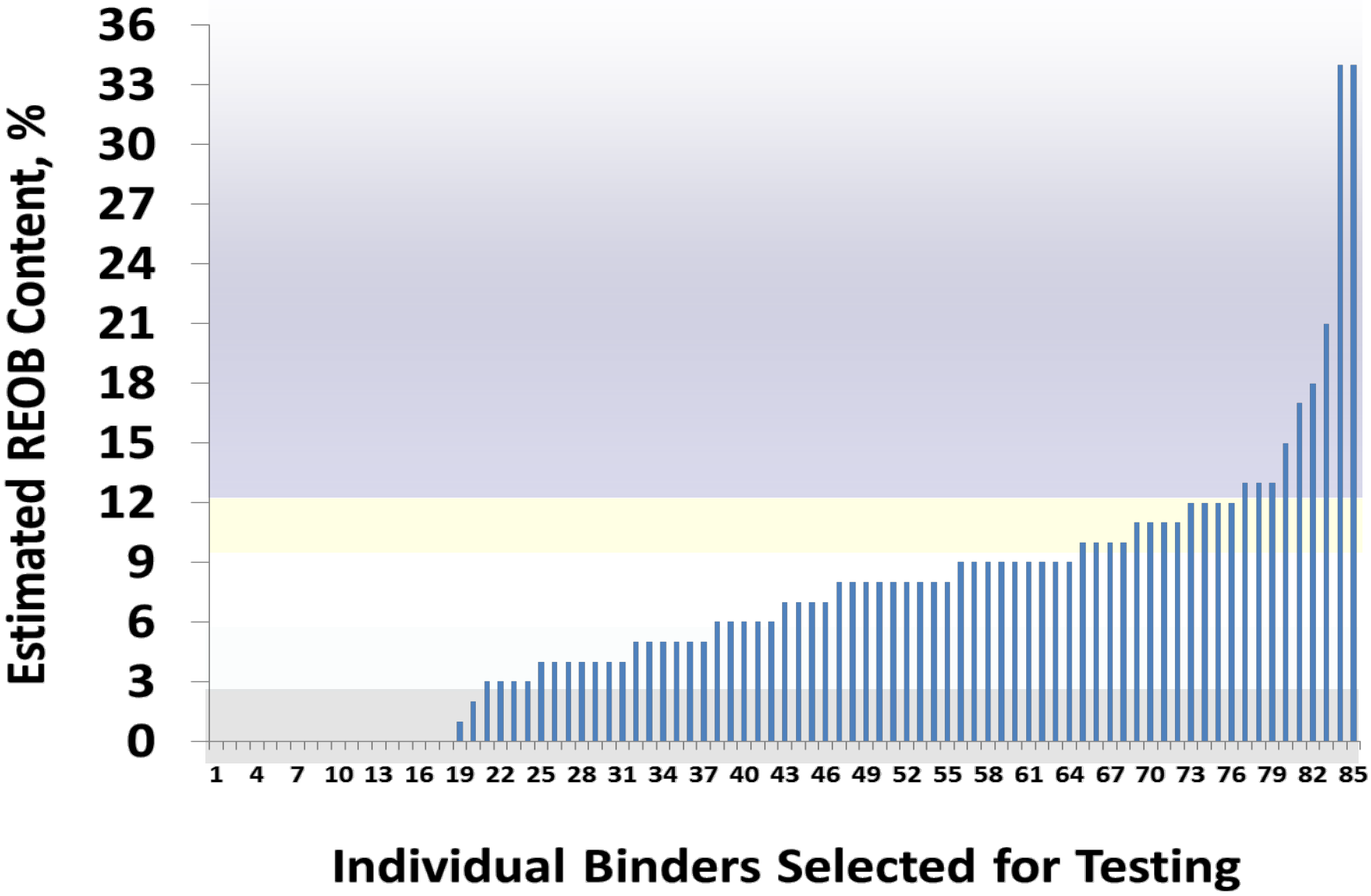
FHWA has tested 2,600 XRF samples

Select ~3% of the data set for further study…






Estimated REOB Content, %
36
33
30
27
24
21
18
15
12
9
6
3
0
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85
Individual Binders Selected for Testing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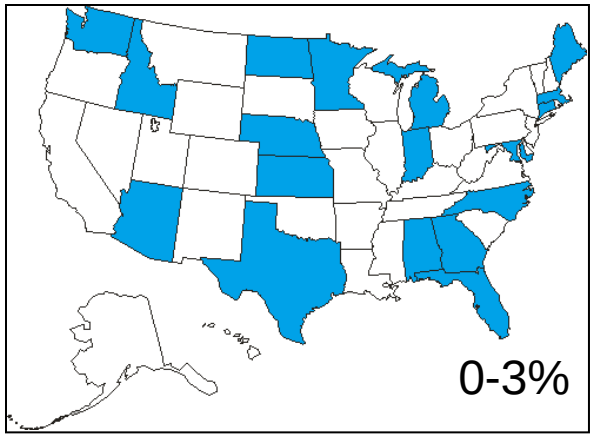
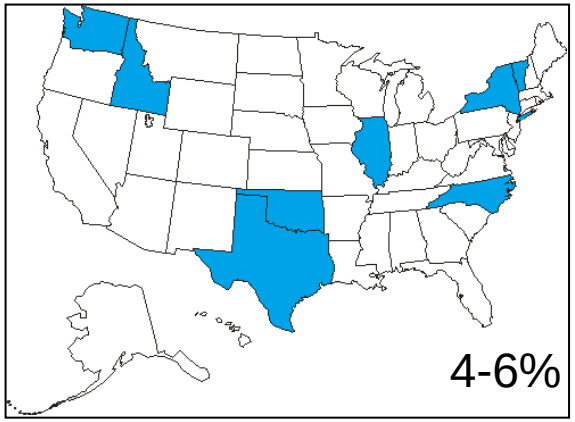
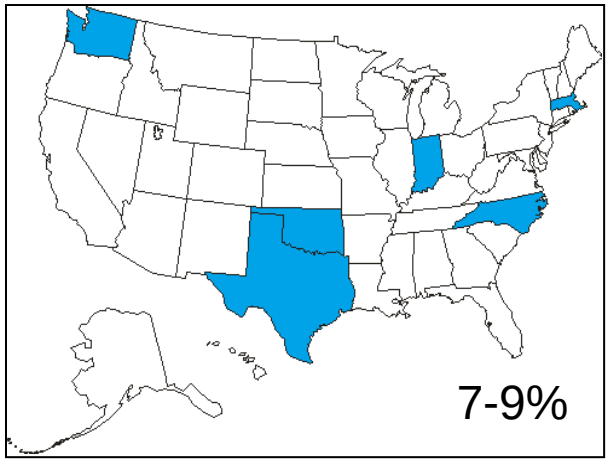
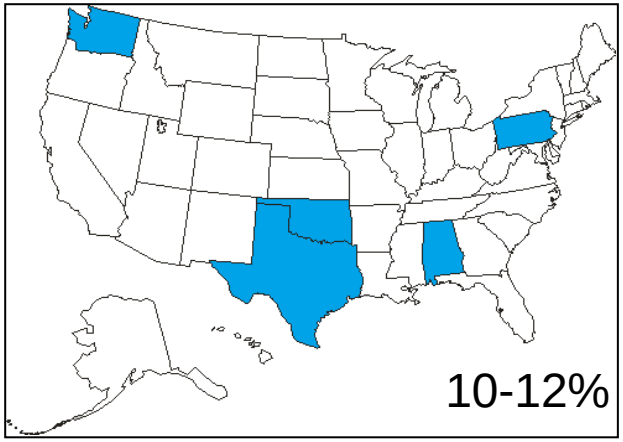
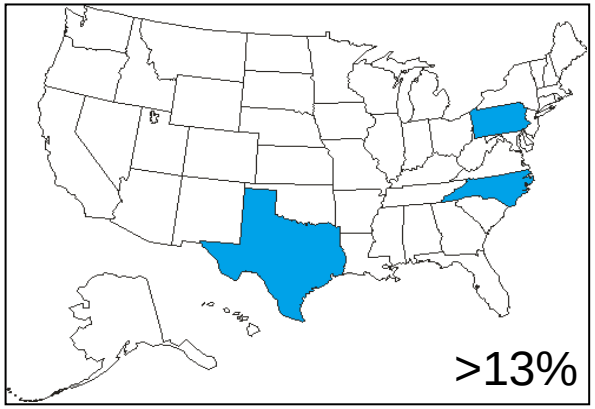
Individual Binders Selected for Testing


0-3%


4-6%


7-9%


10-12%


>13%

of Binders and their Grades Selected Data Set

	52	58	64	70	76
-16			**1**		
-22		**2**	**19**	**2**	**2**
-28		**8**	**15**	**4**	**4**
-34	**2**	**2**	**2**	**1**	

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20
3	**1**	**2**	**2**	**2**	**1**

of Binders and their Grades

0-3%

	52	58	64	70	76
-16			**1**		
-22		**1**	**8**	**1**	**2**
-28		**1**	**2**		
-34	**1**	**1**	**1**	**1**	

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20

of Binders and their Grades

4-6%

	52	58	64	70	76
-16					
-22			**4**	**1**	
-28			**3**	**1**	**2**
-34	**1**	**1**	**1**		

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20

of Binders and their Grades

7-9%

	52	58	64	70	76
-16					
-22		**1**	**3**		
-28		**3**	**7**	**2**	**2**
-34					

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20
			2	**1**	**1**

of Binders and their Grades 10-12%

	52	58	64	70	76
-16					
-22			**4**		
-28		**1**	**3**	**3**	
-34					

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20
				1	

of Binders and their Grades > 13%

	52	58	64	70	76
-16					
-22					
-28		**3**			
-34					

AC 0.6	AC 3	AC 5	AC 10	AC 15	AC 20
3	**1**	**2**			

Work Plan

- **Verify Effect of Additives on High, Intermediate and Low PG Grades**
- **BBR m & S continuous grade**
  - **Standard 20 hr. PAV**
  - **2x PAV *if sufficient binder quantity was provided***
- **<u>Mix Testing??? Insufficient binder quantities ☹</u>**
- **Separate evaluations for binders which contain:**
  - **Ground Tire Rubber**
  - **Hydrolene**
  - **Used motor oil (unrefined)**
  - **Vegetable oil**
  - **etc.**

Questions?

Suggestions?