

Development of a Practical Laboratory Long-Term Loose Mix Aging Protocol for New Asphalt Pavements

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Outline

- Introduction
- Estimation of equivalent aging temperatures for 20 hours
- Laboratory evaluation of the equivalent aging temps. using IDEAL-CT
- Laboratory verification of the equivalent aging temps. using IFIT and OT
- Comprehensive BMD
- Summary and conclusions

Introduction

- Many DOTs are turning to BMD to address several inter-related issues:
 - ▣ Mix durability, recycled materials, additives and ever-changing binders
- One critical issue for BMD is loose mix aging protocol for new pavement.
- Objective of this study is to develop a practical long-term aging protocol, considering of pavement life and distresses.
 - ▣ Aging temperature
 - ▣ Aging duration
 - ▣ Loose mix thickness

Introduction

- Long-Term aging protocols:
 - AASHTO R30 specifies 120 hours (5 days) at 85°C using compacted specimens.
 - Based on literature review, researchers suggested to age loose mixtures at 135°C for 24 hours.
 - **NCHRP 9-54 suggested to age loose mixtures at 95°C from 1 day to more than 20 days depending on location, years, and depth from pavement surface.**

Introduction

- Definition of “long-term” for new asphalt pavements
 - ▣ Design life of new asphalt pavement is about 15-20 years
 - ▣ Fatigue cracking often occurs at 2/3 of the pavement life, around 10-13 yrs
 - Fatigue cracking initiates at the bottom of asphalt layers

- ▣ Summary:
 - 12 years for fatigue cracking

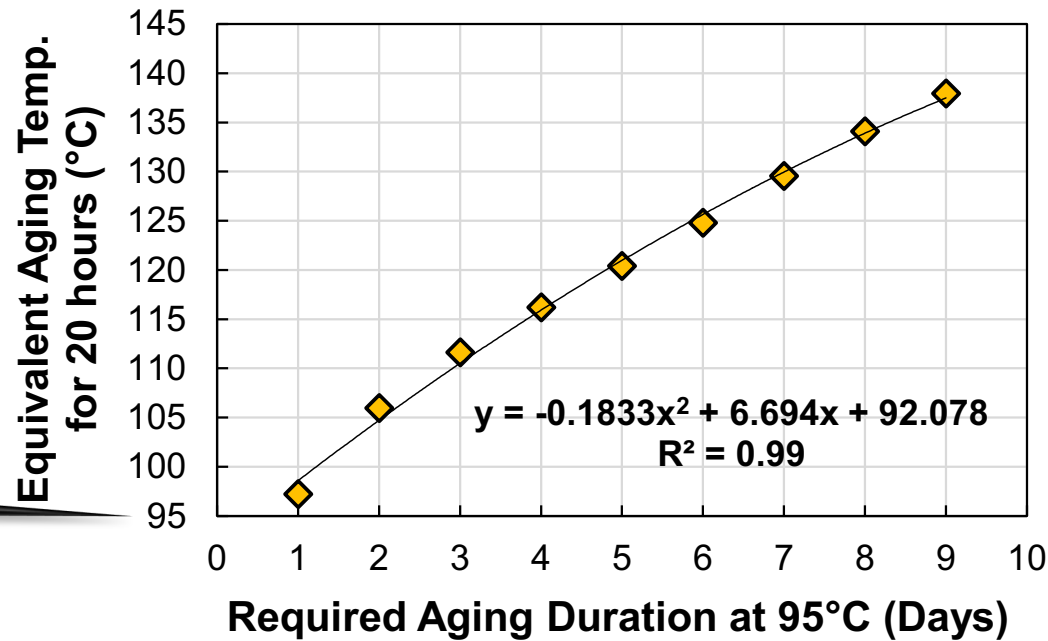
Introduction

- This study recommends:
 - Loose mix thickness: **1.5-2.0" - R 30**
 - Duration: **20 hrs**
 - Temperature: **TBD**

Equivalent aging temperatures for 20 hours

- Dr. Elwardany et al. applied kinetics models with the universal reaction kinetics constant values to make the estimation.

NCHRP 9-54

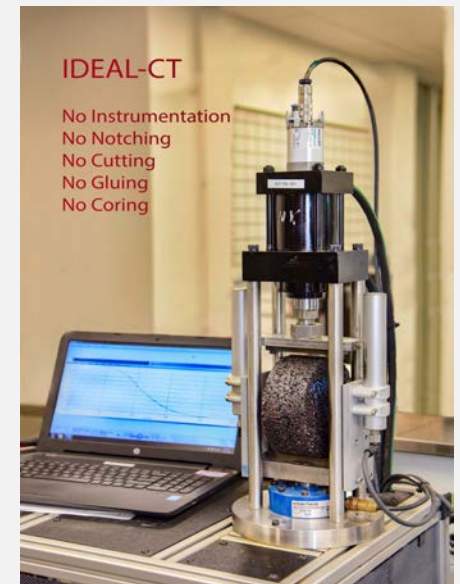


Laboratory evaluation of equivalent. aging temp.

- Seven mixes with various asphalt binders

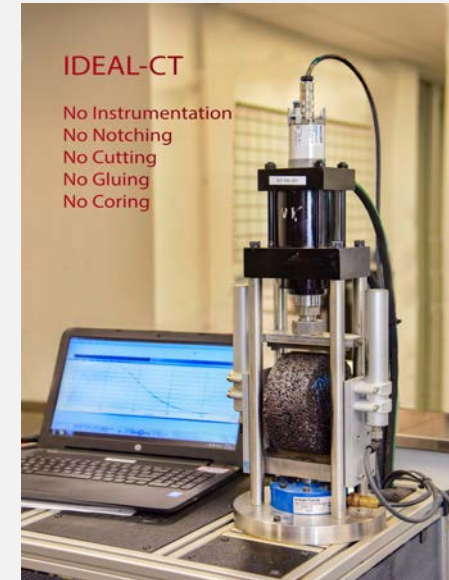
Mixture type		Aggregates	Virgin binder	RAP	Total asphalt content (%)
#1	9.5 mm Superpave	Igneous	PG64-22-Source 1	None	5.5
#2	9.5 mm Superpave		PG64-22-Source 2	None	5.5
#3	9.5 mm Superpave		SHRP AAG	None	5.5
#4	9.5 mm Superpave		SHRP AAD	None	5.5
#5	9.5 mm Superpave		PG76-22-Source 3	None	5.5
#6	9.5 mm Superpave		PG76-28-Source 4	None	5.5
#7	9.5 mm Superpave	Granites	PG64-28-Source 5	15% RAP	6.0

- Laboratory test: IDEAL cracking test with 4 replicates



Laboratory evaluation of equiva. aging temp.

- Loose mix aging conditions before compacting IDEAL-CT specimens
 - ▣ Aging conditioning 1: 20-hr at 100°C
 - ▣ Aging conditioning 2: 20-hr at 115°C
 - ▣ Aging conditioning 3: 20-hr at 125°C
 - ▣ Aging conditioning 4: 3-day at 95°C
 - ▣ Aging conditioning 5: 6-day at 95°C
- Total IDEAL-CT specimens:140
 - ▣ 7 mixes × 5 agings × 4 replicates

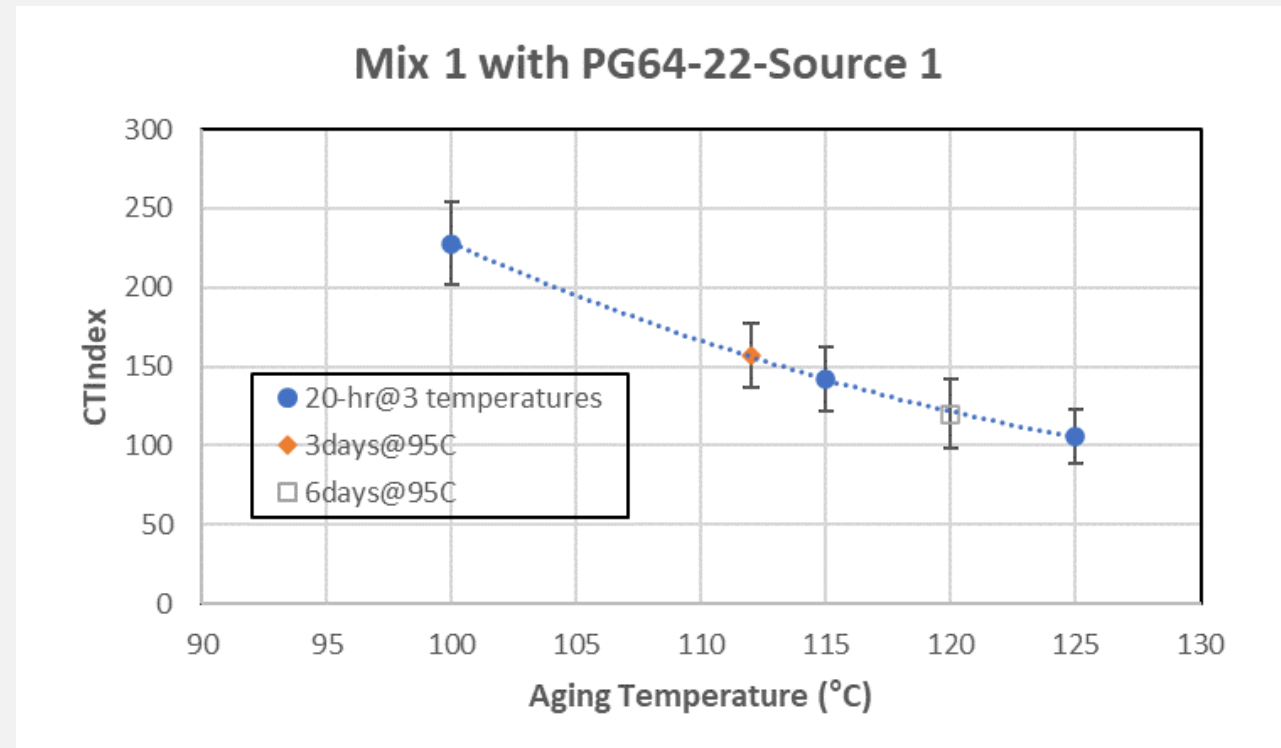


Laboratory evaluation of equiva. aging temp.

- IDEAL-CT test results at multiple aging conditions

- 3-day@95°C ≈ 112°C@20hr

- 6-day@95°C ≈ 120°C@20hr

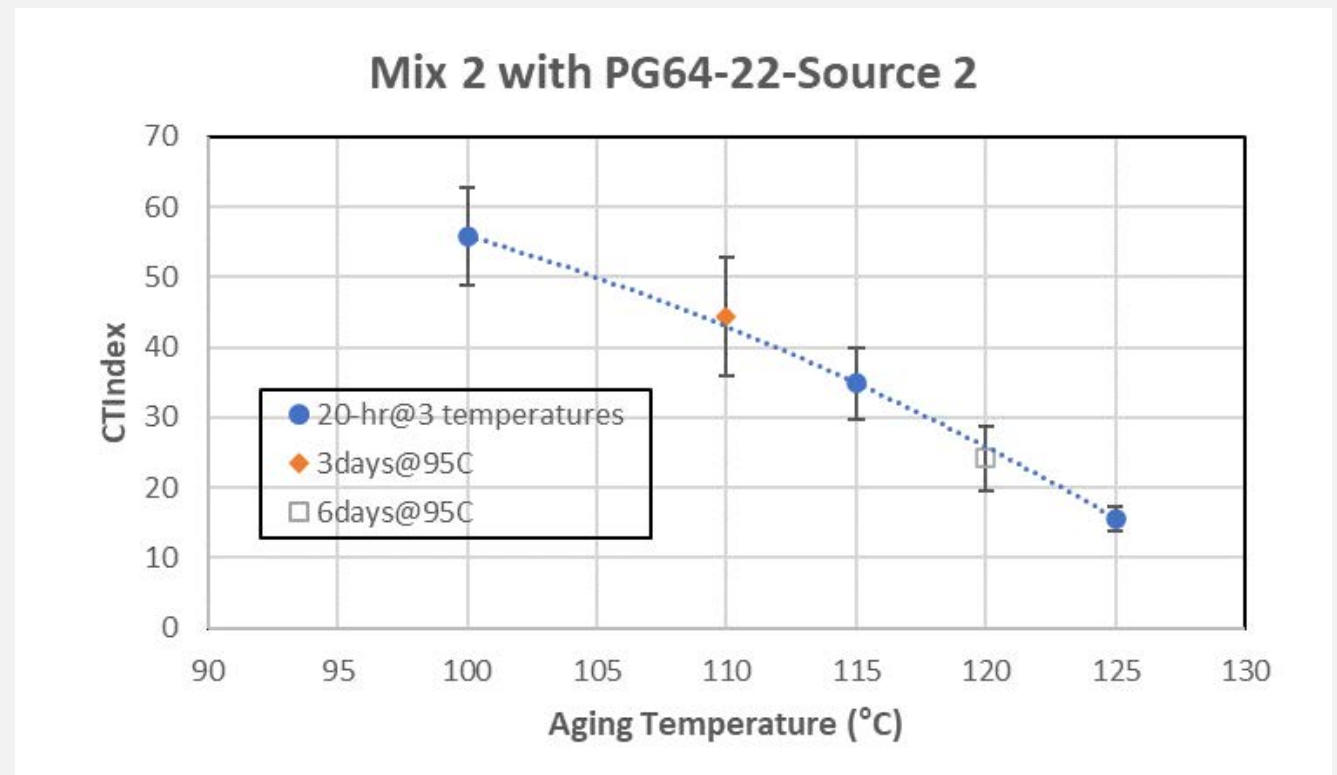


Laboratory evaluation of equiva. aging temp.

- IDEAL-CT test results at multiple aging conditions

- 3-day@95°C ≈ 112°C@20hr

- 6-day@95°C ≈ 120°C@20hr



Laboratory evaluation of equiva. aging temp.

- Equivalent aging temperatures for 7 mixes
 - ▣ 3-day @ 95°C ≈ 110-112°C @ 20hr
 - ▣ 6-day @ 95°C ≈ 120°C @ 20hr

Asphalt Mixes	Aging Temp.-20hrs for 3-day at 95°C	Aging Temp. -20 hrs for 6-day at 95°C
Mix1 with PG64-22-Source 1	112°C	120°C
Mix 2 with PG64-22-Source 2	110°C	120°C
Mix 3 with SHRP AAG	112°C	120°C
Mix 4 with SHRP AAD	110°C	120°C
Mix 5 with PG76-22-Source 3	112°C	120°C
Mix 6 with PG76-28-Source 4	112°C	120°C
Mix 7 with PG64-28-Source 5	112°C	120°C

Laboratory verification of equiva. aging temp.

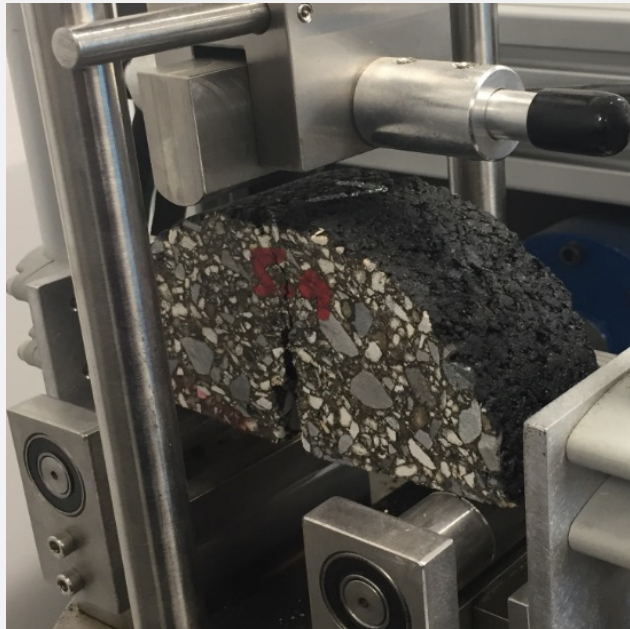
- Two mixes: one from Massachusetts and one from Texas

Mixture type		Aggregates	Virgin binder	RAP	Total asphalt content (%)
#1	9.5 mm Superpave	Igneous	HiMA binder PG88-28	None	5.5
#7	9.5 mm Superpave	Granites		15% RAP	6.0

- Five aging conditions as previous
 - ▣ Aging conditioning 1: 20-hr at 100°C
 - ▣ Aging conditioning 2: 20-hr at 112°C
 - ▣ Aging conditioning 3: 20-hr at 120°C
 - ▣ Aging conditioning 4: 3-day at 95°C
 - ▣ Aging conditioning 5: 6-day at 95°C

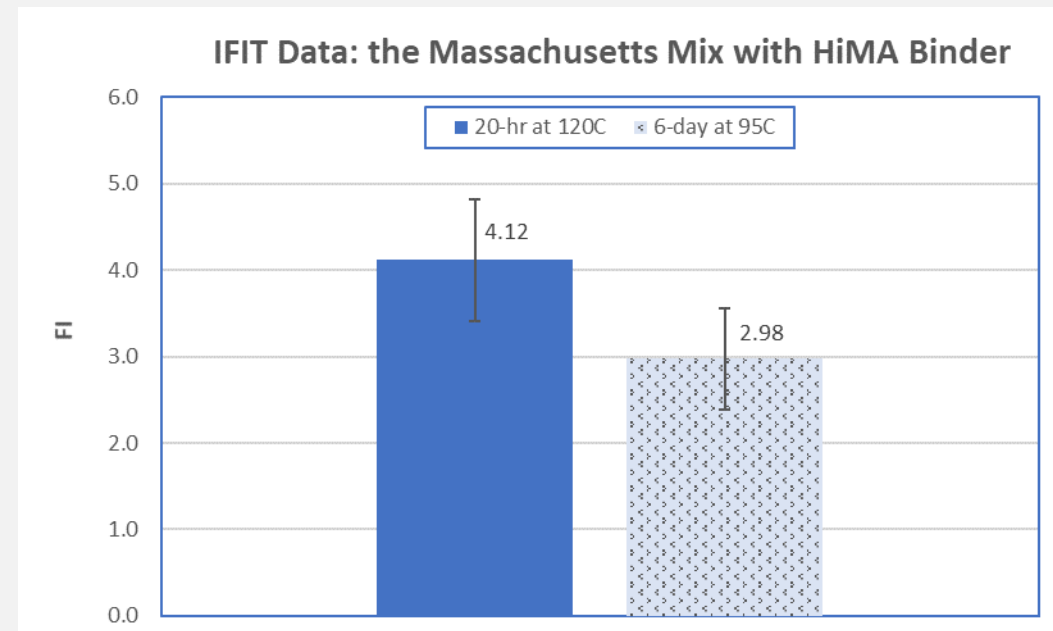
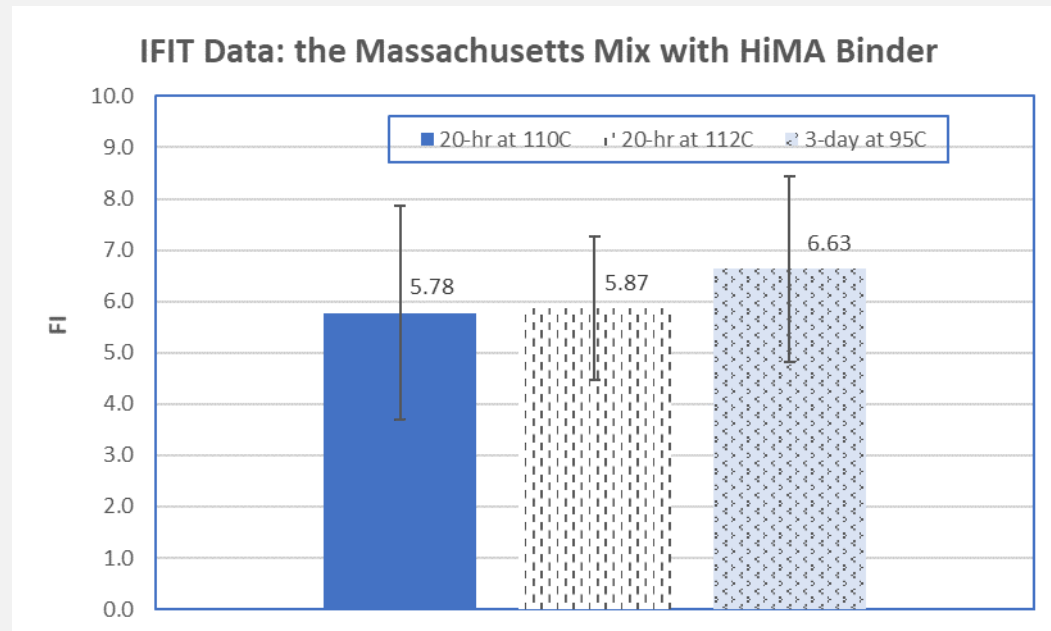
Laboratory verification of equiva. aging temp.

- Two cracking tests: IFIT for Massachusetts mix and OT for Texas mix



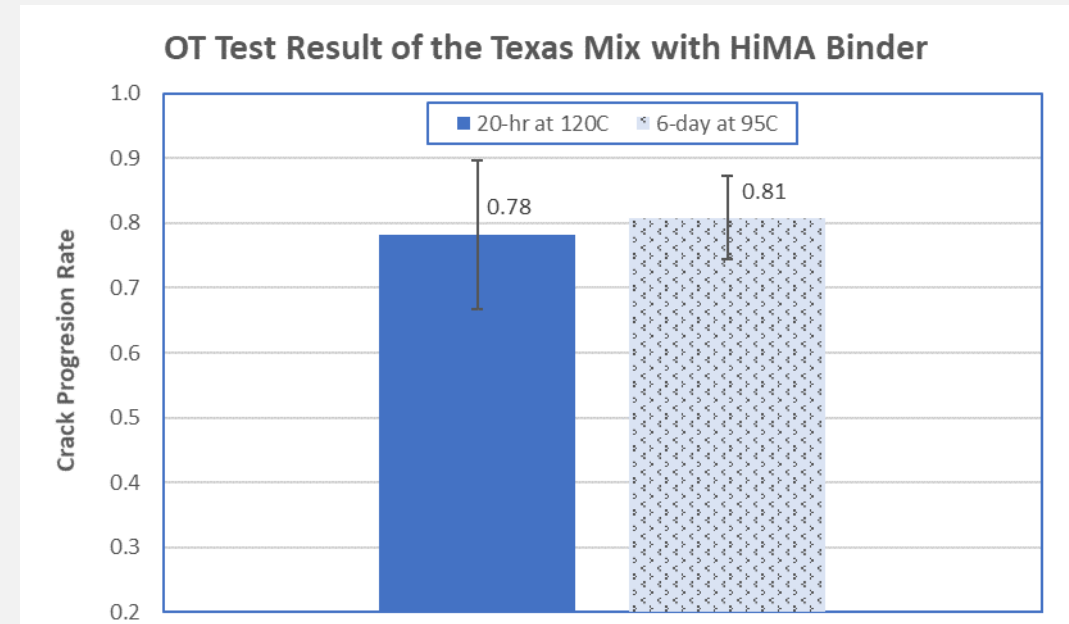
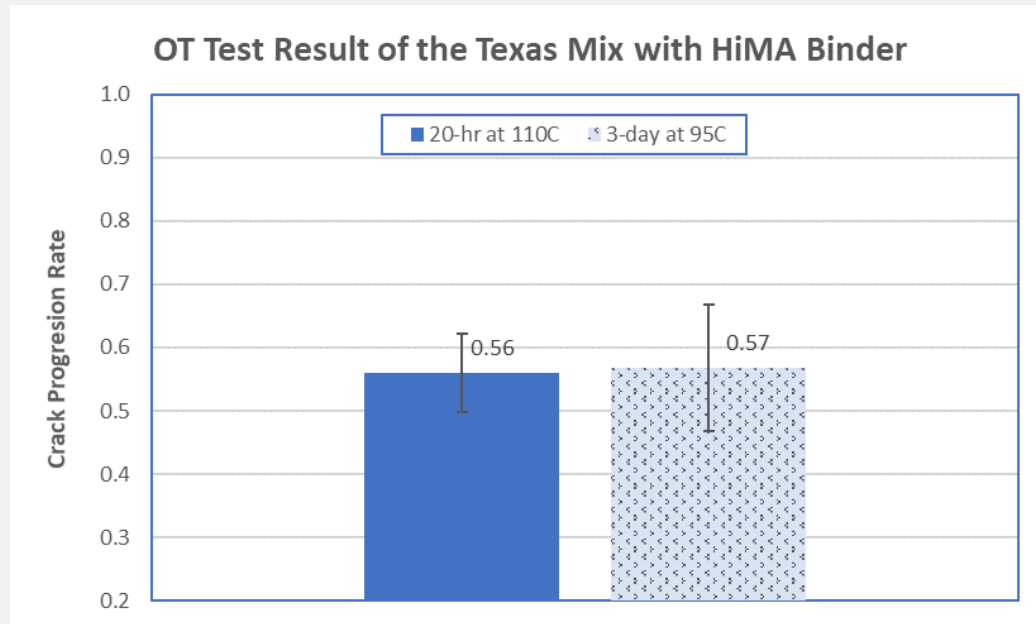
Laboratory verification of equiva. aging temp.

□ IFIT for Massachusetts mix



Laboratory verification of equiva. aging temp.

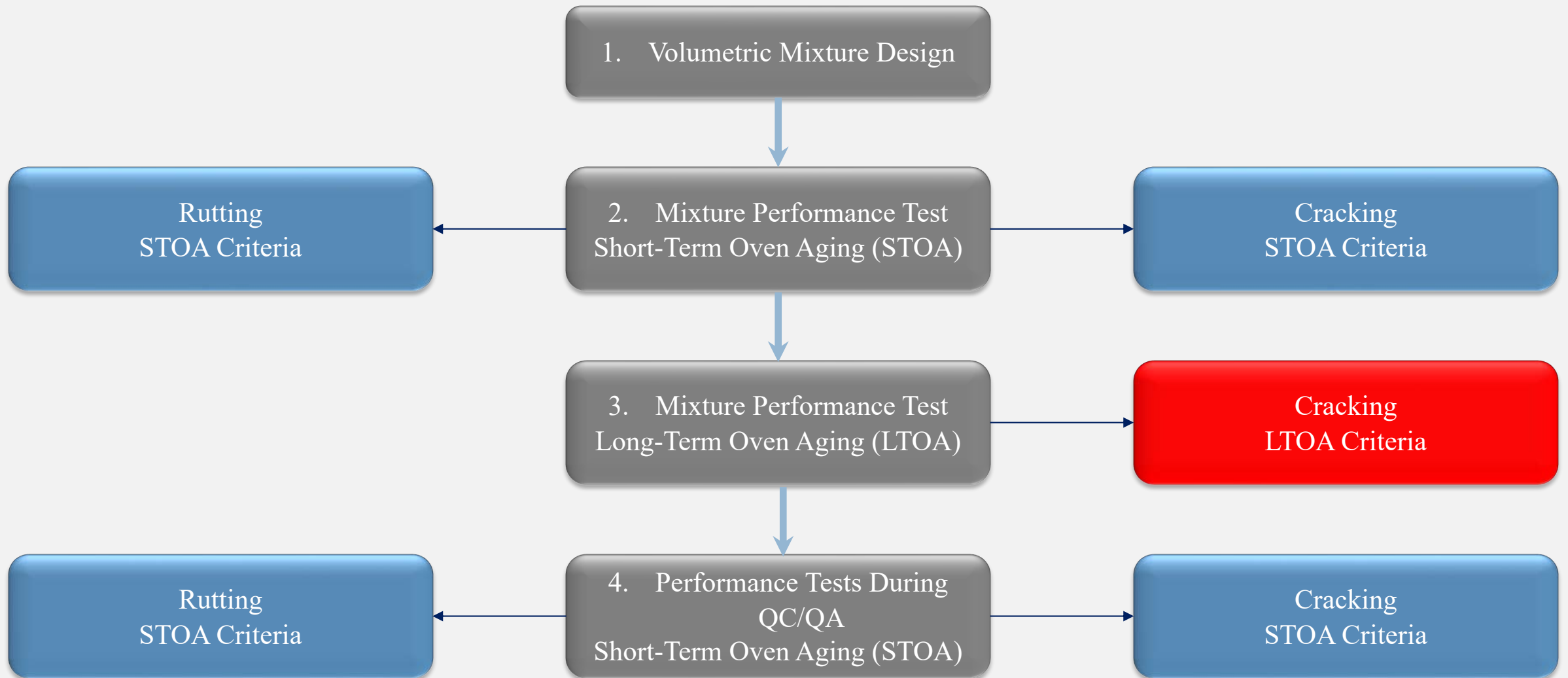
OT for Texas mix



Summary and Conclusions

- ❑ IDEAL-CT data showed that equivalent aging temperatures for 20 hrs to match 3 and 6 days aging at 95°C are 110°C and 120°C, respectively. This observation is confirmed by OT and IFIT.
- ❑ MassDOT BMD integrates both short-and long-term loose mix aging protocols into a coherent BMD.

Outcome of the Study: Comprehensive BMD





Thank You