University of Missouri

MAPIL
Mizzou Asphalt Pavement & Innovation Lab

Mizzou/MAPIL Update

by

Bill Buttlar, Glen Barton Chair in Flexible Pavements

January 8, 2020

MAPA Annual Conference

Outline

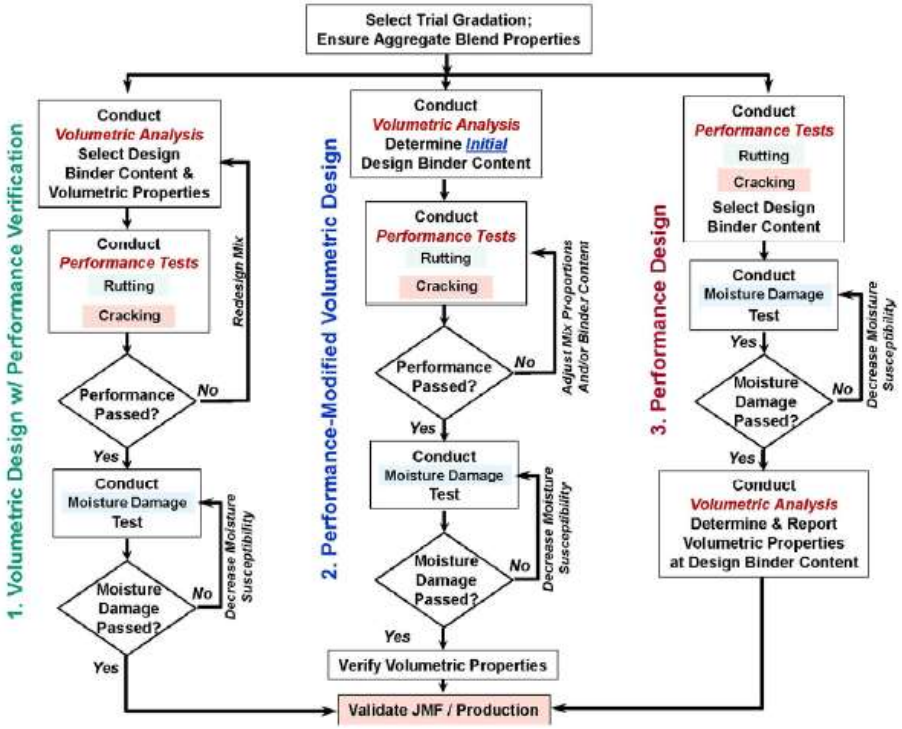
- Highlighted Research Project: MAPIL-MoDOT ‘Support for Balanced Mix Design in MO’
- What can MAPIL do for You
- And now, announcing…

Highlighted Research Project:

MAPIL-MoDOT ‘Support for Balanced Mix Design in MO’

Background/challenges

- SHRP fell short in delivering mix performance test to supplement volumetric design
- Current asphalt mixture design are primarily based on volumetrics
- Inclusion of modern recycling methods is challenging in current binder and volumetrics specs



Balanced Mix Design (BMD), or
Performance - Engineered Mixture Design (PEMD)

Why ‘Performance – based’ Specs?

- Tests the “End result” of a mixture design. **Binder, aggregate, blending, aging, interactions…all captured.**
- Allow innovative volumetric combinations of aggregates, binders and other additives (RAP, RAS, GTR, rejuvenators, fibers etc.) while controlling cracking, rutting, and stripping
- Promotion of contractor innovation to keep cost down and boost mix performance

Development of Pavement Temperature Maps

- Analyze continuous PG grade for Missouri
- More precise testing temperature at any location (DC(T), Hamburg Wheel, iFIT, IDEAL)

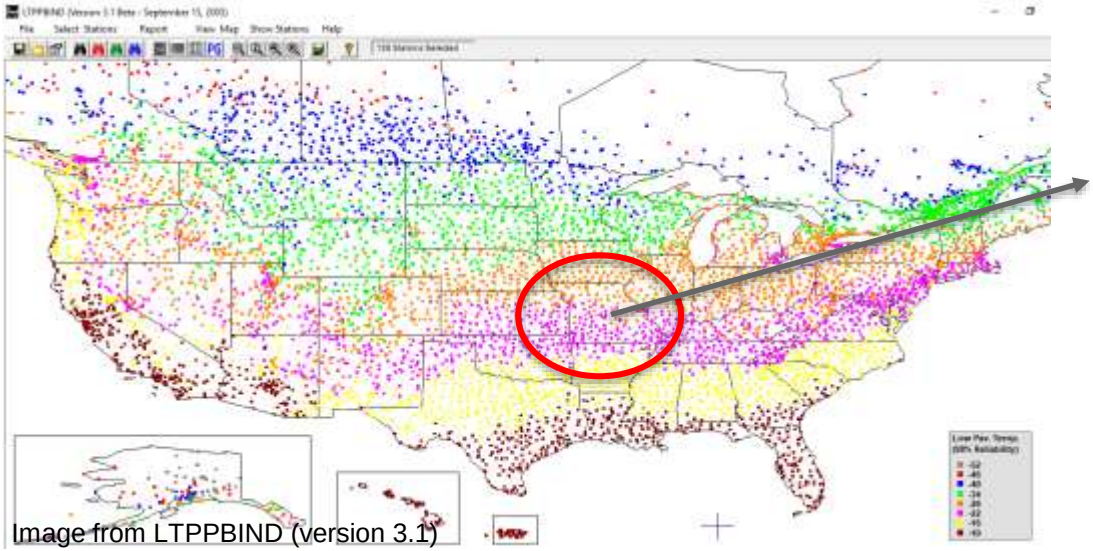
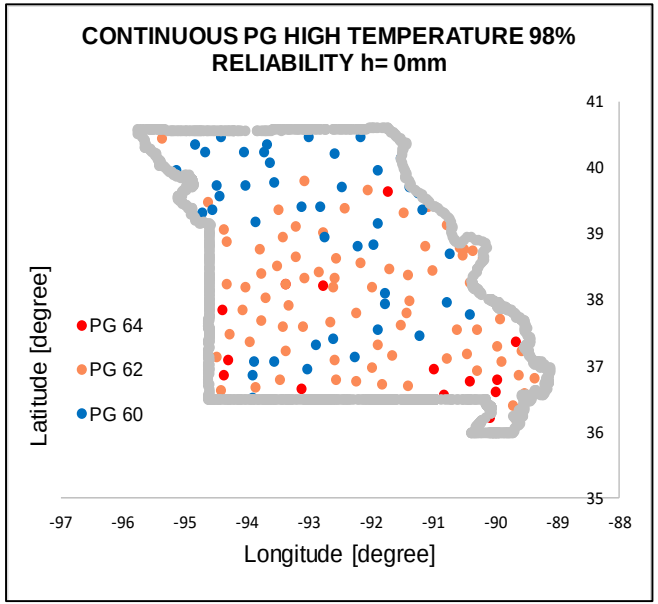


Image from LTPPBIND (version 3.1)

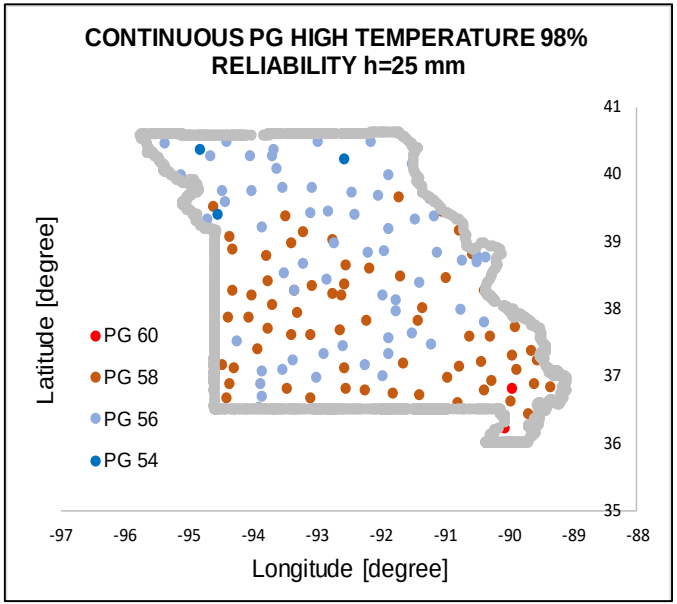
Low pav. temperature
98% reliability
PG : -28 and -22

What about temperatures closer to -24ºC or -26ºC ?

High pavement temperature 98% reliability

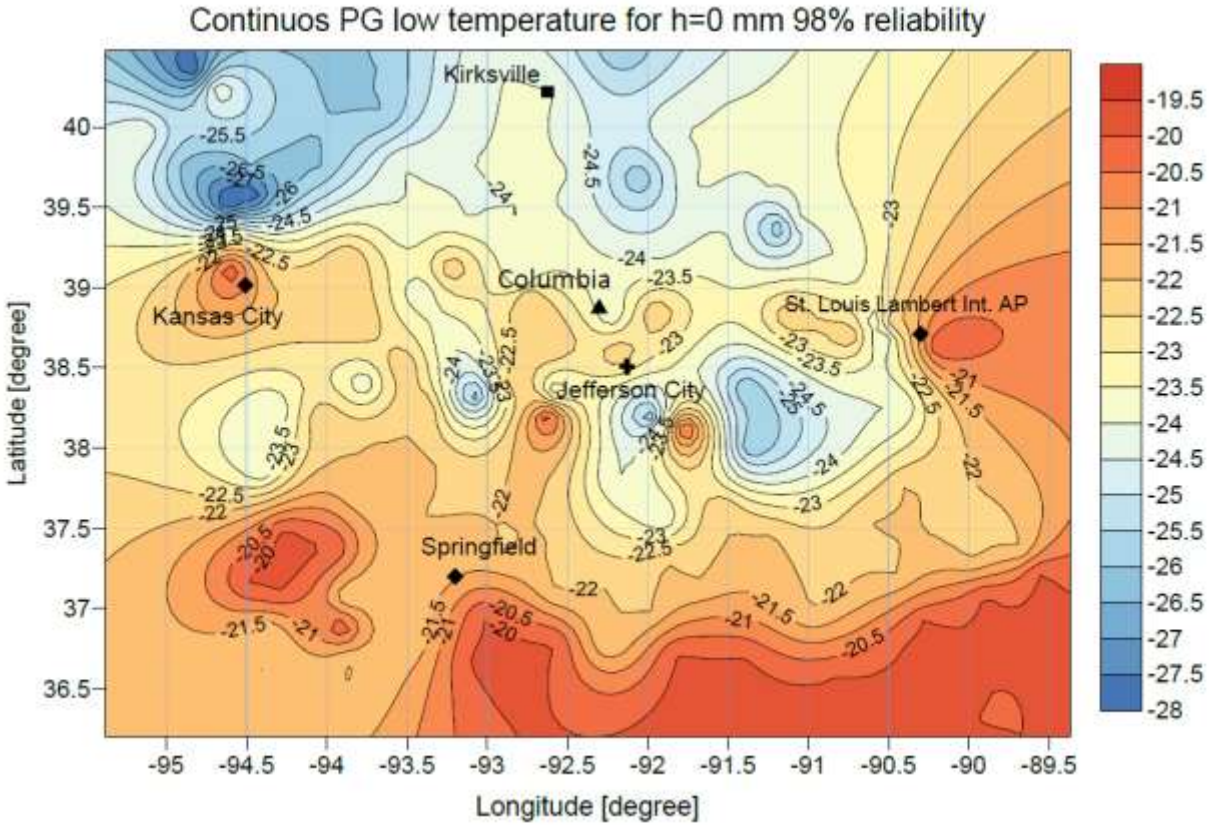


Pav. T at surface



Pav. T at h=25 mm depth

Contour map Missouri – Low Temp



Performance Testing on Asphalt Mixtures at Multiple Temperatures

DC(T) and HWTT

Experimental program

Mixtures	Hamburg wheel test temperature ºC	DC(T) fracture test temperature ºC
US63_1	40,46,52,58,64	-3,-6,-9,-12,-18
MO13_1	46,52,58	-6,-9,-12,-18
US54_1	46,52,58	-6,-9,-12,-18
US54_6	52,58	-6,-9,-12
TRO_L	40,46,50,58	-3,-6,-9,-12,-18, -24
TRO_L10R	40,46,50,58,64	-3,-6,-9,-12,-18, -24
OK_70P	46,50,58,64	-12,-24
OK_70P5	40,46,50,58,64	-12,-18, -24
ACE_PM	40,46,50,58	-3,-6,-9,-12,-18
ACE_CM	40,50,55	-12,-18,-24
ACE_FM	50, 58	-12, -18

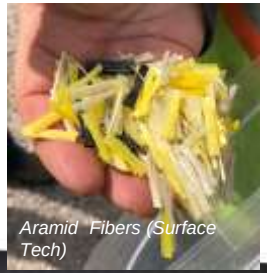
Group A

Group B
Control and
Rubber modified
mixtures

Group C
Control and fiber
reinforced mixtures


NB West Contractor Plant

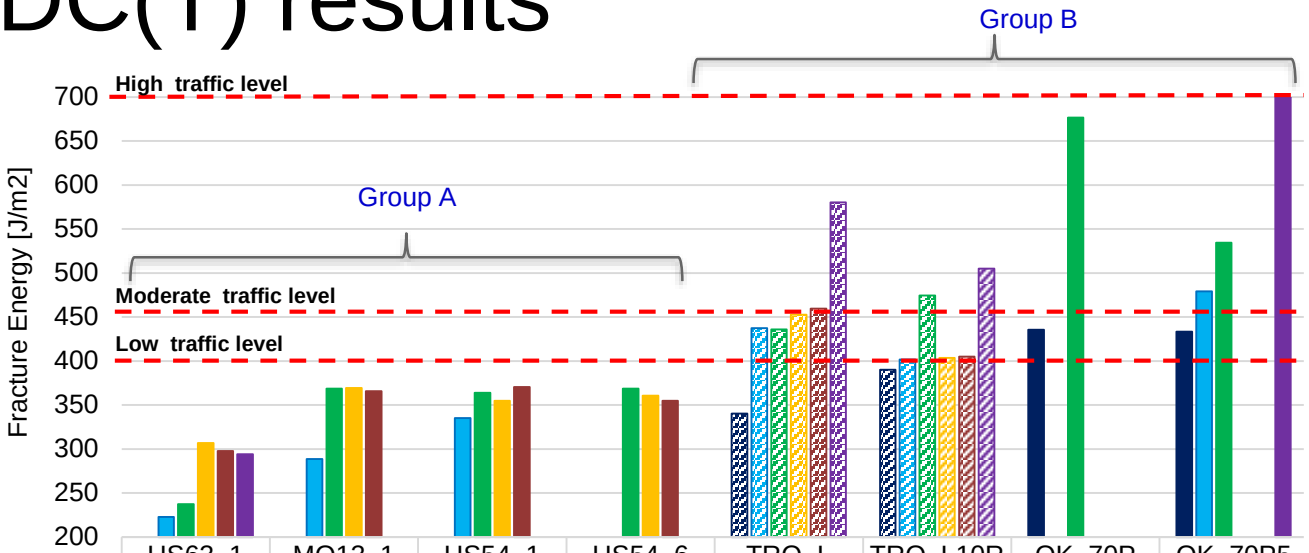
Rubber (Asphalt Plus)


Aramid Fibers (Surface Tech)

HWTT :160 specimens (2 wheel passes each temperature)

DC(T) :129 specimens (3 replicates each temperature)

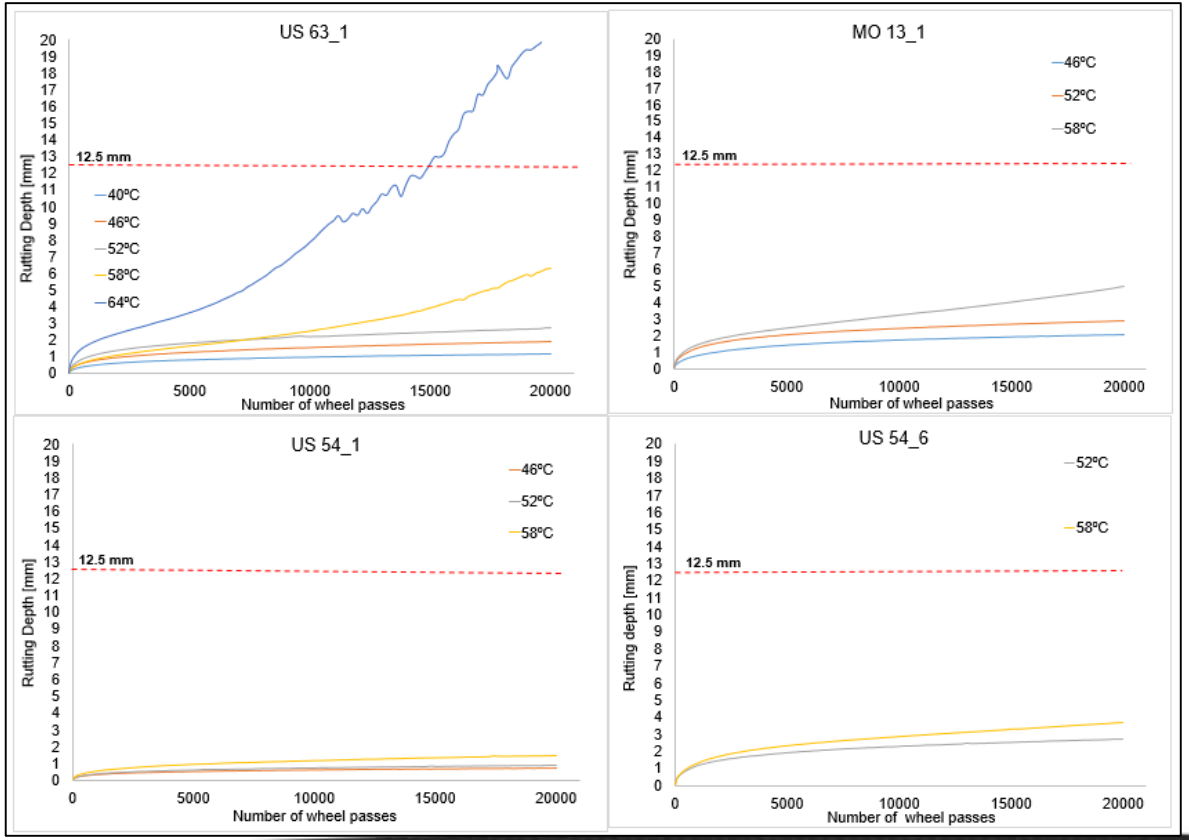
DC(T) results



	US63_1	MO13_1	US54_1	US54_6	TRO_L	TRO_L10R	OK_70P	OK_70P5
-24ºC					340.3	390.0	435.4	433.3
-18ºC	222.6	288.6	335.3		437.3	401.7		479.3
-12ºC	237.3	368.6	363.8	368.5	435.8	474.5	676.9	534.4
-9ºC	306.7	369.5	354.9	360.6	452.7	403.7		
-6ºC	297.8	365.8	370.5	354.9	459.5	405.0		
-3ºC	294.0				580.5	505.0		893.2

Lab mixes Plant mix - Lab compacted

HWTT test results

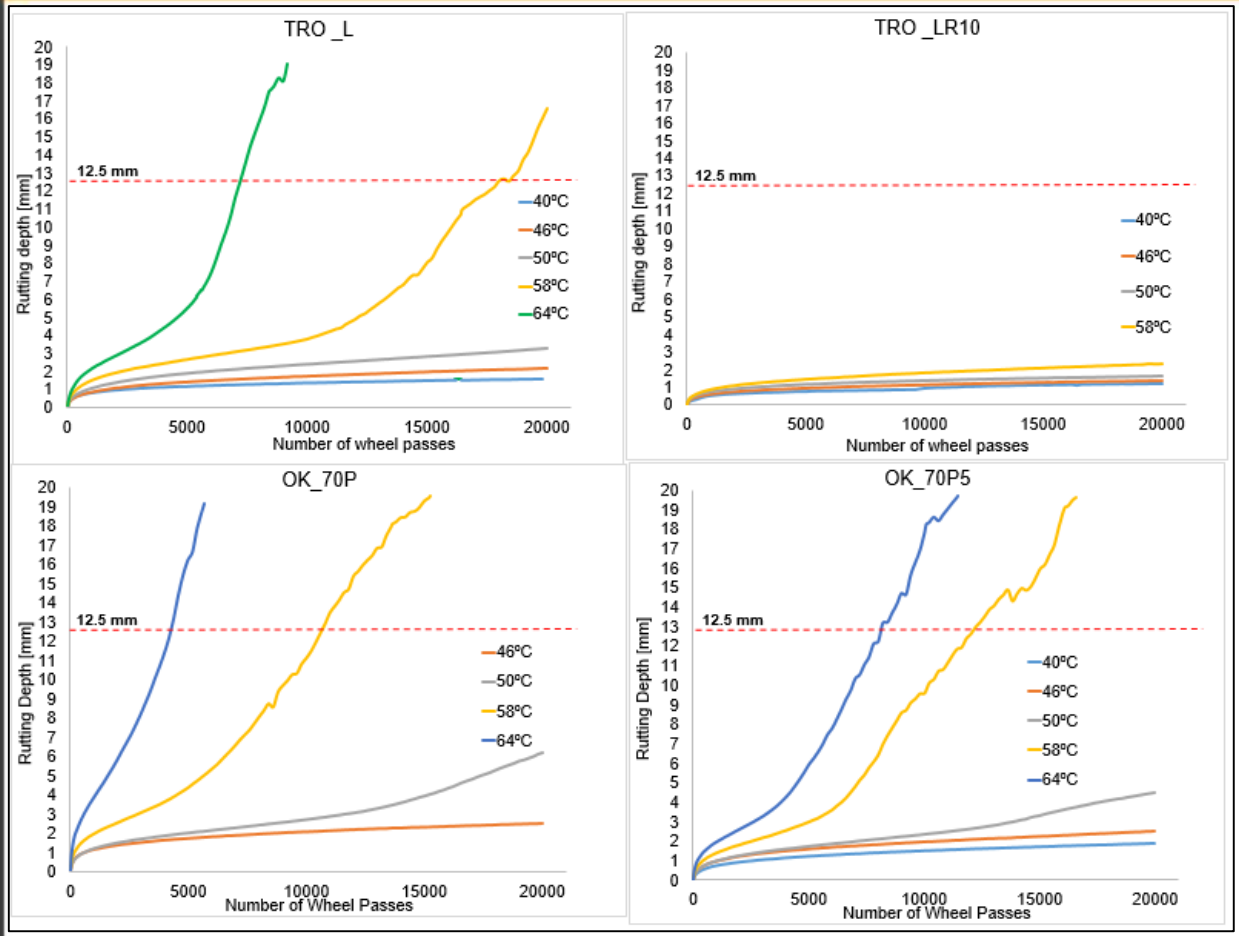


Group A

Plant - Lab compacted mixtures

Mixtures paved on 2016

Wheel passes vs. Rut depth curves



Group B: Rubber modified mixtures

TROL : Control lab mix

TRO_LR10: Lab mix (10% rubber)

OK_70P: Plant control mixture

OK_70P5: Plant modified mixture (5% rubber)

Wheel passes vs. Rut depth curves

Conclusions-Performance testing results

- DC(T)
  - As temperature increases, fracture energy increases
  - Fracture energy results are highly influenced by test temperature

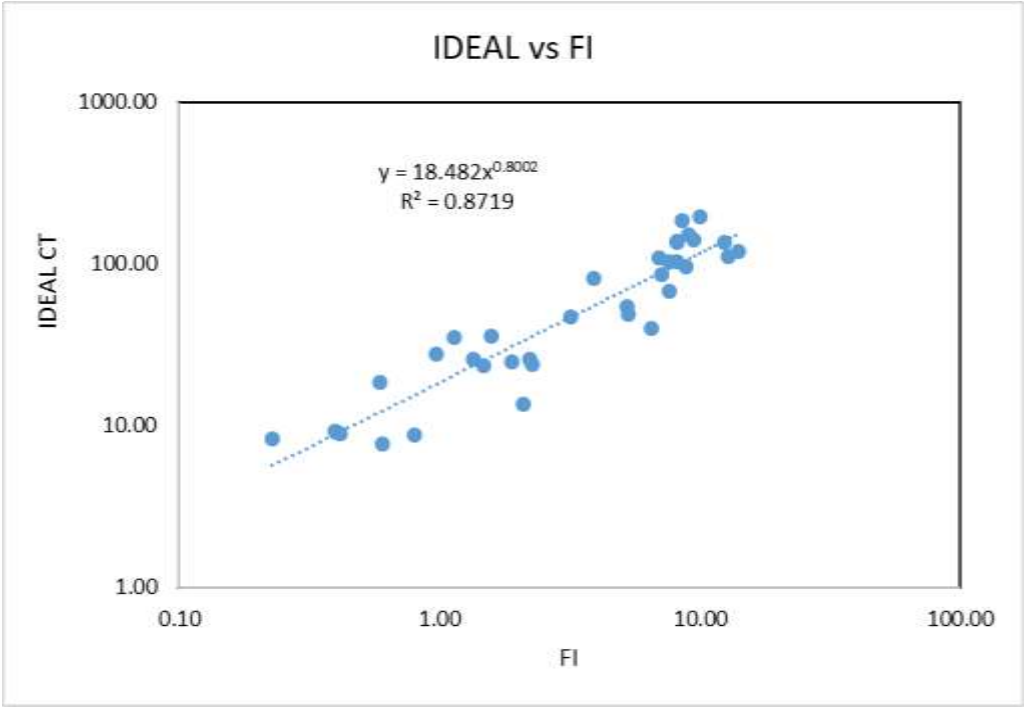
    A variation of 25J/m^2 is high enough to cause damage or crack on asphalt mixtures according to researchers in Minnesota (Hoplin, 2016).

- HWTT
  - Most of mixtures presented showed significant increase in rutting and fail criteria when tested at temperature above 50ºC (55ºC, 58ºC and 64 ºC)
  - Rutting depth results are highly influenced by the test temperature, as the temperature increases the deformation increases

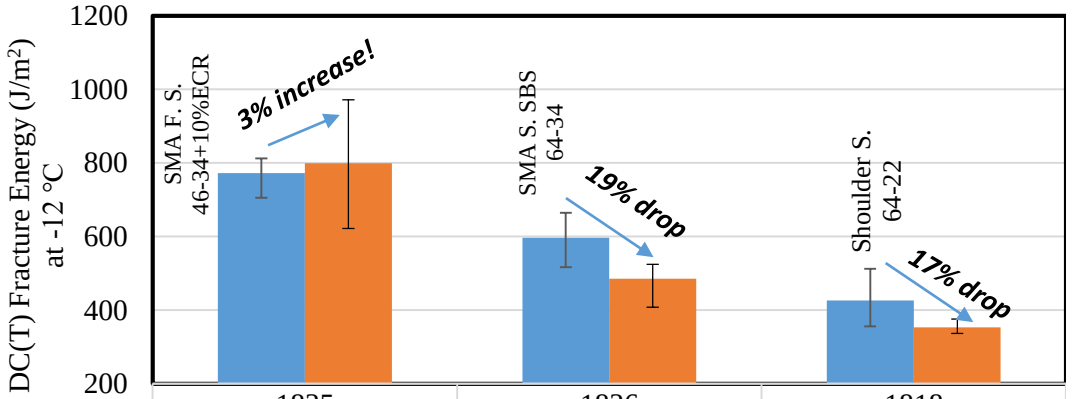
Testing Temperature selection is important !!!

Tailored test temperatures across Missouri are recommended, and tailoring for lift locations below surface, and shoulders.

IDEAL – iFIT Correlation



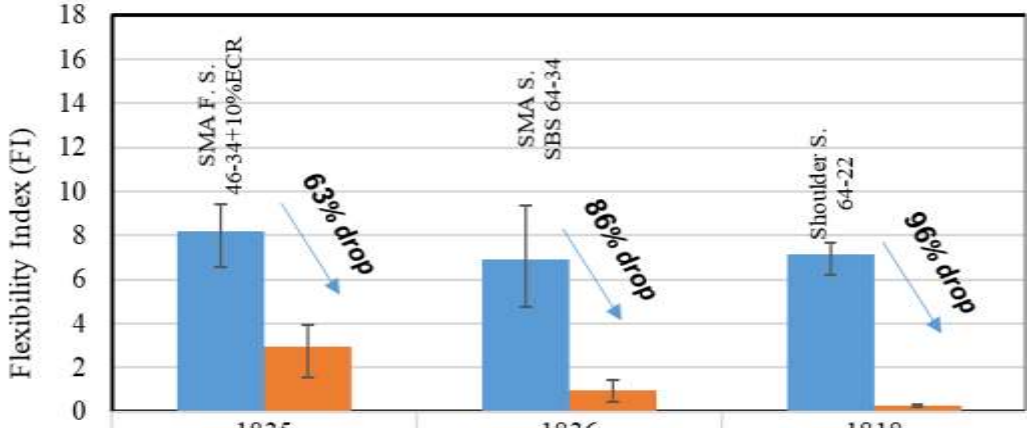
Aging Effect on Cracking Tests - DCT



	1835	1836	1818
Gf (STA)	772	596	427
Gf (LTA)	799	485	353
ABR by RAP	25.0	16.2	20.4
ABR by RAS	16.1	16.3	0.0
Total ABR	41.2	32.5	20.4

IL Tollway Study – 6 days loose mix long-term aging (LTA) at 95°C

Aging Effect on Cracking Tests - iFIT



	1835	1836	1818
FI (STA)	8.2	6.9	7.1
FI (LTA)	3.0	1.0	0.3
ABR by RAP	25.0	16.2	20.4
ABR by RAS	16.1	16.3	0.0
Total ABR	41.2	32.5	20.4

IL Tollway Study – 6 days loose mix long-term aging (LTA) at 95°C

Future Work

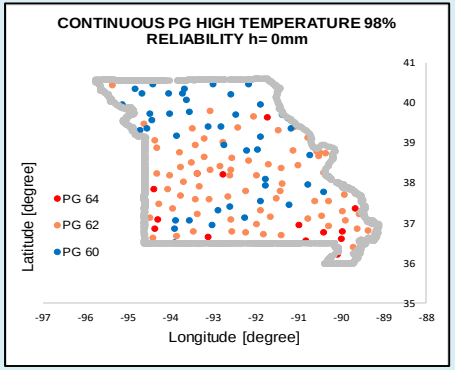
MoDOT Current Balanced Mix design specification

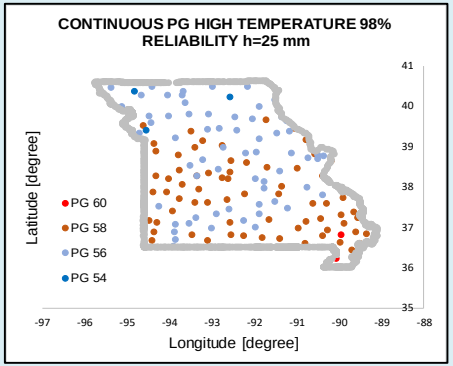
Hamburg Wheel Tracking Test

PG Grade High Temperature *	Minimum Wheel Passes	Maximum Rut Depth (mm)
58S-xx	5,000	12.5
64S-22	7,500	12.5
64H-22	15,000	12.5
64V-22	20,000	12.5

*Determined by the binder grade specified in the contract

Extension of the spec. to binder course mixtures
Continue aging studies, including storage and reheating





Future Work

MoDOT Current Balanced Mix design specification

FLEXIBILITY INDEX	Ideal CT	Percent of Contract
NMAS <190	NMAS <190	Price
< 2.0	< 32	98%
2.0 – 3.9	32 – 60	100%
4.0 – 7.9	60 - 97	102%
>8.0	> 97	103%

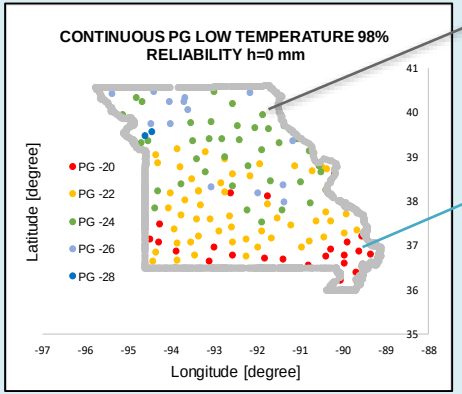
$$Intermediate\ temperature = \frac{HT + LT}{2}$$

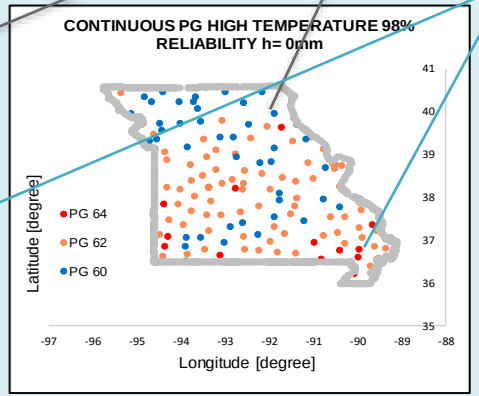
$$IT = \frac{60 + (-24)}{2} = 18$$

$$IT = \frac{64 + (-20)}{2} = 22$$

Adjustment of the spec. to intermediate temperature

I-FIT
50 mm/min
25°C





IDEAL-CT
50 mm/min
25°C

What can MAPIL do for You?

- Superpave Binder and Mixture Testing
- Mixture design
- Mixture Tune-ups and Optimization
- ‘Fix-the-Mix’
- Binder Grading and Mixture Grading (new)
- Binder Extraction and Recovery
- Advanced Testing, Modeling, Sensors….

www.MAPIL.Missouri.edu

And now, Announcing….

MISSOURI CENTER FOR

TRANSPORTATION INNOVATION

PROPELLING PEOPLE · CONNECTING COMMUNITIES · ENERGIZING ECONOMIES

Missouri Center for Transportation Innovation (MCTI)

MCTI Grand Opening

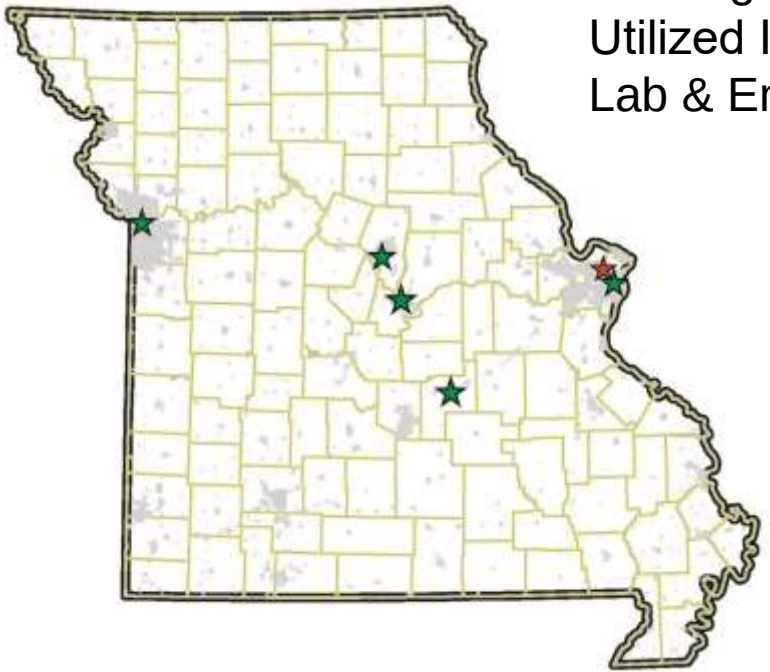
December 17, 2019
Jefferson City

Partnership with the University of Missouri System and MoDOT, in cooperation with FHWA, other universities and transportation professionals.

Goals of the Center

- Identify, conduct and disseminate research
- Complete practical, timely, and implementable research
- Implement innovative technologies
- Increase Missouri's participation and influence in national research
- Produce future transportation engineers
- Create an atmosphere that develops faculty and staff at the University and MoDOT

Existing Laboratory Facilities will be Utilized Including MoDOT's Central Lab & Envisioned I-70 Test Road



Organizational Framework

- Performance Committee
  - State CM Engineer
  - Research Administrative Engineer
  - MoDOT District Engineer
  - FHWA Transportation Engineer
  - University Deans (or designees)

Organizational Framework (cont.)

- Center Operations Cabinet
  - Center Director (Bill Buttlar - MU) and Deputy Director (John Myers – S&T)
  - UM System Lead Faculty (Jill Bernard-Bracy - UMSL; John Kevern - UMKC)
  - MoDOT Research Lead (Jen Harper)
  - MCTI Core Staff
- Technical Advisory Groups
  - Comprised of multiple organizations based on focus areas
- Principal Investigators
  - Successful Proposals Selected by MoDOT

Focus Areas

- Design & Construction Administration
- Geotechnical
- Environmental and Hydraulics
- Maintenance
- Multimodal (Aviation, Transit, Rail, Ports)
- Pavements
- Structures
- System & Data Analytics
- Traffic Engineering and Safety

Technical Advisory Groups (TAGs)

MoDOT and MCTI establish TAGs consisting of:

- MoDOT
- University
- FHWA
- Local Agencies
- Consultants
- Industry
- MoSTIC members
- Other Governmental Agencies

Volunteer to Serve Today!!!

Research to Practice

- A final presentation will be scheduled with applicable MoDOT staff that are instrumental in implementation
- MoDOT executes the research implementation plan with assistance from MCTI

Technology Transfer

- MCTI Sponsored Conferences
- Communication of Research
  - Center website
  - Presentations and webinars
  - Journal publications

Thank you!

Bill Buttlar, PhD, PE
Director
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