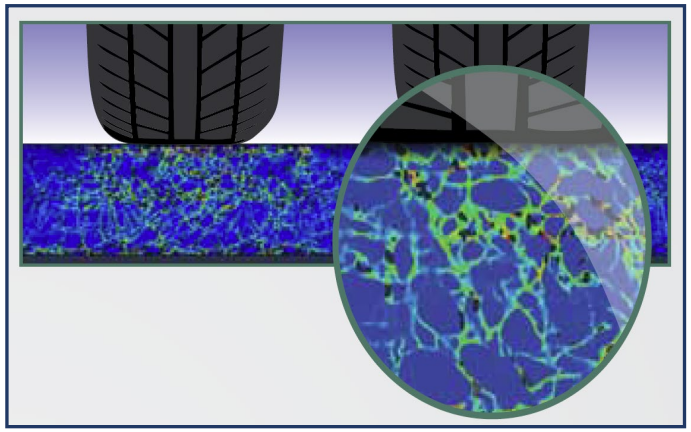
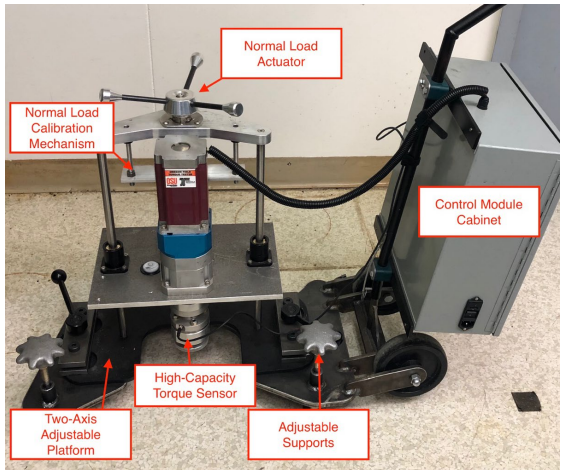
LCA, LCCA, and Sustainability



Advanced numerical modeling

Performance based specs



Technology development

Benchmarking and Implementing Performance-Based Balanced Asphalt Mix Design in Oregon

Erdem Coleri, Ph.D.

Associate Professor

Director of OSU Asphalt Materials and Pavements Laboratory

School of Civil and Construction Engineering, Oregon State University

http://research.engr.oregonstate.edu/coleri/

Oregon Department of Transportation

Oregon State University

Major contributors since 2016

- **Shashwath Sreedhar, Ph.D. - Doctoral Dissertation**
  - Developing Performance-Based Specifications to Improve the Fatigue Life of Asphalt Pavements in Oregon
- **Ihsan Obaid, Ph.D. - Doctoral Dissertation**
  - Improving Fatigue Cracking and Moisture Resistance of Asphalt Mixtures
- **Vipul Chitnis** – Graduate Research Assistant - Ph.D. Candidate
  - Graduating this term

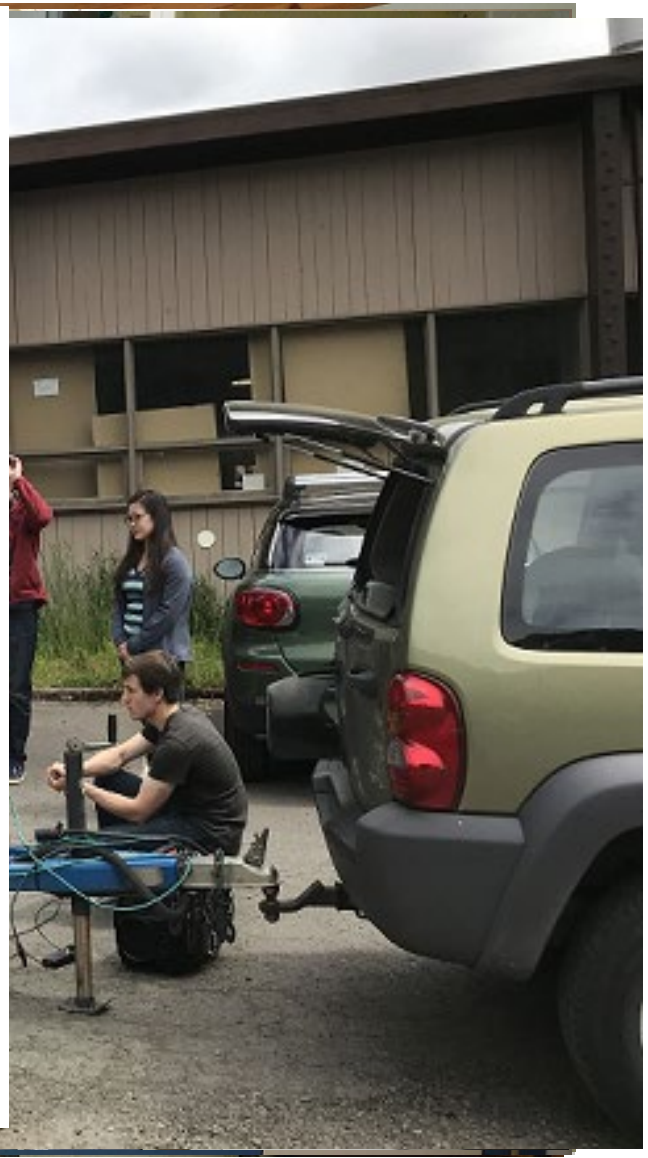
Other partial contributors: **Mayank Sukhija** and **Vikas Kumar**

OSU PAVEMENT RESEARCH PROGRAM OVERVIEW

OSU ASPHALT MATERIALS & PAVEMENTS LAB

OSU PAVEMENT RESEARCH PROGRAM OVERVIEW

OSU ASPHALT MATERIALS&PAVEMENTS LAB



COMING SOON!!! - The Low-Cost Full-Scale Accelerated Pavement Test System

- An autonomous truck is currently being build
- A laser texture scanner DONE
- A profilometer system for surface profile monitoring DONE
- A camera system with an image processing code for crack formation and progression monitoring DONE

OSU ASPHALT MATERIALS RESEARCH PROGRAM OVERVIEW

OSU ASPHALT MATERIALS AND PAVEMENTS LAB

MISSION:

Develop and implement methods and technologies to construct transportation infrastructure that is more cost-effective, socially beneficial, and does less damage to the environment while teaching the fundamentals of pavement engineering to K-12 and college students and the public.

OUR VISION DOCUMENT IS POSTED AND AVAILABLE HERE ON OUR WEBSITE

BALANCED MIX DESIGN (BMD)

Asphalt-Surfaced Pavement Distresses

Source: https://www.pavementinteractive.org

Rutting

NOT A BIG PROBLEM IN OREGON

Low temperature cracking

NOT A BIG PROBLEM IN OREGON

Fatigue cracking

MAJOR DISTRESS MODE IN OREGON
Mostly delamination and moisture related

BMD AND PERFORMANCE BASED SPECS

Why do we need performance based specs?

Good old days

mix

Can we achieve the best taste without tasting it?

Today's mixes

Chicken Tikka Masala

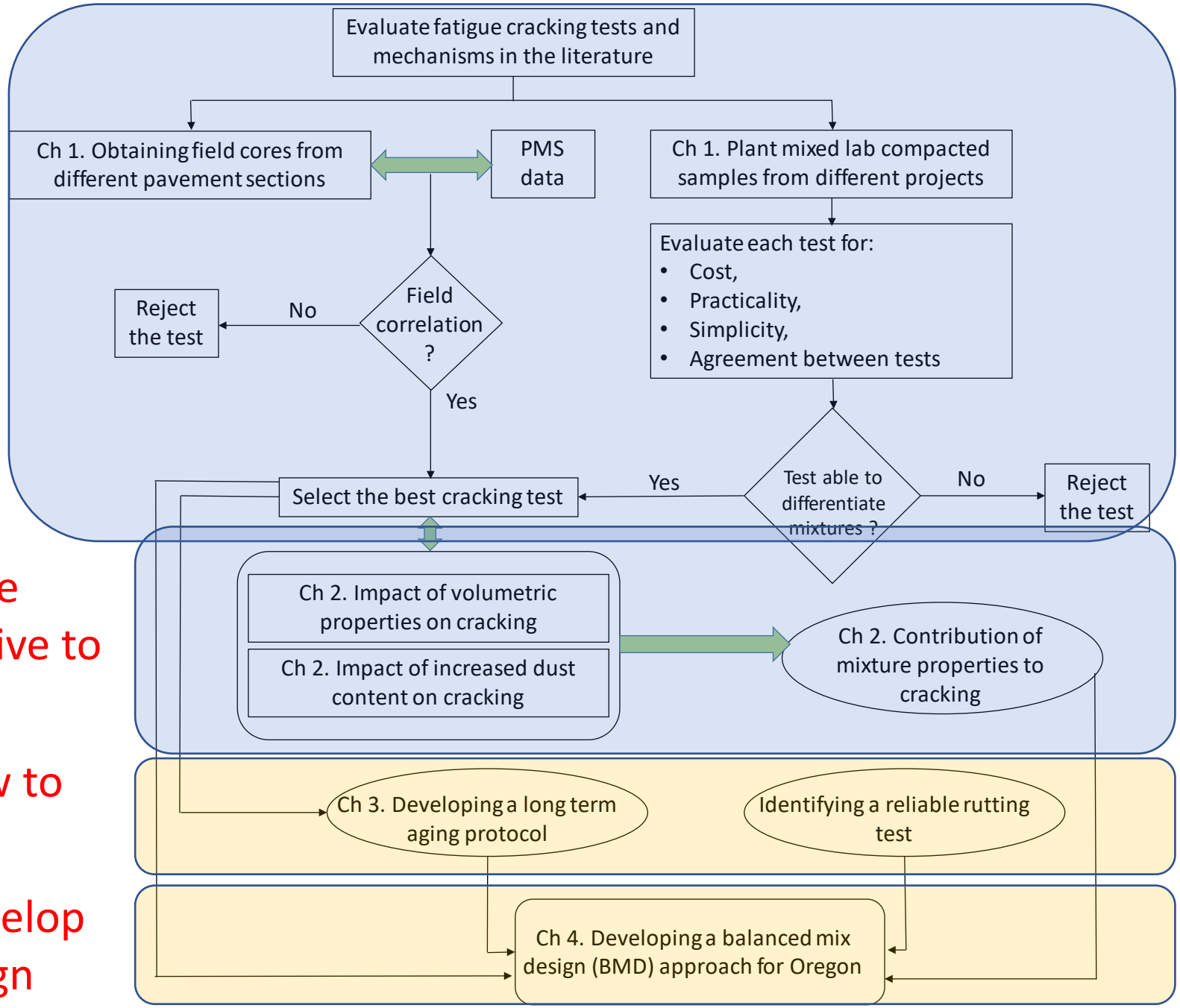
RESEARCH ROAD MAP FOR BMD

Part I-2015: Best cracking and rutting tests?

Part II-2016 – Are the selected tests sensitive to mix properties?

Part III-2018 – How to simulate aging?

Part IV-2019 – Develop balanced mix design

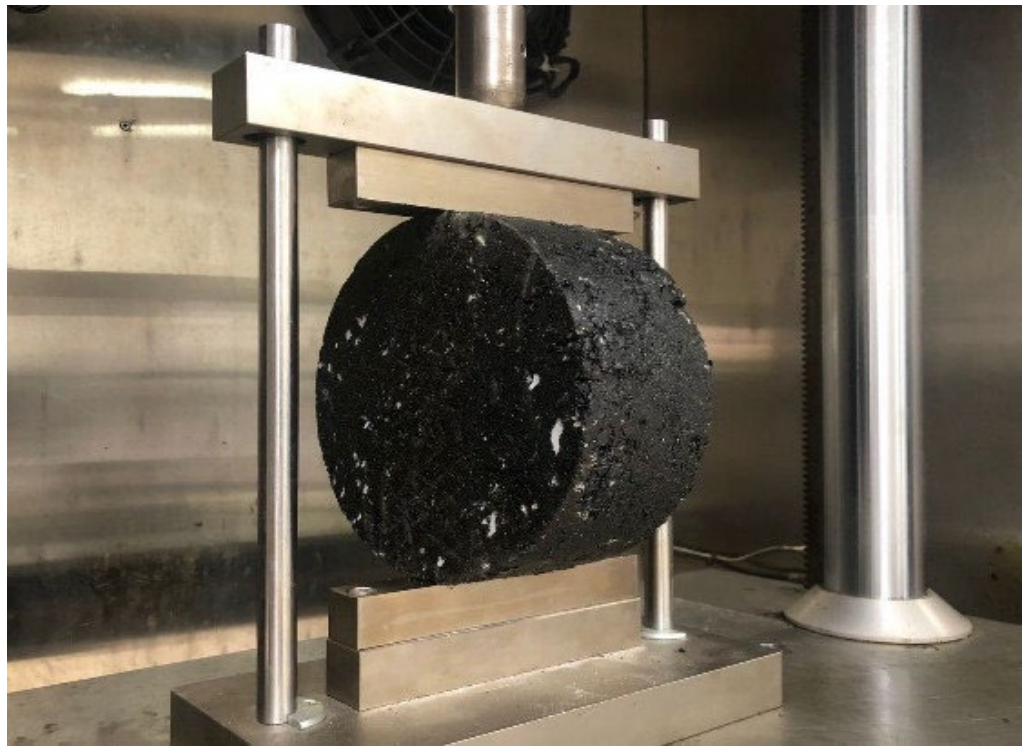


IMPLEMENTATION OF PERFORMANCE-BASED SPECS AND BMD

Part I-2015 and Part II-2016: Best cracking and rutting tests for Oregon

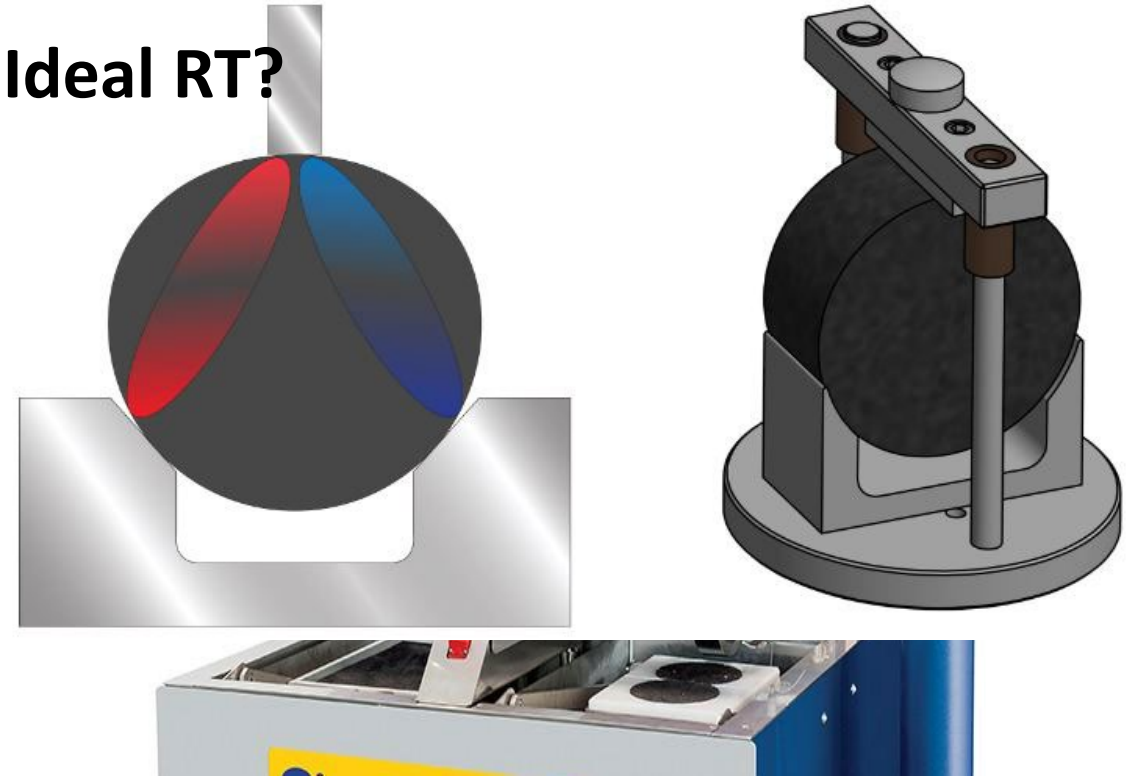
Selected and considered performance experiments

FOR CRACKING PERFORMANCE



Ideal CT – Indirect Tension Test

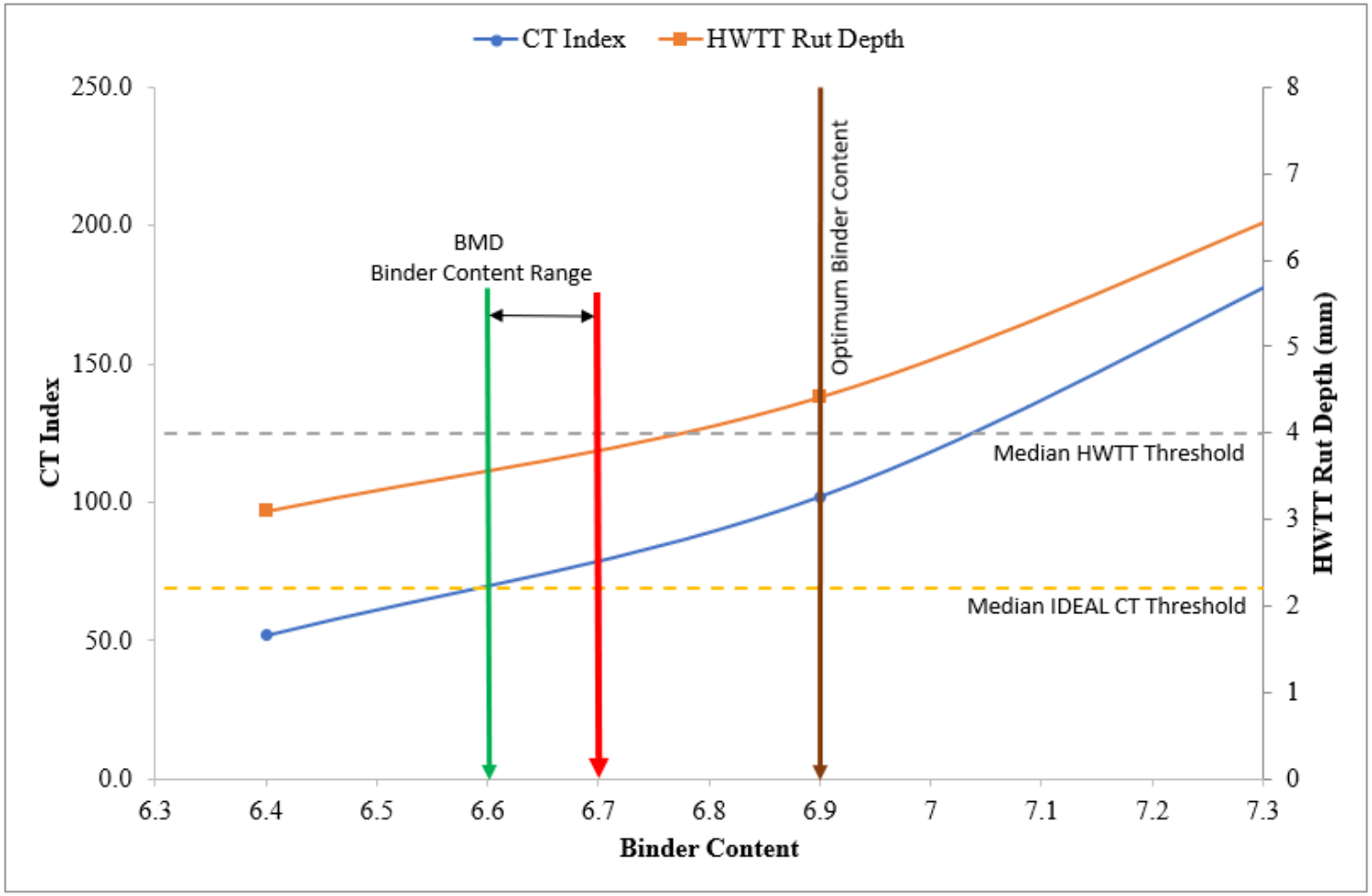
FOR RUTTING PERFORMANCE



Hamburg wheel tracking test

IMPLEMENTATION OF PERFORMANCE-BASED SPECS AND BMD

The BMD PROCESS



IMPLEMENTATION OF PERFORMANCE-BASED SPECS AND BMD

Part III-2018 – How to simulate aging?

- ***Short-term aging***

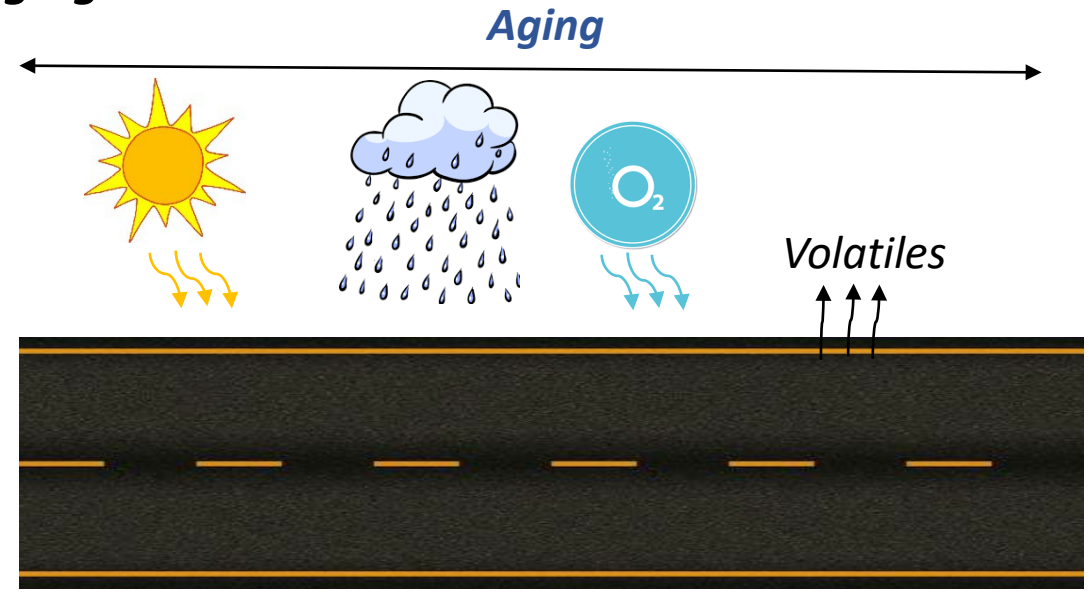
Wikipedia

www.hotmixtrucks.co.uk

sloan-construction.com

- ***Long-term aging***

Before



After

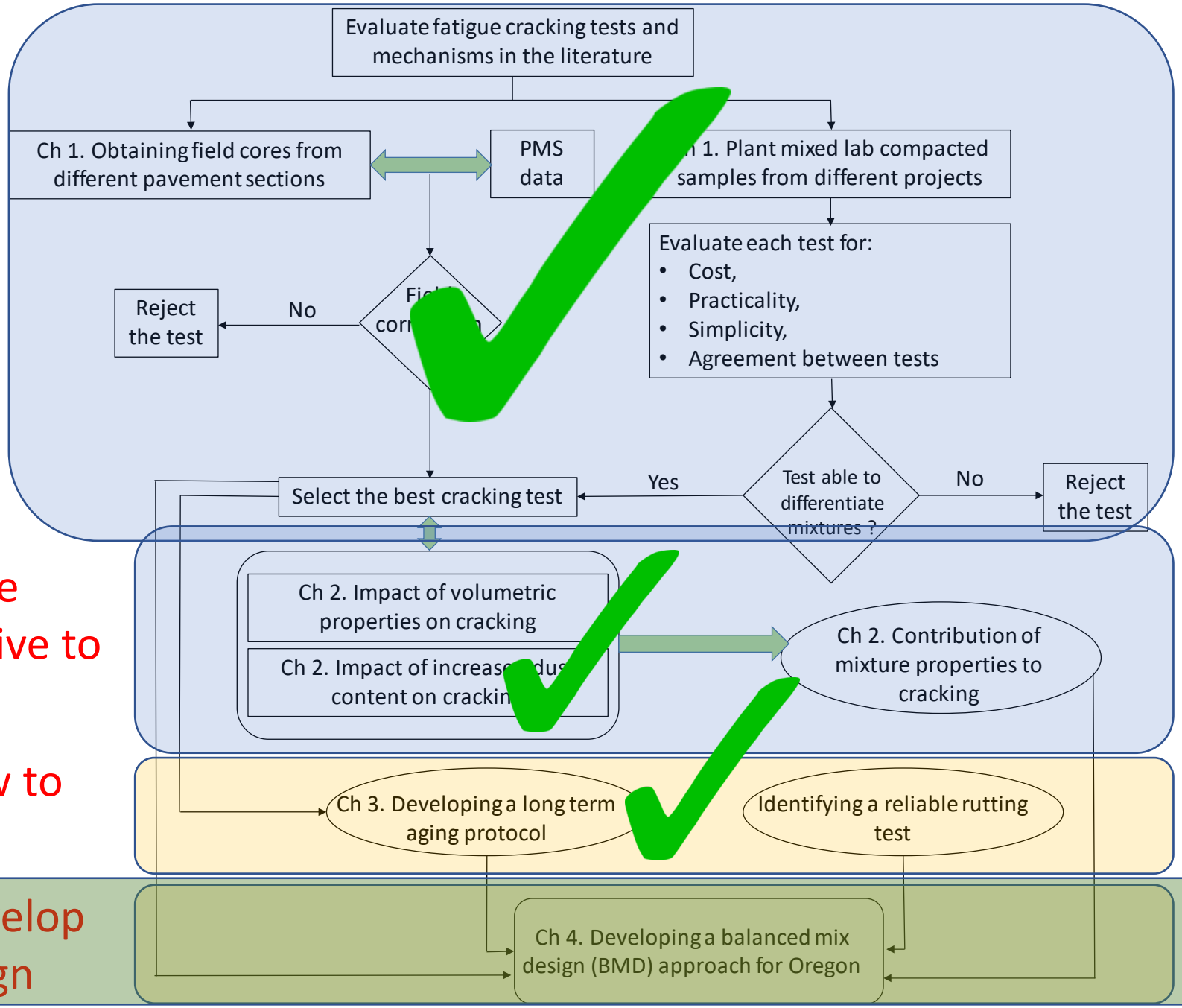
RESEARCH ROAD MAP FOR PERFORMANCE BASED SPECS

Part I-201 Best cracking nd rutting te

Part II-201 – Are the selec tests sensitive to mix properti ?

Part III-2 18 – How to simu e aging?

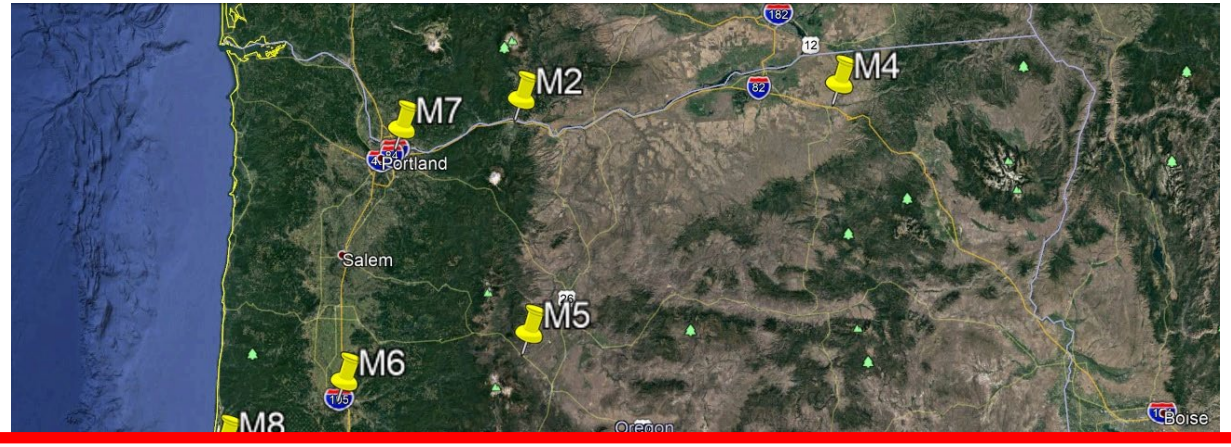
Part IV-2019 – Develop balanced mix design



IMPLEMENTATION OF THE BMD PROCESS

Part IV-2019 – Balanced mix design and performance based specs

8 construction projects in Oregon – Over 600 experiments conducted in this phase



4. Implementation of Balanced Mix Design Methods in Oregon – Pilot Projects

IMPLEMENTATION OF THE BMD PROCESS

Implementation of Balanced Mix Design Methods in Oregon – Pilot Projects

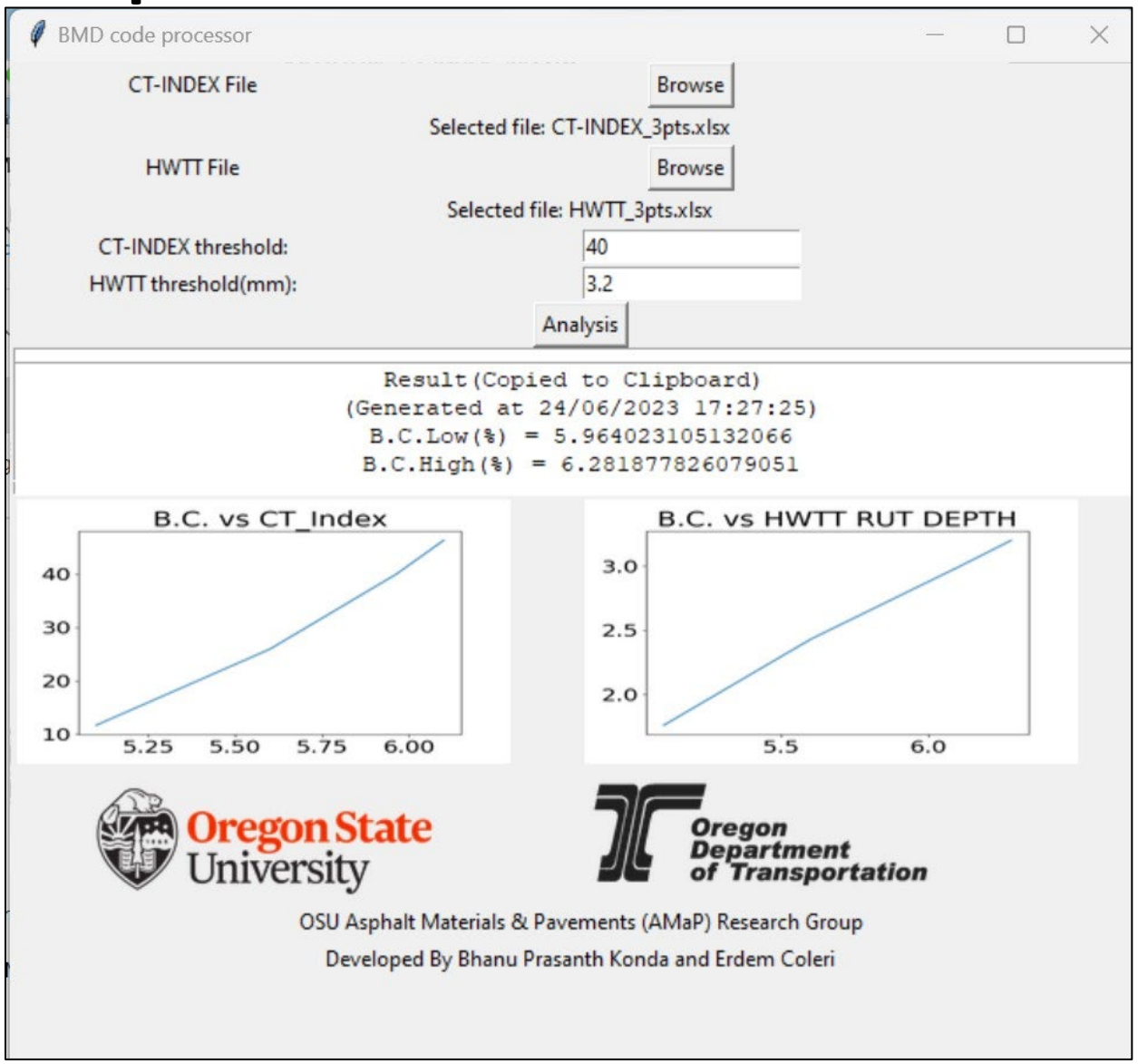
- A comprehensive literature review
- Developed codes for: i) processing laboratory test results
  ii) performing the BMD
  iii) conducting the final checks for volumetrics

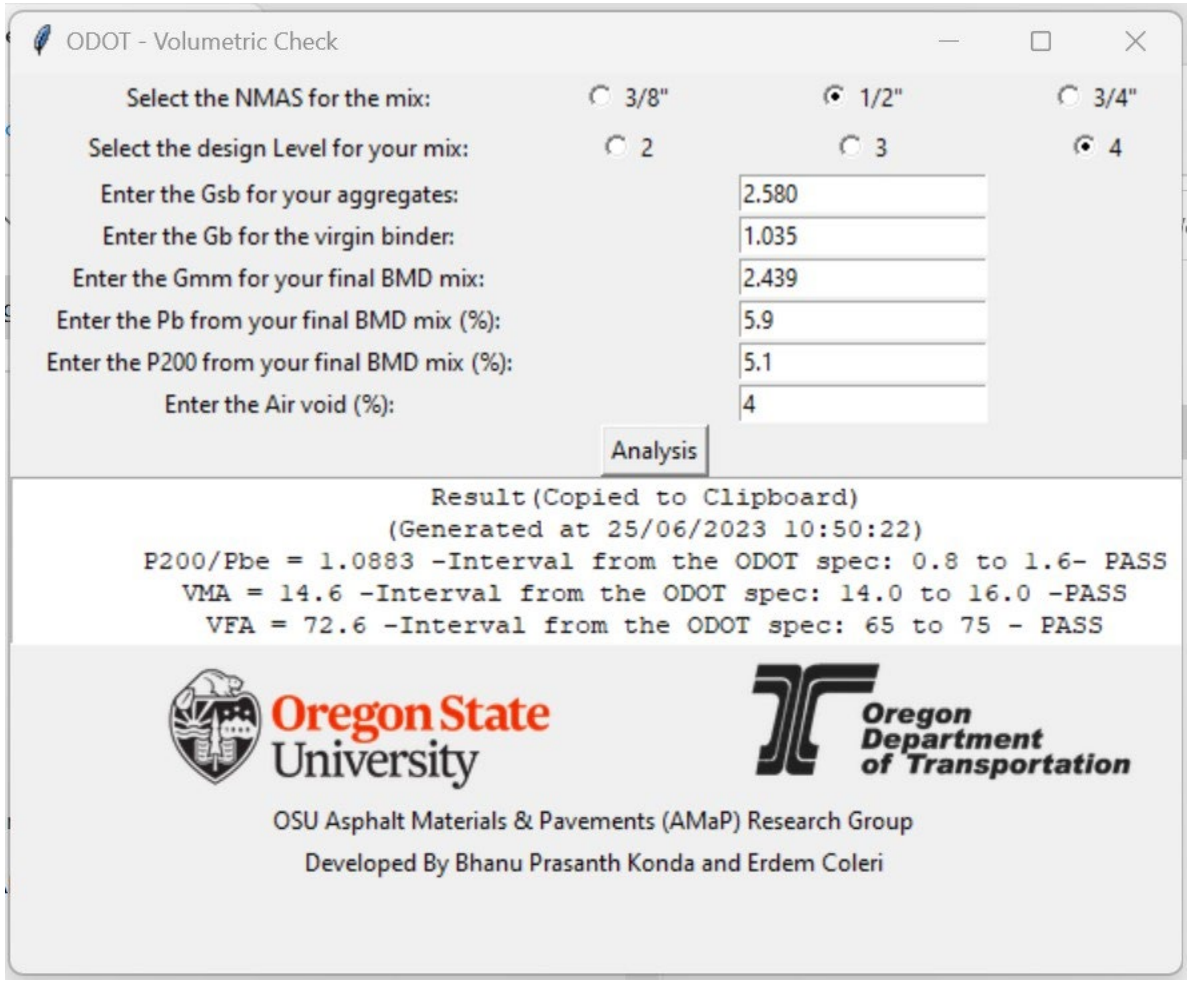
- Finalized the development of laboratory test protocols to improve the practicality and accuracy of the process

- Completed BMDs for 5 different asphalt mixes and constructed the pilot sections last summer.

IMPLEMENTATION OF THE BMD PROCESS

Implementation of BMD – Software packages





Benchmarking the Performance of Asphalt Mixtures

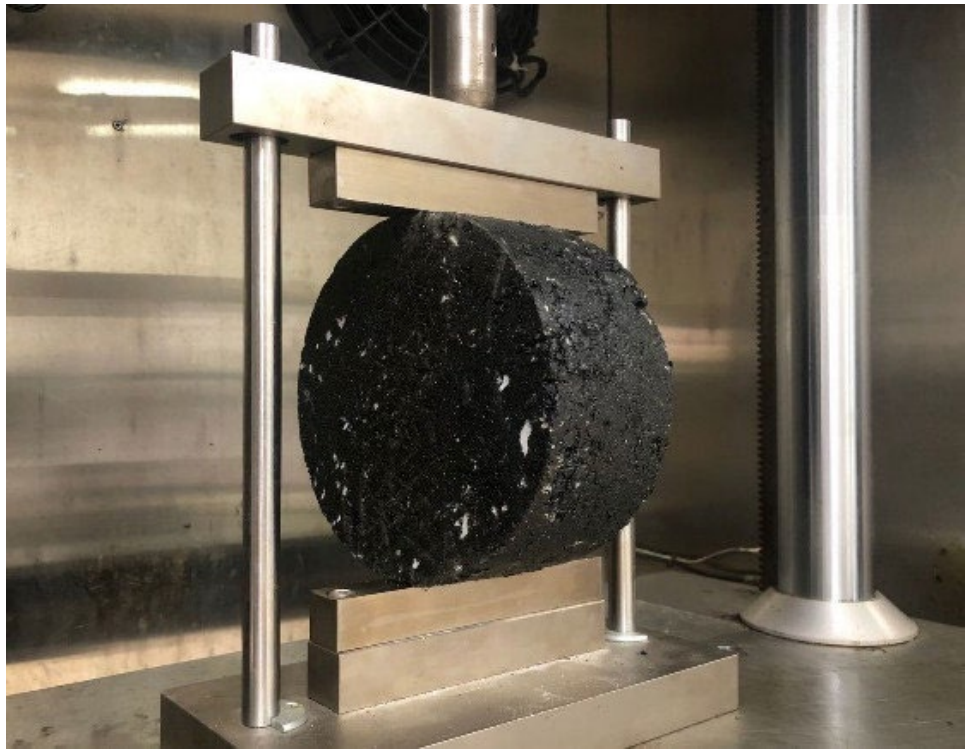
38 different field projects were used for statistical analysis

IDEAL CT And HWTT test data along with the mixture parameters were provided by ODOT

Purpose of Statistical Analysis

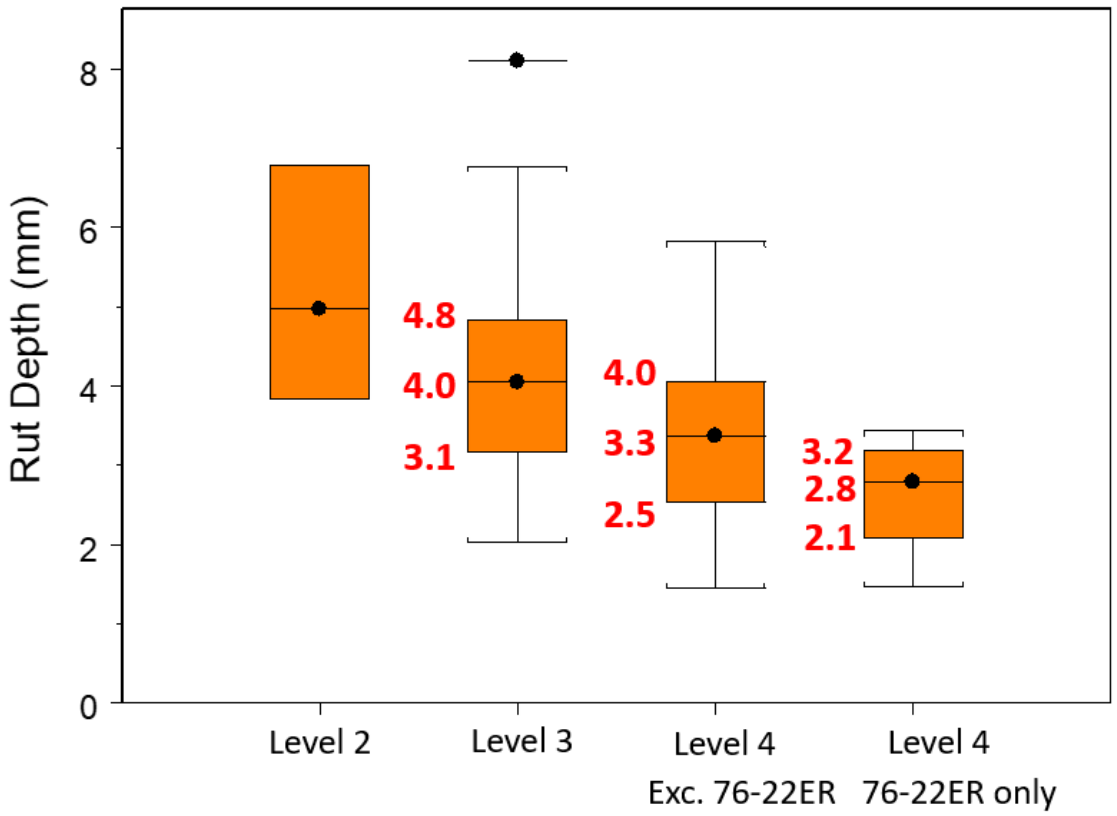
Determine the appropriate parameter for quantifying the performance of asphalt mixes

Developing thresholds that would assist in differentiating the good performance mixes from poor ones.

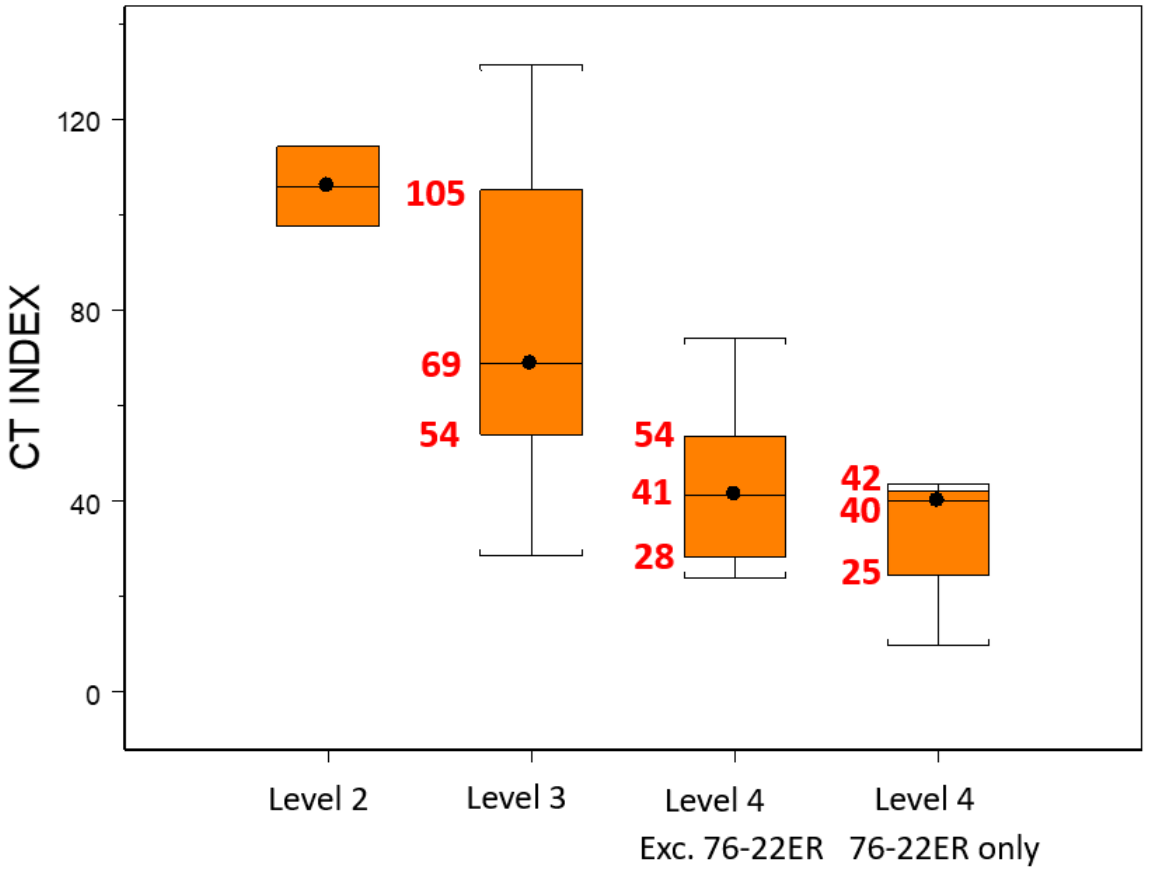


IDEAL CT Test Setup

RESULTS FROM STATISTICAL ANALYSIS



Rutting Thresholds

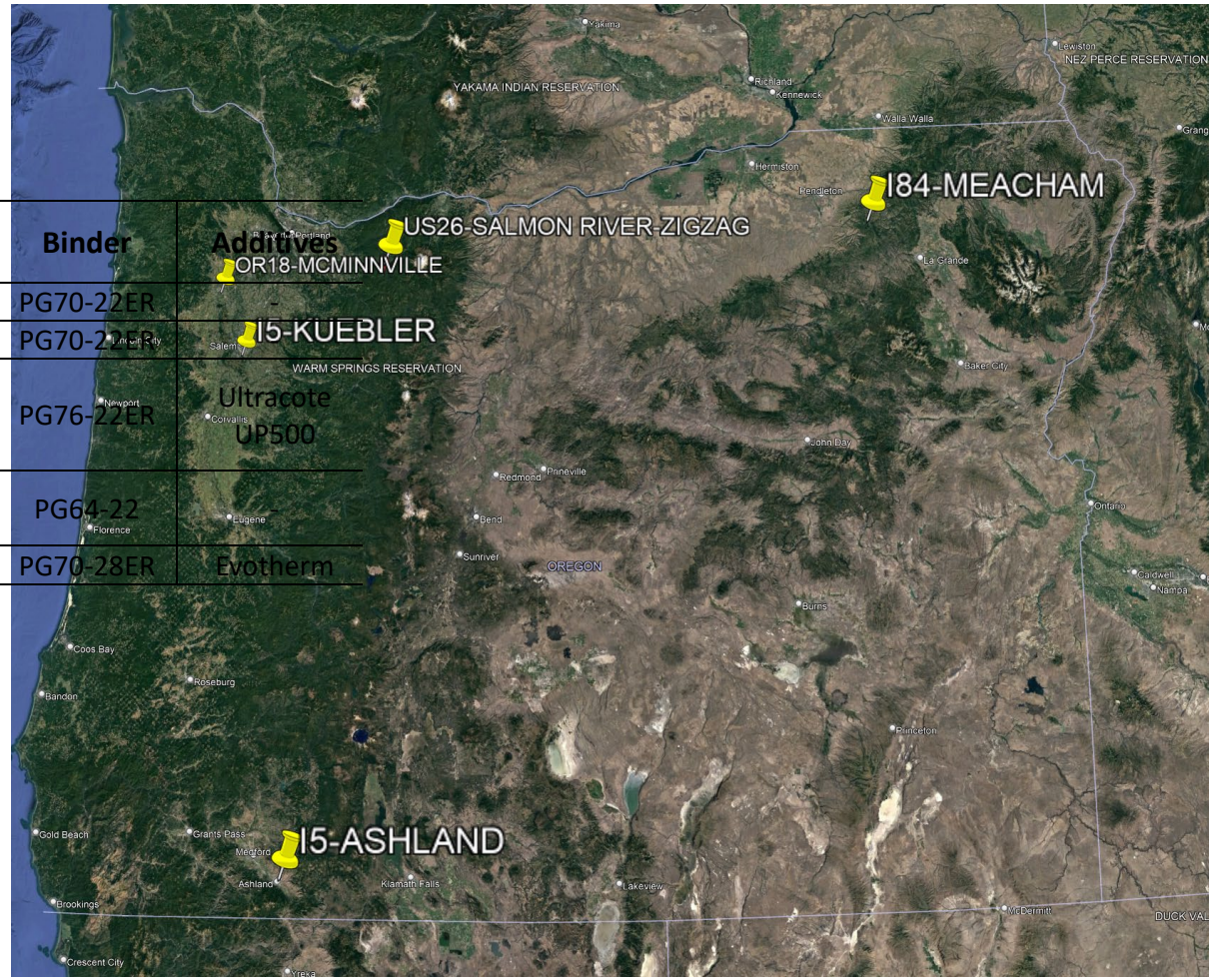


Cracking Thresholds

IMPLEMENTATION OF THE BMD PROCESS

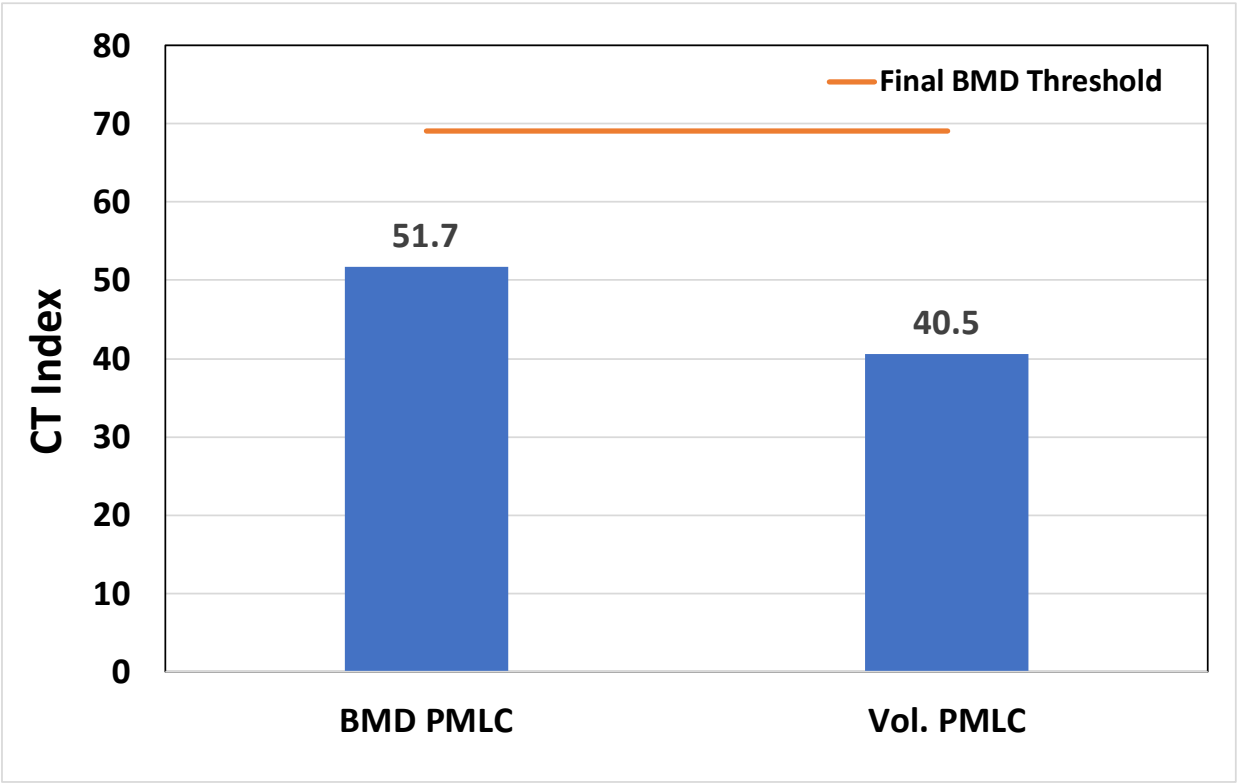
Implementation of Balanced Mix Design Methods in Oregon – Five Pilot Projects

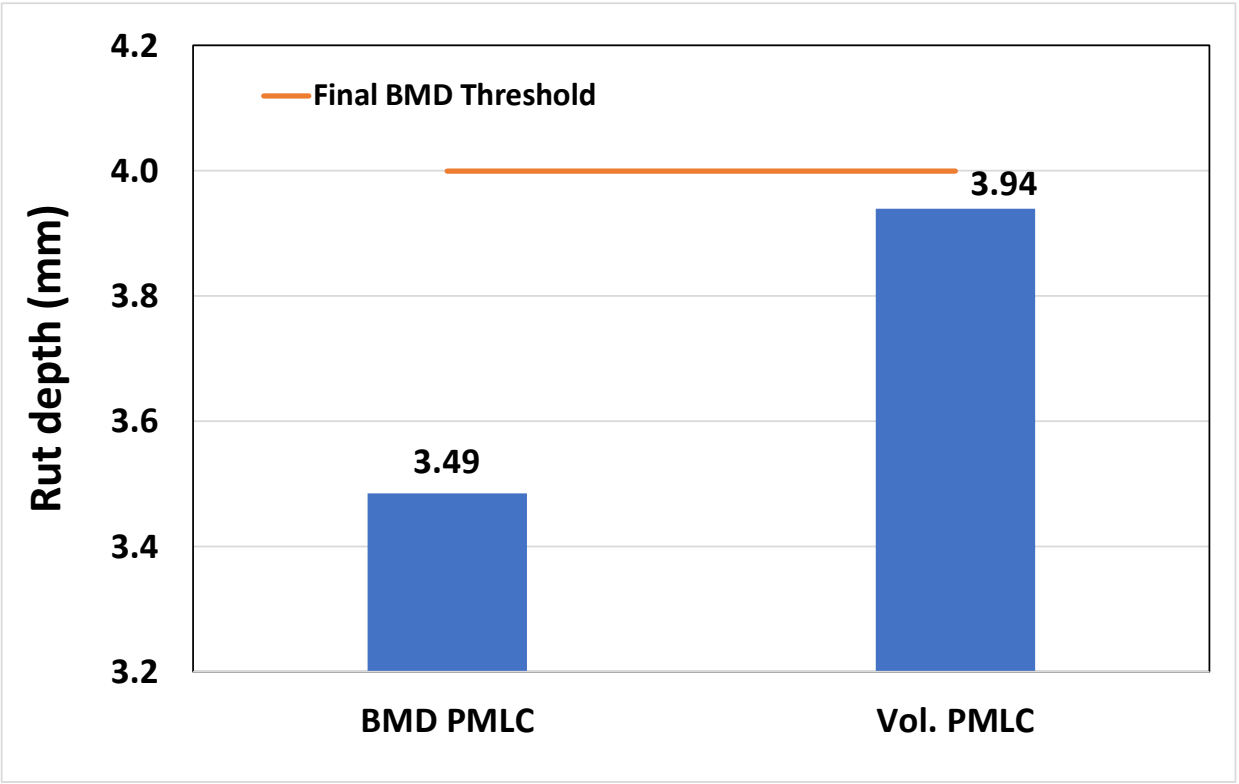
Location	Optimum BC (%)	BMD BC (%)	RAP (%)	Binder	Additives
OR18-McMinnville	6.0	5.9	20	PG70-22ER	-
I5-Kuebler	5.6	5.9	20	PG70-22ER	-
I5-Ashland	6.2	6.3	15 (17.5% for BMD)	PG76-22ER	Ultracote UP500
US26-Salmon River/Zigzag	5.3	5.7	30	PG64-22	-
I84-Meacham	6.2	5.9	20	PG70-28ER	Evotherm



IMPLEMENTATION OF THE BMD PROCESS

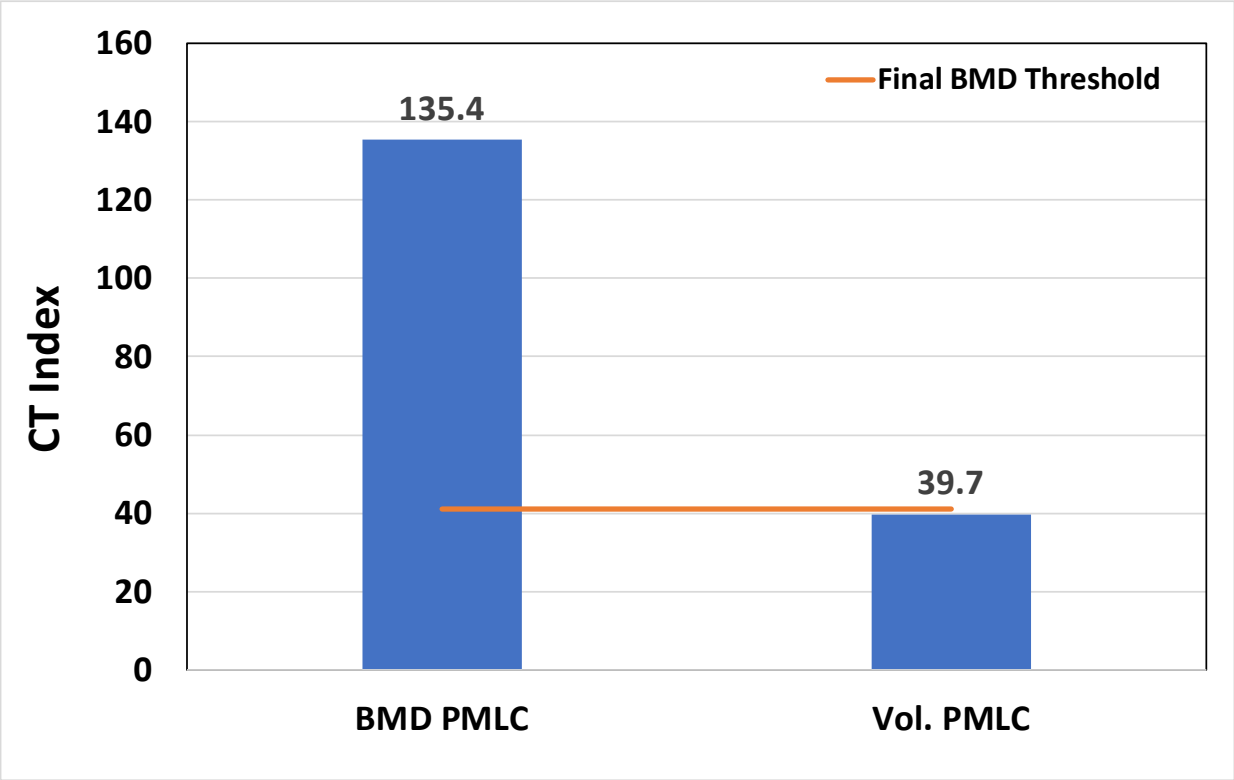
Production mix test results – US26 Salmon River – Level 3 mix

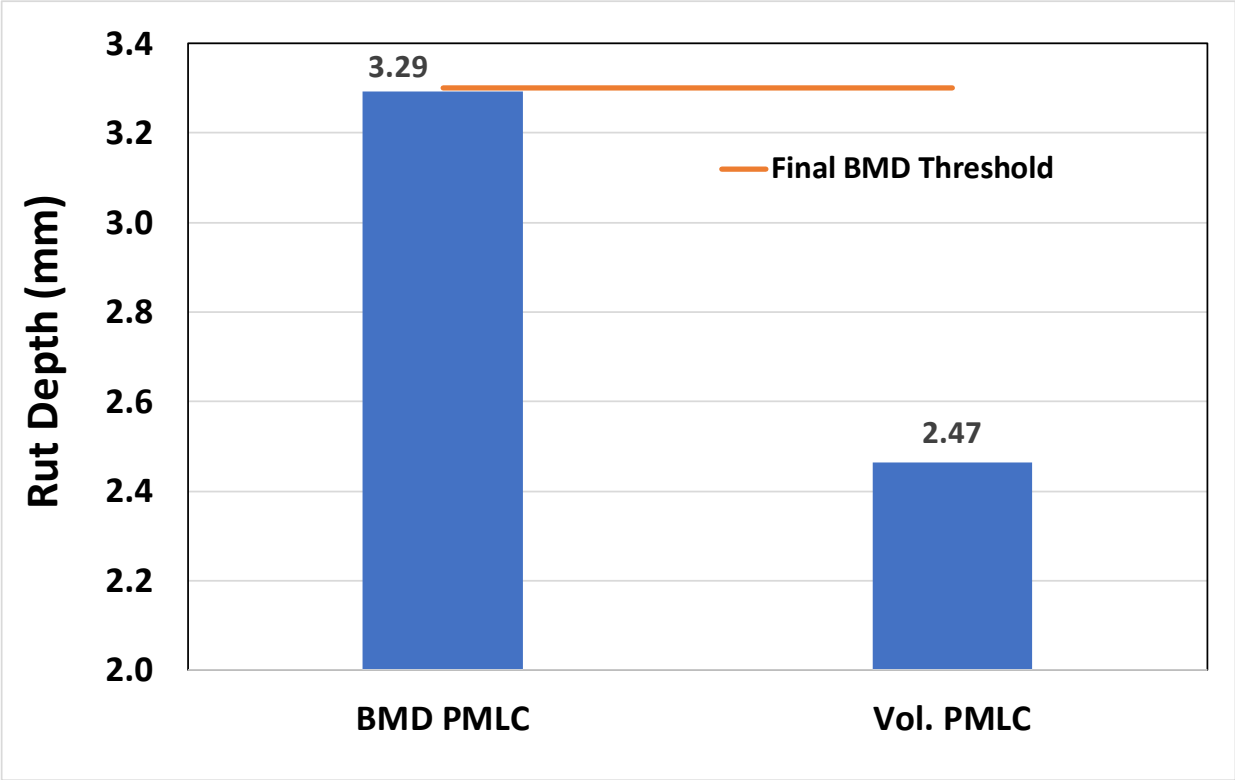




IMPLEMENTATION OF THE BMD PROCESS

Production mix test results – I5 Kuebler– Level 4 mix





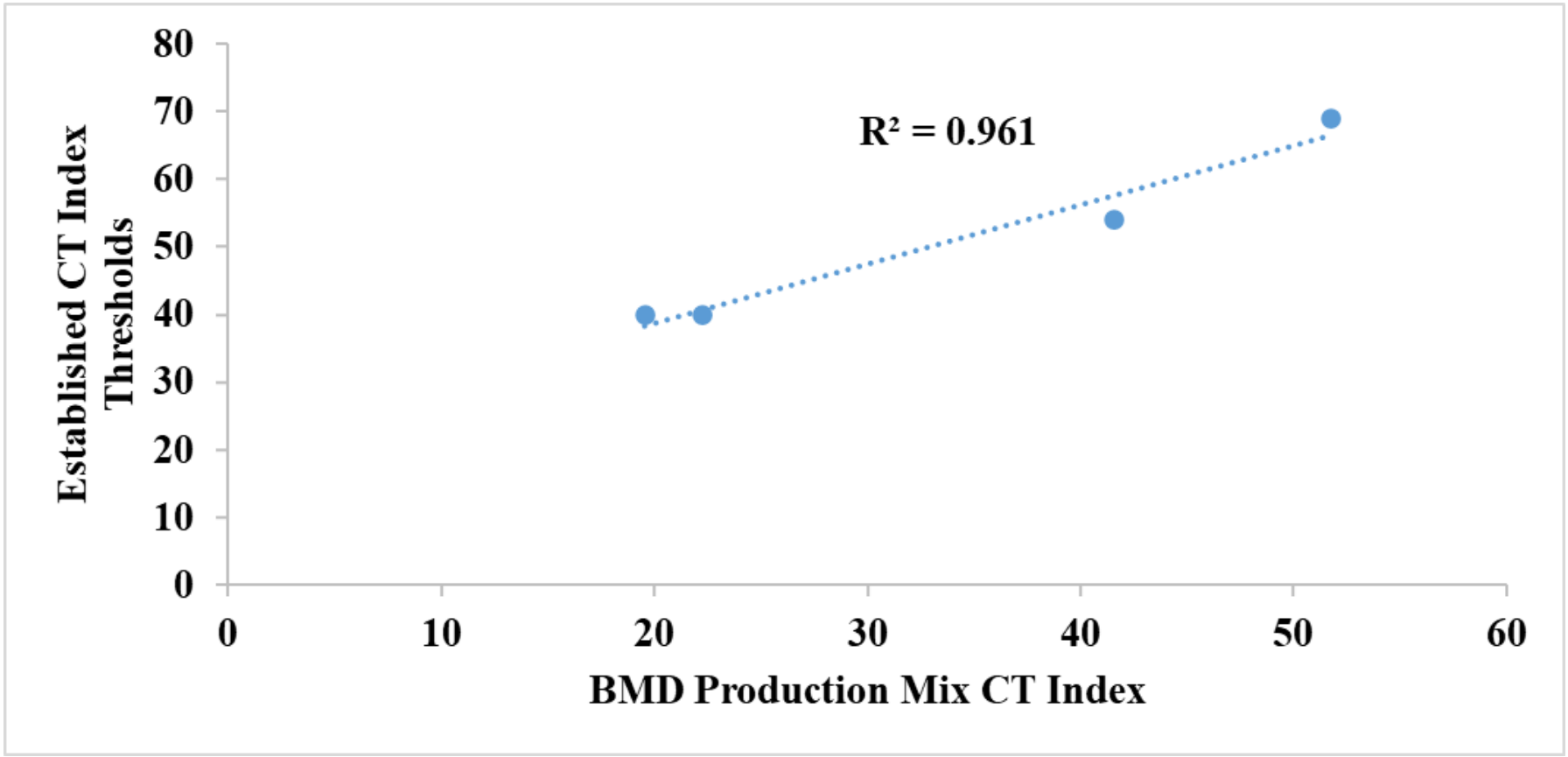
IMPLEMENTATION OF THE BMD PROCESS – *FINAL STEPS*

- **What is next? – FHWA pooled fund study with ODOT**
  - **Automated pavement condition surveys for performance monitoring**
  - **Training the industry labs**
  - **Finalizing all process details for a seamless implementation**

https://www.roadscanners.com/products/road-clinic-rdsv/full-rdsv-system-road-data-collection/

IMPLEMENTATION OF THE BMD PROCESS

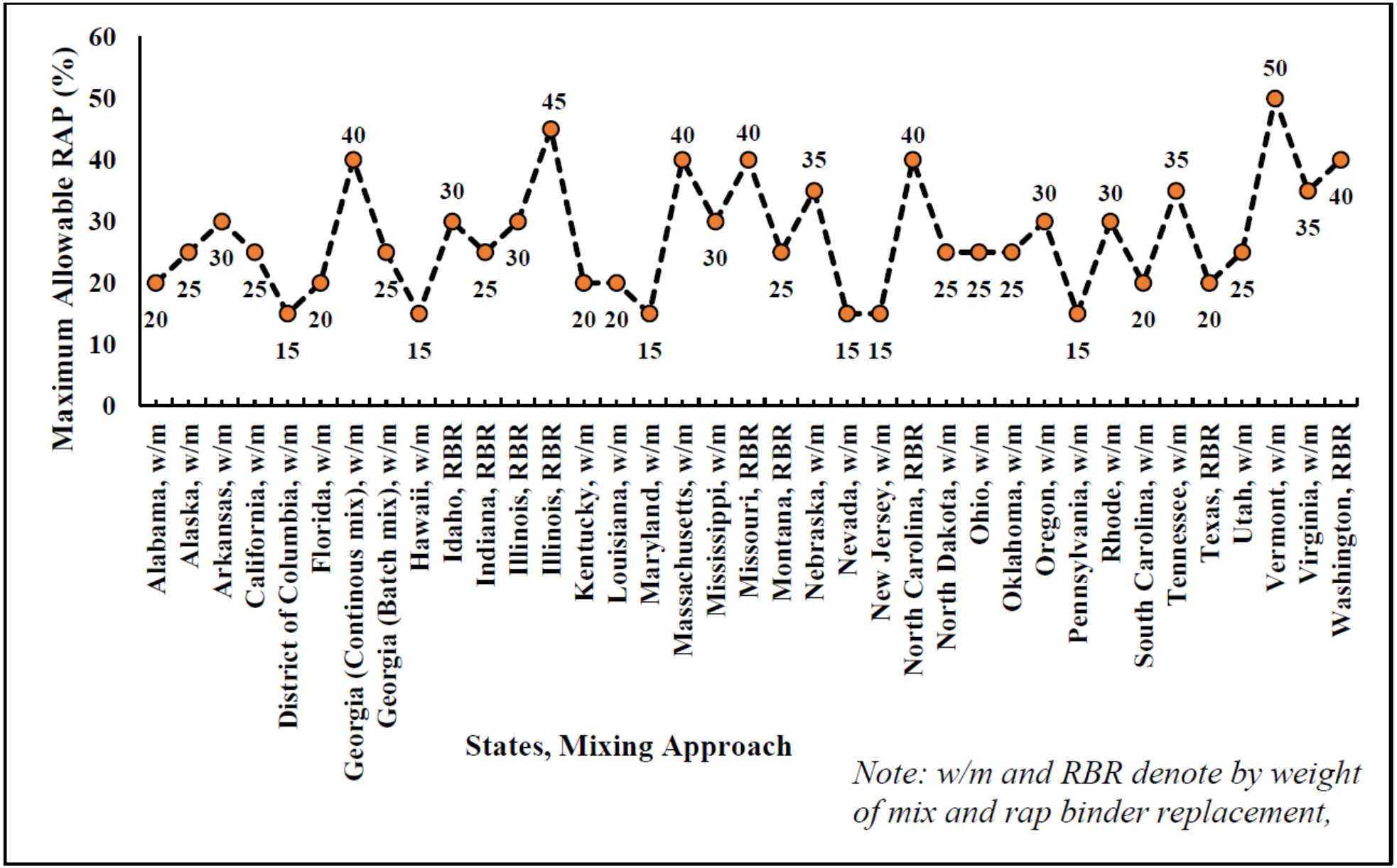
Is the BMD process really working OR are we just getting a random mix from the plants?



CONCLUSIONS

- All the 5 BMD mixes passed the HWTT rutting criteria. **Rut depths are still low.**
- 4 out of 5 projects with BMD performed better than the volumetric mix design.
- BMD does not always increase the binder content rather it fine tunes to balance the cracking and rutting performance.
- Production mixes almost always have lower cracking resistance than lab produced mixes. WHY?
    - Drum not drying the aggregates properly? Not likely but maybe
    - Indirectly heating the RAP with super heated aggregates is not enough to activate the RAP binder? Probably

Allowable limit of RAP percentage for surface course



Effect of Rejuvenator (Evoflex-CA9) on Level 3 asphalt mixtures

Control Mix: 30% RAP

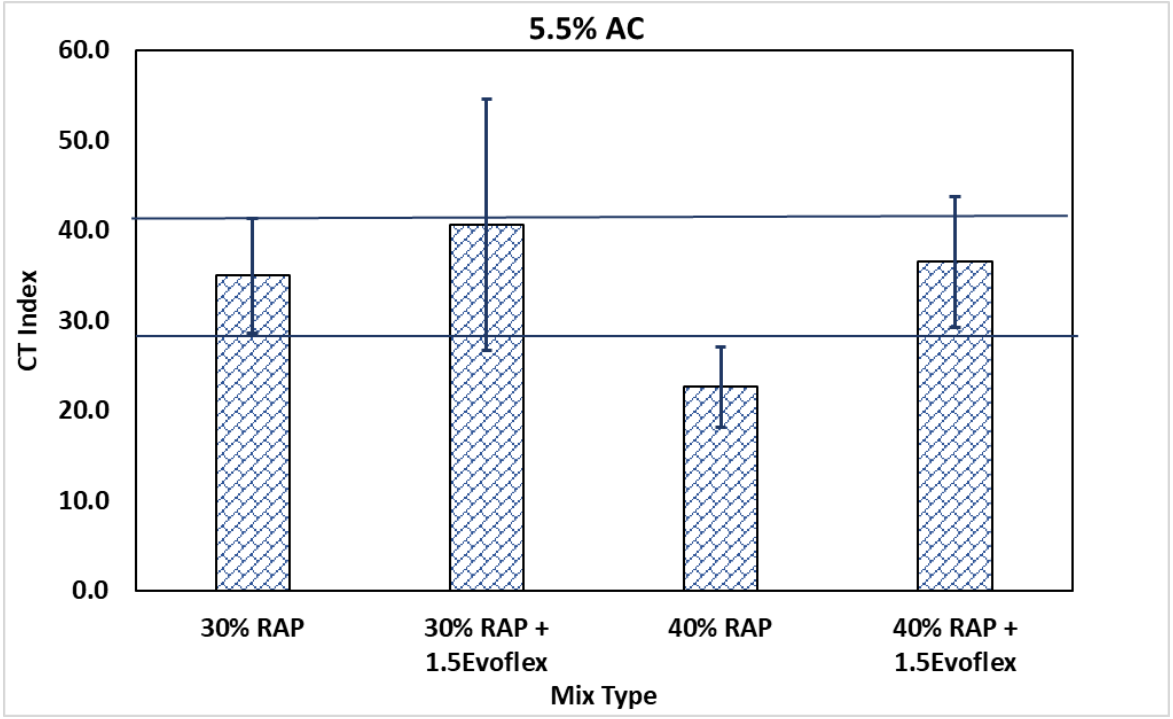
Binder Grade: **PG64-22**

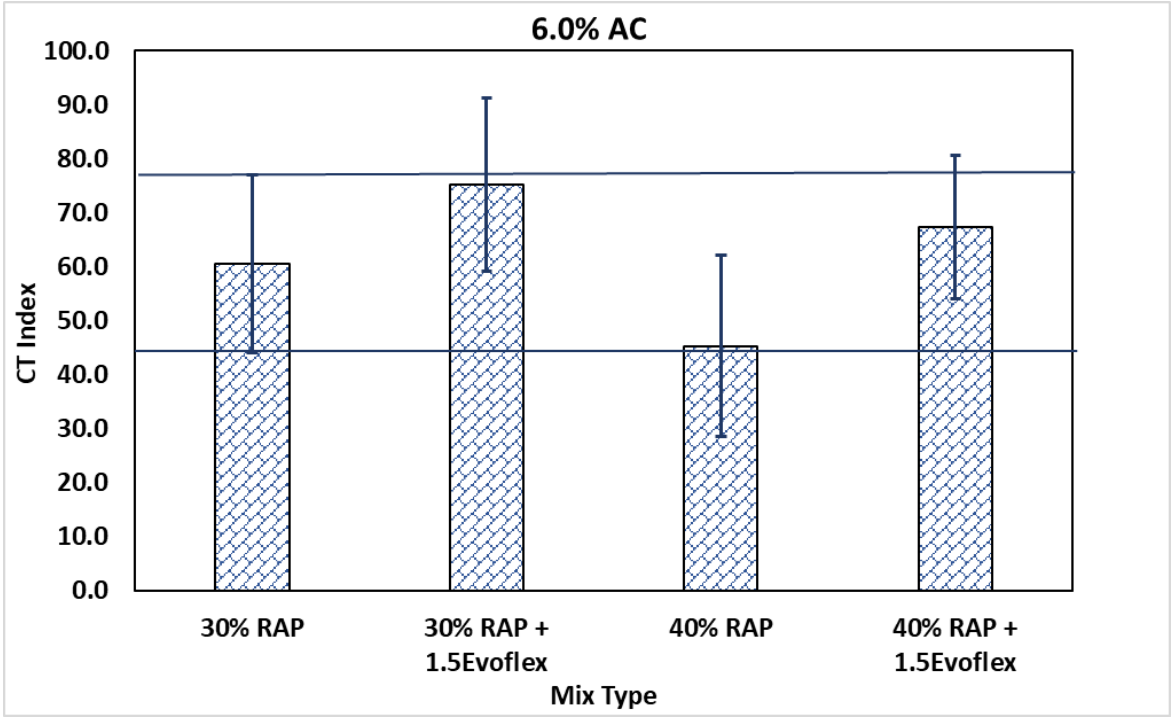
RAP Percentage: **30% and 40%**

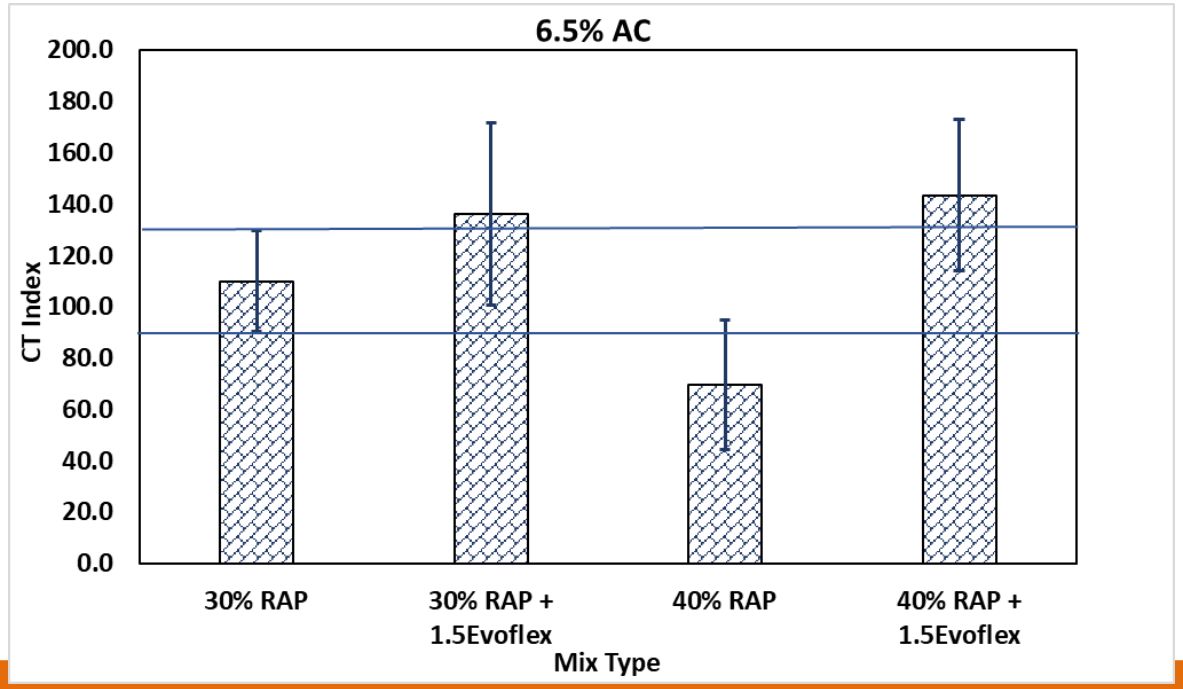
Evoflex Dosage: **1.5% by weight of total binder**

Performance Parameter: **CT Index (Fatigue) and Rut depth (Rutting)**

Cracking Resistance







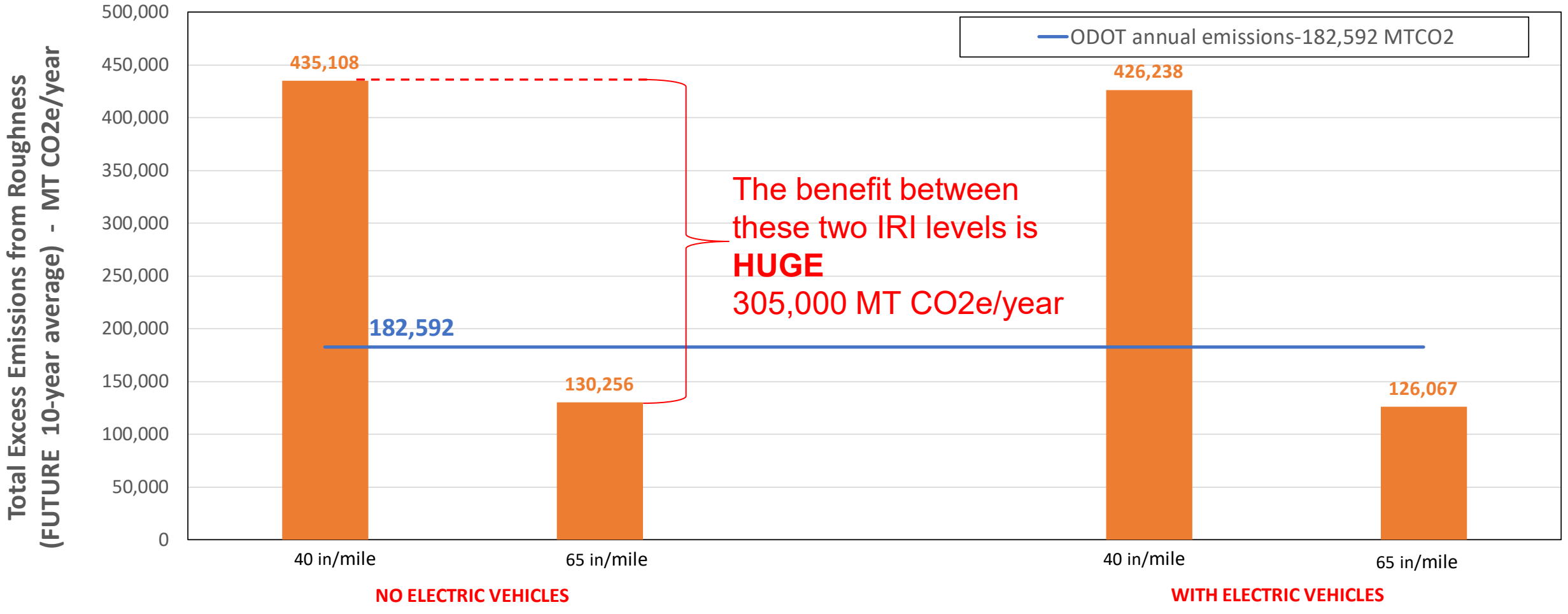
The inclusion of rejuvenator (Evoflex) improved the CT Index relative to their RAP mix without rejuvenator at all the binder content. Rejuvenator tends to activate the oxidized RAP binder by changing the ratio of asphaltene and maltenes, thereby enhancing the capability to bear repetitive loads.

FHWA CLIMATE CHALLENGE

CO2 Emission Outputs for the Analysis Conducted for the Future 10 Years – What If Scenarios

Our baseline is “do nothing” to improve the roughness next 10 years.

What would be the CO2 savings if we pave 5.6% of the highest traffic roadway network to reach Xin/mile IRI annually?

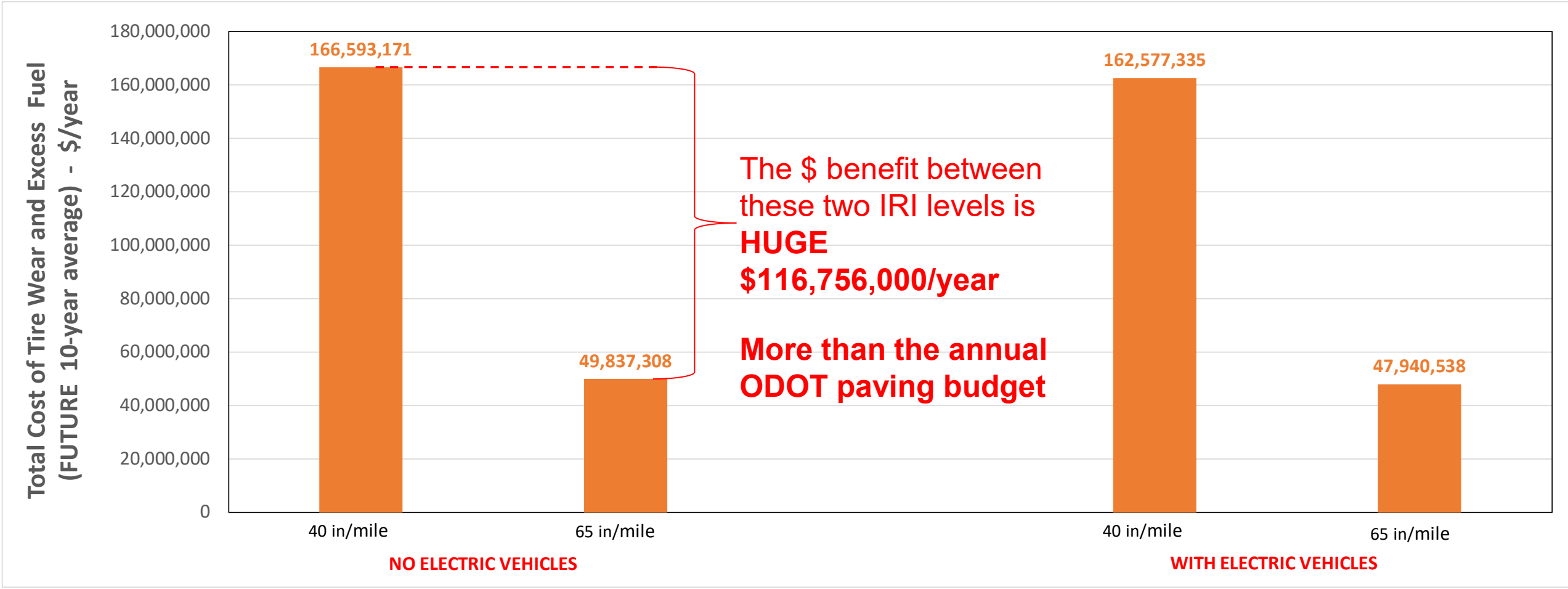


FHWA CLIMATE CHALLENGE

CO2 Emission Outputs for the Analysis Conducted for the Future 10 Years – What If Scenarios

Our baseline is “do nothing” to improve the roughness next 10 years.

REDUCING EMISSIONS IS GREAT!!! HOW ABOUT THE SAVINGS FOR THE TAX PAYERS?



Oregon State University

Oregon Department of Transportation

Thank You

GO BEAVS!

Reach out:

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colerie@oregonstate.edu

**The research study shown in this presentation is sponsored by ODOT.
Funding and support are gratefully acknowledged.**