

Validation Techniques for Setting BMD Test Criteria



Case Study: Missouri DOT Pilot Projects



Objectives

The Missouri Department of Transportation (MoDOT) has pursued balanced mix design (BMD) to move beyond volumetric criteria toward measurable, performance-based acceptance. Pilot projects refined MoDOT’s BMD thresholds under production and field conditions, and assessed the suitability of recycled polymer modifiers as alternatives to virgin polymers.

Benefits

Pilot projects provided a practical validation pathway for MoDOT’s transition to performance-based specifications. Key benefits included: (i) accelerated validation of BMD thresholds using field-constructed pilot sections; (ii) verification of recycled material performance, supporting sustainability goals; (iii) specification refinement for pay factors and statewide BMD adoption; and (iv) improved coordination among agency, industry, and university partners through real-world collaboration.

Background

In 2017, MoDOT began its BMD journey by conducting benchmarking with five tests on existing asphalt mixtures ([DCT](#), [I-FIT](#), [SCB](#), [IDEAL-CT](#), & [HWTT](#)). In 2019, MoDOT selected the IDEAL-CT (CT_{Index}) for assessing cracking resistance and the Hamburg for assessing rutting and moisture resistance. A joint special provision (JSP) was developed for shadow projects, where BMD tests included but did not affect quality assurance (QA) acceptance. From 2020 to 2022, 45 shadow projects were assessed. Specimens were fabricated at the plant without reheating. In 2023, an additional 34 shadow projects were assessed, and MoDOT transitioned from the HWTT to the [IDEAL-RT](#) (RT_{Index}) during production. (Table 1) MoDOT partnered with the Mizzou Asphalt Pavement and Innovation Laboratory ([MAPIL](#)) to establish test criteria and integrate innovative modifiers, such as ground tire rubber (GTR) and waste plastics (WP), within a BMD framework (Figure 2). This led to the revision of the JSP ([JSP 2401](#)), which established cracking and rutting criteria for both dense-graded and stone matrix asphalt (SMA) mixtures. (Tables 2 & 3) The shadow projects served as demonstrations of BMD data collection and use in QA.

Pilot Project Progression

Table 1. MoDOT BMD Pilot Project Progression

Year	Location	Number	Mixes	Polymer/Modifiers	BMD Tests	Sample Prep
2021	Route 740	4 mixes	DG	SBS, PPA, GTR, WP	HWTT, TSR, CT_{Index}	LMLC, PMFC w/o RH
2022	Statewide	16 projects 25+ mixes	DG SMA	SBS (primary), limited GTR/WP trials	HWTT, TSR, CT_{Index} for QA	PMFC w/o RH; LMLC QA
2023	I-155	9 mixes	6 DG 3 SMA	SBS, PPA, GTR, WP (LDPE, HDPE)	HWTT- SIP, TSR, CT_{Index} , RT_{Index} , DCT	LMLC, PMFC, PMLC w/o RH & RH
2024	Statewide	14+ projects	DG SMA	SBS, PPA, GTR, WP expanded use	QA: CT_{Index} , RT_{Index} , TSR, SIP	PMFC w/o RH, LMLC round-robin

Key: dense-graded (DG); stone matrix asphalt (SMA); styrene-butadiene-styrene (SBS); polyphosphoric acid (PPA); Low-Density Polyethylene (LDPE); Medium-Density Polyethylene (MDPE); lab-mixed lab-compacted (LMLC); plant-mixed field compacted (PMFC) at plant typically without reheating; plant-mixed lab-compacted (PMLC) at a lab not located at the plant typically with reheating; reheat (RH); and without reheat (w/o RH).

Results from the 2023 Pilot Project on I-155

- **Cracking Resistance:** All mixtures met or exceeded criteria. Plant-produced specimens generally achieved a higher CT_{Index} than lab-mixed specimens. The PMFC CT_{Index} was approximately 30% to 36% higher than the LMLC CT_{Index} for DG and SMA, respectively. Recycled polymer mixtures yielded test results that were equal to or higher than those of their virgin polymer counterparts.
- **Rutting Resistance:** All mixtures showed exceptional rutting performance (< 5 mm rut depth at 20,000 passes in the HWTT). IDEAL-RT results confirmed strong rutting tolerance.
- **Moisture Resistance:** All dense-graded mixtures exceeded 80% TSR and displayed no stripping.
- **Aging and Handling:** Reheating significantly impacted the CT_{Index} and RT_{Index} results. For the 6 DG mixes, the average CT_{Index} (113) decreased by 68 (a 60% reduction), and the average RT_{Index} (91) increased by 33 (a 36% increase). For the 3 SMA mixes, the average CT_{Index} (293) decreased by over 150 (55%), while the average RT_{Index} (40) increased by 26 (63%).

Tables 2 & 3. MoDOT JSP 2401 Performance Test Criteria (2025)

Mix Type	Min. CT_{Index}	Min. CT_{Index} (LTA)
Non-SMA	50	Info. Only
SMA	135	Info. Only

Long-Term Aged (LTA) loose mix aged 20 hours at 115°C

PG Grade	Min. RT_{Index}	HWTT Min.	Max. Rut Depth
58H-28 / 64-22	50	7,500 passes	
64H-22 / 70-22	65	15,000	0.38 in.
64V-22 / 76-22	80	20,000	



Figure 1. Partnership and Engagement were key to MoDOT's BMD Pilot Success!

Implementation and Lessons Learned

- Industry-Agency-Academia partnership is key. (Figure 1)
- After initial benchmarking and shadow projects, validation through pilot projects established confidence in BMD performance tests and refined thresholds.
- Recycled materials (GTR, LDPE, MDPE) can be incorporated without compromising performance.
- Testing consistency is critical — MoDOT emphasizes immediate plant fabrication and testing within one week.
- Data from pilots supported revisions to the draft BMD specification (2024–2025), including the integration of pay factors for CT_{Index} .

Next Steps

- Monitor pilot sections to correlate lab results and field performance.
- Expand statewide implementation using refined JSP 2401.
- Urgent need for a long-term aging criterion for the CT_{Index} .
- Refine the current RT_{Index} criteria based on HWTT.
- Replace the current TSR requirements with the HWTT SIP.

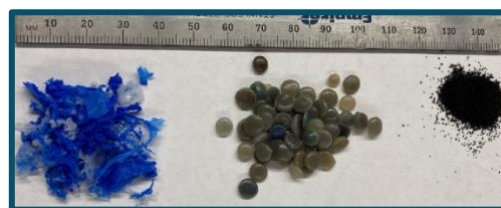


Figure 2. Example of Modifiers Tested: HDPE, LDPE, GTR (Right-to-Left)

References

- [North Central Peer Exchange on Balanced Mix Design \(BMD\) \(2023\)](#), FHWA
- [Implementation of Balanced Mixture Design in Missouri Test Sections with Modifiers \(2024\)](#), MAPIL
- [Research Summary - Implementation of BMD in Missouri Test Sections with Modifiers \(2025\)](#), MoDOT
- [NAPA BMD Resource Guide](#)

Agency & Research Entity

