

Validation Techniques for Setting BMD Test Criteria



Case Study: *NDDOT* Benchmarking



Objective

Starting in 2022, to enhance asphalt performance beyond traditional volumetric designs, the North Dakota Department of Transportation (NDDOT) initiated a benchmarking program to evaluate production mixes using Balanced Mix Design (BMD) tests, with support from the FHWA. This case study highlights the NDDOT benchmarking efforts to assess existing mixes with candidate tests and establish initial criteria.

Benefit

Benchmarking provides an understanding of where current mix practices are with known performance challenges in ND's extreme climate index. This data-driven approach informs the selection of initial test thresholds in the absence of or in conjunction with more robust validation strategies. In addition, benchmarking creates awareness and understanding of BMD tests and the goals of improving durability, optimizing recycled materials use, and improving long-term infrastructure reliability and cost effectiveness.

Background

NDDOT collaborated with the National Center for Asphalt Technology (NCAT), Federal Highway Administration (FHWA), Wisconsin DOT, and Montana DOT to understand and select BMD tests.

Methodology

Benchmarking comprises the following:

- Selection of Performance Tests:** In 2022, NDDOT selected the [Hamburg Wheel Tracking Test](#) (HWTT, AASHTO T 324) for rutting and moisture resistance, the [Indirect Tensile Asphalt Cracking Test](#) (IDEAL-CT, ASTM D8225) for load-related cracking, and the [Disc-Shaped Compact Tension Test](#) (DCT, ASTM D7313) for low-temperature cracking resistance. In 2023, the [Rapid Shear Rutting Test](#) (IDEAL-RT, ASTM D8360) was added for its rapid rutting assessment, suitable for field quality assurance.
- Annual Benchmarking of Production Mixes:** Samples were collected from 34 projects (39 samples) in 2022, 14 projects (31 samples) in 2023, and 8 projects (21 samples) in 2024, representing diverse RAP contents and traffic levels across North Dakota.
- BMD Test Parameters:** Test reporting includes for the HWTT (at 46°C, instead of standard 50°C): stripping inflection point (SIP), maximum cycles (up to 20,000), rut depth (mm) at 5, 10, 15, and 20 thousand passes; IDEAL-CT: fracture energy (J/m^2), tensile strength (kPa), and CT_{Index} ; DCT: fracture energy (Gf) and maximum load (kN); and IDEAL-RT: fracture energy, shear strength (Pa), and RT_{Index} .
- Mixes Considered:** NDDOT specifies asphalt binders under AASHTO M 332, using performance grades like PG 58S-28, PG 58S-34, and PG 58H-34 to suit the state's extreme climate. Mix design designations incorporate fine aggregate angularity (FAA, AASHTO T 304) values of 42–45 and typically include 15–25% Reclaimed Asphalt Pavement (RAP), with maximum RAP content varying by pavement layer, traffic level, and availability.
- Participation in Round Robin Testing:** NDDOT participates in NCAT-led national round-robin studies to assess test reproducibility and align with industry standards, ensuring reliable benchmarking of RAP-inclusive mixes for local conditions.

Results (To Date)

BMD Test	Metric	Number (n)	Average (x)	Std. Dev. (s)	E.g., Typical Threshold	Interpretation
HWTT, SIP	passes	91	13,360	4,500	≥ 12,500	Good
HWTT, RD _{10k}	mm	91	4	2.2	≥ 12.5**	Good
IDEAL-CT	CT _{Index}	87	75 ^(*)	54.0	≥ 80**	Good
DCT	G _f	29	412	182	≥ 400*** (high traffic)	Good
IDEAL-RT	RT _{Index}	52	94	30.1	≥ 90 (high traffic)	Good

(*)-These values are based on a maximum CT_{Index} of 200. Six of the 87 tests had values ranging from 204 to 1,213.

(**)-See Figure 1. (***)-See Figure 2.

Recommendations

- **Continue Annual Testing** of production mixes and compare results to actual pavement performance.
- **Continue Round Robin** participation in NCAT-led effort.
- **Promote Industry Collaboration:** Share benchmarking results with contractors via the Dakota Asphalt Pavement Association to encourage BMD adoption, highlighting durability benefits.

Challenges/Logistics

- Equipment and Setup Costs.
- Staff Training.
- Sample Collection, 2024: 21 samples | 8 projects.
- Data Management: Setting up and managing datasets (NDDOT utilized Microsoft Excel).

Level of Effort / Cost

NDDOT’s benchmarking involved significant initial effort and moderate costs to evaluate production asphalt mixes – sampling collection, preparation, and testing, along with equipment costs (\$150,000), annual maintenance, and continued training.

Next Steps

Benchmarking has established a useful statewide baseline and preliminary screening thresholds. Benchmark-derived criteria are starting points and must evolve with findings of additional validation strategies.

References

- [NAPA BMD Resource Guide](#)

Agency and Research Entity



CAPRI-B-12.25.003

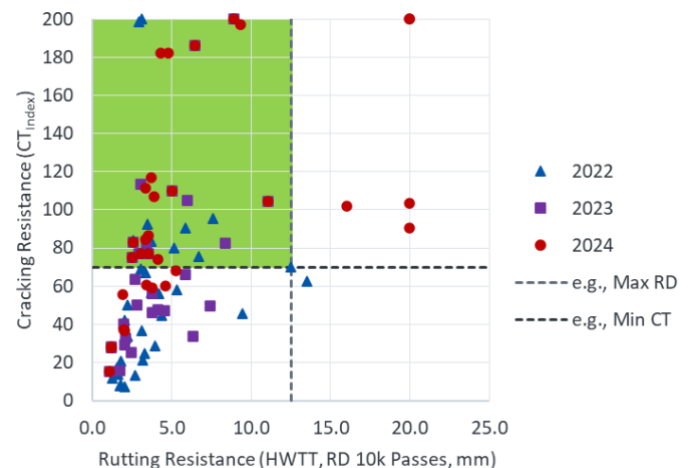


Figure 1. Benchmarking Data: HWTT versus CT_{Index}. Typical Thresholds highlighted by the Green Box.

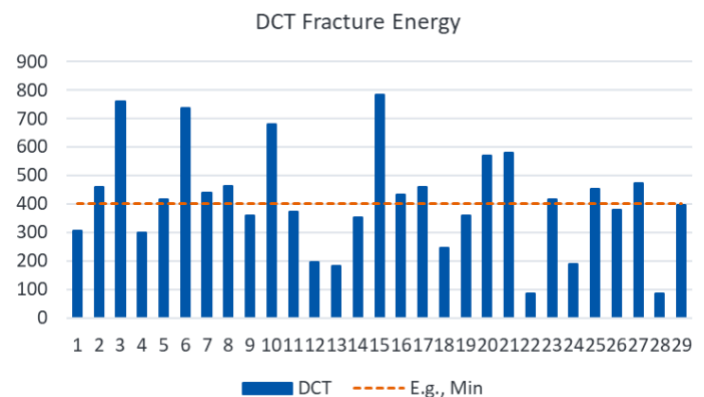


Figure 2. Benchmarking Data: DCT. Typical Threshold: Red Dashed Line.