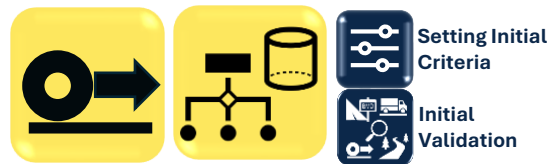


# Validation Techniques for Setting BMD Test Criteria



## Case Study: Virginia DOT Modeling+



Setting Initial  
Criteria

Initial  
Validation

### Objectives

The Virginia Department of Transportation (VDOT) is proactively implementing Balance Mix Design (BMD), leveraging multiple validation strategies. This case study focuses on coupling mechanistic-empirical (ME) modelling with lab testing and heavy vehicle simulation (HVS), to: (a) integrate mechanistic modelling (AASHTOware® Pavement ME Design, FlexPAVE™) with lab testing to set and validate initial criteria for BMD tests, and (b) quantify correlations between index and rapid surrogate tests with ME anchors (*tied to modeled predicted performance*) to enable production-viable acceptance concepts.

### Benefit

This effort employs two validation strategies, providing VDOT with two key benefits: (1) ME anchors build confidence in index tests that keep cost and turnaround compatible with production, (2) better targeting of test methods and thresholds by mix class and traffic, improving durability at optimized binder, reclaimed asphalt pavement (RAP) content, recycling agent (RA) dosing, and warm mix technology (WMT) inclusion.

### Background

BMD index tests are implementable at scale but require robust linkage to field performance. The Virginia Transportation Research Council (VTRC) and the Virginia Tech Transportation Institute (VTTI) compared lab performance/index test results with HVS accelerated pavement performance. Modelling was used to translate lab responses into predicted distresses and to calibrate rapid surrogate tests for production.

### Methodology

- **Identify Tests:** extensive research led to the selection of the following BMD tests: [Indirect Tensile Asphalt Cracking Test](#) (IDEAL-CT, ASTM D8225, aka IDT-CT in VA) for cracking, [Cantabro](#) (AASHTO T 401) for raveling, and [Asphalt Pavement Analyzer](#) (APA, AASHTO T 340) for rutting.
- **Select Mixes:** a non-BMD control mix was included with five BMD 9.5mm NMAS mixes.

MIX ID	30_C	30_O	45_HR	45_HR_RA	45_HR_L	45_HR_L_RA
<i>Description</i>	Control	BMD	BMD High-RAP	BMD High-RAP	BMD High-RAP	BMD High-RAP
<i>%RAP</i>	30	30	45	45	45	60
<i>Binder</i>	PG 64S-22	PG 64S-22	PG 64S-22	PG 64S-22	PG 58-28	PG 58-28
<i>%Binder (RBR)</i>	5.60 (0.24)	6.00 (0.22)	6.80 (0.29)	6.20 (0.32)	6.00 (0.33)	6.00 (0.44)
<i>Additives</i>	WMT	WMT	WMT	WMT + RA	WMT	WMT + RA

- **Build ME test datasets:** dynamic modulus  $|E^*|$ , [flow number](#) – both covered under AASHTO T 378, and small-specimen fatigue and [stress sweep rutting](#) (SSR) were conducted.
- **Run BMD index and surrogate tests** on matched materials (plant- and lab-produced) and evaluate candidate surrogate tests for rutting, which included: [High-Temperature IDT strength](#), [IDEAL-RT](#), and Marshall stability.
- **Model Mixes with Pavement ME Design and FlexPAVE™** to predict performance and compare outcomes across binder/RAP/RA/WMT scenarios.

- **Quantify production variability** by testing job mix formula (JMF) targets and tolerance bounds to inform acceptance/pay-factor feasibility.

## Results of the Study

- Asphalt Mixture Performance Tester ([AMPT](#)) dataset provided inputs for Pavement ME Design, and fatigue/SSR was used with FlexPAVE™, to validate initial BMD index thresholds.
- VTRC/VTTI observed promising correlations between candidate rapid rut surrogates and APA/mechanistic predictions (ongoing effort to assess precision/bias).
- Recycling agents, when dosed appropriately with high-RAP, improved cracking metrics without compromising rut predictions—informing selection versus grade-bumping approaches with softer binders.
- Plant vs lab deltas (notably higher IDEAL-CT on plant mixes) suggest either correction factors or differentiated criteria in specifications.

## Recommendations

- Maintain AMPT/APA as reference anchors; adopt validated production-friendly surrogates for rutting once correlation and repeatability are documented.
- Tailor thresholds to application (traffic level, layer location) and consider separate BMD test criteria for plant versus lab materials or an agreed correction.
- Publish simple quality indicators (e.g., curve/shape checks for IDEAL-CT) alongside thresholds to reduce risk of using bad data.
- Stage acceptance concepts after production variability characterization; pilot pay-factor logic on select corridors before broader rollout.

## Challenges

- Precision/bias across equipment manufacturers and labs; ongoing round-robins required.
- Scheduling and capacity constraints for central AMPT/APA testing.
- Data management and traceability for modelling inputs/outputs across multiple projects.
- This strategy's accuracy relies on quality input data and may oversimplify complex field interactions.

## Level of Effort / Cost

- **People:** Central mechanistic testing expertise (AMPT/SSR), district lab staff for index tests, modelling specialists for Pavement ME/FlexPAVE™.
- **Equipment:** AMPT availability (shared or contracted), APA, IDT-CT fixtures; optional IDEAL-RT/Marshall stability capability for rut surrogates.
- **Throughput:** Anchor testing on a representative matrix of mixes; periodic recalibration as new binders/RAP/RA sources enter the system.
- **Budgeting note:** The critical costs are AMPT time and analyst effort; prioritize a design-of-experiments approach to limit specimens while maximizing inference.

## References

- [VTRC 25-R16](#).
- [NAPA BMD Resource Guide](#).

## Agency and Research Entities

