Validation Techniques for Setting BMD Test Criteria

CAPRI
CONSORTIUM FOR ASPHALT PAVEMENT RESEARCH AND IMPLEMENTATION

Case Study: *FDOT HVS Research*

Setting Initial Criteria

Initial Validation

Objectives

The Florida Department of Transportation (FDOT) uses its Accelerated Pavement Testing (APT) program to validate laboratory performance tests within a balanced mix design (BMD) framework. FDOT's objective is to use APT, through the Heavy Vehicle Simulator (HVS), to establish confidence that BMD index tests [e.g., Hamburg Wheel Tracking Test (HWTT, AASHTO T 324) and Indirect Tensile Asphalt Cracking Test (IDEAL-CT, ASTM D8225)] accurately predict mixture performance under Florida's environmental and traffic conditions. This case study illustrates how the FDOT integrates APT data with laboratory performance testing to refine and confirm the BMD criteria for rutting, moisture damage, and cracking resistance.

Benefits

- ✓ Provides full-scale validation between laboratory BMD tests and field performance under Florida conditions.
- ✓ Enables FDOT to assess new materials, modifiers, and RAP contents in a controlled yet realistic setting.
- ✓ Reduces implementation risk by verifying that HWTT and IDEAL-CT criteria.

Background

FDOT's APT Program, initiated in 2000 at the State Materials Office Research Park (Gainesville), employs two HVS units (Mk IV) to simulate years of traffic in months. The program evaluates structural pavement response, mixture durability, and innovative materials under controlled temperature and loading conditions (Figure 1).
Typical APT structures include a 4- to 6-inch asphalt surface over a granular base and subgrade, loaded by a 9-kip wheel at variable temperatures (typically 40–60 °C). As Florida advanced toward a performance-balanced mix design, the APT program became the cornerstone for verifying relationships between:

- Rutting and moisture resistance measured by the HWTT, and
- Cracking resistance measured by the IDEAL-CT test.

These experiments provide the bridge between laboratory BMD indices and observed pavement performance.

Methodology

1. **Laboratory Assessment**: FDOT evaluated multiple dense-graded Superpave mixtures (SP-9.5, SP-12.5) with varying RAP levels and binder grades (PG 64-22, PG 76-22, and polymer-modified binders). Each mixture underwent HWTT for rutting/moisture resistance and IDEAL-CT for cracking evaluation.

2. **Accelerated Pavement Testing**: Full-scale HVS sections were constructed using the same mixtures. Repeated half-axle loads (≈ 9 kips, 700 kPa tire pressure) were applied at ~10 mph. Rut depth, surface strain, and cracking initiation were continuously monitored. Testing temperatures matched Florida's critical high-temperature design conditions (≈ 50 °C).

3. **Data Correlation and Analysis**: Results from HVS testing (rut progression, visual cracking, stripping) were compared with laboratory HWTT rut depths and IDEAL-CT index values to verify whether laboratory thresholds align with observed APT performance and to identify adjustments for Florida specifications.

Results of the Studies

- HWTT Validation: Mixtures demonstrating low HWTT rut depths and steep post-SIP slopes exhibited minimal rutting under HVS loading, validating the HWTT as an effective predictor of field rutting and moisture resistance.
- Cracking Validation: IDEAL-CT results correlated reasonably with delayed crack initiation under APT, confirming the test's practicality as a routine cracking index.
- Material Innovations: APT studies on polymer-modified and Highly Modified Asphalt (HiMA) binders showed extended fatigue lives and reduced rutting, supporting FDOT's adoption of PG 76-22 and HiMA in performance-based specifications.
- Implementation Impact: FDOT's combined HWTT + IDEAL-CT validation framework forms the foundation of its current BMD approach and informs future specification thresholds and risk tolerance definitions.

Recommendations

- Continue using APT as a validation bridge between lab BMD indices and field performance.
- Integrate Residual Standard Error (RSE) and regression diagnostics to quantify confidence in lab-to-field relationships.
- Combine FDOT APT data with NCAT Test Track and local field sections to refine HWTT and IDEAL-CT thresholds across Florida's diverse climates.
- Use APT findings to establish BMD thresholds for RAP, binder type, and modifiers, supporting future performance-related specifications and LCTM life-cycle datasets.

Figure 1. FDOT HVS

Challenges

- **Time and Resources:** Each APT campaign requires substantial effort — construction, instrumentation, and months of continuous loading per section.
- **Environmental Aging**: Accelerated loading compresses traffic time but cannot replicate long-term environmental oxidation.
- **Limited Replication**: APT lanes are limited in number; therefore, complementary field projects and NCAT Test Track partnerships are essential for broader validation.

Level of Effort / Cost

The study required significant effort, including:

- Archival data collection from DOT pavement management systems.
- Laboratory replication and testing (HWTT, ITS, etc.), depending on the number of mixtures and tests.
- Coordination with agencies for field data and material access.

References

FDOT APT Program Overview – https://www.fdot.gov/materials/pavement/research/apt/index.shtm
FDOT Mixture Performance and BMD Evaluation Reports (2020–2024)
NAPA BMD Resource Guide

Agency

Florida Department of Transportation – State Materials Office