Balanced Mix Design Production Analysis of Asphalt Mixtures in Vermont

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Background

Motivations – Why?

- VT State Law has mandated up to 50% RAP by aggregate weight since 2008
  - 3% RAS by aggregate weight max was added to specifications in 2018
  - State Law was amended in 2022 under Annual Transportation Budget to consider other "sustainable building components" (19 VSA § 10m)
- Rutting, raveling, and cracking observed in VT Pavements
- Balanced Mix Design (BMD) is an approach to meeting mandates while improving performance

Study Objectives

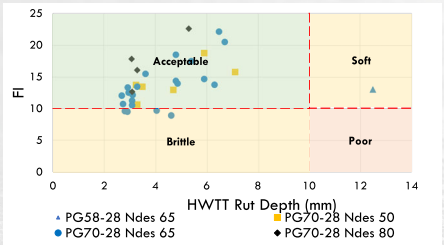
- Analyze the typical production variability observed with the selected performance tests to aid in specification development for performance testing in Acceptance.

Study Details

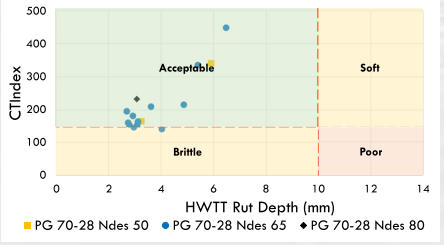
- Splits from plant-produced acceptance samples taken at plant
- Reheated to fabricate specimens for volumetric and BMD testing without additional laboratory aging
- Data collected over last 4 years
- HWTT & I-FIT since 2018, added IDEAL-CT in 2020
- Proposed criteria developed in previous or ongoing work

Test / Measure	Test Method	Criteria Used for Analysis
HWTT – Rut Depth (mm)	AASHTO T324	10.0 mm max.
I-FIT – FI	AASHTO T393	10.0 min.
IDEAL-CT - CT_{Index}	ASTM D8225	150.0 min.

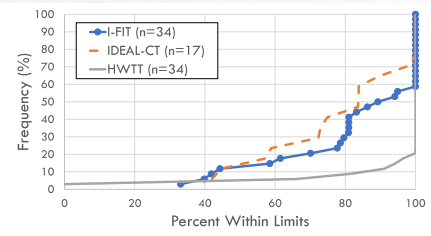
Balanced Mix Design Results by Lot



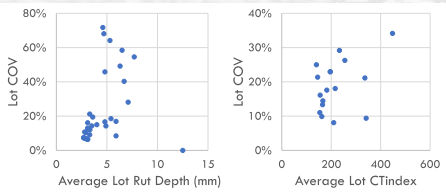
Most lots showing better performance in HWTT than in cracking test and effect of binder grade is evident



Production Variability Analysis



Cumulative distribution curves for cracking tests are significantly lower than for HWTT. Within-lot coefficient of variations (COV) vary significantly for a narrow range of results, unlike current quality characteristics.



Typical Lot Variability Calculation

Test	No. of Lots	Total No. of Sublots	Pooled Estimate of within-Lot Variance	Typical Lot Standard Dev
HWTT – Rut Depth (mm)	34	161	2.7	1.6
I-FIT – FI	34	166	9.4	3.1
IDEAL-CT - CT_{Index}	17	77	2526.5	50.3

Typical production variability for developing acceptance procedures calculated using the procedure recommended in *Optimal Procedures for Quality Assurance Specifications* published by FHWA.

Burati, J. L., Weed, R. M., Hughes, C. S., & Hill, H. S. *Optimal procedures for quality assurance specifications.* Turner-Fairbank Highway Research Center. Report Number: FHWA-RD-02-095., 2003

Findings

- BMD parameters show a higher range of within-lot variability over the expected ranges than currently used acceptance quality characteristics (i.e. air voids, asphalt content, etc.)
- Typical within-lot standard deviation values for HWTT, I-FIT, and IDEAL-CT were relatively high compared to the criteria and average values, especially for the cracking tests.
- Higher variability can create challenges for incorporating these performance tests into acceptance specifications, especially in establishing criteria.
- More work needed to identify and reduce variability in the three major categories (sampling, testing, and materials variability) for BMD implementation into Quality Assurance.