

Validation Techniques for Setting BMD Test Criteria



Case Study: FHWA Accelerated Loading Facility



Objective

This strategy uses accelerated loading facility (ALF) results as an initial validation tool for Balanced Mix Design (BMD) tests, specifically for the Indirect Tensile Asphalt Cracking Test (IDEAL-CT). The 2013 FHWA ALF experiment (1) provided a controlled dataset linking accelerated field performance and laboratory tests. This dataset was leveraged by NCHRP IDEA Project 195 (2), which pioneered the development of the IDEAL-CT as a practical cracking index. NCAT expanded the analysis (3) to demonstrate the relationship between a BMD test and field performance.

Benefits

The combined efforts of FHWA, NCHRP IDEA, and NCAT illustrate the role in validating a test's relationship to field performance. NCHRP IDEA early work established IDEAL-CT as a viable cracking index test. This case study demonstrates how accelerated loading data can inform national BMD test selection and give state DOTs greater confidence in adopting tests, like the IDEAL-CT, in their specifications.

Background

In 2013, the FHWA constructed 10 test lanes under the ALF at the Turner-Fairbank Highway Research Center (TFHRC) in McLean, Virginia, to evaluate fatigue performance of reclaimed asphalt pavement (RAP), reclaimed asphalt shingle (RAS), and warm mix technologies (WMT) in mixes. The pavement structure was a 4-inch asphalt layer over a 26-inch granular base over the existing subgrade. The sections were designed as 12.5mm NMAS Superpave (65 N_{design}). A 425 super-single tire (14,000 lbs. at 100 psi) applied the loading at 11 mph with a normally distributed lateral wander across 40 inches. The effective testing length was 45 feet.



Figure 1. FHWA ALF

Table 1. FHWA ALF Experimental Matrix (note: Lane 10 was not part of the study)

Lane No.	1	2	3	4	5	6	7	8	9	11
Binder PG	64-22	58-28	64-22	64-22	64-22	64-22	58-28	58-28	64-22	58-28
RBR, %	Control	40 RAP	20 RAS	20 RAP	40 RAP	20 RAP	20 RAS	40 RAP	20 RAP	40 RAP
WMT		Foamed		Evotherm					Foamed	Evotherm

The 2013 ALF experiment included mixtures with two binder types, varying recycled contents, and two WMT. Cracking performance was monitored under ALF loading with companion lab testing. In 2017, NCHRP IDEA Project 195 used this dataset as part of the initial validation of the IDEAL-CT.

Methodology

The study compared accelerated performance data to a proposed cracking index test:

- Accelerated Performance Data:** ALF fatigue cracking – parameters: ALF passes to first crack observed (crack initiation) and accumulative cracking (inches/passes).
- Mixtures:** 10 combinations, see Table 1 above.
- Aging:** NCHRP IDEA obtained one 5-gallon bucket of cooled, plant-produced mix from each test lane. The loose mix was short-term conditioned in the oven for four hours at 135°C.
- Lab Testing:** IDEAL-CT: 3-replicates of 150mm diameter by 62mm height specimens compacted to 7.0 ± 5% air voids. IDEAL-CT testing was performed at room temperature, 25°C, with a loading rate of 50 mm/min.

5. **Analysis:** NCHRP IDEA compared the CT_{Index} to the number of ALF passes corresponding to the first crack observed for 8 of the 10 lanes. At the time of the analysis, only seven of the test lanes had cracked, and lane six (20% RAP, PG 64-22) was estimated to track at 125,000 passes (*actual cracking occurred at 122,363*). The IDEA report shows a power equation trendline ($y = 79.462x^{1.622}$) and a corresponding R^2 of 0.87.
6. **NCAT** re-analyzed the correlations between CT_{Index} and ALF passes using the actual cracking data. With the original eight lanes and a power regression, a corresponding R^2 of 0.79 was found. The inclusion of the remaining two lanes reduces the correlations as follows: lane 2 (40% RAP with foamed WMT) yields an R^2 of 0.70, and adding lane eight (40% RAP with no WMT) yields an R^2 of 0.33. (Figure 2)

Results of the Study

- [CAPRI \(3\)](#), “in general, an R^2 of 0.60 or higher is considered satisfactory.” In addition, the Residual Standard Error (**RSE**) should be included in the analysis. RSE gives an estimate of observed vs. predicted values.
- The original eight lanes produced $R^2 \approx 0.8$ with a reasonable residual error band (RSE $\approx 67,200$ passes).
- However, the inclusion of all 10 lanes results in an R^2 of 0.33 with a wide residual error band (RSE $\approx 101,500$)

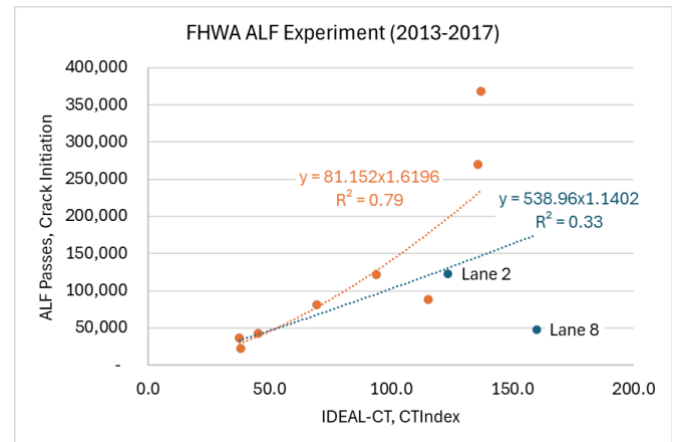


Figure 2. NCAT Analysis

Challenges

- ALF is resource-intensive and limited to a small number of sections per campaign.
- FHWA has two load frames, and loading occurs sequentially over several years.
- Lanes two and eight were loaded last; Lane eight sat 2.7 years, and Lane two over 3 years before loading.
- Accelerated loading does not replicate long-term environmental aging and real-world trafficking speed.
- Broader validation across climates and traffic spectra remains essential.

Recommendations

- Agencies should use ALF and similar loading systems to assess existing and future performance/index tests.
- These accelerated loading systems are also effective in assessing innovative materials and other alternative pavement systems in a highly controlled environment.
- Residual standard error should be incorporated into all validation studies to improve risk assessment.

Level of Effort / Cost

- Moderate effort and cost.
- Accelerated testing in a controlled loading and controlled environment.

References

- 1) [FHWA Pavement Testing Facility Overview](#) (2013-2017)
- 2) [NCHRP IDEA Project 195 – Development of an IDEAL Cracking Test for Asphalt Mix Design...](#) (2019)
- 3) [Guidelines and Recommendations for Field Validation of Test Criteria for BMD Implementation](#) (2024)
- 4) [NAPA BMD Resource Guide](#) (Website)

Agency and Research Entities

