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Glossary of Terms for Balanced Design of Asphalt Mixtures

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PUBLISHER'S NOTE

The views expressed in this publication are those of the committee and do not necessarily reflect the views of the Transportation Research Board or the National Academies of Science, Engineering, and Medicine. This publication has not been subjected to the formal TRB peer review process.

Introduction

The design of asphalt mixtures for use in infrastructure applications is a topic that has generated significant research and focus over recent years. The Superpave® (SUperior PERforming Asphalt PAVEments) method was developed as a result of the Strategic Highway Research Program (SHRP) where the performance of asphalt mixtures was studied under different traffic, and environmental conditions. The original Superpave mixture design method included measurements of engineering properties using the Superpave Shear Tester (SST) and performance predictions. The Superpave mixture design method used today relies heavily upon volumetric properties to ensure adequate performance of asphalt mixtures to the many distresses they can experience in the field. Recent advancements in mechanical testing of asphalt mixtures, often referred to as "performance tests," brought the concept of Balanced Mix Design (BMD) and the use of these tests to augment or go beyond volumetric design to the asphalt community.

BMD, like many other specialized subject areas, has its own unique language containing numerous technical terms or expressions having very specific meanings. Some of these terms are not well understood, and their use is subjected to a variety of different interpretations. Moreover, the BMD language is continually changing to keep pace with advances in research and implementation. As transportation agencies move to implement BMD, it is paramount to standardize language so that communication between different agencies, contractors, and stakeholders can be done effectively and without confusion.

This document contains terms of common usage and accepted practice. This E-Circular was generated by a task group of the Transportation Research Board (TRB) Standing Committee on Production and Use of Asphalt (AKM10), with contributions from the following committees in a supporting role:

- Standing Committee on Asphalt Materials Selection and Mix Design (AKM30),
- Standing Committee on Asphalt Mixture Evaluation and Performance (AKM40),
- Standing Committee on Pavement Condition Evaluation (AKP10),
- Standing Committee on Design and Rehabilitation of Asphalt Pavements (AKP30),
- Standing Committee on Pavement Structural Testing and Evaluation (AKP40), and
- Standing Committee on Quality Assurance Management (AKC30).

AKM10 thanks the following individuals for their contributions to writing and ensuring the technical accuracy of this document:

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- Carolina Rodezno, National Center for Asphalt Technology; and
- Babatunde Onase, University of Delaware.

The purpose of this publication is to provide a reference document for usage of BMD terminology in the United States. It is hoped that this publication will foster improved communications among those who are involved in the asphalt mixtures community.

ORGANIZATION

This publication is divided into four parts: Glossary of Asphalt Pavement Balanced Mix Design Terms, Glossary of Asphalt Balanced Mix Design Tests and Properties, Abbreviations and Symbols, and References. The major parts are the two Glossary sections. The first Glossary is divided into two subsections: the Overall Definition which describes BMD as a concept and the Key Terms which defines all the terms related to BMD. The terms selected for definition include many terms that frequently are misinterpreted, misunderstood, or generally confused. The definitions provided are often more than basic definitions as they attempt to clarify the impact of the term under BMD specifically. The Key Terms section is organized alphabetically so that finding terms can be accomplished easily. Also, several key figures are provided to illustrate important concepts and strengthen the understanding of relationships among terms.

The second major section is the Glossary of Asphalt Balanced Mix Design Tests and Properties that provides a succinct description of the common mechanical tests used within a BMD system. This section is further divided by the type of distress the test is often used to correlate with and then tests are listed alphabetically. In this section, each test has a short description, the test method(s), and the parameter used for potential BMD criteria. The section is not intended to be exhaustive as only those tests have a test method and are being used or proposed in agency specifications for BMD. In addition to the tests for BMD, there is a variety of mixture conditioning procedures to simulate aging of asphalt mixtures in the field. Although conditioning to simulate aging is critical for use alongside BMD cracking and durability tests, the different procedures are not listed and explained in this document. The concepts of conditioning and aging are described in the Glossary, but no specific procedures are detailed.

Many glossaries and publications containing definitions were examined informing the definitions in this document. What is believed to be the best thoughts and wording and most necessary features were then taken from these existing definitions; only minor changes were made to create appropriate definitions for use. A collective judgement of the committee was used in determining which references should be cited.

Glossary of Balanced Mix Design Terms

OVERALL DEFINITION

Pavement Performance. Performance of an asphalt pavement can be defined as the physical condition of the pavement structure and its response to traffic and environment over time. Pavement performance is typically easier to assess and measure when compared with mixture performance although it is not the focus of BMD performance comparisons.

Asphalt Mixture Performance. Performance of an asphalt mixture can be defined as the physical condition of a specific asphalt layer within a pavement structure and its response to traffic and environment over time. BMD is primarily concerned with asphalt mixture performance as it does not consider all the other items that may impact overall pavement performance (e.g., supporting structure and condition, climactic conditions, drainage).

Balanced Mix Design (BMD). An asphalt mixture design framework using mechanical tests correlated to field performance on appropriately conditioned specimens that address multiple modes of asphalt layer distress taking into consideration mixture aging, traffic, climate, and location within the pavement structure. An example of mechanical testing diagram for BMD is shown in Figure 1, with the red dashed lines representing criterion for each BMD parameter.

As of this writing, there are four primary approaches to BMD for mixture design, as described below. The differences between the approaches are highlighted in Table 1.

- **Approach A: Volumetric Design with BMD Verification**. This approach starts with the current volumetric mixture design method (i.e., Superpave, Marshall, or Hveem) for determining an optimum asphalt binder content (OBC). The asphalt mixture is then tested with selected mechanical tests correlated to field performance to assess its resistance to distresses of interest at the OBC. If the mix design meets the test criteria, the job mix formula (JMF) is established and production begins; otherwise, the entire mix design is repeated using different mixture proportions or materials (e.g., aggregates, asphalt binders, recycled materials, and additives) until all of the volumetric and BMD test criteria are satisfied.
- **Approach B: Volumetric Design with BMD Optimization**. This approach is an expanded version of Approach A. It also starts with the current volumetric mixture design method (i.e., Superpave, Marshall, or Hveem) for determining a preliminary OBC. Asphalt mixture mechanical tests correlated to performance are then conducted on the mix design at the preliminary OBC and two or more additional contents. The asphalt binder content that satisfies all the test criteria is identified as the final or target OBC. In cases where the BMD test criteria are not met at all binder contents, the entire mixture design process needs to be repeated using different mixture proportions or materials (e.g., aggregates, asphalt binders, recycled materials, and additives) until all the BMD test criteria are satisfied.
- **Approach C: BMD-Modified Volumetric Design.** This approach begins with the current volumetric mixture design method (i.e., Superpave, Marshall, or Hveem) to establish preliminary component material properties, proportions, and asphalt binder content. The mechanical test results are then used to adjust either the preliminary asphalt binder content or the mixture component properties or proportions (e.g., aggregates, binders, recycled materials, and

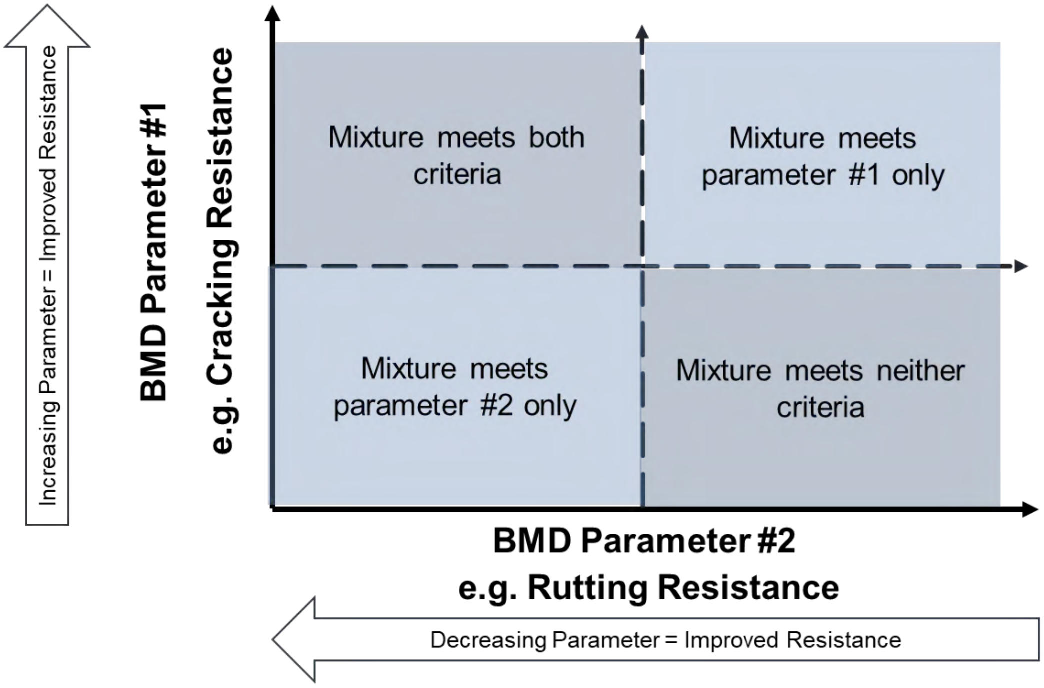

FIGURE 1 Example of performance diagram for BMD (with two parameters) for agencies.

TABLE 1 Comparison of Different BMD Approaches for Mixture Design

BMD Approach	Volumetric Requirements	Mixture Mechanical Testing Requirements	Flexibility	Innovation Potential
A: Volumetric Design with BMD Verification	Full compliance.	Full compliance.	Most conservative.	Lowest.
B: Volumetric Design with BMD Optimization	Full compliance at preliminary OBC.	BMD optimization through moderate changes in asphalt binder content.	Slightly more flexible than Approach A.	Limited.
C: BMD-Modified Volumetric Design	Some requirements relaxed or eliminated.	BMD optimization by adjusting preliminary asphalt binder content or mixture component properties or proportions.	Less conservative than Approach A and Approach B.	Medium degree.
D: BMD Design Only	Limited or no requirements.	BMD optimization by adjusting mixture components and proportions.	Least conservative.	Highest degree.

additives) until the criteria are satisfied. For this approach, the final design is primarily focused on meeting BMD test criteria and may not have to meet all the mixture design volumetric criteria.

- **Approach D: BMD Design Only**. This approach establishes and adjusts mixture components and proportions based on performance analysis with limited or no agency requirements for volumetric properties. The agency may set minimum requirements for asphalt binder quality and aggregate properties. Once the mechanical test results meet the BMD criteria, the mixture volumetric properties may be checked for use in production.

Within BMD, there are also several approaches to incorporate mechanical tests correlated to field performance into quality assurance of plant-produced asphalt mixtures in the field. These approaches are briefly described below.

- **Status Quo**. This approach is to conduct BMD mechanical tests in addition to (or in place of depending on the BMD approach selected) volumetric analysis at the mix design and approval stage, but then use existing Acceptance Quality Characteristics (AQCs) during production.
- **BMD Verification.** This approach is to have the agency perform a verification of BMD parameters on an initial production lot or test strip of the asphalt mixture, then use existing AQCs during further production for acceptance and pay.
- **BMD Verification and Production Monitoring**. This approach is to have the agency perform a verification of BMD parameters on an initial production lot or test strip of the asphalt mixture then use existing AQCs during further production for acceptance and pay. In addition to the previous approach, the agency or contractor will perform periodic mechanical testing on asphalt mixtures during the project, but the results will not be used for pay adjustment. Instead, the results are used as occasional verification checks to ensure that the material produced still meets performance requirements. Materials failing to meet performance requirements could result in corrective action by the contractor until acceptable results are obtained.
- **BMD for Acceptance (in Addition to Traditional AQCs).** This approach is to have mechanical testing parameters serve as AQCs as part of owner agency acceptance, in addition to traditional AQCs. As part of acceptance the agency establishes a quality measure for the performance parameters (e.g., lot average, percent within limits) to relate quality to pay adjustment. Some of the traditional AQCs are still used for acceptance, although they may be conducted at a higher frequency than the BMD testing.
- **BMD for Acceptance Only.** This approach is to have mechanical testing parameters serve as AQCs as part of owner agency acceptance while removing the traditionally used AQCs.

KEY TERMS

Terms in *italics* are directly referenced from *Transportation Research Circular E-C235: Glossary of Transportation Construction Quality Assurance Terms*, Seventh Edition. Added descriptions are provided to add how the term is used in BMD specifically.

Accuracy. “The closeness of agreement between a test result and an accepted reference value. The term accuracy, when applied to a set of test results, involves a combination of a random component and of a common systematic error or bias component” (ASTM E177, 2020).

Aging. The change in rheological properties of asphalt binders and mixtures due to changes in chemical composition caused by the environment during its production and construction (short-term aging) and service life (long-term aging). In terms of BMD, the changes caused by long-term aging is key to correlating mechanical tests to field cracking performance.

Benchmarking. The process by which existing asphalt mix designs are tested using selected BMD mechanical tests to analyze how currently approved asphalt mixtures compare against prospective BMD criteria. The collected data is often analyzed against important mixture design factors (e.g., percent reclaimed asphalt pavement, volumetrics, air void content) to evaluate the characteristics from the mechanical testing results. The data is also used to help evaluate the impact of potential mechanical testing criteria on the approval of existing mixture designs within a proposed BMD framework. A common approach is to display benchmarking in cumulative distribution curves to visualize the distribution of results like the example below in Figure 2.

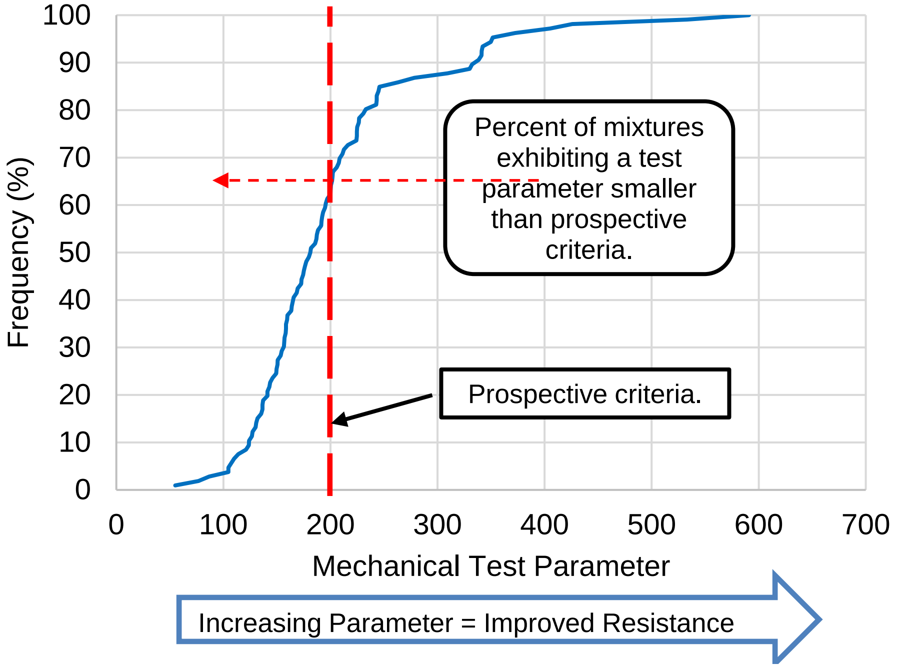

FIGURE 2 Example cumulative distribution curve for benchmarking results.

BMD Relationship Confirmation and Criteria Development. Process by which a relationship between field performance or asphalt layer distress (ideally of pavement sections with consistent traffic, environmental, and pavement structure conditions but different asphalt mixtures of interest) and mechanical test results of mixtures is established. The primary goal is to ensure that mechanical tests results have a strong relationship to field performance and asphalt layer distress in a well-controlled environment while minimizing other confounding factors. This activity is crucial for developing rational criteria for mixture design approval and/or acceptance like the example in Figure 3.

Conditioning. Conditioning is a laboratory procedure to simulate the effects of environmental effects (aging or moisture damage) on lasphaltasphalt mixture specimens. Laboratory procedures to simulate long-term aging are of importance for use in BMD cracking tests to properly correlate the resulting parameters to the field performance of the asphalt layer at its critical condition.

Empirical or Index Parameter. Empirical or index parameters are not engineering properties that can be used in a mechanics of materials model to predict stress or strain from applied loads through which performance can be evaluated. Instead empirical or index parameter can be empirically correlated to the occurrence of distress or performance. An empirical or index parameter is often dependent on the way it is measured and often is not a fundamental property of the material itself. An example of an index parameter is the Flexibility Index (*FI*), which indicates the fatigue cracking resistance of an asphalt mixture measured in the Illinois Flexibility Index Test specified in AASHTO T 393. The properties measured in the test, fracture energy and strain rate, are engineering properties but are not used in a mechanics of materials model. Instead they are correlated to cracking behavior. Another example of an index parameter is the Rut Depth (*RD*) of the Hamburg Wheel-Tracking Test (HWTT) per AASHTO T 324, which may indicate the relative rutting susceptibility of asphalt mixtures. In this case it is an index value not a fundamental property of the asphalt mixtures.

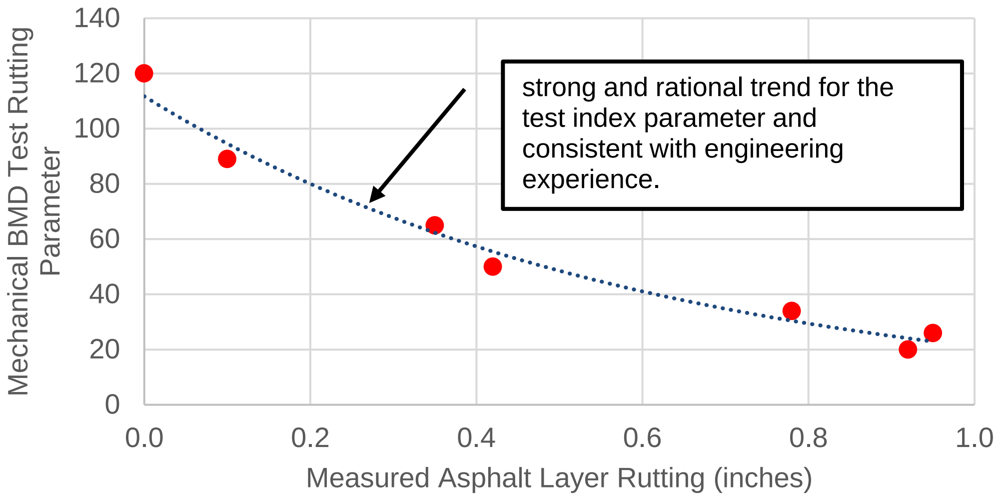

FIGURE 3 Performance relationship confirmation example.

Fundamental Property. Fundamental properties are those that result from measurement and analysis of the mechanistic responses (stresses, strains) of asphalt mixtures to load, deformation, or environmental conditioning that can be combined with mechanistic models to predict the performance of asphalt mixtures under various traffic settings, environments, and pavement structures. These measurements can be made over a range of situations, such as applied loads, strain levels, temperatures, saturation levels, or aging. Examples of fundamental properties include creep compliance from indirect tensile testing (AASHTO T 322) or the dynamic modulus (AASHTO T 378).

Inter-Laboratory Study (ILS). A controlled experiment designed to evaluate the consistency of multiple laboratories conducting a given mechanical test. Understanding test variability is important in test selection (tests with poor precision may be unable to discern good-performing mixtures from poor-performing mixtures) and important in setting test specification criteria. An ILS can be designed to measure the variability in each test method. An ILS can also be referred to by other terms including round robin, proficiency testing program, among others.

Mixture Design Verification. Process by which an agency will verify the appropriateness and compliance of a contractor's proposed mixture design with agency's specification requirements. The activities performed by the agency may include component materials testing, laboratory sample fabrication and testing, plant-produced mixture sampling and testing from a test strip, initial production lot, or trial batch, or paper review of the JMF.

Monotonic and Cyclic Loading. Terms used to describe the characterization of the loading applied to asphalt mixture specimens in mechanical tests used for BMD as defined below:

- **Monotonic Loading**. Applied loading to an asphalt mixture specimen that either continuously increases or is held constant (e.g., IDEAL-CT test).
- **Cyclic Loading**. Applied repetitive loading to an asphalt mixture specimen that repeats itself and may increase or decrease over time (e.g., direct tension cyclic fatigue test).

Precision and Bias. Terms used to describe the exactness of a test measurement as defined below and in Figure 4.

- **Precision.** "The closeness of agreement between independent test results obtained under stipulated conditions. Precision depends on random errors and does not relate to the accepted reference value" (ASTM E177, 2020).
- **Bias.** "The difference between the expectation of the test results and an accepted reference value. Bias is the total systematic error as contrasted to random error. There may be one or more systematic error components contributing to the bias. A larger systematic difference from the accepted reference value is reflected by a larger bias value" (ASTM E177, 2020). For example, a laboratory running stiffness tests at higher than a specified test temperature will produce stiffness results that are systematically lower than those tested at the correct temperature.

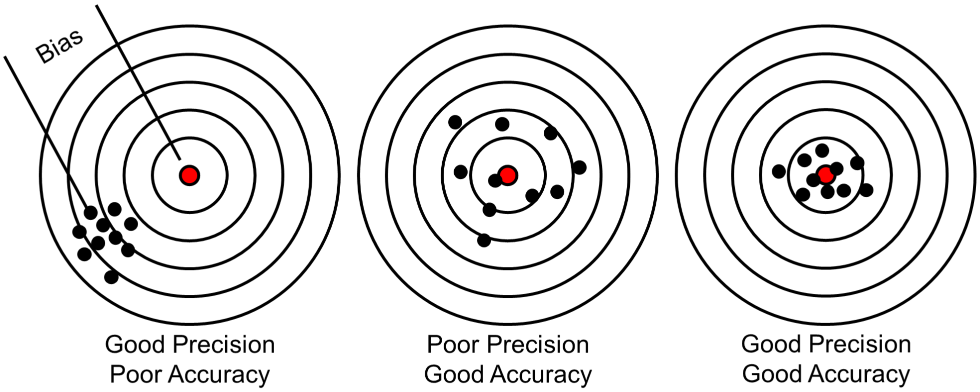

FIGURE 4 Graphical illustration for exactness of measurements.

Pilot Project. Paving project where BMD tests are required as part of mixture design approval or acceptance (if part of the agency goals). Mechanical test requirements are added to the contract in addition to, or in lieu of, typical mixture design and acceptance requirements. These projects are often used as the test trials for agencies to evaluate their BMD approach and specifications.

Repeatability. "Precision of test results from tests conducted within the shortest practical time period on identical material by the same test method in a single laboratory with all known sources of variability conditions controlled at the same levels" (ASTM E177, 2020). The repeatability of a mechanical test is important to compare mixtures against each other; if the single-operator variability of a given mechanical test is high it will be difficult to discern between mixtures with different properties.

Reproducibility. "Precision of test results from tests conducted on identical material by the same test method in different laboratories" (ASTM E177, 2020). The reproducibility of mechanical tests will be especially important when comparing contractor and agency lab results against one another; if the between labs variability is high for a given mechanical test then production and quality assurance issues may result.

Ruggedness. Insensitivity of a test method to departures from specified test or environmental conditions. An evaluation of the ruggedness of a test method or an empirical model derived from an experiment is useful in determining whether the results or decisions will be relatively invariant over some range of environmental variability under which the test method or the model is likely to be applied. The ruggedness of a mechanical test is important to ensure the selected test method has proper controls and limits to minimize variability.

Shadow Project. Paving project where mechanical tests are conducted during mixture design or production for informational purposes only. Conventional mixture design approval and acceptance tests are used for contractual requirements. Often additional samples are obtained for mechanical testing through the project by the agency or contractor. The data from the additional testing is shared and discussed with contractor and project personnel. Data from multiple shadow projects may be used to establish production variability statistics that could be considered in setting quality assurance specifications.

Surrogate Test. Mechanical test used primarily for acceptance during production in lieu of the mechanical test used for mixture design. Tests that are easier and faster to conduct are often selected as surrogates to provide quicker turnaround on the test results during acceptance. Correlation between the surrogate test and mix design test needs to be established, often on a mixture-by-mixture basis, during mixture design development or trial production as seen in Figure 5 below.

Test Strip (may be referred to as Initial Production Lot). The production of an asphalt mixture on a limited basis for the purpose of verification by agency of mixture design production and in-place properties. Test strips are used at the beginning of project production to generate field-produced material to perform testing for mixture design verification. Test strips may be conducted at an off-project location, in lower use areas such as shoulders, or in the mainline if no other areas are available.

Trial Batch (may be referred to as Trial Run). The limited production quantity of an asphalt mixture to generate plant-produced material to sample and test for the purpose of mixture design evaluation or verification by the agency without requiring placement and compaction.

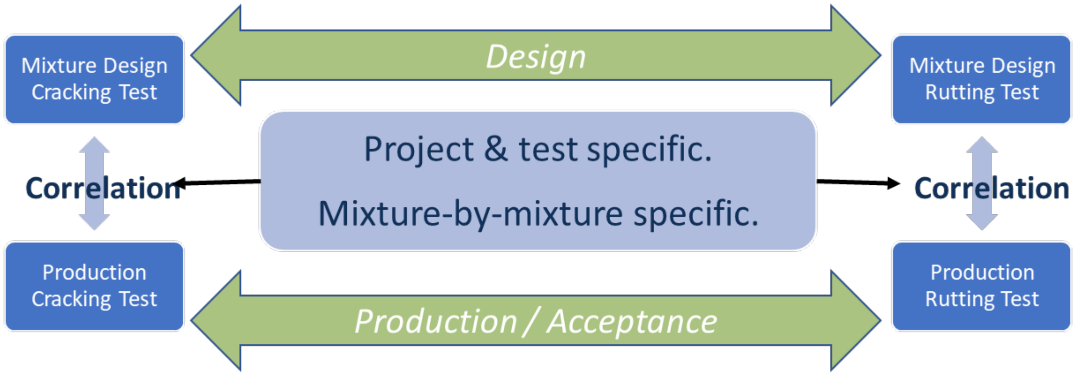

FIGURE 5 Example performance testing surrogate approach for BMD.

Glossary of Balanced Mix Design Tests and Properties

This section presents the mechanical mixture tests commonly being used or evaluated for use in BMD in the United States. The criteria used by the authors to decide which tests to include as part of this glossary were as follows:

1. The tests in question must be performed on asphalt mixture specimens.
2. There must be a published test method and/or standard available. The prevailing test method(s) are listed in the document with preference given to AASHTO and ASTM methods or standards, then the prevailing state method if no ASTM and AASHTO methods or standards are available.
3. The test must be in use or being proposed for use in agency BMD specification in the United States.

CRACKING TESTS

Direct Tension Cyclic Fatigue Test. The Direct Tension Cyclic Fatigue test assesses the intermediate temperature fatigue cracking resistance of asphalt mixtures by applying a repeated cyclic loading (displacement controlled) to cylindrical test specimens until failure. The resulting applied stress and on-specimen strain responses are used to develop the relationship between the damage (S) and pseudo secant modulus (C), otherwise known as the damage characteristic curve. Number of loading cycles to failure and the cumulative pseudo secant modulus up to failure are used to determine the fatigue failure criterion, D^R. The C versus S relationship, D^R, and dynamic modulus (AASHTO T 342 or AASHTO T 378) are used to produce the fatigue index parameter, S_{app}, calculated by the FlexMAT cracking analysis. These test outcomes are also used with the FlexPAVE analysis to evaluate long-term cracking damage in a pavement.

Test Method(s): AASHTO TP 107 (large specimens)
AASHTO TP 133 (small specimens)

Properties Calculated: S_{app} = fatigue index parameter
C versus S *curve* = damage characteristic curve
D^R = failure criterion

Disc-Shaped Compact Tension (DCT) Test. The DCT test assesses the low-temperature fracture resistance of asphalt mixtures by applying a tensile load to a cylindrical test specimen cut and notched into a disk-shaped geometry. The tensile loading is applied through a constant crack mouth opening displacement rate at the notch location until the specimen fails. The resulting load-displacement curve is analyzed to produce the fracture energy, G_f.

Test Method(s): ASTM D7313

Properties Calculated: G_f = fracture energy

Flexural Bending Beam Fatigue (BBF) Test. The BBF test assesses the intermediate temperature fatigue cracking resistance of asphalt mixtures by applying repeated flexural bending to beam specimens until failure.

Test Method(s): AASHTO T 321
ASTM D8273

Properties Calculated: N_f = number of cycles to failure
S = flexural stiffness

Illinois Flexibility Index Test (I-FIT). The I-FIT test assesses the intermediate temperature fracture resistance of asphalt mixtures by applying a monotonic load to cylindrical test specimens cut to a half-disk geometry with a notch cut parallel to the direction of load application. The resulting load-displacement curve is analyzed to produce the final test parameter, *FI*.

Test Method(s): AASHTO T 393

Properties Calculated: FI = flexibility index

Indirect Tensile Cracking Test (IDEAL-CT). The IDEAL-CT test assesses the intermediate temperature cracking susceptibility of asphalt mixtures by applying an indirect tensile load at a constant load-line displacement rate to compacted cylindrical test specimens. The resulting load-displacement curve is analyzed to produce the final test parameter, cracking tolerance index, CT_{Index}.

Test Method(s): ASTM D8225

Properties Calculated: CT_{Index} = cracking tolerance index

Low-Temperature Semi-Circular Bend (SCB) Test. The SCB test assesses the low-temperature fracture resistance of asphalt mixtures by applying a monotonic load to cylindrical test specimens cut to a half-disk geometry with a notch cut parallel to the direction of load application. The load is applied such that a constant crack mouth opening displacement rate for the duration of the test. The resulting load-displacement curves is analyzed to produce the fracture energy (G_f), stiffness (S), and fracture toughness (K_{IC}).

Test Method(s): AASHTO T 394

Properties Calculated: G_f = fracture energy
S = stiffness
K_{IC} = fracture toughness

Overlay Test (OT). The OT test assesses the intermediate temperature fatigue and reflective cracking resistance of asphalt mixtures by applying repeated direct tensile loads to cylindrical test specimens with trimmed sides. The tensile loading is applied through a cyclic triangular waveform to a constant maximum displacement until the specimen fails. The number of cycles to failure is reported and the resulting test response curves are analyzed to produce the critical fracture energy (CFE) and the crack progression rate(CPR) depending on the methodology used.

Test Method(s): NJDOT B-10
Tex-248-F

Properties Calculated: N_f = number of cycles to failure (NJDOT B-10)
CFE (Tex-248-F)
CPR = crack progression rate (Tex-248-F)

Intermediate Temperature SCB Test. The SCB test assesses the intermediate temperature fracture resistance of asphalt mixtures by applying a monotonic load to cylindrical test specimens cut to a half-disk geometry with varying notches cut parallel to the direction of load application. The resulting load-displacement curves for the multiple specimens with varying notch depths are analyzed to produce the final test parameter, critical strain energy release rate, J_c.

Test Method(s): ASTM D8044

Properties Calculated: J_c = critical strain energy release rate

RUTTING TESTS

Asphalt Pavement Analyzer (APA) Test. The APA test assesses the rutting susceptibility of asphalt mixtures by applying repetitive linear loads to compacted test specimens through pressurized hoses via steel wheels. The loading is applied to the specimens for a specified number of cycles at relatively elevated temperatures and a final *RD* of the specimens is measured at the conclusion of the test.

Test Method(s): AASHTO T 340

Properties Calculated: *RD* at the selected number of cycles

Flow Number (FN) Test. The FN test assesses the permanent deformation characteristics of asphalt mixtures by applying repeated haversine axial compressive loads to a cylindrical specimen at a specific test temperature. The test may be conducted with or without confining pressure. For each load cycle, the recoverable strain and permanent strain are recorded. The FN is an index parameter determined as the number of load cycles corresponding to the minimum rate of change of permanent strain (i.e., onset of tertiary flow).

Test Method(s): AASHTO T 378

Properties Calculated: FN = flow number

Hamburg Wheel-Tracking Test (HWTT). The HWTT test assesses the rutting and moisture susceptibility of asphalt mixtures by applying cycles of loaded steel wheels passing across test specimens. The test is conducted on two sets of cylindrical specimens, or two slab specimens submerged in temperature-controlled water and subjected to repeated loading. *RD*s along the specimens are recorded during each wheel pass. The specimens are commonly loaded for a maximum of 20,000 passes or until the *RD* reaches a preset failure point. Analysis of the plots of *RD* versus passes are used to assess rutting susceptibility and/or moisture damage susceptibility of the mixture.

Test Method(s): AASHTO T 324

Properties Calculated: *RD* at selected number of passes
SIP = stripping inflection point

High-Temperature Indirect Tension Test (HT-IDT). The HT-IDT test assesses the rutting susceptibility of asphalt mixtures by applying an indirect tensile load at a constant load-line displacement rate to compacted cylindrical test specimens at an elevated temperature. The Indirect tensile strength, ITS, is then reported from testing.

Test Method(s): ALDOT-458

Properties Calculated: ITS = indirect tensile strength

Rapid Shear Rutting Test (IDEAL-RT). The IDEAL-RT test assesses the rutting susceptibility of asphalt mixtures by applying monotonic load to compacted cylindrical test specimens at three points. The loading conditions create two shear planes in the specimen and the resulting peak load is used to calculate the rutting tolerance index, RT_{Index}.

Test Method(s): ASTM WK71466

Properties Calculated: RT_{Index} = rutting tolerance index

Stress Sweep Rutting (SSR) Test. The SSR test assesses the rutting susceptibility of asphalt mixtures by applying repeated cyclic loading to confined cylindrical test specimens at two temperatures. The low temperature and high temperature are determined for the project location using LTPPBind v 3.1 at the location of interest. Confined specimens are loaded for 200 cycles each at three increments of deviator stress.. The SSR test result is used to calculate the average permanent strain (in percent) and produce the rutting strain index parameter, RSI, calculated by the FlexMAT rutting analysis. Test results are also used to generate a permanent strain shift model that can be used with the FlexPAVE analysis to model rutting in the pavement layer.

Test Method(s): AASHTO TP 134

Properties Calculated: RSI = rutting strain index

MOISTURE DAMAGE TESTS

Indirect Tensile (IDT) Strength Ratio Test. The IDT test assesses the moisture susceptibility of asphalt mixtures by applying an indirect tensile load at a constant load-line displacement rate to compacted cylindrical test specimens. The IDT strength is determined for one set of dry specimens and one set of conditioned specimens. The conditioned set of speciemns are often suvjected to soaking in water or freeze–thaw cycles. The tensile strength values are then analyzed to calculate the tensile strength ratio, TSR, as the ratio between the average conditioned strength and the average dry strength.

Test Method(s): AASHTO T 283

Properties Calculated:
St_m = wet tensile strength
St_d = dry tensile strength
TSR = tensile strength ratio

Hamburg Wheel-Tracking Test (HWTT). The test is conducted on two sets of cylindrical specimens, or two slab specimens submerged in temperature-controlled water and subjected to repeated load using reciprocating steel wheels moving back and forth across the specimens. *RD*s along the specimens are recorded during each wheel pass. The specimens are loaded for a maximum of 20,000 wheel passes or until the rut depth reaches a preset failure point. Analysis of the plots of rut depth versus passes can be used to assess rutting susceptibility or moisture damage susceptibility of the mixture.

Test Method(s): AASHTO T 324

Properties Calculated:
RD at selected number of passes
SIP = stripping inflection point

OTHER TESTS

Cantabro Mass Loss Test. The Cantabro Mass Loss test produces a brittleness index that has been shown to relate to factors generally thought to impact durability of asphalt mixtures by abrading cylindrical test specimens in a Los Angeles abrasion apparatus (without the use of steel charges) for 300 cycles. Dense-graded and open-graded mixtures can be tested.

Test Method(s): AASHTO T 401

Properties Calculated: Percent abrasion loss

Abbreviations and Symbols

AASHTO	American Association of State Highway and Transportation Officials
AQC	Acceptance Quality Characteristic
APA	Asphalt Pavement Analyzer
ASTM	American Society for Testing and Materials
BBF	Bending Beam Fatigue
BMD	Balanced Mix Design
C	Secant Modulus
COV	Coefficient of Variation
CRI	Crack Resistance Index
CT_{index}	Cracking Tolerance Index
DCT	Disc-Shaped Compact Tension
DOT	Department of Transportation
D^R	Pseudo Strain Energy-Based Fatigue Failure Criterion
FHWA	Federal Highway Administration
FI	Flexibility Index
G_c	Critical Fracture Energy
G_f	Fracture Energy
HT-IDT	High-Temperature Indirect Tension Test
HWTT	Hamburg Wheel-Tracking Test
IDEAL-CT	Indirect Tensile Cracking Test
IDEAL-RT	Indirect Tensile Asphalt Rutting Test
I-FIT	Illinois Flexibility Index Test
ILS	Inter-Laboratory Study
ITS	Indirect Tensile Strength
J_c	Critical Strain Energy Release Rate
JMF	Job Mix Formula
NCHRP	National Cooperative Highway Research Program
N_f	Number of Cycles to Failure
OBC	Optimum Binder Content
OT	Overlay Test
QA	Quality Assurance
QC	Quality Control
RD	Rut Depth
RSI	Rutting Strain Index
RT_{Index}	Rutting Tolerance Index
S	Flexural Stiffness
S_{app}	Fatigue Index Parameter
SCB	Semi-Circular Bend
SIP	Stripping Inflection Point
SHRP	Strategic Highway Research Program
SSR	Stress Sweep Rutting Test
SST	Superpave Shear Tester
St_m	Wet Tensile Strength
St_d	Dry Tensile Strength
TRB	Transportation Research Board
TSR	Tensile Strength Ratio
U.S.	United States

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