MOVING BEYOND APPROACHES

WHY REIMAGINE BALANCED MIX DESIGN?

BMD IMPLEMENTATION WORKING GROUP

INTRODUCTION

In the realm of pavement engineering, achieving optimal performance while ensuring cost-effectiveness and sustainability is a continual challenge. The concept of Balanced Mix Design (BMD) serves as a pivotal methodology aimed at addressing this challenge by integrating performance-based criteria into the design of asphalt mixtures. This document introduces BMD, explains its definition, explores the four current approaches that underpin its application, and advocates for reimagining its future. It underscores the need to evolve beyond the current practices to effectively address current and future demands and advancements in the industry.

DEFINITION OF BMD

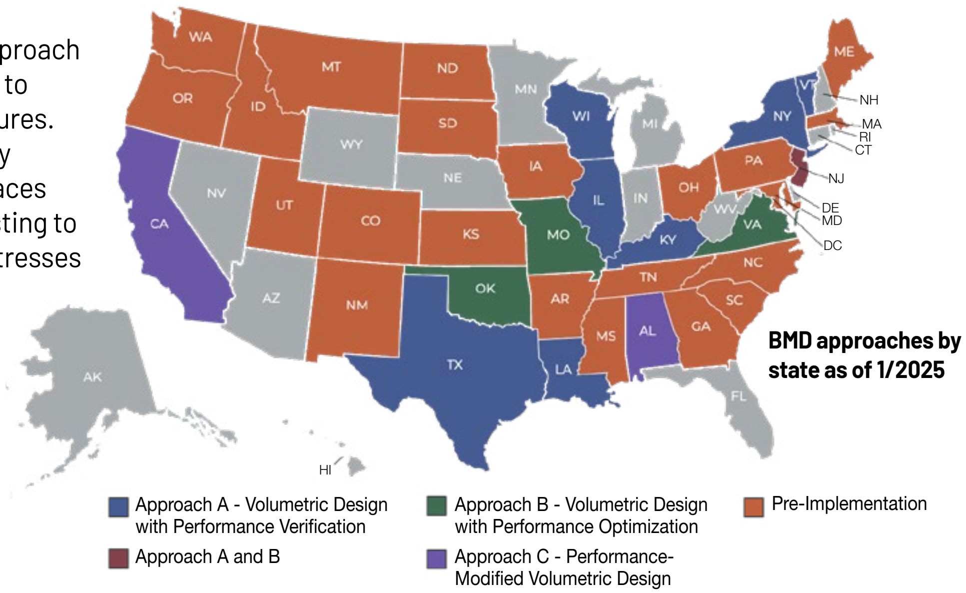
Balanced Mix Design is an innovative approach that balances durability with resistance to permanent deformation in asphalt mixtures. Unlike traditional methods that primarily focus on volumetric properties, BMD places significant emphasis on mechanical testing to ensure the mixture can withstand the stresses it will encounter in service. The goal is to create asphalt mixtures that are durable, resistant to all forms of distress that can reduce an asphalt pavement's life, and capable of performing well under varying traffic and environmental conditions.

CURRENT APPROACHES TO BMD

There are four prevalent approaches to implementing BMD, as referenced in AASHTO PP105, each incorporating unique strategies and testing protocols to achieve the desired balance of performance characteristics.

A *Volumetric Design with BMD Verification*

This approach begins with traditional volumetric design methods to establish initial mixture proportions. Once the volumetric properties meet the specified criteria, mechanical tests are conducted to verify that the mixture meets the desired BMD thresholds. This ensures the mixture meets volumetric standards and demonstrates adequate durability and permanent deformation resistance.



BMD approaches by state as of 1/2025

B Volumetric Design with BMD Optimization

In this approach, BMD criteria are incorporated into the volumetric design process from the outset. The design process iteratively adjusts the mixture proportions based on mechanical testing results to achieve a balance between volumetric properties and BMD test criteria. This method emphasizes a more integrated approach, where mechanical tests directly influence the mixture design.

C BMD-Modified Volumetric Design

This approach focuses on optimizing the mixture to meet specific BMD criteria tailored to the expected service conditions. This approach involves comprehensive mechanical testing throughout the design process, ensuring that the mixture is fine-tuned to address potential issues such as cracking, rutting, and moisture damage. The goal is to create a mixture that is highly resilient to the specific challenges it will face in the field. Volumetrics are modified during the design process in this method.

D BMD Design Only

This approach prioritizes BMD criteria above all other factors in the mixture design process. It relies heavily on mechanical testing protocols to guide the selection of materials and mixture proportions. The mixture is designed purely based on its ability to meet BMD standards, ensuring that the final product is exceptionally durable and resistant to various forms of distress.

ADVANTAGES OF MOVING TO BMD

Transitioning to BMD offers several significant advantages in pavement engineering. One of the primary benefits is the enhanced durability and resilience of asphalt mixtures. By integrating mechanical testing into the design process, BMD ensures that mixtures not only meet volumetric standards, but also withstand various forms of distress such as cracking, rutting, and moisture damage.

BMD also promotes a holistic approach to asphalt mixture design, enabling the development of tailored solutions that address specific service conditions. This method allows for the fine-tuning of mixtures, resulting in a higher performance under diverse and demanding conditions.

Adopting BMD supports innovation and the use of advanced materials, since performance-based criteria drive the selection process. This leads to more sustainable and longer-lasting pavements, ultimately reducing maintenance costs and extending the lifespan of roadways.

TIME TO RESET

In sports, most professional teams aim for a championship. While expectations of winning might be tempered by realism, the desire to perform at the highest level is unwavering. When teams fall short of expectations, they often reset their approach. This may involve a coaching change or a strategic shift, but the goal and definition of success remain unchanged.

Similarly, it is time for asphalt pavement stakeholders to take a different approach. Pavement owners would mostly agree that their goal is to build and maintain the best performing pavement at the lowest environmental and economic costs. However, the current widespread reliance mainly on BMD Approach A, though effective in improving performance, falls short in reducing costs and maximizing environmental impact.

To meet the goal of high-performing, lower life-cycle cost, and environmentally conscious asphalt pavements, owners must be willing to move beyond Approach A. The current system, however, often misguides stakeholders into believing that adopting Approach A as an endpoint (while falling short of maximizing the benefits of BMD).

Approach A, while a step in the right direction, does not embody the principles of true BMD. Instead, it is more properly categorized as Superpave Level 3 – a framework that integrates some performance-based elements but remains heavily rooted in traditional volumetric methods. This approach has been described by some as 'volumetrics plus,' similar to the concept of a Performance Grade (PG) Plus specification used for asphalt binders by some agencies. In those cases, testing methods such as the elastic recovery from a ductilometer or the adoption of a maximum phase angle are added to the standard PG criteria, resulting in an additional requirement, often established based on the properties of current materials, so that the specifier gets the product that they always have been getting. In doing this, there is a focus on performance but not on other aspects like economics or life-cycle cost.

Frameworks should be developed that provide a clear pathway toward achieving the goal. The purpose of a reimagined BMD framework is to provide agencies with flexible options that enable them to advance BMD based on specific performance characteristics. This flexibility is essential, as it accommodates the varying levels of experience agencies may have with mechanical testing and BMD implementation. The key performance characteristics to consider include design and construction factors (e.g., mixture type or geometric constraints), permanent deformation resistance, cracking resistance (both load-related and non-load-related), moisture damage resistance, and surface characteristics such as friction resistance and permeability.

It is also time to move beyond the traditional focus on balancing cracking and rutting primarily by adjusting asphalt binder content. A true BMD framework should capture the full spectrum of an asphalt mixture's performance characteristics, tailored to the specifics of each project and the intended applications. By doing so, agencies can more properly address the diverse demands of different pavement types, climates, and traffic conditions. Furthermore, the framework should recognize that mixture design extends beyond determining the 'optimum' asphalt binder content. It must also incorporate the impact of other constituents like aggregate properties and additives into the analysis. This comprehensive reimagined BMD approach reflects the true essence of BMD, enabling agencies to design asphalt mixtures that are not only high-performing, but also cost-effective and environmentally sustainable.

A BMD framework must also be integrated within an agency's quality assurance program. Current practices lack comprehensive methods for specifying and assessing mixture acceptance. For example, properties such as theoretical maximum specific gravity, asphalt binder content, and gradation may remain as indicators of consistency during production, provided the mixture continues to meet mechanical test criteria. These properties can help maintain uniformity throughout production while addressing practical constraints of frequent testing such as turnaround time and sample size.

SUMMARY

In conclusion, while the definition of BMD remains steadfast in its commitment to integrating performance criteria into asphalt mixture design, it is evident that the current approach to achieving BMD must evolve. The current practices, exemplified by Approach A, may enhance performance yet fall short of addressing the broader goals of cost-effectiveness and environmental sustainability. As the industry faces increasing economic pressures and a growing imperative to consider environmental impacts, a reimagined framework for BMD is essential.

This updated approach should guide agencies toward achieving high-performing pavements by incorporating a comprehensive range of performance characteristics. Initially, the approach would emphasize meeting specific constituent, volumetric, and mechanical test requirements, providing a baseline for asphalt mixture design. With progression, there is increased flexibility in material selection and mixture adjustments, with a greater emphasis on performance-properties from mechanical testing over volumetric properties. Eventually, the focus moves almost entirely to performance optimization, with minimal reliance on detailed constituent and volumetric requirements, along with a primary emphasis on mechanical testing to validate the mixture's ability to meet desired performance characteristics. This would be complemented by an efficient integration into an agency's quality assurance program to ensure consistency during production.

To truly realize the potential of BMD, stakeholders must embrace innovations and advanced materials that can meet the stringent performance standards without compromising on cost or environmental considerations. By shifting toward a reimagined BMD approach, the industry can develop tailored solutions that not only enhance durability and resilience, but also contribute to sustainability and fiscal responsibility. It is through this redefined pathway that pavement owners can attain their ultimate goal: the construction and maintenance of superior asphalt pavements at the lowest possible economic and environmental costs.