BALANCED MIXTURE DESIGN:

AGENCY BUSINESS CASE

WHAT IS BALANCED MIXTURE DESIGN?

A critical step in achieving long-lasting asphalt pavement performance begins with mixture design. An asphalt mixture should possess adequate stability (i.e., resistance to permanent deformation/rutting), durability (i.e., resistance to cracking), and other properties like surface friction for the intended design application (pavement). Many acknowledge that current

design procedures may not be optimizing performance using volumetrics alone. Current procedures may not adequately evaluate the impact of alternative mixture components or additives and they also may lack a performance optimization for the intended use of the mixture. Recently, State Departments of Transportation (DOTs) have researched and implemented a variety of approaches, including Balanced Mixture Design (BMD), aimed at improving the long-term performance of asphalt mixtures. Defined as "using performance tests on appropriately conditioned specimens that address multiple modes of distress taking into consideration mixture aging, traffic, climate and location within the pavement structure," BMD is simply a philosophy for designing the right mixture for the right application. BMD can be implemented to use a range of approaches, from simply adding performance tests to existing mix design procedures to a purely performance design approach where most other requirements are removed.

BUSINESS OPPORTUNITIES

BMD implementation efforts are ongoing in several states and the design approach will be increasingly used by owner agencies. For agencies and, more generally pavement owners, BMD offers significant opportunities, described below.

1. Enhanced Mixture Performance: Mixture performance testing allows the agency to enhance pavement design and ensure mixture properties are appropriate for the pavements being constructed, without conservative requirements that can drive up infrastructure investment costs. Understanding the anticipated mix performance provides enhanced mix performance reliability (i.e., reduced exposure or risk of performance issues that may lead to decreased pavement service life). In simple terms, knowing the mix performance beforehand via performance testing can help limit bad surprises afterwards.

2. Sustainable and Economically Optimized Mixtures: BMD allows for the optimization of mixes in terms of cost-effective and environmentally friendly material use (e.g., asphalt binder, aggregate, recycled material, additive, etc.) to meet the performance need. Without a stronger tie between design elements and field performance, decisions on material use will likely be made based on assumptions, experience (which may not hold true), raw material cost, or specification limits or constraints.

3. Budget-Conscious Pavement Solutions: BMD focuses on the performance needed and moves away from requirements that can lead to increased material costs. Performance testing focuses material producers on the critical mixture properties and allows them to innovate in ways that can increase construction quality and efficiency, while using the most cost-effective inputs available. Ensuring mixture quality leads to meeting or exceeding expected pavement service life and will lead to improved Life Cycle Costs for pavement owners.

CHALLENGES FOR IMPLEMENTATION

1. Labs, Equipment, and Workforce: The addition of performance testing to agency operation can require significant resources to properly implement. Performance testing requires existing laboratories to assign space to sample preparation and testing equipment. The sample preparation and performance testing equipment acquisition require an allotment of funds that can be significant depending on the number of facilities, and some tests require more expensive devices. Limited equipment resources can exacerbate down time if an equipment breakdown occurs during design or production. Technical staff will likely require additional training and education to achieve BMD success. The performance testing conducted within BMD requires additional knowledge (perhaps even dedicated BMD-related personnel in addition to normal acceptance personnel) to understand the performance tests and the factors influencing the test results. Adjustments to the normal testing protocols can increase man hours, which may lead to overtime and other additional workforce expenses. Implementation will require significant planning and commitment from agency staff and upper management to achieve successful adoption.

2. Validation of Performance Tests for Specifications: The process of developing specifications takes time and significant investment in data collection to ensure that criteria are properly validated and set to ensure performance. Performance test benchmarking of existing mixtures without field performance validation can result in specifications that eliminate mixtures that perform well. Some test procedures include aging and other protocols that will require decisions to be made on how the agency will proceed and specify the performance testing. Most agencies will find it helpful to have a champion that is well versed in performance testing and the procedures accompanying the tests.

BALANCED MIXTURE DESIGN OFFERS A GREAT OPPORTUNITY TO MOVE PAVEMENT PERFORMANCE FORWARD IN TERMS OF ASPHALT MIXTURE QUALITY AND INNOVATION.

3. Production Acceptance: Many agencies have expressed a desire to incorporate BMD into production, although there are challenges in determining how to do so. Aside from the time to conduct production testing, there is some concern with the variability of the performance tests. Some tests do not have precision statements established, which presents issues when using them for acceptance and payment. With high variability the producer may have to "over design" the mix in terms of performance to obtain the minimum performance thresholds.

RECOMMENDATIONS

Balanced Mixture Design offers a great opportunity to move pavement performance forward in terms of asphalt mixture quality and innovation. Historically, specifications were established and modified to provide a very structured "recipe" to achieve desired field performance. While the intent was good, the existing systems may not be adequately optimizing mixture performance while also not allowing for the most innovative and economical solutions to be utilized. It is recommended that agencies move towards adoption of a BMD approach after careful validation and testing, while also moving away from traditional specification items that don't relate to field performance, to encourage innovation. Substantial testing and validation to ensure the performance tests and associated thresholds are appropriate are required to help ensure acceptable field performance. The BMD approach, along with minimal traditional design requirements, can best be used to design future mixtures. This approach maximizes the innovation and value potential for the agency and should be considered the ultimate goal.

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