



BALANCED MIXTURE DESIGN

INDUSTRY 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) and durability (i.e., resistance to cracking) for the intended design application (pavement). Recently, State Departments of Transportation (DOTs) 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” Balanced Mixture Design means designing the right mixture for the right job.

Balanced Mixture Design can use one of four main approaches. One approach, Volumetric Design with Performance Verification, evaluates mixture performance using traditional volumetric mixture design. Expanding on the first approach, the Volumetric Design with Performance Optimization approach also starts with a current volumetric design, but evaluates mixture performance at interval binder contents, including the optimal binder content, resulting in selection of a final binder content which satisfies the performance criteria. Another approach, Performance-Modified Volumetric Design, begins with volumetric design, then modifies the design based on performance testing results. A fourth conceptual

approach, Performance Design, utilizes performance testing to engineer the design for performance, minimizing the use of the traditional design requirements. Nationwide usage of the Performance Design approach is the ultimate goal as it maximizes the innovation and value potential for both the pavement owner and asphalt producer.

BUSINESS OPPORTUNITIES

BMD implementation efforts are ongoing in several states and the design approach will be increasingly used by owner agencies.

For asphalt producers, BMD offers significant business opportunities which are highlighted below.

- 1. Ability to Optimize Mixes:** BMD allows for the optimization of mixes in terms of cost-effective material use (e.g., asphalt binder, aggregate, recycled material, additive, etc.) and performance. Without knowing the true performance of mixes, 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.
- 2. Reduce Risk:** Understanding the anticipated mix performance provides enhanced mix performance reliability (i.e., reduced exposure or risk to penalties and performance issues that may arise during production/construction and post-construction). In simple terms, knowing the mix performance beforehand via performance testing can help limit bad surprises afterwards.

3. Opportunity to Lead: BMD will enable individual companies, and ultimately the entire industry, to lead quality and innovation initiative development. Establishing the state of performance of commonly used mixes (i.e., cataloging mixes) and optimizing those mixes for performance allows companies to move asphalt related specifications forward while ensuring obtainable field performance. Additionally, improved asphalt mixture performance yields lower life cycle costs for owners enabling road owners to go longer between maintenance and a lower cost, better performing pavement to owners.

4. Enhanced Workforce Knowledge and Expertise: BMD can assist in building personnel knowledge and expertise. Training and educating personnel to truly understand the factors that influence mixture performance is critical. A highly trained workforce is required for industry success. Advanced testing may also attract new employees that have interests in engineering and technology, leading to advancements in other areas of your organization's business.

CHALLENGES FOR IMPLEMENTATION

1. Skilled workforce: Properly trained and educated personnel is the key to BMD success. The performance testing conducted within BMD requires additional knowledge (perhaps even dedicated BMD related personnel in addition to normal quality control personnel) to understand the performance tests, factors influencing the test results, and how to modify the mix to achieve the required performance.

2. Cost and time: Performance testing can be conducted internally or via third party testing laboratories, with testing conducted internally likely being the most cost effective and providing contractors the best ability to optimize the mix. Testing at independent laboratories can be expensive costing between \$1,000 and \$2,000+ per mix. Performance testing equipment cost ranges from ~ \$5,000 to \$50,000+ based on the specific test equipment, however, the return on investment (ROI) of most performance testing equipment purchases will generally be short. Even with a short ROI, significant cost would be incurred.

3. Construction Delay: The time required for the mix design and subsequent field acceptance testing can

also present challenges. Some performance tests take minutes to complete, but specimen preparation may take longer, especially if cutting/trimming of the specimen is required. The time to conduct performance testing will likely extend the mix design time and needs to be addressed during production.

4. Production acceptance: 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 using them for acceptance and payment. With high variability the producer will likely 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 the asphalt industry forward in terms of asphalt mixtures 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, many of these specifications have become convoluted over time and parts of the specifications may conflict with the goal of providing long-term performance.

For most projects (i.e., sufficient tonnage and time allowed for testing), it is recommended that the performance design BMD approach be utilized, moving away from the traditional specification towards performance and innovation. Substantial testing to ensure the performance tests and associated thresholds are appropriate is required to help ensure acceptable field performance. The BMD approach, along with minimal traditional design requirements, can best be used to design future mixtures. As mentioned previously, this approach maximizes the innovation and value potential for the asphalt producer and owner and should be considered the ultimate goal.



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