TECH BRIEF

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Refinements to Superpave Volumetric Mix Design: Incremental Gains and Remaining Gaps in Mixture Performance

The Superpave volumetric mix design system, introduced in the early 1990s, has significantly improved the rutting resistance of asphalt pavements. However, the system has not sufficiently addressed the growing need for improved cracking resistance and long-term durability, particularly for mixtures with high proportions of reclaimed materials.

In response, state departments of transportation (DOTs) have implemented several approaches to improve traditional volumetric mix design procedures. These approaches include: (1) regressed air voids to increase optimum asphalt contents, (2) increased minimum voids in mineral aggregate (VMA) requirements and/or lowered design air voids to yield higher optimum asphalt contents, (3) corrected optimum asphalt content (COAC) to account for reduced binder availability in recycled mixtures, and (4) the Superpave 5 approach to increase in-place density. This tech brief summarizes those approaches and highlights other complementary strategies, including adjustments to design gyrations, minimum asphalt content thresholds, and effective binder volume requirements. While these refinements have demonstrated measurable benefits, they reinforce the need for performance-related approaches such as Balanced Mix Design (BMD).

Introduction

The Superpave volumetric mix design system was developed under the Strategic Highway Research Program (SHRP) in the early 1990s to improve the durability and performance of asphalt pavements by incorporating requirements for aggregate structure, binder, and mixture under varying traffic loading and environmental conditions into a unified framework.[1] The system included volumetric parameters for air voids (Va), voids in the mineral aggregate (VMA), and voids filled with asphalt (VFA) to guide the selection of optimal aggregate gradation and binder content. Although originally envisioned with three design levels (Levels I, II, and III), performance testing for Levels II and III was deemed impractical for routine use, and thus, the industry adopted Level I, the volumetric mix design method, as the standard practice.[2]

The Superpave volumetric method introduced advancements in asphalt mix design, primarily aimed at preventing rutting under high-temperature and high-traffic conditions. Over time, however, it became evident that the method did not adequately address long-term cracking performance. One key limitation was its reliance on achieving a target Va level, typically set at 4.0 percent, and compliance with VMA and VFA thresholds, without directly evaluating mixture durability.[3] As a result, highway agencies are concerned that Superpave mixtures, particularly those with high reclaimed asphalt pavement (RAP) or reclaimed asphalt shingles (RAS) contents, may contain insufficient virgin binder, which may lead to early cracking and reduced service life.[4] In some states, cracking has become the primary distress affecting asphalt pavement durability.[5]

In response, state departments of transportation (DOTs) have explored various approaches to improve the traditional volumetric mix design process, aiming to enhance cracking resistance. The most effective changes are those that increase virgin binder content or improve in-place density during construction. Approaches such as using regressed air voids, increasing minimum VMA requirements (or lowering design air voids), and correcting the optimum asphalt content for high RAP/RAS mixtures all aim to increase the virgin binder content. Other approaches, such as the Superpave5 mix design procedure with reduced design gyration levels, target higher in-place density.[4,6] These approaches increase effective asphalt content and reduce permeability, which slows the rate of oxidative aging and leads to more durable, crack-resistant asphalt pavements.

The following sections describe these approaches, their working principles, impacts on volumetric and performance properties, and the current state of implementation.

Regressed Air Void Approach

Background

The regressed air void approach was introduced as a practical method to increase the virgin binder content in asphalt mixtures without fundamentally changing the traditional Superpave volumetric mix design process.[7] Historically, the Superpave system has specified a design air void level of 4.0 percent to ensure stability, durability, constructability, and sufficient void space to allow for traffic densification without creating other issues such as bleeding. However, both field experience and laboratory testing have demonstrated that asphalt mixtures designed with 4.0 percent air voids—especially those containing high proportions of reclaimed materials—often lead to binder-deficient and brittle mixtures that are prone to cracking at an early age.[4]

For the regressed air void method, the initial design must meet all the design requirements at 4.0 percent air voids. The target air voids used for production are then reduced (or regressed) to 3.5 percent, or even as low as 3.0 percent, to determine the optimum asphalt content for the job mix formula (*Figure 1*).[3,7]

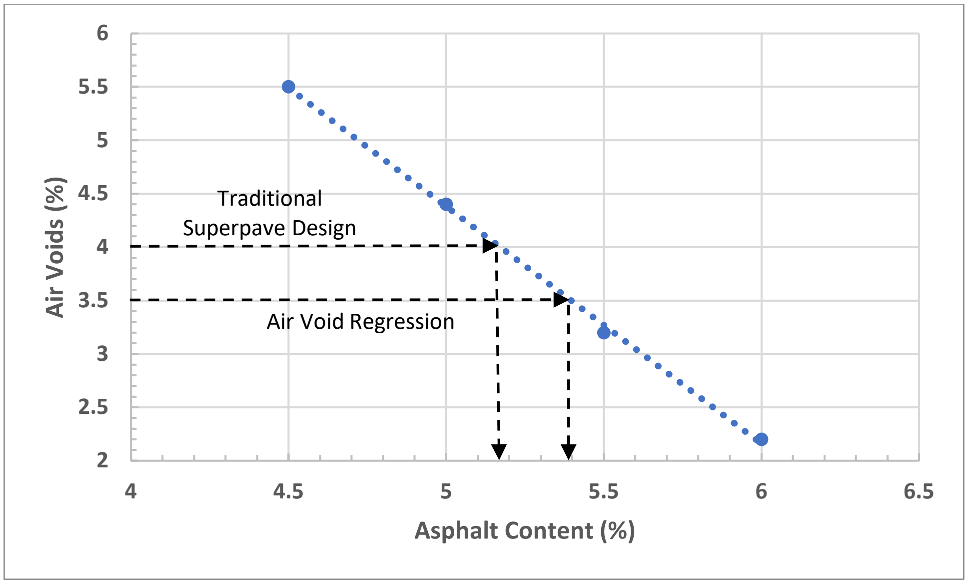

Figure 1. Regressed Air Void Approach to Increase Optimum Asphalt Content

Working Principles

The regressed air void approach is based on the principle that reducing the target air voids in production leads to a corresponding increase in the total binder content, provided that the materials, design gradation, and VMA remain unchanged. Empirical data suggest that a 1.0 percent reduction in air voids results in approximately a 0.3 to 0.4 percent increase in binder content.[4]

The typical workflow under this method includes:

- Designing the mixture using standard Superpave protocols at 4.0 percent Va.
- Verifying compliance with all volumetric criteria, such as VMA, VFA, and gradation.
- Increasing virgin binder content in production to target a lower Va (e.g., 3.5 percent or 3.0 percent), without requiring redesign or re-approval of volumetrics at that lower Va.

Importantly, the increase in virgin binder content is introduced only in the field production phase, which requires minimal changes in mix design specification while still improving durability. The higher virgin binder content increases the effective binder volume (Vbe), a factor known to improve cracking resistance.[4,7] If agencies are using volumetric properties, such as Va and Vbe, for acceptance, they need to adjust the target values of these properties. This adjustment is necessary to account for the impact of increased binder content on the volumetric properties being evaluated.

Implementation

Several DOTs have explored or adopted the air void regression method to enhance durability. A prior survey indicated that four agencies, Colorado, Michigan, Wisconsin, and Kansas, have implemented this method.[4] These agencies specify that the optimum asphalt content for the job mix formula be based on regressed air voids of 3.0 percent.

A study sponsored by the Wisconsin DOT (WisDOT) evaluated mixtures that were regressed to 3.5 percent and 3.0 percent air voids. At regressed air voids of 3.0 percent, the resulting asphalt content increased by approximately 0.3 to 0.4 percent. Performance tests using the Illinois Flexibility Index Test (I-FIT) (AASHTO T 393-22) and Disc-Shaped Compact Tension (DCT) (ASTM D7313-20) indicated improvements in cracking resistance. Specifically, the flexibility index increased by 73 percent on average when air voids were regressed by 1.0 percent, and DCT fracture energy increased by approximately 12 percent.(7)

The Ontario Ministry of Transportation (MTO) implemented the regressed air voids method on five paving projects across Ontario. The mix design and field production data collected by MTO showed that the regressed air voids of 3.5 percent resulted in binder content between 0.2 and 0.3 percent higher than the original optimum asphalt content in the mix design. A key observation made during paving was that it was easier to achieve in-place density due to the better workability of the mix with the additional asphalt. In all five paving projects, the air voids of plant-mixed laboratory-compacted specimens met the specifications with the higher asphalt content levels, with no rejectable sublots due to low air voids.(8)

In both studies, agencies used laboratory performance tests, including the Indirect Tensile Asphalt Cracking Test (IDEAL-CT) (ASTM D8225-19), I-FIT, and DCT, to confirm that the increased binder content improved cracking resistance. The Hamburg Wheel Tracking Test (HWTT) (AASHTO T 324-17) was performed and showed that the increased binder content did not compromise rutting resistance. Field trials showed consistent enhancements in observed durability, supporting the effectiveness of this method.(7,8)

Increased Minimum VMA Approach

Background

VMA is a critical parameter in asphalt mix design, representing the intergranular void space within the compacted aggregate structure (*Figure 2*) that must be filled with an adequate amount of binder to ensure durability. In the Superpave mix design method, minimum VMA thresholds were established in AASHTO M 323-22 to ensure sufficient binder content in mixtures. The VMA calculations are based on the bulk specific gravity of the aggregate, Gsb. However, experience has shown that mixtures, especially those with high RAP or RAS contents, designed at or near the minimum VMA values often lack adequate binder, resulting in reduced durability and increased susceptibility to cracking.(3) To overcome this durability concern, several DOTs have increased their minimum VMA requirements. This approach aims to ensure that more binder is utilized in the mix, thereby improving cracking resistance and extending pavement life while maintaining adequate rutting resistance.(3)

Working Principles

VMA has a direct relationship with binder content. A higher VMA requires more binder for a given air void content to fill the increased volume of aggregate voids, as illustrated in *Figure 2*. The effective binder volume (Vbe) is calculated as the difference between VMA and Va (i.e., Vbe = VMA – Va). Thus, increasing the VMA while keeping air voids constant will result in a corresponding increase in

Vbe. Similarly, if air voids decrease while maintaining a constant VMA, Vbe will also increase by the same amount as the decrease in Va. Therefore, both approaches lead to a higher design binder content. However, it is important to note that increasing VMA necessitates a change in gradation, while reducing Va does not. Empirical evidence indicates that increasing VMA by 1.0 percent typically results in an increase of approximately 0.3 to 0.4 percent in total binder content.(9) Raising the minimum VMA requirement can be combined with lowering the design air voids, resulting in a greater increase in virgin binder content.

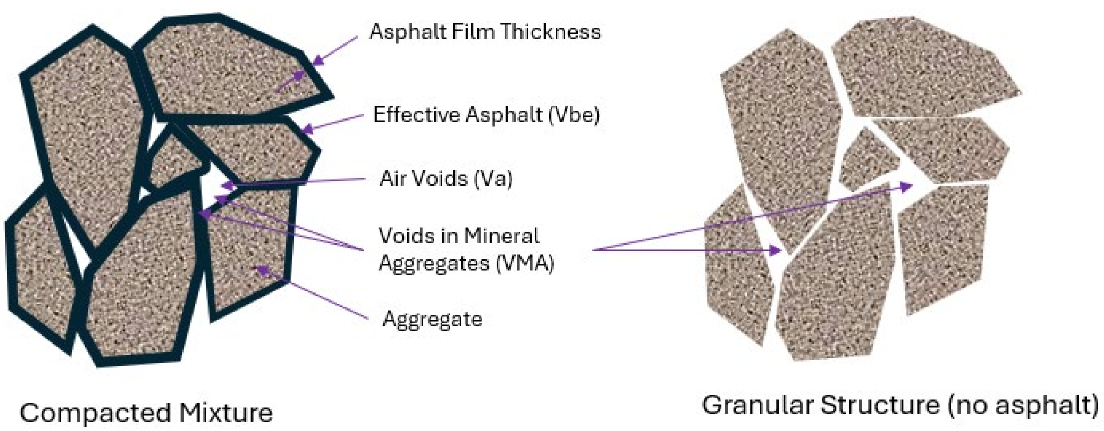

Figure 2. Schematic of HMA Volumetric Properties (Air Voids, Effective Binder, and VMA)

Implementation

A previous survey of DOTs identified 18 state DOTs that increased the minimum VMA requirements by 0.5 to 1.0 percent above the recommended values in AASHTO M 323-22 to achieve higher binder contents.(3) This adjustment typically adds 0.2 to 0.4 percent more binder to the mix design. For instance, the Illinois DOT (IDOT) implemented higher VMA thresholds in several pilot projects and reported consistent increases in binder content and improved field performance. These changes led to more durable mixtures meeting both the IDEAL-CT and HWTT performance specifications.(10)

Since VMA is highly sensitive to G_{sb}, accurate measurement of G_{sb} is essential for maximizing the benefits of increasing VMA requirements. A previous study showed that a multi-laboratory d2S difference for G_{sb} measurement can change the calculated asphalt content by more than 1.0 percent.(4)

Achieving higher VMA in practice often requires careful adjustments to the aggregate gradation to create more intergranular voids without compromising the integrity of the aggregate skeleton. In general, mix designers can increase VMA by adjusting the gradation away from the "maximum density line" that represents the tightest packing. This typically involves adjusting the proportions of coarse, fine, and filler aggregates to balance void space and packing efficiency. (11)

For better control of volumetric properties, specifically VMA, mix designers can follow the Bailey method. The Bailey method offers a structured framework for controlling aggregate packing and interlock. It divides the aggregate into coarse and fine fractions and further splits the fine fraction into a coarse portion (FA_c) and a fine portion (FA_f). The procedure uses ratios for coarse aggregate (CA) to define the primary skeletal structure and ratios for fine fractions to analyze the packing efficiency of the smaller particles. Together, these relationships allow designers to manage the "space between" aggregates and target specific VMA levels.[12]

Another approach for increasing VMA is to use a gap-graded gradation, as in the Stone Matrix Asphalt (SMA) mix design procedure (AASHTO R 46-22). This design eliminates some sand-sized particles to achieve stone-on-stone contact among coarse aggregates, creating space for a rich asphalt mortar, which includes a high-quality binder, filler, and fiber. Stone-on-stone contact is verified by comparing the voids in coarse aggregate (VCA) of a loose, dry-rodded aggregate sample and a compacted asphalt mixture sample.[13]

Other aggregate characteristics, such as dust content, particle shape, and surface texture, may also affect mixture volumetric properties.[11,14]

- Dust content: Reducing the dust content (material passing through a 0.075 mm sieve) is an effective way to increase VMA. When dust comes from mineral fillers, its proportion can be easily adjusted. If the dust originates from a screened aggregate stockpile, minimizing the use of that stockpile in the mix design can help. During production, adding baghouse fines back into the mixture can lead to a decrease in VMA. To prevent unexpected reductions in VMA during production, it is important to consider the addition of baghouse fines during the mix design phase.
- Shape Effect: The shape of aggregate particles greatly affects the packing density of the mix. Flat and elongated particles tend to align and pack closely together, resulting in lower VMA. Limiting the amount of such particles can help achieve a higher VMA.
- Surface Texture: Aggregates with rougher textures create more internal friction and resist compaction, leading to a higher VMA at a given compaction effort. Increasing the proportion of manufactured sand, which usually has a rougher texture than natural sand, can improve the surface texture and, as a result, increase VMA. However, it is essential to balance this with the potential increase in dust content, as an excess of fine particles can diminish the benefits gained from improved surface texture.

By managing the characteristics of aggregates, mix designers can control and achieve the desired VMA, resulting in asphalt mixtures that are more durable and resistant to cracking.

Corrected Optimum Asphalt Content (COAC) Approach

Background

The incorporation of RAP and RAS in asphalt mixtures has become increasingly common due to their economic and environmental advantages. When appropriately designed and controlled, mixtures with high RAP and RAS contents can achieve satisfactory performance. However, one challenge in mix design is accurately accounting for the contribution of aged binder in recycled materials. Assuming that 100 percent of the RAP/RAS binder is available and behaves similarly to virgin binder is misleading and can, in some cases, lead to mixtures with lower effective binder content, increased stiffness, and reduced cracking resistance. To address this issue without discouraging the use of recycled materials, the corrected optimum asphalt content (COAC) approach adjusts the assumed contribution of recycled binder based on estimated availability. This correction increases the required virgin binder content, thereby improving effective binder content and enhancing mixture durability and cracking resistance, while maintaining acceptable rutting performance.[4]

Working Principle

The COAC approach acknowledges that not all the binder in RAP and RAS becomes fully activated during mixing and compaction. To address this, the method uses the recycled binder availability (RBA) factor, which indicates the percentage of recycled binder that is expected to contribute to the performance of the mixture.[6,15] For example, an RBA of 60 percent means that only 60 percent of the recycled binder is assumed to be available for blending, while the remaining 40 percent must be compensated for by adding additional virgin binder, as illustrated in *Figure 3*.

The required increase in virgin binder content depends on both the RAP/RAS content and the absorption characteristics of the aggregate. Generally, for RAP contents between 20 percent and 50 percent, each 10 percent reduction in assumed RBA typically necessitates an increase of approximately 0.1 percent to 0.3 percent in virgin binder content.[16]

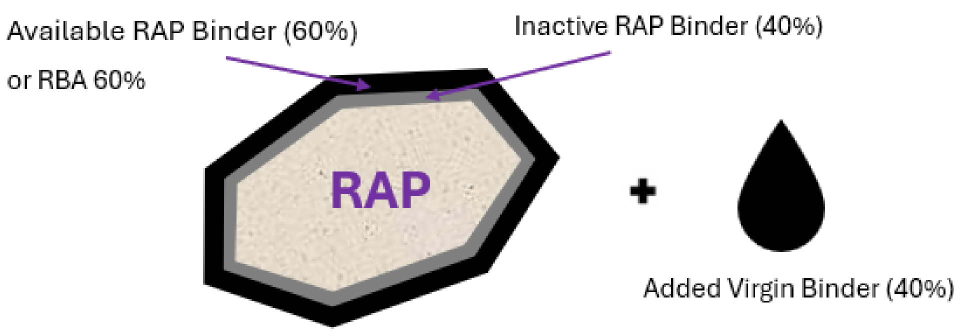

Figure 3. Illustration of the COAC Approach for 60% RBA

Implementation

The Georgia Department of Transportation (GDOT) implemented a COAC approach by initially adopting a 75 percent RBA in 2012. Based on further field experience and observed performance, the RBA was reduced to 60 percent in 2019. This means that only 60 percent of the RAP binder is credited in the mix design. As a result, the virgin binder content increased by approximately 0.6 percent for a 20 percent RAP mix design. Laboratory tests, including IDEAL-CT and HWTT, showed improved resistance to cracking without compromising rutting performance.[16]

The Florida Department of Transportation (FDOT) conducted a study to evaluate the COAC approach using an assumption of 80 percent RBA. The study showed that modifying the binder content based on this RBA resulted in an increase of approximately 0.2 percent in virgin binder for mixtures containing 20 percent RAP and about 0.4 percent for mixtures with 40 percent RAP. Performance testing showed significant improvements in cracking resistance, particularly for mixtures with high RAP content. Initial testing of mixtures containing 30 percent RAP with a PG 52-28 binder indicated an increased susceptibility to rutting. However, when switching to a stiffer PG 58-28 binder, the concerns regarding rutting susceptibility were effectively addressed, without compromising the cracking resistance. [6]

The North Carolina Department of Transportation (NCDOT) evaluated the COAC method alongside the availability adjusted mix design (AAMD) approach, which considers partial RBA in the interpretation of mixture volumetric properties and RAP agglomerations on the combined aggregate structure. The study suggested that while COAC improved cracking resistance, it could lead to increased rutting susceptibility if aggregate structures were not adjusted accordingly. The AAMD method, which considers both binder availability and aggregate structure, was found to enhance cracking resistance without adversely affecting rutting performance.[17]

The COAC approach shows promise for increasing virgin binder content and improving performance in high recycled content mixtures. However, the RBA should be selected based on the ability of the aggregate structure to resist rutting at an elevated binder content and a thorough analysis of RAP/RAS binder contribution, which differs based on material sources, processing methods, aging conditions, and agency-specific mix design practices, as many agencies have modified the Superpave mix design procedure (AASHTO M 323-22). Incorrect estimations—whether too high (e.g., 100 percent RBA) or too low—can compromise performance and reduce efficiency.

Superpave5 Approach

Background

The Superpave5 mix design approach represents a strategic shift from the traditional Superpave system, aiming to enhance pavement durability by significantly reducing gyration levels and increasing in-place density. Conventional Superpave designs target 4.0 percent air voids in the laboratory, and compaction to the 93.0 percent density range (7.0 percent air voids) during construction. Historically, it was assumed that future traffic would continue to densify the pavement towards the design air void level of 4.0 percent. However, field studies indicated that many pavements do not achieve this target even after years in service, often resulting in higher air voids and associated durability issues. Superpave5 addresses this by aligning the laboratory mix design and in-place field air voids at 5.0 percent, corresponding to a 95.0 percent density, thereby reducing permeability and oxidative aging, which are primary contributors to cracking, as presented in *Figure 4*.[18,19]

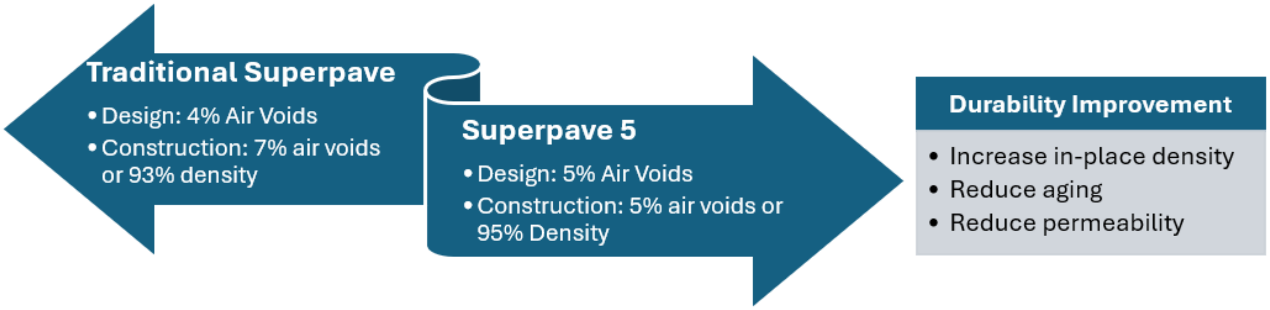

Figure 4. Superpave 5 Method to Improve In-place Density

Working Principles

The Superpave5 methodology involves several key modifications to the traditional Superpave mix design:[18]

- Increased Design Air Voids: The design air void content is raised from 4.0 percent to 5.0 percent, aligning laboratory and field targets.
- Adjusted VMA: To maintain adequate binder content at the higher air voids, VMA is increased by 1.0 percent from the current values specified in AASHTO M 323-22.
- Reduced Gyration Levels: The N_{des} is decreased to prevent over-compaction in the lab, which could cause aggregate breakdown and result in an overly stiff mixture. For instance, the Indiana Department of Transportation (INDOT) reduced N_{des} from 100 to 50 gyrations for traffic levels exceeding 3 million equivalent single axle loads (ESALs).

By targeting a 95.0 percent density in-place, Superpave5 aims to produce pavements with greater cracking resistance. Moreover, higher density enhances load distribution, potentially improving rutting resistance.[18]

Implementation

INDOT began implementing Superpave5 in 2013. Superpave5 projects demonstrated that achieving 95 percent in-place density is feasible without altering standard construction practices. Field data indicated that Superpave5 sections had an average in-place density of 94.4 percent, compared to 93.2 percent for conventional Superpave sections.[20] Performance evaluations showed that Superpave5 sections exhibited similar or improved rutting resistance and reduced permeability compared to adjacent conventional sections.[21]

Following INDOT, the Minnesota Department of Transportation (MnDOT) evaluated the Superpave5 mix design procedure to enhance pavement service life.[22] This involved modifying four Superpave mixtures by adjusting gradation, mainly increasing coarse aggregates, while keeping binder content constant, leading to a gradation curve closer to the maximum density line. N_{des} values for compaction were reduced for traffic levels 3 (1-3 million ESAL), 4 (3-10 million ESAL), and 5 (>10 million ESAL) from 60, 90, and 100 gyrations to 30, 50, and 50 gyrations, respectively. The field density of Superpave5 mixtures reached 94.22 percent, nearly meeting the target of 95.0 percent and surpassing the 93.46 percent achieved by traditional mixtures. Performance tests showed no significant differences in rutting, cracking, or stiffness, confirming the effectiveness of the Superpave5 mix design in improving durability through higher density during construction.

Based on INDOT and MnDOT experiences, the procedures for designing the Superpave5 mixture are illustrated in *Figure 5*.[22] The procedure includes, first, testing aggregate properties and then selecting trial blends. Each blend is compacted at a lower N_{des} (e.g., 50) to design with air voids equal to or slightly lower than 5.0 percent. In case the air void is much lower than 5.0 percent, the binder content can be adjusted to meet the air void criterion. Once the candidate trials are selected, performance testing is needed to validate the design. If either the air voids or performance testing fails to meet the criteria, more trial blends with necessary adjustments are needed.

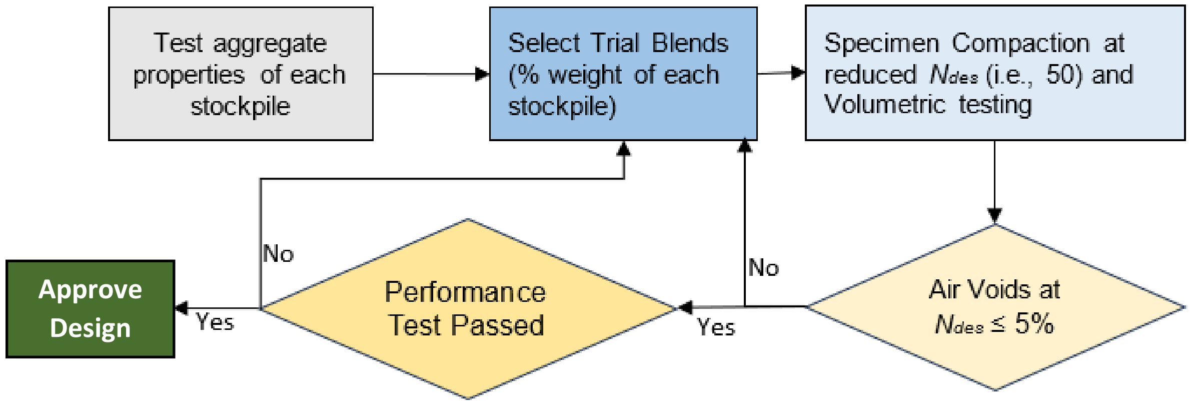

Figure 5. The Superpave5 Design Protocol

For the MnDOT research study, performance tests such as flow number using AASHTO T 378-22, semi-circular bend (SCB) using AASHTO TP 105-20, and dynamic modulus (E*) using AASHTO T 378-22 were conducted. Further research was also performed using IDEAL-CT, HWTT, and disk-shaped compact tension (DCT) tests based on ASTM D7313-20. MnDOT results showed the aggregate gradation of Superpave5 mixes was closer to the maximum density line and had CA ratios closer to the recommended values of the Bailey method than the conventional Superpave mixtures. Flow number, SCB, and E* indicated higher rutting resistance and higher low-temperature cracking resistance than conventional mixtures. The HWTT tests also confirmed better rutting resistance of the Superpave5 mixes.(22)

Other Approaches

In addition to the strategies described above, other approaches have been employed by DOTs to enhance asphalt mixture durability and cracking resistance. These include lowering the N_{des}, specifying minimum total or effective binder content, and requiring minimum asphalt film thickness.(3) While these methods have shown varying degrees of success, their effectiveness often depends on careful consideration of other mixture components and acceptance testing practices.

Lower Design Gyrations (N_{des})

Lowering the design compaction effort is a common adjustment made by DOTs that can result in increased binder content in the mixture and higher in-place density. However, reducing design gyrations alone may not result in higher virgin binder content unless the minimum VMA requirement is also increased. Otherwise, mix designers can adjust the gradation to offset the higher binder content resulting from the reduced compaction effort.

The Alabama Department of Transportation (ALDOT) and GDOT determined that the number of design gyrations should reflect the compactibility of the asphalt mixture, which is indicated by the point at which the aggregate particles begin to interlock. For their materials, ALDOT has set N_{des} at 60, while GDOT has set it at 65 for all Superpave mixtures. To accommodate projects with increased traffic loading, a higher performance grade (PG) binder is used.

MnDOT followed a different methodology by correlating laboratory gyrations to field density through the equivalent gyration level (N_{equ}). Field data from several projects showed an average in-place density of 94.29 percent, which corresponded to approximately 29 gyrations in the compaction curve illustrated in Figure 6. Based on this information, MnDOT set N_{des} at 30 gyrations for Superpave5 mixtures.[22]

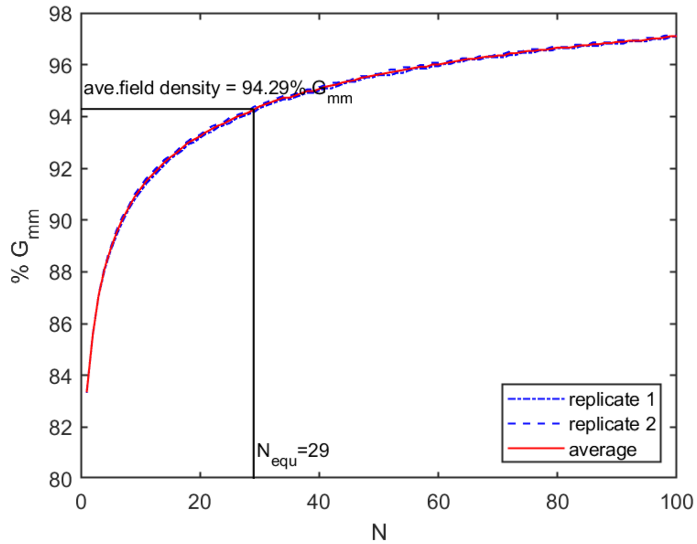

Figure 6. Correlation of MnDOT Mix Compaction Curve to Field Density.[22]

Setting Minimum Total or Effective Binder Content

Another strategy is to set minimum thresholds for total or effective binder content. This approach aims to ensure there is enough binder to enhance the durability of the mixture. However, the effectiveness of this method is significantly influenced by the aggregate type, specific gravity, absorption rates, gradation, and nominal maximum aggregate size; as well as whether RAP and RAS are included in the mixture. In regions where the aggregate sources have consistent absorption characteristics, establishing a minimum binder content can be effective. On the other hand, in areas with varying aggregate absorption, this method may result in inconsistent outcomes.

Asphalt Film Thickness Requirements

Implementing requirements for asphalt film thickness is an adjustment designed to enhance the durability of the mixture. This concept involves calculating the average thickness of the binder coating on aggregate particles. The calculation is performed by dividing the effective binder volume by the total surface area of the aggregate. Increasing the effective binder volume directly enhances film thickness, which can potentially improve durability. However, accurately determining and verifying the aggregate surface area can be challenging due to variations in particle shape and surface texture, even within the same range of sieve sizes, which can lead to potential inaccuracies in the asphalt film thickness calculation. Additionally, the assumption that the binder coating is uniform across all aggregate particles is an oversimplification, as the actual film thickness can vary significantly within the mix, and where aggregate particles touch, the asphalt film is shared.

Summary of Volumetric Adjustment Approaches to Enhance Mixture Durability and Cracking Resistance

The original Superpave volumetric mix design system has been effective in reducing rutting, but it does not directly address mixture durability or resistance to cracking. This is particularly true for mixtures that incorporate high contents of recycled materials or are exposed to harsh environmental conditions. In response, highway agencies across the U.S. and Canada have adopted several volumetric adjustment approaches to increase virgin binder content, improve in-place density, and enhance the overall durability of asphalt mixtures. This section summarizes four principal approaches and other adjustments adopted by agencies.

Regressed Air Void Approach: This strategy retains the traditional air void target of 4.0 percent during the mix design approval process. The job mix formula also specifies a higher binder content corresponding to lower air voids (e.g., 3.5 or 3.0 percent). This increased binder content is then used to produce the asphalt mixture at the plant. For every 1.0 percent reduction in target air voids, binder content increases by approximately 0.3 to 0.4 percent, which improves cracking resistance. Importantly, no changes are required in the original volumetric mix design approval, making this approach both practical and easily implementable. Field applications in Wisconsin and Ontario have demonstrated improved compaction, better cracking resistance, and no increase in rutting susceptibility.

Because this approach consistently increases asphalt content by about 0.4 percent for every 1.0 percent reduction in target air voids, a practical alternative is to perform the mix design using standard Superpave criteria and then set the production asphalt content 0.4 percent above the Superpave optimum for each 1.0 percent decrease in target air voids. Rutting performance should be verified at the higher asphalt content, and the laboratory-molded density can be targeted at the lower air void level (e.g., 3.0 percent).

Increased Minimum VMA Approach: Increasing the minimum VMA requirement by 0.5 to 1.0 percent or lowering the design air voids from 4.0 percent to 3.5 or 3.0 percent can result in increased effective binder content. These changes can increase the binder content by 0.2 to 0.4 percent, thereby enhancing mixture durability. However, because VMA is highly sensitive to the G_{sb}, precise testing and QA practices are essential, especially when RAP and RAS are included in the mix. Agencies and contractors can optimize aggregate gradation, particle shape, texture, and dust content to facilitate a higher VMA without compromising mixture stability.

Corrected Optimum Asphalt Content (COAC) Approach: The COAC approach is designed to improve the performance of RAP and RAS mixtures by applying a recycled binder availability factor. Rather than assuming 100% recycled binder availability, only a portion (e.g., 60 percent) is credited, and the remaining balance is supplemented with virgin binder. GDOT adopted a COAC approach that credits only 60 percent RBA. This leads to an increase of approximately 0.6 percent in virgin binder content for a mix design that incorporates 20 percent RAP. This change results in higher CT_{index} values while having minimal impact on rutting. Florida and North Carolina DOTs have also reported improved cracking resistance using this method, especially when paired with aggregate structure adjustments.

Superpave5 Approach: Superpave5 targets a higher in-place density (95 percent) by aligning the design and field compaction air void target at 5.0 percent. This approach increases durability by reducing permeability and slowing oxidative aging. To achieve this, the method involves increasing VMA, lowering the design gyration levels (typically to 30–50), and adjusting aggregate gradation to approach the maximum density line. Field studies in Indiana and Minnesota show in-place density increases of up to 1.2 percent compared to traditional mixes, with no significant increase in rutting or reduction in stiffness. Thus, Superpave5 offers a long-term strategy for extending pavement life.

Other Approaches: Several complementary practices have also been adopted by agencies:

- **Lowering N_{des}** can increase VMA and binder content, but its impact is contingent on the aggregate gradation remaining constant. When used in conjunction with increased VMA requirements, it has proven effective in increasing virgin binder contents and can result in achieving higher in-place density.
- **Specifying minimum total or effective binder content** helps prevent under-asphalting and is most effective where aggregate specific gravity and aggregate absorption characteristics are uniform. In variable conditions, specifying minimum effective binder content provides more consistency.
- **Asphalt film thickness requirements** aim to improve binder coating around aggregates by ensuring a minimum average asphalt film thickness. However, the aggregate surface area used in the calculation is difficult to accurately determine, and the actual coating may vary even on the same aggregate particle.

Collectively, these approaches represent incremental improvements from a rutting-focused design toward more balanced approaches that prioritize long-term durability. When implemented with robust quality assurance—particularly accurate G_{sb} measurement and aggregate characterization—these strategies can enhance cracking resistance and extend pavement life. However, their benefits are incremental and may diminish in mixtures with higher RAP contents or more severely aged binders. As such, volumetric refinements should be viewed as incremental improvements to the Superpave system, not substitutes for the broader adoption of performance-related procedures such as BMD, which remains essential for achieving reliable performance across today's diverse range of asphalt mixtures.

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