Asphalt Mix Curing at the De

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Proper curing of HMA prior to testing will result in more accurate volumetric properties. Mixes that use absorptive aggregates must be cured differently.

In this day of high production plants and statistically based acceptance programs, more emphasis is being placed on accurate test results of plant-produced hot mix asphalt (HMA). In particular, there has been a significant shift in agency specifications to the use of volumetric properties of HMA, like air voids and voids in mineral aggregate (VMA), for at least a portion of the acceptance criteria.

Because of this situation, these volumetric properties have assumed increased importance in contractors' process control testing during production. Mixture designs of laboratory blends are also routinely approved subject to plant verification of these same volumetric properties. Why is there such a focus on volumetric properties of plant-produced HMA?

Performance Indicator

The main reason is the gradual understanding that volumetric properties are the best indicators of performance that are currently available. Almost everyone now agrees that making sure that the component materials are being blended correctly to obtain an optimum level of volumetric properties during production is a vital step in the attainment of a quality HMA.

For a given project, asphalt, aggregate and mixture criteria will be established based on the level of traffic expected to travel the roadway within the specified design period. Complying with the volumetric criteria from a blend of materials that are right for the specific roadway conditions is the best assurance that the asphalt mixture can be used to produce a long lasting and well performing HMA pavement.

What is VMA?

Since so much emphasis is being placed on VMA, it is important to have an understanding of what it is. VMA is a unit volume measurement consisting of the sum of the component volume of the *effective* asphalt binder and the volume of air voids. The effective binder is defined as the binder added to the mix but not absorbed by the mineral aggregate.

Why is it important to make a distinction between the absorbed and unabsorbed binder? The simple answer is that the absorbed binder makes no contribution to the durability of the mix. Therefore, it is important to check the properties and the durability of the mixture after this absorption has taken place.

The other component volume of the VMA, air voids, is calculated by comparing bulk and maximum specific gravities of the mixture. Again, asphalt absorption can have a significant effect on the accurate determination of these specific gravities. Specific gravity is obtained by comparing the density of the compacted specimen of asphalt mixture to the density of water.

To obtain the density of the mixture, first, divide the weight of the specimen, by its volume, then divide this value by the unit weight of water to obtain the specific gravity of the mixture. Since asphalt that has been absorbed into the aggregate is not part of the volume of the mixture, a true volume for the maximum specific gravity of the mixture cannot be obtained until all the absorption has taken place.

Figure 1 illustrates that maximum specific gravity, G_{mm}, will increase significantly as a result of more asphalt absorption during oven curing. This is especially true when a highly absorptive aggregate is being used such as the limestone in the Figure that has a 2.7% water absorption. As long as additional asphalt absorption is taking place, the calculated air voids will continue to increase. As the air voids increase, the effective binder content decreases.

Laboratory Curing

One of the critical steps of determining accurate volumetric properties during the mix design is oven curing of the mix for an appropriate period of time before laboratory compaction. The widely accepted laboratory curing time of the mix is normally two hours. In fact, the AASHTO Subcommittee for Materials recently changed to a standard two hours cure time from the four-hour cure time originally established in Superpave criteria.

The proposed specification requires a two-hour curing time *when non-absorptive aggregate is used* in the mix. The specification does not provide a definition of non-absorptive aggregate nor does it spell out what cure time should be used when a highly absorptive aggregate is used. Since a significant amount of HMA is produced using aggregates that have relatively high absorptions, these questions must be addressed. Suggestions on these issues are included in this article.

Accommodating Absorption

It must be remembered that the basic purpose of the curing process is to allow for an amount of asphalt absorption during mix design that is equivalent to the asphalt absorption that will occur during typical production practices. The best way to evaluate the absorptive characteristics of an aggregate is to look at the water absorption.

Water absorption is determined as part of the aggregate specific gravity testing. Typical water absorption values for a given coarse aggregate are also usually available from quality testing records that the aggregate source or the State DOT maintains.

These water absorption values can be used to make a distinction between a non-absorptive and an absorptive aggregate. When a coarse aggregate has a water absorption of less than 2.5%, it should be considered a non-absorptive (or low absorption) aggregate.

A good rule of thumb is that a two-hour curing time is adequate where low absorption coarse aggregate is being used. When water absorption

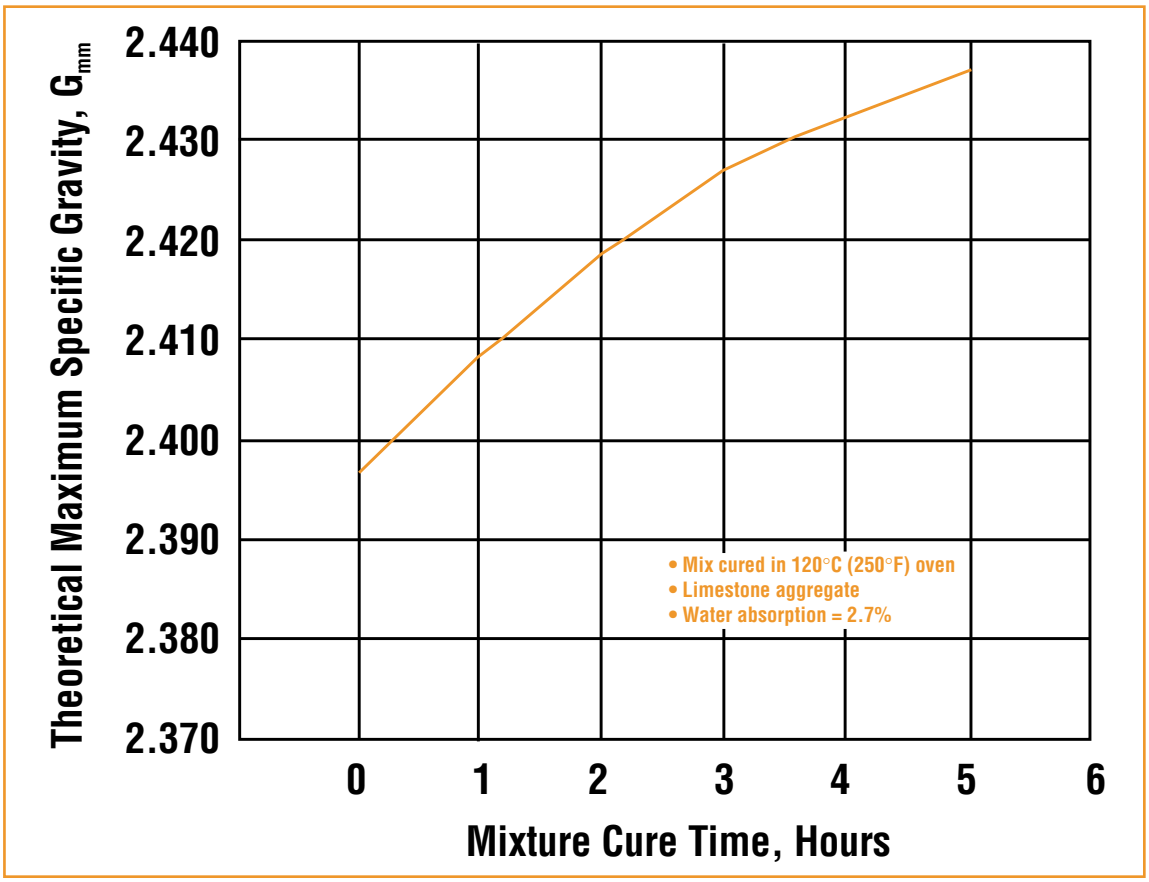

Figure 1. Curing Time Influence on Maximum Specific Gravity

Asphalt Mix Curing at the Design Lab and at the Field Lab

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exceeds 2.5% in the coarse aggregate, the curing time should be increased to approximately four hours.

Failure to increase the curing time when using these highly absorptive aggregates, will result in incomplete absorption of the asphalt into the aggregate and, ultimately, erroneous mix specific gravities and volumetric properties.

As a general rule, the higher the *water* absorption, the more *asphalt* absorption that will take place. However, there is no precise relationship between the amount of water and asphalt absorption on aggregates. The amount of asphalt absorption can vary greatly in a general range of 50 – 80 % of water absorption. Many factors can affect the percentage of asphalt to water absorption including the grade (viscosity) of asphalt cement used, aggregate type and pore size and a number of construction variables.

Field Curing

Two of the construction variables that can have the most dramatic impact on the amount of asphalt absorption are initial mixing temperature and the length of time that the mixture is held at an elevated temperature after mixing. The length of time that the mix is kept at an elevated temperature (at or near mixing temperature) would start immediately after the mix is produced and would include any storage time of the mix and also the time that the mix is being transported to the project laydown site.

When highly absorptive aggregates are being used in situations where storage time is limited to less than two hours and haul distances are short, asphalt absorption may not be completed prior to paving and the sampling / testing process.

In these circumstances, problems can be encountered in both mixture construction and QC testing. The mixture may react as being over-asphalted during placement and compaction, and have low VMA and air voids and high VFA (voids filled with asphalt) when tested. This is because the aggregate has not been given sufficient time to complete its absorption of the asphalt.

The best way to avoid these problems is make sure that the produced mix is adequately cured prior to testing and to ensure that the production, storage and haul process allows for enough time for asphalt absorption to be completed prior to laydown.

To ensure that asphalt absorption has been completed prior to testing plant-produced mixture in which high absorption aggregates are used, it is good practice to oven cure the mixture prior to testing for volumetric properties. When a four-hour oven cure is used during the design process, a two-hour oven cure should be performed on the plant–produced mixture. This will result in more accurate air void and VMA determinations to be made.

The first steps in the volumetric analysis of plant produced HMA is accomplished by obtaining a representative sample. Proper curing of the mix is the essential second step that should be accomplished prior to testing to determine the asphalt content of the mix, performing the maximum specific gravity (AASHTO T-209) test on the loose mix and determining bulk specific gravities of the compacted mix.▲

SUMMARY

1. It is essential to evaluate the volumetric properties (including VMA) of plant produced HMA to ensure a quality product.

2. It is important to allow for the total amount of asphalt absorption that will occur during production when absorptive aggregates are used. During mix design, when coarse aggregates with high water absorption (> 2.5%) are used, curing time should be increased from the standard two hours to four hours to approximate asphalt absorption that may occur during production.

3. When a four-hour cure time is used during the mix design phase (due to the use of high absorption coarse aggregate), plant-produced HMA should be oven cured for two hours prior to volumetric testing.

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