TROUBLE-FREE MIX DESIGN

with performance-based testing

THE MIX OF THE FUTURE, with trouble-free performance on the roadway, might be the result of a better design and testing procedure. Astec Industries' corporate research and development lab, the RocDoc Lab, has been working on developing a performance-based asphalt mix-design procedure. If this concept proves to be feasible to all concerned, it may mean that asphalt mixes in the future can be designed and controlled based on actual performance instead of strictly volumetric properties.

Hot-mix asphalt (HMA) design methods have improved over the years. At one time, the design methodology involved simplistic procedures that attempted to visually determine the optimum asphalt content of a mix. Today, mix designers are using much more complex procedures.

These current design methods, however, are time consuming, trial-and-error procedures in which various asphalt contents are carefully tested until an optimum asphalt content can be estimated. This estimated optimum asphalt content is typically based on volumetric properties such as voids in mineral aggregate and voids filled with asphalt, which are assumed to relate to pavement performance. Furthermore, the most prevalent design methods used today do not include a performance-based test that can verify the conclusion that the estimated optimum asphalt content will actually result in the desired pavement properties.

Often, HMA job mix formulas that are created according to currently accepted design methods can meet required design criteria in the laboratory, only to experience a variety of problems during and after construction. Examples of these problems include bleeding, rutting, tenderness, and fatigue cracking. All of these phenomena are problems that can supposedly be avoided through volumetric mix design, but nonetheless are still quite prevalent in today's asphalt mixes.

With the availability of performance-testing equipment like the Asphalt Pavement Analyzer, it may be more advisable to design mixes based on performance as well as volumetrics.

Many DOTs, producers, and researchers use performance testing as a way to prove the viability of asphalt mixes prior to construction. The Asphalt Pavement Analyzer is the equipment of choice for much of that testing.

Problems also occur in basing mix design and field control strictly on volumetric criteria. It is not at all uncommon for designers to spend weeks testing multiple variations of mix designs, attempting to achieve a mix that meets all of the required volumetric criteria.

Similar problems occur during field production of some mixes. Quality-control technicians often require large amounts of time while they constantly monitor and alter a mix to assure that the required volumetric properties of the mix are maintained.

The volumetric properties that the mix designers are looking for are specific properties such as voids in mineral aggregate (VMA) and voids filled with asphalt (VFA). These volumetric properties—which can change drastically with small changes in asphalt content, gradation, and air voids—are assumed to relate to the performance of the HMA. Unfortunately, with volumetric designing, there is usually no test performed that would verify the validity of these properties with respect to actual mix performance.

Performance testing of asphalt mixes is widely accepted by many asphalt producers and researchers as a means for testing and proving asphalt mixes prior to construction. The Asphalt Pavement Analyzer (APA) is a multi-function wheel-tracking device that was designed for performance testing of HMA. The APA *(see photo above, left)* is capable of testing HMA specimens

for their resistance to a number of performance characteristics, including rutting, fatigue, and moisture susceptibility.

The APA is the latest generation of a device known as "the Georgia loaded wheel tester" that was originally developed by the Georgia Department of Transportation (DOT). The APA is currently used by the Georgia DOT for acceptance of mix designs. Several other state DOTs have also included the APA as a required mix design test in recent years.

The ability of the APA to determine an HMA mix's susceptibility to various pavement problems makes it an invaluable tool in validating HMA mixes prior to construction. With the availability of performance testing equipment such as the APA, it may be more advisable to design mixes based on performance as well as volumetrics.

The RocDoc Lab has successfully completed several projects that investigated ways of utilizing a performance testing procedure in the mix design process. Here is a summary of these projects:

Study 1—The purpose of this particular study was to investigate several asphalt mixes that had experienced bleeding and flushing. The contractor who had placed the mixes felt that a lower asphalt content would have stopped the bleeding, but he was forced to produce the mixes at the asphalt content determined by the Superpave mix design. Rut and fatigue testing of these mixtures in the APA indicated that an asphalt content 0.2% to 0.3% lower than the specified optimum would have been sufficient for a good-performing pavement. This study indicated that performance testing with the APA during mix design may help in adjusting the optimum asphalt content to give the best-performing mix.

Study 2—To further investigate performance-based mix design, this study looked at determining a mix's optimum asphalt content based solely on the mix's performance data. Several 12.5-mm and 9.5-mm blends were utilized in this study. An estimated optimum asphalt content was chosen based on theoretical volumetric calculations. Beam specimens were then fabricated at this asphalt content, as well as 0.5% above and 0.5% below the estimated optimum asphalt content. These beams were then tested for rut resistance and fatigue resistance in the APA. Graphs for rut depth versus asphalt content and fatigue cycles versus asphalt content were then plotted. The optimum asphalt content was chosen by identifying the asphalt content that resulted in the desired rut and fatigue resistance.

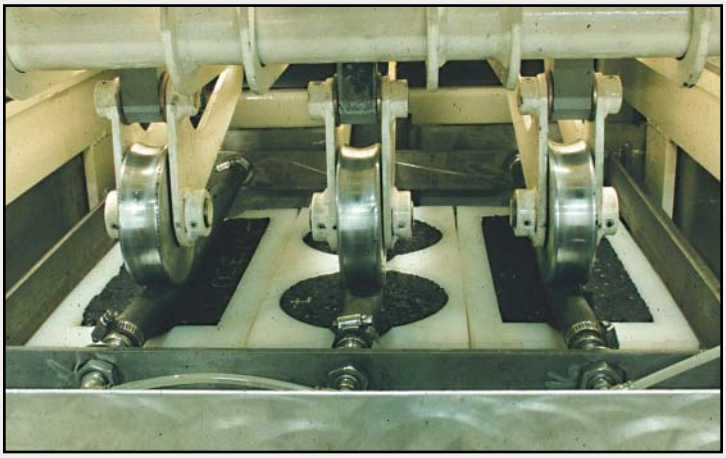
Study 3—This special study of performance-related mix design investigated the use of the APA as a supplement to the existing Superpave mix design system. Several 12.5-mm Superpave mixes were designed according to conventional Superpave criteria. The specimens fabricated during the mix design were tested for their volumetric properties and then subjected to the resistance-to-rutting test in the APA. A graph for rut depth versus asphalt content was then plotted which could be used to help in identifying the optimum asphalt content *(see the graph in the center of this page)*.

All of these studies indicate that performance testing during mix design can help the designer pinpoint an optimum asphalt content that will result in a desired level of performance. This information can help designers avoid mixes that may be too "rich" in asphalt or too "dry" and difficult to compact in the field. Perhaps most important, valuable information on the performance of the mix can be obtained. If a mix is found to be inferior based on performance testing in the APA, it can be redesigned before it is placed in the field. This can result in huge savings by avoiding costly rework.

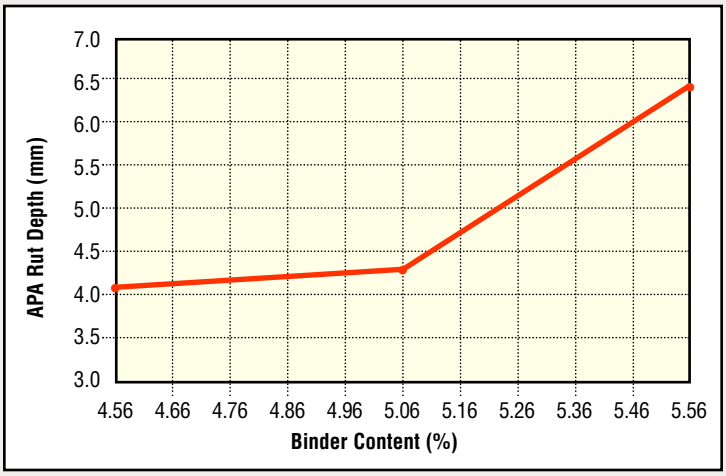
Many asphalt experts across the nation agree that a performance test for the Superpave mix design method is desperately needed. The APA may be the solution to this problem. Its usefulness in the design process was verified in a recent report published by the National Center for Asphalt Technology *(NCAT Report 01-05A)*, where it was ranked as the top choice for testing equipment.

The RocDoc Lab is continuing its research into this area. If a viable performance-related mix design process can be identified, it will mean improved asphalt mix design and pavement performance for years to come. ▼▲▼

If this concept proves to be feasible, it may mean that asphalt mixes can be designed and controlled based on actual performance instead of strictly by their volumetric properties.



The Asphalt Pavement Analyzer (above) from Pavement Technology, Inc. is capable of conducting a range of performance tests, including the rut test on three material samples that is shown in this photograph. An example of one of the APA's tests is shown in the graph (below) that illustrates the relationship between binder content and APA rut depth for mix-design purposes.



FOR MORE INFORMATION
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