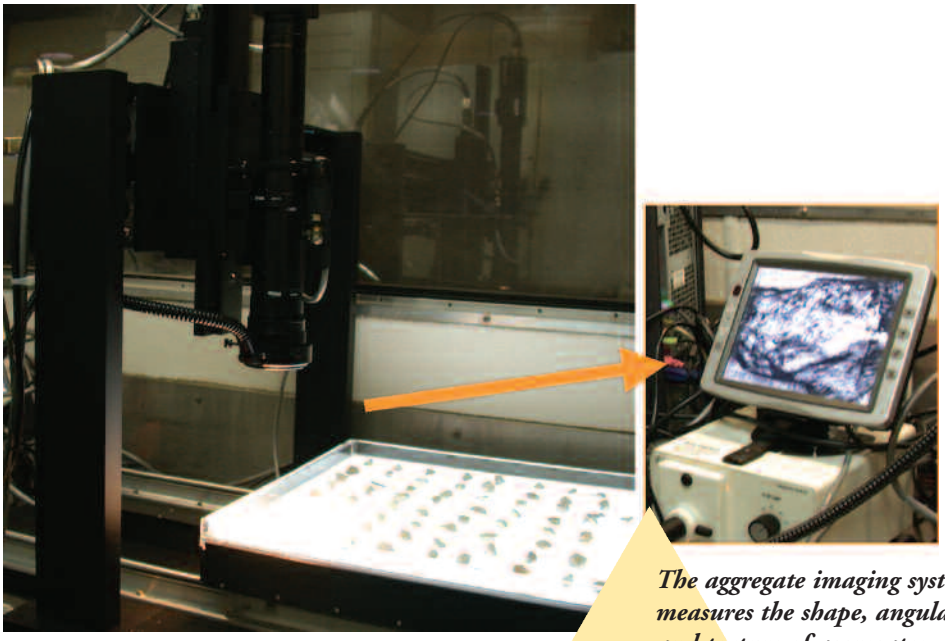
HMA Testing and Quality for the Future

By John D'Angelo and John Bukowski
Office of Pavement Technology, FHWA

Over the past 15 years, there have been significant changes in hot mix asphalt (HMA) quality control, testing and acceptance practices. In the past, it was common for the highway agency to do all the quality control testing and use that same data for acceptance. The standard for quality control was asphalt content and gradation.

Density was typically evaluated by comparing the roadway to a lab-compacted specimen, possibly made long before the project even started. If the ingredients were proportioned correctly, the pavement should perform well.

Today what we measure and who does the measuring has changed. The contractor does the quality control testing. Binder content and gradation are typically still part of the quality control program but they are not the controlling factors in determining the quality of the mix. Quality control today is typically based on the volumetric properties of the mix and density is based on in-place air voids determined from the maximum specific gravity. Additionally, some highway agencies now use the contractor's tests to determine pay values.



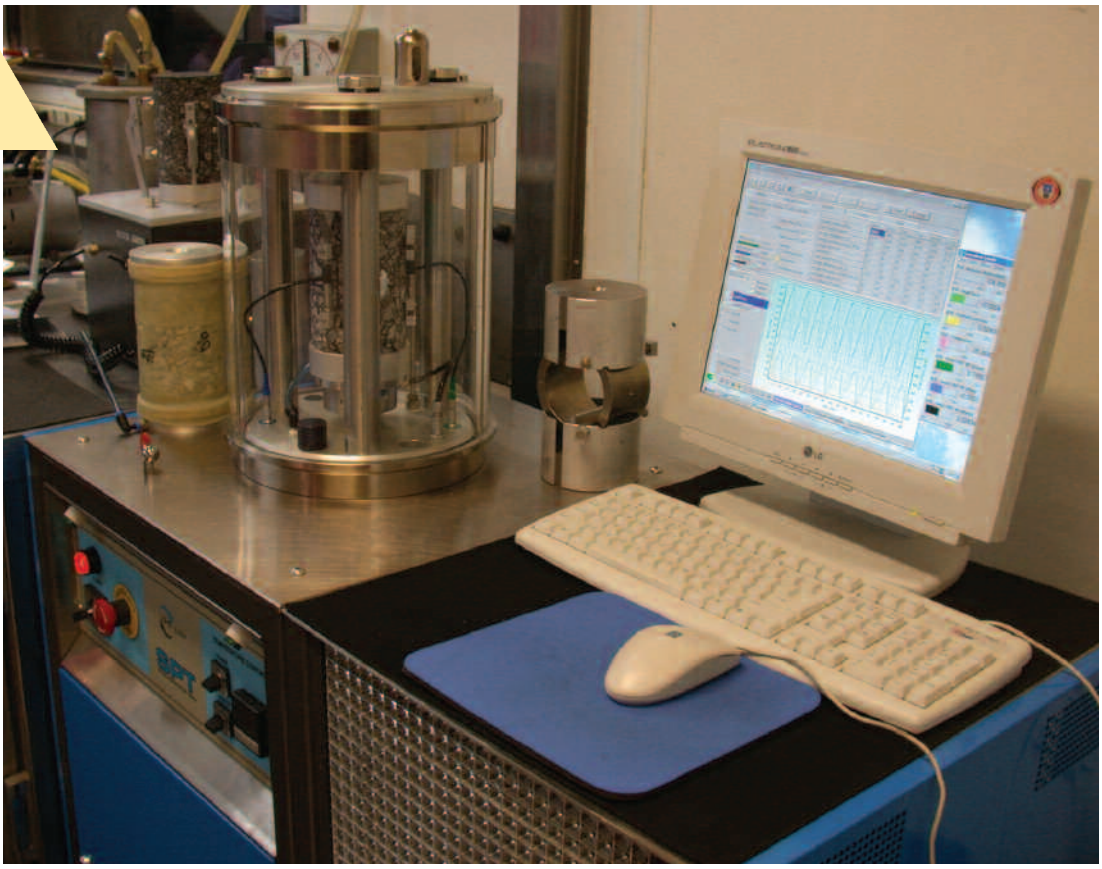
The aggregate imaging system measures the shape, angularity and texture of aggregates.

From Art to Science

The testing of HMA is changing from an art to a science. New tests that provide more accurate and performance-related mix properties are being developed for use in the quality control process. For example, the shape, angularity and texture properties of coarse and fine aggregates can be quickly and easily measured by a new aggregate imaging system (AIMS) developed by Dr. Eyad Masad and the Federal Highway Administration (FHWA). The AIMS can be used in the quality control of aggregates during their production, and the measured characteristics can be related to pavement performance.

The AIMS evaluates the shape and texture characteristics of coarse and fine aggregates by analyzing the images of the aggregate particles captured by video camera (black, white and gray format). The black and white images are analyzed for form and angularity; gray images are analyzed for texture. The AIMS evaluation reduces the variability of test results and speeds up the testing process. Potentially, it may replace the coarse aggregate angularity, fine aggregate angularity and flat and elongated particles tests.

The results from the AIMS are being used to determine a more direct relationship between aggregate properties and HMA pavement performance. A study is currently underway to determine the relationship between AIMS test results and the Superpave repeated load, permanent deformation performance test.



The Superpave Performance Tester is used to measure the stiffness or strength of HMA.

The Superpave Performance Tester was developed as a small, compact unit that fits into a field lab or trailer. The software used to operate the equipment was developed with ease of operation in mind and automatically goes through numerous self-checks to assure that the test is properly set up.

Traditional Process Control

Process control is the contractor's quality control system for monitoring the HMA manufacturing operation. The traditional approach to process or quality control is to evaluate a series of independent tests. This approach includes such steps as determining if the proper binder is in the contractor's tank and the right aggregates are in the stockpiles. It includes cold feed checks to make sure the proper amount of each stockpile is being added to the feed belt. This is where an AIMS evaluation can be used to check if the aggregates in the stockpile match the materials used in the original mix design.

Traditionally, the owner agency was expected to perform testing for acceptance analysis while separate quality control testing was performed by the contractor. But reductions in owner agency staff have made it increasingly difficult to perform adequate and timely testing. For high production operations, the concept of a few samples to represent large amounts of material also places high risks on the owner agency or the contractor. To address these concerns, new

approaches to testing and increased reliance on automation are likely.

New Technology

Automated testing, data management and computer-controlled manufacturing potentially allow for reduced testing when these technologies can be applied to hot mix production and placement. Ultimately it is envisioned that real-time gathering of production information may reduce the time gap between production and data availability and improve the reliability of that data.

PHOTO COURTESY OF NCAT

An in-line viscometer can be used to check the stiffness of the asphalt binder being pumped at the HMA mixing plant.

PHOTO COURTESY OF NCAT

Belt-mounted moisture sensors can be used to monitor the moisture content of aggregate entering the plant.

Applying the Technology

In 2004, a project was initiated by the Alabama DOT, working with the National Center for Asphalt Technology (NCAT), to evaluate a number of specific devices for automated sampling and testing of component materials. In-line viscometers were used to check the binder being fed into the plant. Sensors were used to measure the moisture in the aggregate. Automated belt samplers were used to obtain a sample of the virgin aggregates from the conveyor before it entered the dryer. An automated sample dryer and gradation device, integrated with the belt sampler, provided rapid feedback about the consistency of the aggregate and its conformity to the job mix formula. In the future, each of the automated technologies can be integrated as a system with programmable controls, data acquisition and report generation.

New Paving Technology

Computer-equipped rollers—or intelligent compaction—is one emerging technology that will allow greater control and oversight of the compaction process, resulting in better, more uniform density. Vibratory rollers with a measurement/control system can automatically control compaction parameters in response to materials stiffness measured during the compaction process.

The rollers can also be equipped with a documentation system that allows continuous recordation, through an accurate positioning system of roller location and corresponding density-related output. The information can include number of roller passes and roller-generated materials stiffness measurements. This output can enhance the ability of the roller operator and/or project inspection personnel to make real-time corrections in the compaction process. This output is available for inspector review, allows for a plan-view plot of stiffness throughout a designated section of roadway and provides a link to a pavement management system database.

Ultimately this technology will provide new tools for measurement of in-place pavement properties. Through the use of computers, modeling, and innovative software, intelligent asphalt compaction equipment offers the potential to improve operations, result in more uniform pavement density, reduce inspection requirements, and provide a long-term quality record that can be related to pavement performance.

Automated Testing

The quality assurance system of the future will include new processes and innovative testing equipment. This will not mean, however, that increased or excessive testing will be done. It will mean that we use all the tests to give us a better overall picture of what is being produced and how it relates to performance.

Under the future system, devices such as the AIMS will be used at the plant to check the aggregate as it is delivered to verify specifications compliance, and to check that the aggregate is similar to the material used during the original design. After the initial tests, the automated system takes over with continuous monitoring of production. When the monitoring indicates aggregate changes, additional testing may be done.

The system of the future may allow the testing frequency to be dramatically reduced. Unlike current practice where samples are taken every 500 or 1,000 tons, the automated systems may allow samples to be taken every other day—just to verify that the process is working.

Mix Acceptance

The idea that we can make one or two tests

PHOTO COURTESY OF NCAT

An automated belt sampling device can be used to sample the aggregate before it enters the dryer.

An automated sample dryer and gradation device can be integrated with a belt sampler to provide data on aggregate consistency.

on a material and decide if it has the desired quality is outdated. HMA production has to be looked at as a manufacturing process. There are many steps that have to be checked in that process to assure quality with some type of performance measure at the end. The new tests and plant automation processes that are becoming available will look at HMA in a new way.

For example, this is where the Superpave Performance Tester could come into the picture. The process might go like this: the production process control and quality control are established; the system has been calibrated and running smoothly. At this point the performance properties of the mix, as determined by the Superpave Performance Tester, are used to accept the mix for payment. This testing would be done at the start-up of the project and at extended intervals during production. If the process control indicates a problem has occurred, a sample can be taken and tested later.

HMA testing in the future will use quick accurate tests on the initial components. Plant automation will assure that the production process runs smoothly and limited quality control testing will verify the process. Finally performance tests will be evaluated to accept the material. Then we will have an advanced quality assurance system that tells us more about the material we are placing on the roadway and how it performs.