Battered by weather and increasing traffic loads, asphalt concrete pavements throughout the nation are wearing out much sooner than expected. According to the American Association of State Highway and Transportation Officials (AASHTO), the result is rough pavements, higher maintenance and rehabilitation expenses, and more temporary work zones that slow traffic and endanger workers and motorists.

Developed under the Strategic Highway Research Program, Superpave technology is aimed at improving the performance, durability, safety and efficiency of the nation’s highway system. Superpave—an acronym for SUperior PERforming Asphalt PAVement—is a system of performance-related hot asphalt (HMA) mix design specifications.

Fouad Bayomy, professor of Civil Engineering and NIATT affiliate faculty, Eyad Masad, assistant professor at Texas A & M, and former Washington State University graduate student Samer Dessouky, have developed a new method for calculating hot mix asphalt stability using data collected from a Superpave Gyratory Compactor (SGC). The research was sponsored by the Idaho Transportation Department.

Gyratory Stability to Predict Performance

The Gyratory Stability method allows for the determination of the energy consumed in compacting samples of HMA using the SGC. The fundamental concept of the new method assumes that a mix that has higher resistance to deformation will require higher energy to compact and to create its aggregate structure (and vice versa). Researchers measure the forces and deformations that occur in the sample during compaction. The values are used to calculate what the research team calls Contact Energy Index (CEI), which is an energy indicator of the mix stability. Bayomy’s research team believes that the CEI can be a powerful tool to complement the Superpave mix design method.

According to Bayomy, the CEI is advantageous because it “can be measured as the sample is compacted. No further steps or additional testing equipment are required as in the case of traditional stability tests.”

Using CEI

The response of HMA samples to the applied forces during compaction is manifested by the gradual change in the sample air voids and can be displayed...
A typical compaction curve shows how the air voids change with the number of gyrations (Fig. 1). At the initial stage of compaction, the mix is loose and tends to deform quickly. When aggregate particles start to touch (contact) each other, there is an increased resistance that causes a slower rate of air void reduction. The mix continues to compact until all particles are in their optimum position to resist deformation. After investigating this phenomenon, the research team was able to divide the compaction curve into two parts: Part A represents the fast reduction in the sample height during the initial stage of compaction and Part B reflects the slower rate of the air void reduction as the mix develops its shear strength. Using this information, the team developed a mathematical formula—the CEI—to indicate the “Gyratory Stability” of the mix. Using an Excel spreadsheet, the CEI calculation is readily available once the sample is compacted. “We intend to develop user-friendly software that can be run simultaneously with the compaction so that the mix designer does not have to do extra steps for calculating the CEI,” says Bayomy.

**Gyratory Stability and Mix Performance**

The research team, in cooperation with their counterparts at the Asphalt Institute, used 16 different asphalt mixes under investigation in a National Cooperative Highway Research Program (NCHRP) project. The mixes, designed in accordance with the Superpave mix design method, were tested to evaluate the CEI’s sensitivity to various changes in the mix constituents.

In one test, the levels of sand were varied in the HMA samples, since it is known that the presence of natural sands has an adverse effect on the mix stability. Results showed that the CEI was sensitive to levels of sand in the mix: values for those with no sand were consistently higher than those with 40 percent natural sand (Fig. 2). Likewise, when components of the asphalt mixes were changed (e.g., comparing mixes with limestone to those with gravel or changing the asphalt content), the CEI likewise reflected the differences. CEI values, which represent mix stability, were consistently lower for mix samples made with the asphalt contents higher than their desired optimum. Mixes with angular aggregate shape showed higher CEI values when compared to mixes with gravel, a more rounded aggregate. In summary, CEI seems to have a great potential to be a mix design parameter to complement the current Superpave mix design method.

We believe Fouad’s work will be very beneficial when ITD begins to use Superpave mixes. The gyratory stability procedure will provide a simple way to determine the strength of the asphalt mix during construction.

Mike Santi
Idaho Transportation Department
The Future of Gyratory Stability

Ahmad Abdo, a current graduate student at the University of Idaho, studied more than 30 mixes designed using Hveem, another mix design procedure. His work showed that there is a good correlation between the Hveem stability of these mixes and their measured Gyratory Stability.

Dr. Bayomy believes that Gyratory Stability has the potential to complement the current Superpave mix design method. While it is not intended to replace physical performance tests such as the Superpave shear test or the new proposed Superpave simple performance test, it can provide an early indicator of the mix stability. Further research at the University of Idaho will determine if HMA stability as predicted by the Superpave simple performance test could actually be predicted using gyrratory stability.

Recent Publications


Idaho Asphalt Conference

Since 1991, Fouad Bayomy has cochaired the Idaho Asphalt Conference held yearly in Moscow, Idaho. The conference is held under the auspices of the University of Idaho, the Asphalt Institute and the Idaho Transportation Department. It addresses issues related to asphalt pavements that are of concern to local and state governments as well as consulting and engineering firms. Attendees, including contractors and material suppliers, have found this conference to be a good forum to address design, construction and management issues.

Bayomy and other members of the organizing committee (John Duval of the Asphalt Institute, Mike Santi of the Idaho Transportation Department, and Ed Schlect, Emeritus member) hosted more than 200 participants at the 44th Idaho Asphalt Conference. The 45th conference is scheduled for October 27, 2005. To add your name to the mailing list, write conferences@uidaho.edu. (See also http://www.webs1.uidaho.edu/bayomy/iac/)

About Fouad Bayomy

Dr. Bayomy received his BSCE with honors from Cairo University, and his MS and PhD from Ohio State University, Columbus. Before coming to the University of Idaho in 1991, he worked as Senior Consultant at Resources International, Inc. in Columbus, Ohio and Kuwait; Assistant Professor at the University of Petroleum and Minerals in Saudi Arabia; and as Engineering Manager at Southwestern Laboratory in Houston. He is currently a full professor at UI and teaches courses related to construction materials and pavement systems. Bayomy is a member of several national committees of the Transportation Research Board, the American Society of Civil Engineers and the Association for Asphalt Paving Technologies.

Dr. Bayomy has traveled extensively to numerous countries where he has presented seminars and provided consultation regarding pavement technologies. He enjoys traveling for pleasure with his wife and three sons as well as playing squash and swimming.