JERSEY DOT'S
"Turning Problems into Solutions"
Tech Brief

Evaluation of Modified Binders

FHWA-NJ-2003-017 March 2003

SO, HERE'S THE PROBLEM…

- Pavements are being exposed to heavier traffic loads at a more frequent rate than ever;
- Many pavement designers are leaning towards using modified binders/asphalt binder modifiers to increase the performance of the HMA;
- Because of the gained popularity of modified binders, more and more companies are developing and selling asphalt binder modifiers (materials that can be added to asphalt binder to increase its performance). It is generally assumed that the asphalt binder modifiers can be added directly to a pre-determined HMA mix design without causing any detrimental affects to the compactability or performance of the HMA;
- However, at the moment, Superpave does not provide a performance test/criteria to evaluate the performance of HMA, or even compare between two different HMA mixes.

AND, HERE'S OUR SOLUTION

- Utilize current Superpave methods to determine the performance grade (PG) of the asphalt binder modifier added to a PG64-22 asphalt binder;
- Utilize currently accepted HMA performance tests, the Asphalt Pavement Analyzer (APA) and the Superpave Shear Tester (SST), to determine the simulative and fundamental properties of the modified HMA;
- Evaluate different methods of data analysis parameters from the performance testing and compare to the PG test results;
- Provide a testing procedure that would allow a quick and dependable means of evaluating the impact of asphalt binder modifiers on the performance of HMA.

The Superpave Shear Tester (SST) and the Asphalt Pavement Analyzer (APA), shown as Figures 1 and 2, were used to test a coarse-graded 12.5mm Superpave mix. The HMA mix was tested with 6 different asphalt binders; a PG64-22, two PG76-22 from different manufacturers, a PG64-22 mixed with a polymer from Creanova, a PG64-22

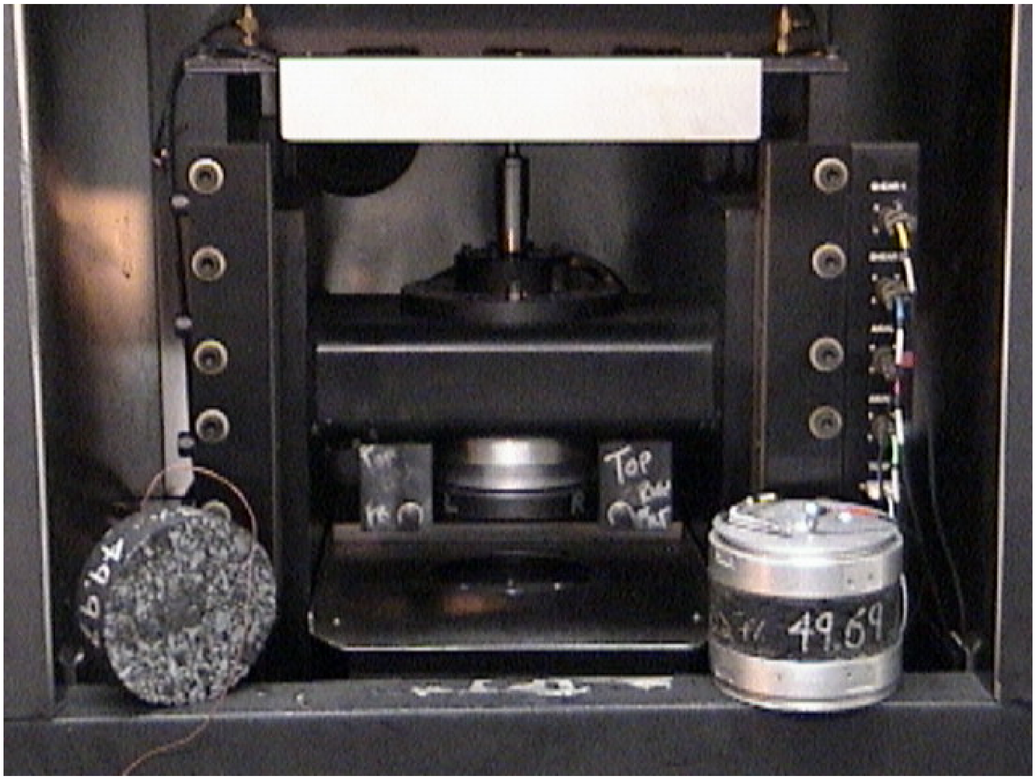

Figure 1 – Superpave Shear Tester (SST)


Figure 2 – Asphalt Pavement Analyzer (APA)

Mixed with a polymer from Eastman Industries, and a PG64-22 mixed with a Carbon Black from Hydrocarbon Technologies.

Each asphalt binder was mixed with the 12.5mm aggregate gradation and compacted to identical volumetric conditions; APA samples were compacted to 7% (+/- 0.5%) air voids and the SST samples were compacted to 4% (+/- 0.5% air voids). The SST samples were tested under Simple Shear , Frequency Sweep, and Repeated Shear test modes. The APA was tested until 8,000 loading cycles were accumulated. Overall, 13 different test parameters were evaluated and statistically compared using the t-Test. The t-Test is a statistically method that provides a comparison of test results to determine if the results are statistically equal or not equal at a 95% confidence level. A final test parameter that would be recommended would have the least number of "equal" values since this test method would be able to discriminate between the different asphalt binders.

HMA samples were also laboratory aged to evaluate the effect long-term aging would have on the asphalt binder modifiers. Sample were placed in an oven at 85oC for 5 days. Previous research under SHRP indicated that this represents approximately 10 years of environmental aging.

HERE'S WHAT WE CAME UP WITH…

The statistical analysis showed that test procedure that was best able to discriminate among the 6 different asphalt binders tested in the HMA mix was the APA at a test temperature of 60^{o}C, wheel load at 100 lbs, and a hose pressure of 100 psi, using gyratory compacted samples (Figure 3). The second best test parameter was the creep slope and permanent shear strain from the SST Simple Shear test at a test temperature of 40^{o}C, with the third best test parameter was the rutting parameter from the SST Frequency Sweep at 40^{o}C and the permanent shear strain from the SST Repeated Shear at 64^{o}C. If was found that for low temperatures, a test parameter did not exist that provided a good statistical indicator.

The HMA mixture rankings from the APA test were then compared to the binder test high temperature PG rankings. The high temp PG ranking correlated well with the APA tests, except for the Carbon Black material. The binder tests ranked the PG64-22 + Carbon Black better than the PG64-22 by itself. However, the APA test results clearly show that the Carbon Black rutted more than the PG64-22 sample. This was most likely due to the fact that the Carbon Black was treated as a direct add-in modifier, assuming that the addition of the Carbon Black would not change the final asphalt binder content of the pre-determined mix design. However, this was not the case, and in fact, it seemed that the addition of the Carbon Black "over asphalted" the mix, causing the material to be more rut susceptible.

Results of the performance testing on the laboratory aged samples showed that all HMA mixes generally underwent age hardening (stiffening) at low temperatures. This is shown in Figure 4; lower creep slope values means that the material stiffened due to the laboratory aging. STOA in the figure means Short-Term Oven Aged and LTOA means Long Term Oven Aged. The LTOA samples were the samples that underwent the simulated long term environmental aging. The age hardening of the HMA is important to

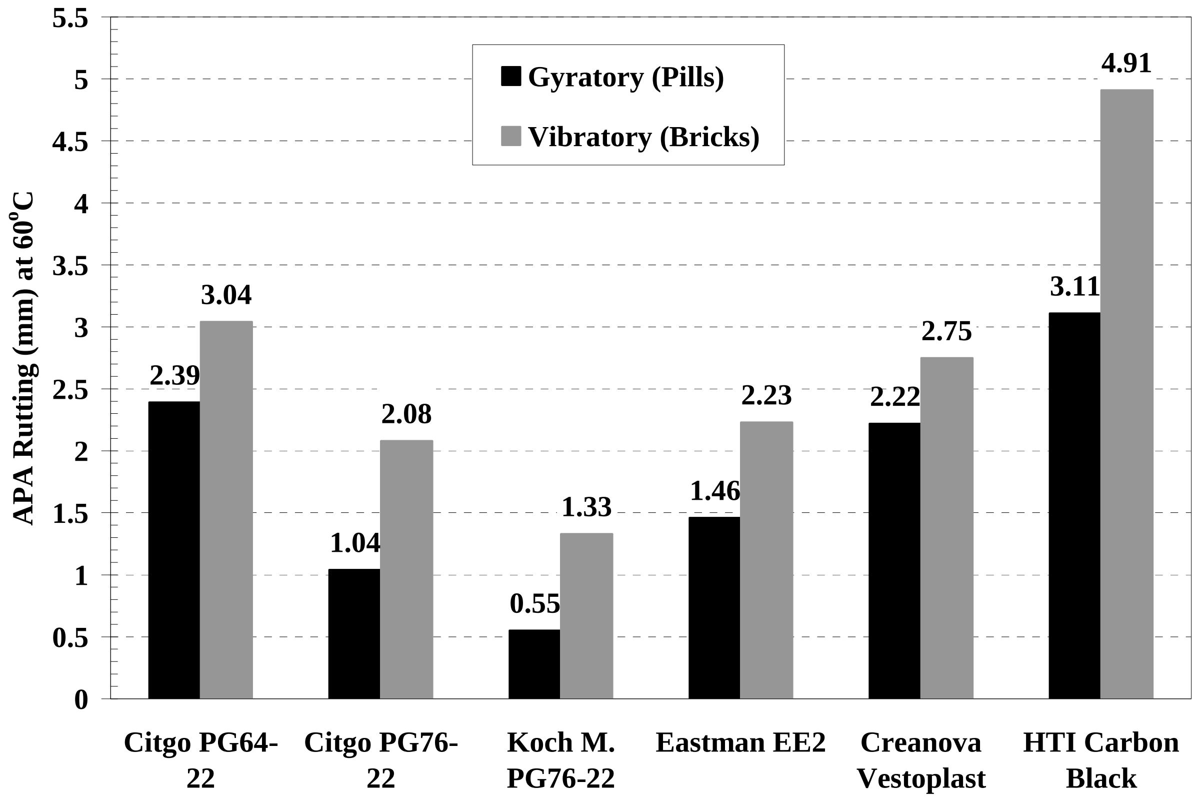

Figure 3 – 10 Quietest Pavement Sections Tested

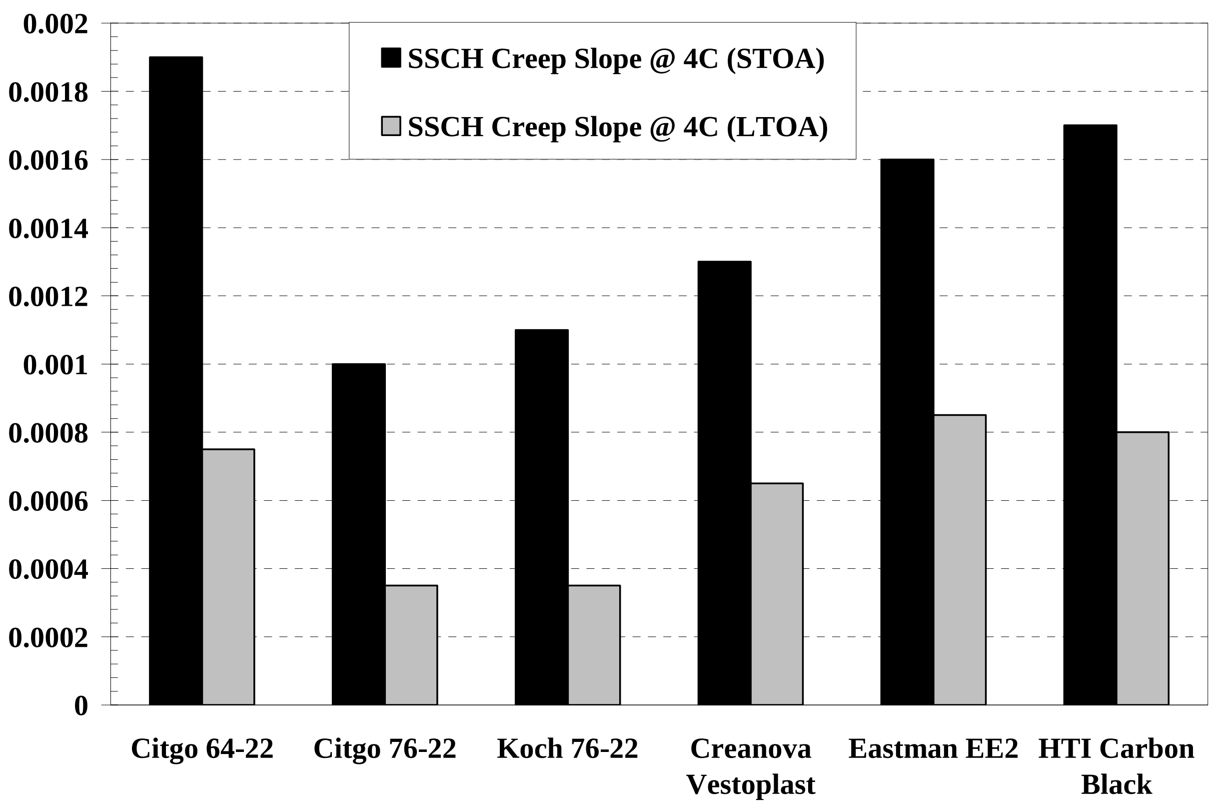

Figure 4 – Effect of Laboratory Aging on the Stiffness of the Different HMA Samples

consider since materials that stiffen too much due to aging will be more susceptible to fatigue cracking/low temperature related fatigue cracking in the future.

THE BOTTOM LINE…

Two test procedures were developed for the New Jersey Department of Transportation (NJDOT) to evaluate the effect an asphalt binder modifier will have on the performance of the predetermined HMA mix. The first procedure, called the Quick Method, is used for materials that the NJDOT may have some experience with but still would like to know the overall effect on the HMA mix. This test procedure, from compaction to data analysis, would take approximately 3 days. The second procedure, called the Full Test Procedure, is similar to the Quick Method, however, this method also uses the laboratory aging procedure to evaluate the age hardening characteristics of the HMA. This procedure is recommended when the NJDOT has little to no experience with an asphalt binder modifier. The Full Test Procedure takes approximately 8 days, from compaction to data analysis, to complete.

FOR MORE INFORMATION CONTACT

NJDOT PROJECT MANAGER:	Anthony Chmiel
PHONE NO.	**(609) 530-3711**
e-mail	**Anthony.Chmiel@dot.state.nj.us**
UNIVERSITY PRINCIPAL INVESTIGATOR:	Thomas Bennert
UNIVERSITY:	**Rutgers University -CAIT**
PHONE NO.	**(732) 445-5376**
e-mail	**bennert@eden.rutgers.edu**

A final report is available online at
http://www.state.nj.us/transportation/research/research.html

If you would like a copy of the full report, please FAX the NJDOT, Division of Research and Technology, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Division@dot.state.nj.us and ask for:

Evaluation of Modified Binders

NJDOT Research Report No: FHWA-NJ-2003-017