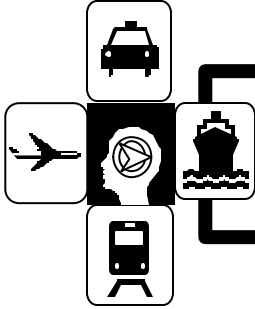


JERSEY DOT'S

"Turning Problems into Solutions"



Tech Brief

Evaluation of a Rutting/Fatigue Cracking Device

FHWA-NJ-2001-031-TB

April 2001

SO, HERE'S THE PROBLEM...

- The rutting of hot mix asphalt (HMA) pavements in New Jersey is the primary pavement distress encountered
- Currently, there are a number of tests that claim can measure the rut susceptibility of HMA
- A new test that simulates the loading and failure that occurs in HMA pavements due to moving wheel loads is the Asphalt Pavement Analyzer (APA) – Figure 1
- However, currently there does not exist a standardized test procedure that accounts for testing temperature, sample compaction, or sample size

AND, HERE'S OUR SOLUTION

- Conduct an evaluation of the APA using four different HMA mixes
- Compact specimens using the Superpave gyratory compactor and vibratory compactor to achieve both round (pills) and bricks for testing
- Test the materials at two temperatures that are the most commonly used in industry
- Evaluate and compare the results to optimize the testing procedure and specify a test temperature, sample compaction method and a sample size

We set out to evaluate the effect of sample compaction, size and configuration on the rutting measurements within the Asphalt Pavement Analyzer (APA). Four HMA mixes were constructed at the Rutgers Asphalt/Pavement Laboratory (RAPL). The mixes were designed under the Superpave asphalt design and encompassed; 12.5 mm coarse and fine, and a 19 mm coarse and fine mix. All four mixes used a PG64-22 asphalt binder and designed for a traffic of 3 to 30 million ESAL's. The samples were compacted in the Superpave gyratory compactor to make round (pill) samples, as well as a vibratory compactor to produce both pill and brick samples. The samples were tested under identical conditions and the results analyzed. The practical aspects of the compaction methods were also evaluated and considered for final recommendation. The results of the study will be used as a final testing specification for the future development of a

performance test to be used after HMA mix design.

HERE'S WHAT IT LOOKS LIKE... AIN'T IT A BEAUTY!!!

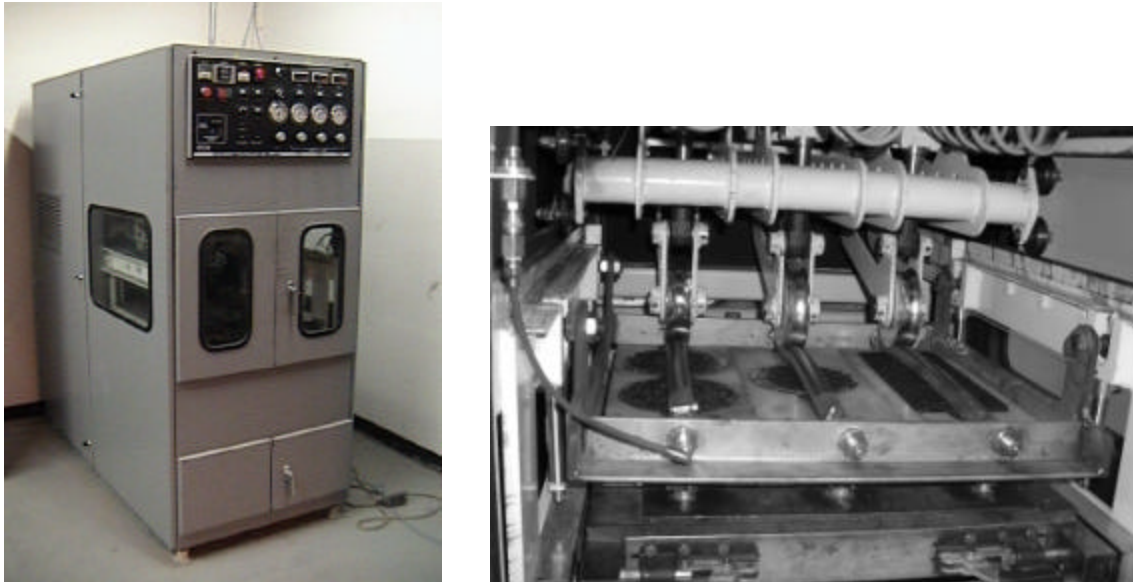


Figure 1 – The Asphalt Pavement Analyzer (APA)

The use of the loaded wheel tester has become a popular test for transportation agencies to use. The test has shown to be both robust and repeatable. It is simple to use, with a minimal amount of data processing.

The first type of loaded wheel test used for the rutting evaluation of HMA was by the Georgia DOT (Collins et al., 1996). This device was developed in the mid 1980's through the cooperative work between the Georgia DOT and the Georgia Institute of Technology. Since this time, a number of other institutions have developed similar versions of loaded-wheel tracking devices (Table 1).

Table 1 – Loaded-Wheel Tracking Devices and the Developer(s)

Loaded-Wheel Device	Developer
Georgia Loaded Wheel Tester (GLWT)	Georgia DOT/Georgia Institute of Tech.
Hamburg Wheel-Tracking Device (HWTD)	Helmut-Wind Incorporated
LCPC (French) Wheel Tracker	Laboratoire Central des Ponts et Chausees
PurWheel	Purdue University
Model Mobile Load Simulator (MMLS3)	South African Government

But perhaps the most popular type of loaded-wheel testing device is the Asphalt Pavement Analyzer (APA). The APA has been called the second-generation loaded-wheel tester, as it has a similar design to the GLWT. It has the capability of testing compacted brick or pill samples under various environmental conditions in both rutting (high temperature permanent deformation) and fatigue (low temperature cracking). The device can also be linked to a computer and data acquisition system so the user can measure the rutting of the HMA for each load cycle.

The APA's loading mechanism is as such; a moving wheel load (100 lbs) is applied at a rate of about one cycle per second to a $\frac{3}{4}$ inch 100 psi pressurized hose that rests atop the HMA samples. This simulates (on a small scale) the pavement loading that occurs on an HMA pavement.

THIS IS WHAT IT CAN DO

- 1) Provide a means, after mix design, to compare different HMA designs to determine which design is more rut resistant

HERE'S WHAT WE CAME UP WITH...

Asphalt Pavement Analyzer rutting results were determined with respect to changes in sample characteristics and/or testing configurations (Figure 2) that most influence rutting characteristics of the pavement samples, i.e., aggregate gradation, compaction method, and testing temperature. The following conclusions can be made based on the project results:

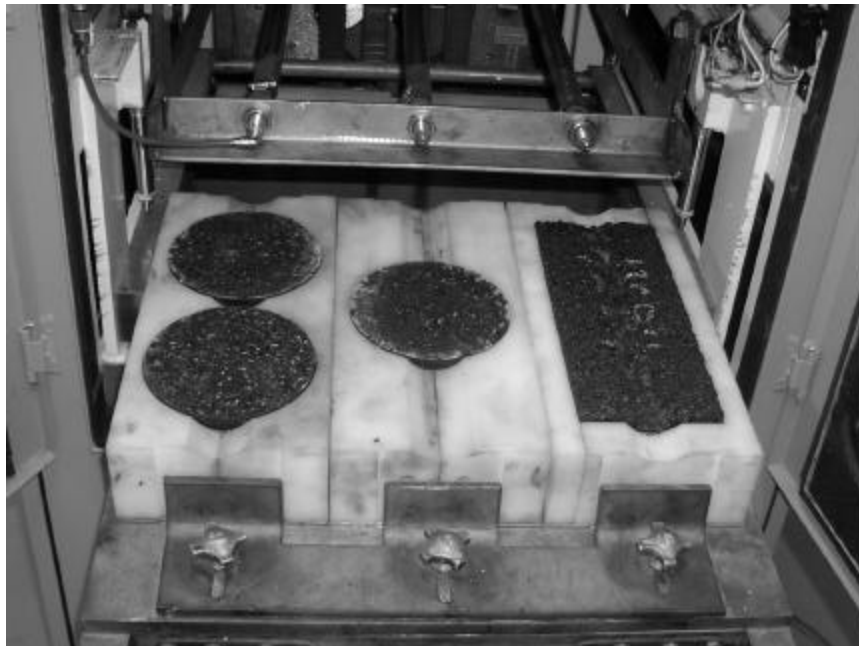


Figure 2 – Various Sample Sizes and Loading Configurations Tested

The gyratory compactor produced samples of similar rut resistance to the vibratory samples, except for the fine mix used in the study (12.5 mm fine Superpave mix). This may be due to the manner in which the compaction stresses are applied to the hot asphalt mix.

The gyratory compaction effort is a multi-directional applied stress that encourages the hot mix asphalt to seek a slightly horizontal aggregate structure, which may cause for stone-to-stone contact. The vibratory compaction effort is a one-dimensional stress that leaves the aggregates in the same orientation and simply forces the mix to compact.

Center-cut tested pill samples rutted less than samples tested in traditional double molds. This was shown in all the vibratory and gyratory pills tested, with the exception of the 12.5 mm TRZ gyratory pills. This may be due to two different scenarios; 1) There exists some accelerated rutting near the ends of the APA wheel path, due to the slower moving loading application at these locations or 2) The measurement locations on the center-cut samples prohibited some rutting because of the locations near the edge of the mold.

Traditionally tested gyratory pills and vibratory bricks showed extremely similar rutting results for the 12.5 mm mixes. However, due to differences in compaction efficiency, the gyratory pills and vibratory bricks may not be suitable for comparison of coarser mixes, as observed in the 19 mm mixes. The vibratory compactor had difficulties compacting the coarser mixes.

Changing the testing temperature from the 1999 APA User Group recommendation of 60°C to the Group's year 2000 recommendation of 64°C had a significant affect on APA rutting results. Average rutting was increased by 5 to 200 percent.

The geometry of a sample appears to have no bearing on the rutting observed in a particular mix type. Pills and bricks outperformed one another at a fairly even rate. In the 12.5 mm TRZ and BRZ mixes, the gyratory pills displayed better rutting resistance than the bricks, but the vibratory pills displayed less resistance to rutting than the bricks. In the 19 mm ARZ mix, the center-cut tested pills outperformed the bricks, while the samples tested in the double molds rutted more than the bricks. In the 19 mm BRZ mix, all pill samples showed much better resistance to rutting than the bricks. (Figure 3)

Caution should be observed whenever comparing any testing results. As demonstrated in the project, variations in sample characteristics and/or testing conditions can have significant results on observed results. Comparisons between agencies in different geographical locations are even more susceptible to misinterpretation due to such factors as varied climatic conditions and variations in local aggregate composition and quality.

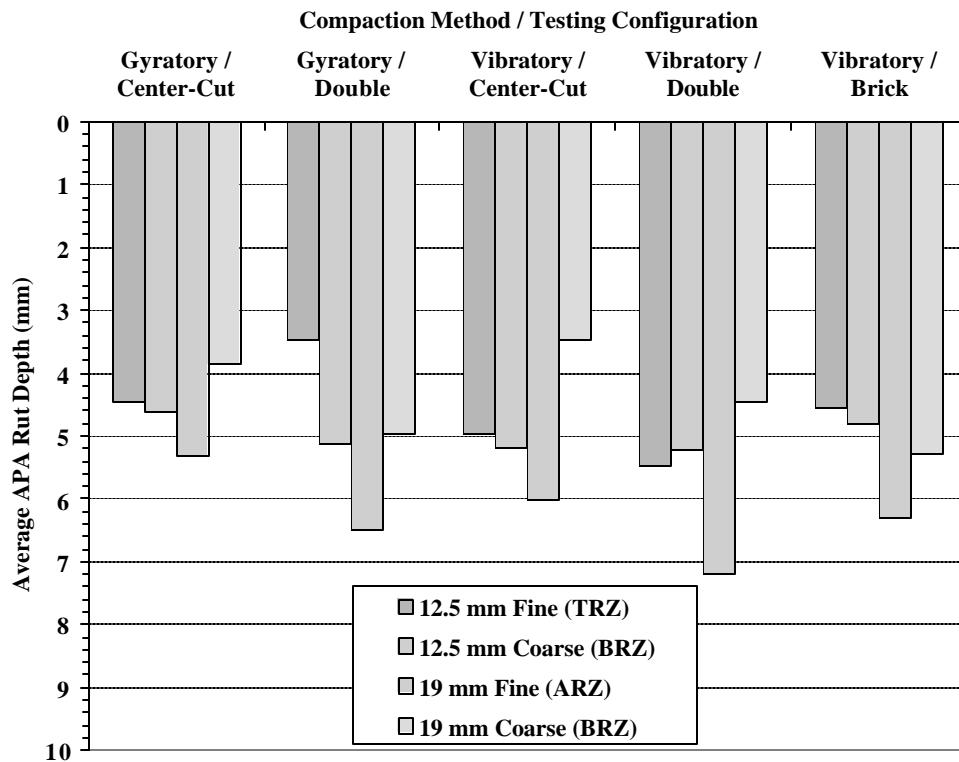


Figure 3 – Results of All Compaction Methods/Testing Configurations

THE BOTTOM LINE...

The Asphalt Pavement Analyzer (APA) is recommended to use the gyratory compactor to produce samples for evaluation. This is mainly due to the ability of the compactor to compact coarser samples to the required density. The vibratory compactor had difficulties compacting the 19 mm coarse sample to the required air voids. Also, the gyratory pills showed similar rutting trends to the vibratory brick sample. Therefore, by using the gyratory samples, twice as many samples can be tested at one time (6 more the gyratory and 3 for the brick).

The test temperature of 64°C was recommended based on the testing. At this temperature, which is the typical PG binder grade for New Jersey, the evaluation of the HMA design is also dependent on the aggregate structure and not just the binder stiffness. A test temperature that does not meet the PG high temperature binder grade would rely heavily on the rut resistance of the binder stiffness. This is why both small and large differences were found in the APA rutting among the samples that were tested at both 60 and 64°C.

While this study illustrated that the APA can be a valuable tool in determining the rut resistance of HMA samples, the fatigue capability of the device was not yet available (more accurately, perfected). However, as of the end date of the project, the fatigue capability of the device was finished and is recommended to the future evaluation to compliment the rutting capability of the Asphalt Pavement Analyzer (APA).

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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, Bureau of Research, Technology Transfer Group at (609) 530-3722 or send an e-mail to Research.Bureau@dot.state.nj.us and ask for:

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