pennsylvania
DEPARTMENT OF TRANSPORTATION
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January 16, 2009

Mr. Eugene Olinger, Research and Technology Engineer
Federal Highway Administration
228 Walnut Street, Room 508
Harrisburg, Pa 17101-1720

RE: RP #2003-054 Evaluation of Crumb Rubber Modifier with Vestenamer in HMA for Anti-Rutting

Dear Mr. Olinger,

The Pennsylvania Department of Transportation is requesting that the above referenced project be closed out.

Introduction

The subject project was initiated in 2003, to evaluate the performance of Hot-Mix-Asphalt (HMA) incorporating Crumb Rubber Modifier (CRM) produced from Ground Tire Rubber (GTR), plus the further addition of a polymeric processing aid, Vestenamer 8012. The processing aid acts as a plasticizer of rubber compounds during the mixing and manufacturing process of the HMA. The Vestenamer chemically bonds GTR with the asphalt binder via the vulcanization reaction between the sulfur on the GTR surface and the sulfur associated with asphaltenes and maltenes in the asphalt binder. This vulcanization reaction transforms the thermoplastic asphalt binder into a thermoset modified asphalt binder, which is commonly associated with rut resistant HMA. Additionally, according to the Vestenamer manufacturer, Degussa Corporation, the modified binder chemically binds to the aggregate which results in a HMA that resists stripping and raveling as well.

Philadelphia Department of Streets in the $1^{st}/2^{nd}/3^{rd}/6^{th}$ Highway District, like many urban highway agencies own roadways which carry heavy truck traffic, and was interested in evaluating alternative solutions for rut resistant pavements. Current practices for combating rutting were effective but could be costly. These methods included the use of latex-modified emulsion paving course (microsurfacing) in conjunction with a wearing course and whitetopping. Although less expensive, limited experience using Superpave mix design with PG 76-22 binder had been initiated, however, construction problems relating to mix workability were reported.

The anticipated benefits of the Vestenamer/CRM HMA include an improved rut resistant surface (providing safer motoring conditions), cost savings relative to alternative treatments, and superior workability.

The purpose of this experiment was to document the construction process differences and associated costs of Vestenamer/CRM modified HMA compared to Superpave Wearing Course with a PG 76-22 binder (rut resistant control) and Superpave Wearing Course with a PG 64-22 binder (non-rut resistant control); and analyze the mixture performance differences, particularly in regard to rut resistance.

Evaluation

Two roadway segments within the City of Philadelphia, and located within the PENNDOT Engineering District 6-0, were selected for this construction evaluation.

- Tasker Street between 8th and 10th streets is 26 feet wide with parking on both sides and one westbound travel lane. The corridor serves as a traffic trolley route and experiences rutting within the trolley track path. At the time of construction, the Average Daily Traffic (ADT) was 3,900 with 9% trucks and Equivalent Single Axle Loads (ESALs) of 1,301,000 for a 20 year design period.

- Pine Street between 19th and 23rd Streets is 26 feet wide with parking on one side and two eastbound travel lanes. This corridor is located within the central city business district, where shoving of the pavement mix is common due to the high volume of slow moving traffic. At the time of construction, the ADT was 8,400 with 9% trucks and ESALs of 1,970,000 for a 20 year design period.

Adjacent sections of roadway with similar loading conditions were evaluated as designated control materials for baseline comparison of performance. These locations were:

- Tasker Street from 6th to 8th Street (Superpave 12.5 mm Wearing Course with PG 76-22 binder).

- Pine Street from 16th to 19th Street (Superpave 9.5mm Wearing Course with PG 64-22 binder).

There were no existing paving records or history on file for any of the street locations selected for the evaluation, however, preconstruction survey of the areas indicated in addition to previously mentioned rutting and shoving, there were numerous utility patches apparent with a potential to result in reflective cracking in the new overlays. In general, it was assumed that the existing base courses were in good condition.

Although the work plan was originally developed and approved in 2003, the contract was not let until June of 2004 and actual work did not commence until the spring of 2005, with completion in the fall of 2005. Tony DePaul & Sons of Blue Bell, PA was awarded the contract, which included 1.5 inches of milling existing pavement and replacement overlay of the same depth of the three (3) previously indentified mixes in the designated locations.

The following summarizes the sequence, results and any differences noted in the construction operations:

- Tasker Street between 6th and 10th Streets was milled in March 2005 and both control PG 76-22 Superpave 12.5mm Wearing Course and the experimental Vestenamer/CRM HMA 12.5mm Wearing Course were placed in April 2005.

- Pine Street between 16th and 23rd Streets was milled in September 2005 and both the control PG 64-22 Superpave 9.5mm Wearing Course and the experimental Vestenamer/CRM HMA 12.5mm Wearing Course were placed in October 2005.

- Due to excessive settlement of the base in much of the utility trench areas exposed after milling, the overlay thickness was increased (up to 4.5 inches on Tasker Street) and the addition of a Superpave Binder Course (PG 64-22), for leveling, was included on Pine Street between 21st and 23rd Streets.

- The only difference in construction operations noted between the control and the experimental sections was the experimental paving sections (Vestenamer/CRM HMA) did not require the use of vibratory compaction to achieve the minimum specification density.

- All material tests for acceptance (mixture composition and density) met specifications for all material courses placed.

The contract unit price for each material placed was as follows:

- Vestenamer/CRM HMA 12.5mm Wearing Course - $5.60/square yard(sy) (for 8,090 square yards)

- Superpave 12.5mm Wearing Course with PG 76-22 binder - $4.60/sy (for 80,005 square yards)

- Superpave 9.5mm Wearing Course with PG 64-22 binder - $4.05/sy (for 240,170 square yards)

Findings and Conclusions

Following construction, visual field inspections were planned in the spring and fall of each year for the evaluation period of five (5) years. However, due to changes of all personnel originally responsible for initiating and conducting all follow-up activities planned for this evaluation, limited and incomplete documentation occurred.

A field inspection was conducted on November 6, 2006 by the new primary project researcher and new Degussa manufacturer representative. This inspection indicated that the experimental sections of Vestenamer/CRM HMA were performing unsatisfactory after only one year of service. The pavement exhibited loss of rubber particles (raveling) and rutting.

Based on the anticipated benefits of using Vestenamer/CRM HMA, only improved mix workability over the alternate rut resistant Superpave mix (PG 76-22 binder) was achieved. Due to lack of rut resistance and higher cost, Vestenamer modification is not considered an acceptable alternative to current rut resistance paving strategies.

Recommendations

Based on the findings and conclusions of this abbreviated research project, the use of Vestenamer 8012 for modification of CRM HMA, is not approved for use on any Department funded paving project, without a new and approved research evaluation being conducted.

Any proposed new evaluation should require verifiable documentation of adequate and uniform base conditions and detailed field documentation and sampling during construction, to eliminate any unaccounted influences which could significantly impact performance. Also, historically, the benefit of rut resistance using rubber modification has most often been demonstrated through the use of "wet" processing, as opposed to "dry" processing utilized in this research initiative.

Please accept this report as completion of Research Project 2003-054. If you have any questions, please contact J. Alberto Medina at telephone (717)-787-3580 or amedina@state.pa.us email address. Thank you.

Sincerely,

M. Alaa Azab, P.E., Chief
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