
**Preliminary Summary Report**

# Ground Tire Rubber (GTR) Asphalt Pavement Demonstration Project

## Contract: RR-06-9092

Submitted to: Illinois Tollway
Open Roads for a Faster Future

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## EXECUTIVE SUMMARY

In an effort to improve the performance of our asphalt pavements and overlays and to improve environmental stewardship, the Illinois Tollway has initiated test pavements to study the use of Ground Tire Rubber (GTR) in hot mix asphalt (HMA) pavements. GTR is derived from recycling auto and small truck tires. The environmental stewardship provided by the use of GTR comes in the recycling of waste materials and in the performance benefits and noise reduction that are expected on the road. Using GTR in HMA has the potential of recycling up to 2,000 tires per lane mile of highway and is anticipated to improve pavement performance.

Potential benefits of using GTR in HMA include longer life, resistance to rutting and cracking, reduced road noise and reduced maintenance costs. The potential to reduce noise levels and noise abatement expenses (sound walls) makes GTR modified HMA worth investigating.

In the fall of 2006, the Tollway included 3 GTR sections in a Tri-State Tollway (I-294) resurfacing contract. Each section included one or more experimental features including Open Graded Friction Course (OGFC) mixtures, Stone Matrix Asphalt (SMA) mixtures, and diabase (Trap Rock) stone. The project was lead by the Tollway materials department and included coordination and cooperation with the Illinois DOT, consultants, and contractors.

The HMA mix designs were successfully designed and produced with little adjustment or problems. The contractor, construction management team, and quality assurance personnel were satisfied with the overall material performance during the paving operations.

A laboratory and field testing plan was conducted by ARA, S.T.A.T.E. testing, Illinois DOT, and the University of Illinois. This testing included HMA materials tests to predict performance, in service pavement condition surveys, noise, surface characteristics, and friction testing. The following conclusions are made from the data collection, analysis, and results.

- GTR has been successfully incorporated into a range of asphalt pavements providing improvements to material test results and engineering properties.
- Using GTR and steel slag aggregate in an SMA or OGFC mixture produces a mixture with over 85% recycled materials with the potential to go up to 95% recycled material.
- The OGFC pavement is stable, performing similar to the other pavement types, and reduced pavement noise. No adverse maintenance issues were noted.

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## BACKGROUND

In an effort to help reduce the environmental impact and overall cost of building highways, the Illinois State Toll Highway Authority (Tollway) undertook a series of test sections to evaluate the performance and viability of various asphalts modified with ground tire rubber. In the fall of 2006 the Tollway included 3 Ground Tire Rubber (GTR) sections in a Tri-State Tollway resurfacing contract. Each section included one or more experimental features. This report documents and summarizes the mix design, production, initial laboratory, and field performance tests.

The decision to proceed with this research project was backed by the assistance and cooperation of a local AC suppler, Seneca Petroleum. Seneca had recently added equipment and storage tanks to offer GTR asphalt cement at a local terminal. They have trucked the GTR AC as far as Phoenix and had several other out-of-state contracts. They approached the Tollway about local GTR use. They shared their out-of-state experience and provided guidance in the development of the Tollway specifications.

The Tri-State (I-294) project offered a convenient opportunity to try GTR mixes with local contractors, asphalt cement, aggregates, weather, and traffic. In June, ISTHA decided to include 3 GTR HMA demonstration sections in the Tri-State project. The project was bid on July 24th and the 3 mixes were produced and placed in October.

### *Use of GTR*

Environmental stewardship is a significant concern for agencies charged with building and maintaining roadways. The environmental impact of a highway comes from a variety of sources and can be mitigated by using environmentally friendly technologies. The environmental stewardship provided by the use of GTR comes in the recycling of waste materials and in the performance benefits and noise reduction that are expected on the road.

The storage, disposal, and recycling of used tires is a massive problem. Old tires are a major component in many landfills across the nation. Tires are bulky with up to 75% of the space that a tire occupies as void, thereby requiring a large amount of space in landfills. Using GTR in hot mix asphalt (HMA) has the potential of recycling up to 2,000 tires per lane mile of highway. As used here, GTR is ground tire rubber from recycled auto and small truck tires. Manufacturing by-product and heavy equipment tires are not part of this GTR designation.

The use of recycled tires to build and improve asphalt pavements provides a good opportunity to utilize recycled material while improving the quality of asphalt pavements. Using GTR in HMA can improve performance and help the surface last longer. Potential benefits include longer life, resistance to rutting and cracking, reduced road noise and reduced maintenance costs. The potential to reduce noise levels and noise abatement expenses (sound walls) makes GTR modified HMA worth investigating.

Recent high-profile projects, such as the City of Chicago's Green Alley Program, have shown that creative solutions to environmental issues can provide solid performance, good public relations, and cost savings.

### *Asphalt Mixes and Test Sections*

The South Tri-State (I-294) resurfacing project offered a convenient opportunity to experiment with GTR mixes using local contractors, asphalt cement, aggregates, weather,

and traffic. The test sections were prepared and paved under typical nighttime construction restrictions. Test sections were constructed on the southbound lanes of the Tri-State Tollway (I-294) in October, 2006 as follows:

1. Standard dense graded HMA located between the Crawford (MP 10.3) and Rexford (MP 9.7) bridges.
2. Open-graded friction course (OGFC) HMA modified with GTR located between the Rexford (MP 9.7) and Kedzie (MP 9.0) bridges.
3. Stone matrix asphalt modified with GTR located between Kedzie (MP 9.0) and Route 147 (MP 8.4) bridges.
4. Dense graded HMA modified with GTR located between Route 147 (MP 8.4) and I-57 (MP 7.8) bridges.

Open Graded Friction Course (OGFC) pavements are high void, porous asphalt mixtures that are used to improve surface friction, decrease water spray, and reduce pavement noise. OGFC mixtures are primarily coarse aggregate with little fine aggregate, yielding a 'popcorn' appearance. OGFC mixtures have a mixed performance history in northern climates where significant snow and ice are encountered. OGFC mixes, when used in applications such as the Tollway, generally have useful service life of approximately 7 years. An OGFC modified with GTR was included in the test sections.

Stone Matrix Asphalt (SMA) asphalt mixtures are high stability mixes that have a gap grading of the aggregate to produce a stone skeleton to carry high loads and a matrix of dust and high asphalt content to improve durability. SMA mixes have been shown to carry high traffic loads with excellent rutting performance and improved durability. Use of SMA mixes in full-depth asphalt pavements is expected to produce pavement surface life of 15 or more years.

### *Study Participants*

This study is a joint effort with the Tollway, the Illinois DOT, consultants, and contractors. The specific participation of each company is provided below.

**Illinois Tollway:** Management, funding, and oversight of all aspects of this project.
**Illinois DOT:** Initial materials specifications, HMA materials testing, and pavement friction testing.
**Applied Research Associates:** Project selection, specification review, mix design review, noise testing, texture measurements, condition surveys, reporting.
**S.T.A.T.E Testing:** Specification review, mix design (OGFC), Quality Assurance.
**Gallagher Asphalt / Central Blacktop (JV):** Contractor.
**Seneca Petroleum:** GTR binder supplier.
**Chicago Testing Lab:** Mix design (SMA & dense graded), and quality control.
**University of Illinois:** HMA materials testing (fatigue & dynamic modulus).

## MIX DESIGNS

Four mix designs were used for this project. A standard dense graded mixture was used as a reference. The experimental asphalt mixtures were an OGFC modified with GTR using traprock as aggregate, a stone matrix asphalt (SMA) with GTR, and a dense graded mixture modified with GTR. The mix designs are included in Appendix I.

### *Dense Graded Superpave Mix*

This is standard ISTHA 12.5-mm HMA surface mix, incorporating GTR-modified AC with the following mix requirements.

- $N_{DES}$ of 105, 4.0% Design Voids, per IDOT specifications
- Coarse Aggregate - "D" mix aggregate, 100% Dolomite
- Asphalt Cement – PG 64-22, blended with GTR at the Terminal. The terminal blend process brings economy and efficiency to rubber asphalt mixes. It eliminates expensive rented equipment for handling the ground rubber at the mix plant, and significantly simplifies mix control.

### *Modified SMA Mix*

Stone Matrix Asphalt (SMA) has become IDOT's preferred mix for Chicago expressway overlays. It has high strength, and expected long durability life because of its heavy AC film thickness. For this project, the Tollway modified the basic IDOT SMA spec, substituting GTR-Modified AC for the highly polymer-modified PG Binder including the following mix requirements.

- $N_{DES}$ of 100, 3.5% Design Voids; minimum VMA – 17.0%
- Coarse Aggregate – Crushed Steel Slag. SMA mixes require an extremely hard aggregate. The IDOT spec requires the use of Crushed Steel Slag. A Tollway special provision to also allow Diabase stone (Trap Rock) was not selected by the contractor.
- Fibers – Required – 0.4% by weight. (Fibers do not reinforce HMA, but prevent drain-down of the AC off the aggregate while in silo storage and transit.)
- Asphalt Cement – PG 64-22, blended with GTR at the Terminal.

SMA's restrictive aggregate specifications and high AC content come with a significant price premium. Owners want performance data to evaluate the payback. This project may provide good long-term data for both ISTHA and IDOT.

### *Open Graded Friction Course*

Open graded friction courses (OGFC) have a very high void content, allowing water to flow vertically and laterally through the mix. OGFC reduces splash and spray, and improves nighttime and traffic striping visibility. One other advantage of OGFC is significant tire noise reduction. They are more common in more temperate climates, where snow and freeze-thaw cycles are not as damaging. The mix requirements follow.

- $N_{DES}$ of 50, 18.0% minimum Design Voids
- Coarse Aggregate – Diabase (Trap Rock). The contractor had an option to use Crushed Steel Slag or Diabase. Like SMA, OGFC requires a hard aggregate that will not break during compaction. The Diabase absorption was 0.3% vs. 1.9% for Slag (spec limit 1.5%).
- Fibers – 0.3% by weight. (0.3 – 0.5% required to prevent drain-down)
- Asphalt Cement – PG 64-22, blended with GTR at the Terminal.

## PRODUCTION AND CONSTRUCTION

Mix designs were successfully produced with relatively little adjustment, including the test strips. Asphalt production and construction were accomplished without major problems. Both S.T.A.T.E. Testing (QA) and Gallagher Asphalt (Contractor) were satisfied with the overall material performance during the paving operation. Specific production detailed comments are provided in Appendix II.

OGFC and SMA asphalt mixes can be prone to drain-down, or the gravity flow of liquid asphalt out of the mix. No significant draindown was observed during this project. Experiments have shown that the use of GTR mitigates drain-down. This effect may have helped prevent potential draindown issues in these test sections. An additional test section

on the same project has empirically shown that OGFC can be produced and placed using GTR witout fibers with no noted drain-down.

In a telephone interview with Gallagher Asphalt, then noted little difficulty in producing Ground Tire Rubber asphalt modified mixes. The liquid asphalt supplier, Seneca Petroleum, had warned Gallagher that potential settlement of the rubber in the liquid asphalt could be problematic. It was determined that producing the HMA from liquid asphalt pumped directly off of a freshly delivered tanker truck would not be sufficient to remedy the issue. Gallagher retro-fitted one of their existing tanks with a circulation pump to draw liquid asphalt from the bottom of the tank and return it to the top of the tank. This extended the amount of time the rubber could be suspended in the asphalt, but was not a complete solution to the minor problem. Some clogging of screens was still encountered. Additional agitation methods may be incorporated by Gallagher in pending GTR work to attempt to remedy the settlement problem.

Gallagher Asphalt expressed some concerns with the production rates they were able to obtain using the GTR modified mixes. Gallagher stated that they would typically expect to lay approximately 2000 tons of standard HMA during a single shift of mainline Tollway paving. They stated that paving production was closer to 1000 tons per shift during this project. Continued use of these asphalts should result in increased paving productivity as the paving crews and roller operators become accustomed to using the new asphalt and develop procedures to accelerate the paving process. The specified compaction was, however, attained without slowing the process.

This project had a tight schedule, including the design, bidding, and construction periods. Coupled with new ingredient materials and the need for new mix designs, this project was a challenge to manage with high potential for problems. However, management, suppliers, contractors, consultants, and the weather cooperated and the project was successfully completed.

## FIELD PERFORMANCE OF PAVEMENTS

ARA visually surveyed the pavement test sections during the first week of May 2007. At that time, all pavements appeared sound and intact. A patch was placed in lane 1 of the OGFC section. The cause of the failure was determined by the Tollway to be underlying pavement failure. All sections exhibited some transverse cracking. The cracking was considered to be within normal limits and does not appear to vary significantly between sections. The cracking was not considered to be related to a problem with the new pavement surface course.

OGFC pavements can be prone to a few problems associated with winter maintenance operations. The porous nature of the pavement can cause the roadway to require additional salting to remain clear of ice. Additionally, the thermal conductivity of the material can cause the roadway to form ice earlier than other asphalt pavement types. Interviews with Tollway maintenance personnel noted that the Tollway did not observe this affect during the first winter of service. This observation was based on empirical evidence rather than formalized data. Future tests may be necessary to document the actual impact on operations. OGFC is also susceptible to clogging of the pore structure by contamination from road dust and de-icing particulates. Cursory inspection showed the OGFC to be clean and clear. No signs of clogging of the OGFC structure are evident.

Rubberized OGFC has been shown to provide high resistance to rutting and reflective cracking. Continued monitoring of the test section will demonstrate whether this benefit has been realized in the section on the Tri-State.

The sections will be formally inspected as part of the annual pavement testing performed by ARA. This testing will include visual condition assessment and structural testing. Further evaluation of the performance of the pavements can be made at that time.

## PAVEMENT NOISE AND TEXTURE EVALUATION

Ground tire rubber has been shown to provide noise reduction benefits when incorporated in asphalt pavements. ARA conducted 2 types of noise surveys to determine if benefits are realized with the GTR test sections: near-field tire/pavement noise measurement and wayside/fence line noise measurement. Complete reporting of these studies to date is available in the attached project memorandums dated 1/16/2007 and 2/14/2007 and provided in Appendix III.

The noise generated by the tire/pavement interface is measured in the near-field tire/pavement noise method, commonly referred to as the On-Board Sound Intensity (OBSI). Readings are taken very close to the tire/pavement interface by a pair of sound intensity microphones mounted to the test vehicle via a specialized bracket adjacent to a low-mileage Goodyear Aquatred tire commonly used by other researchers in the field.

Figure 1 presents the wayside, fence line, and sound intensity measurements for the test sections. Figure 2 presents the mean texture depth of each test section.

### *OGFC Mixture*

The primary objective in using OGFC pavements is noise reduction. Near field testing at the tire/pavement interface demonstrated that the OGFC with GTR was the quietest pavement in the test section. The OGFC also demonstrated the highest mean texture depth. The same open graded property that provides the drainage properties associated with OGFC pavements also serves to trap sound generated by passing tires.

### *SMA Mixture*

SMA mixes are generally found to have similar noise characteristics as dense graded HMA pavements. The SMA with GTR showed higher noise levels at the tire pavement interface. The wayside measurement showed a reduced noise level from the reference section. The next round of noise and texture testing will attempt to address this apparent inconsistency. A larger sample size will be used for wayside noise measurements to attempt to eliminate biasing possibly due to exceptionally large truck noises.

### *Dense Graded HMA Mixture*

The dense graded HMA with GTR showed higher noise levels at the pavement/tire interface than the reference section. This increase in noise was accompanied by a decrease in the mean texture depth of the pavement.

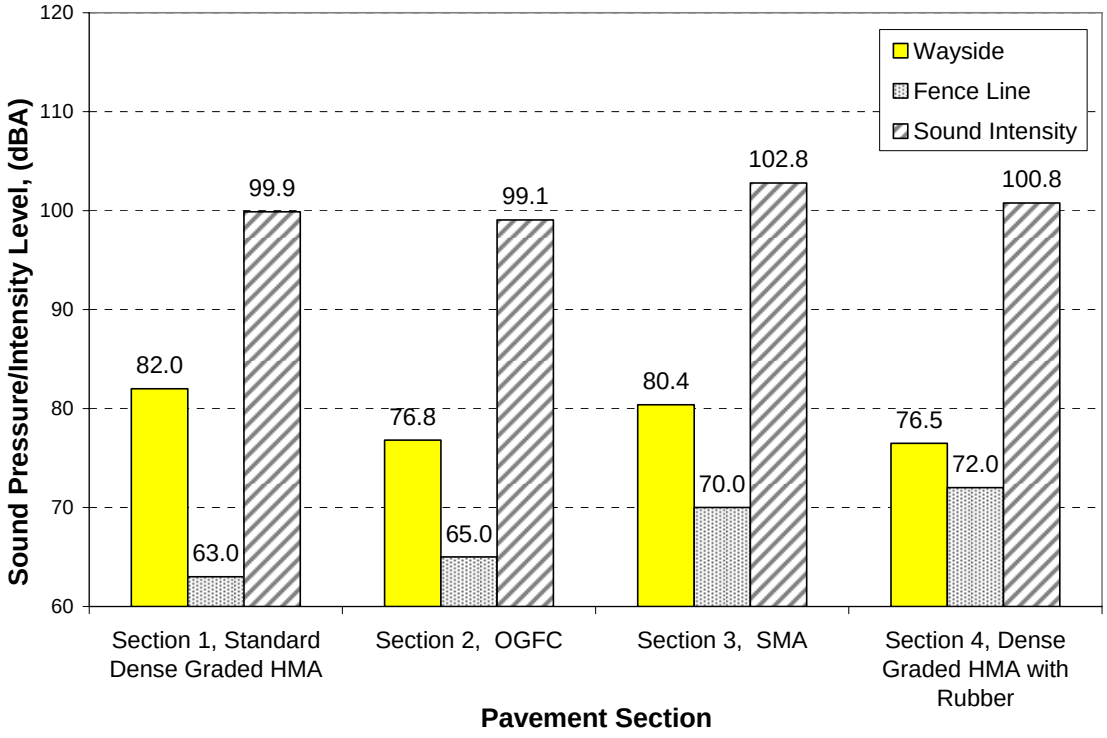



**Figure 1: Noise Measurement Data**

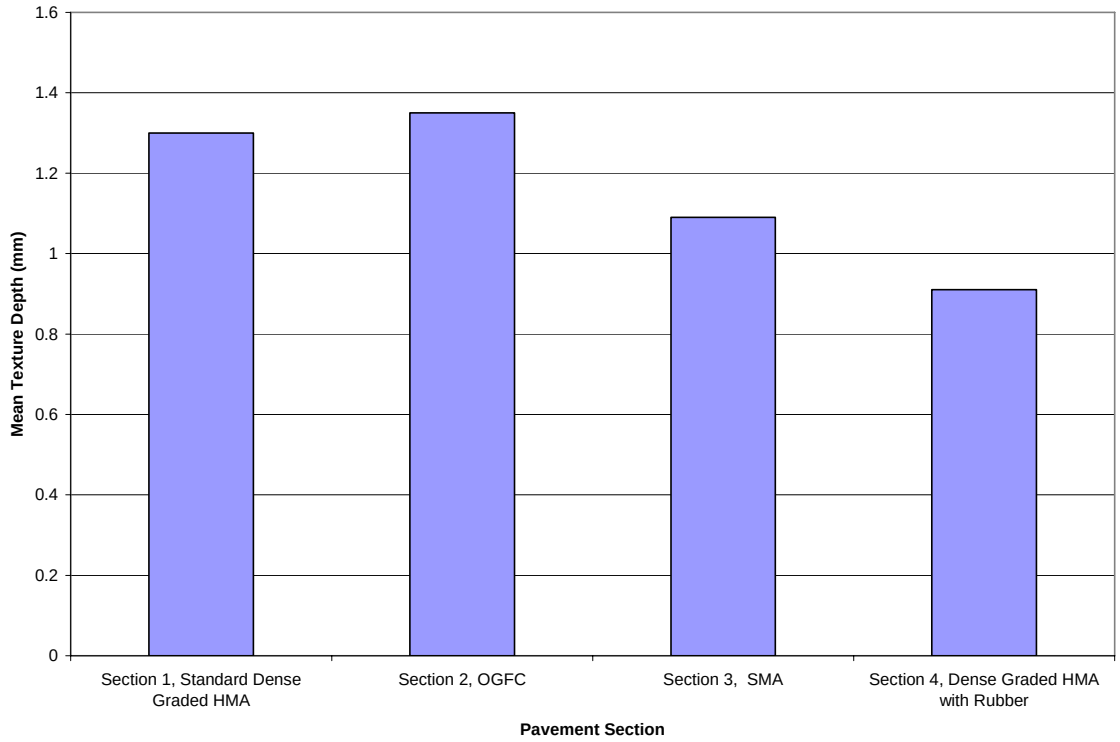



**Figure 2: Texture Measurement Data**

## PAVEMENT FRICTION

IDOT performed ASTM E274 locked-wheel skid testing on the test sections to determine the friction number of each section. The friction number is a measurement of the amount of grip the road has with a skidding tire. The higher the friction number, the better the grip between the road and the tire. All GTR modified pavements exhibited equal or greater friction numbers than the reference pavement (as shown in figure 3). The SMA with GTR pavement generated the highest friction number, thereby demonstrating increased skid resistance.

Test sections 1 and 2 were mistakenly combined into one test segment for the first round of friction testing. As a result, the same value has been reported for both sections. This value is actually an average value for pavement lying in both test sections. The test sections will be clearly marked to prevent this error in future testing. ARA will perform pavement friction testing across the entire Tollway network during the summer of 2007. Additional friction data will be available for comparison at that time. Data will also be available to evaluate the friction difference between SMA with GTR and without GTR. At this time, no OGFC without GTR is available for comparison.

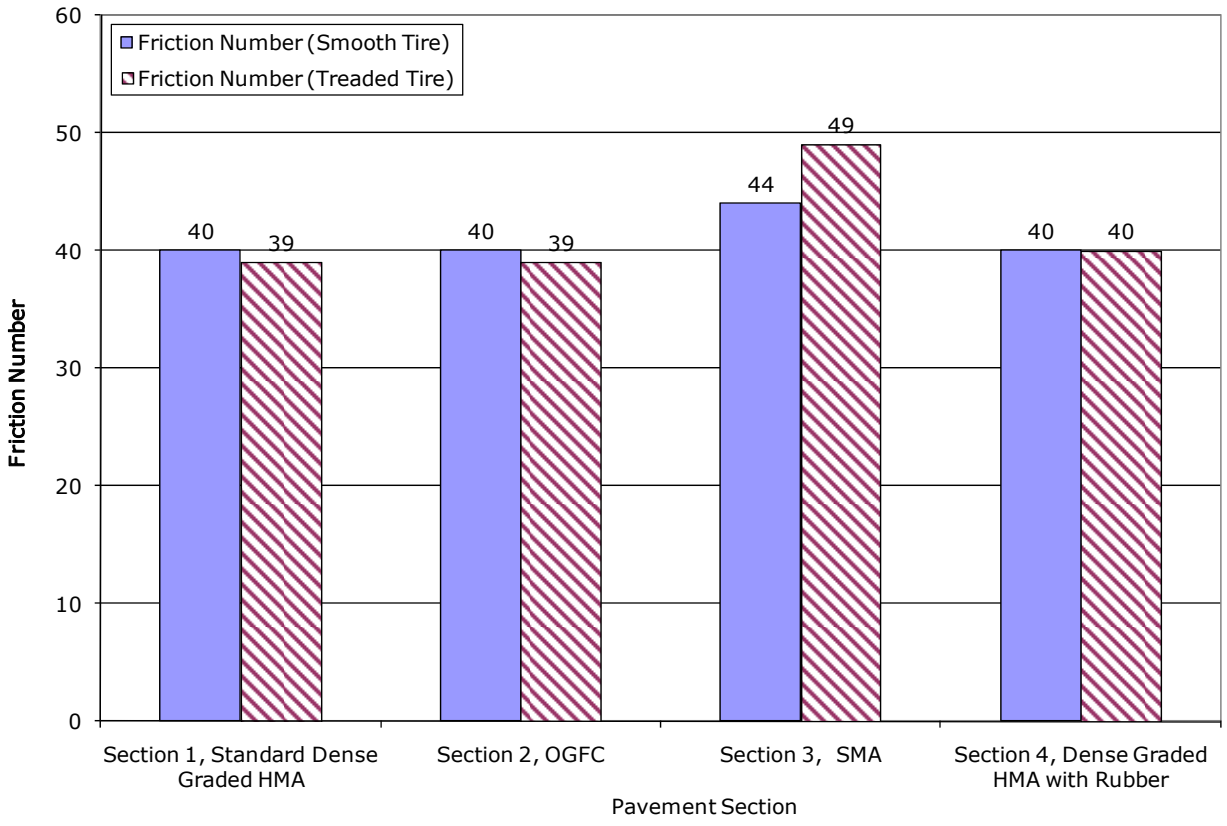



**Figure 3: Pavement Friction**

## LABORATORY TESTING

Laboratory testing of the asphalt mixtures in this project were tested at the ATREL lab at the University of Illinois. Two types of asphalt material testing were performed: fatigue and dynamic modulus. The fatigue testing was performed on the standard dense graded section and the GTR modified dense graded mix. The dynamic modulus was performed on all mixes.

### *Fatigue Testing*

Asphalt fatigue is a distress that is primarily concerned with the bottom-up cracking in a full-depth asphalt section. While the use of GTR is currently not being considered for full-depth applications, fatigue testing is an indication of the fracture toughness of a mixture and its resistance to cracking. Asphalt fatigue testing requires the compaction of asphalt beams that are placed in a testing apparatus and subject to repeated bending. The equipment monitors the loads and deflections during this bending and identifies the failre point as when the sample loses ½ of its initial stiffness. Table 1 shows the fatigue test results for the standard and GTR modified mixes.

**Table 1. Fatigue test data results.**

| | Test Strain (με) | Sample Stiffness (MPa) | Number of Cycles to Failure | Fatigue Slope |
|---|---|---|---|---|
| Standard Mix | 300 | 5,688 | 146,170 | - 3.532 |
| | 500 | 5,159 | 26,310 | |
| | 800 | 4,514 | 4,000 | |
| | 1000 | 4,188 | 2,310 | |
| GTR Modified | 300 | 3,735 | 3,965,110 | - 4.625 |
| | 500 | 3,612 | 115,820 | |
| | 800 | 3,162 | 37,940 | |
| | 1000 | 2,857 | 11,270 | |

The fatigue data show that the GTR modified mixtures provide significantly improved fatigue performance over a standard non-modified mixture. At medium to high strain levels, the GTR provided a fatigue life of 4 to 9 times longer while at low strain levels the GTR sample showed a 27 fold increase in fatigue life. These life increases can be observed by comparing the number of cycles to failure for at a constant strain level. For example at 300 με the standard mix failed at 146,170 cycles where the GTR modified sample failed at 3,965,110 cycles.

The GTR mixture also showed a decreased sample stiffness in the fatigue testing. According to Dr. Sam Carpenter and materials tested by the University of Illinois for IDOT, the fatigue life of the GTR mixtures are similar to SBS modified asphalt mixtures used throughout Illinois.

### *Dynamic Modulus*

The Dynamic modulus of all materials was tested to determine the temperature- and speed-related modulus of the asphalt mixtures. Each material was compacted to 7% air voids and tested at multiple temperatures and frequencies. The dynamic modulus test is the simple performance test that has come from years of asphalt research and is a direct input into the Mechanistic-Empirical Pavement Design Guide. This test presents the response to asphalt materials under dynamic loads under varying temperature and speed conditions.

Dynamic modulus test results are generally presented as an asphalt master curve. The modified power law equation shown below is an appropriate model in the intermediate temperature range, corresponding to the pavement design temperatures. The data in table 2 present the dynamic modulus model parameters shown in the equation below and the modulus of each mix at a standard reference temperature and frequency.

$$E^* = E\infty + \frac{Eo - E\infty}{\left(1 + \left(\frac{1}{\frac{f * at}{\tau o}}\right)\right)^n}$$

Table 2. Dynamic Modulus Master Curve Fit Data and sample modulus point.

| | Standard Dense | GTR Modified Dense | OGFC | SMA |
|---|---|---|---|---|
| n | 0.32 | 0.45 | 0.35 | 0.35 |
| Eo | 2,200,000 | 3,500,000 | 1,300,000 | 2,800,000 |
| Eoo | 30,000 | 30,000 | 30,000 | 50,000 |
| To | 0.04 | 0.15 | 0.007 | 0.005 |
| | | | | |
| **Modulus (20ºC, 10 Hz)** | **400,309** | **550,788** | **129,881** | **242,263** |

The following can be noted regarding the dynamic test results.

- As noted by the University of Illinois, the Tollway Standard Dense graded mix gives similar test results from other IDOT D-1 mixes.
- The GTR Modified Dense graded mix has a higher modulus than the standard dense graded with a decrease in the temperature susceptibility.
- The SMA and OGFC mixes have lower modulus than the dense graded mixes (as expected) without temperature susceptibility.

### *Tensile Strength Ratio*

The Tensile Strength Ratio (TSR) is the ratio between the "wet" indirect tensile strength (IDT) value and the "dry" ITS value for an Asphalt Concrete mixture, expressed in percent form. A low TSR value (below 85%) means that the mix lost a relatively large amount of strength when exposed to heat and moisture, and it can probably be considered a Moisture Susceptible mix. The Illinois DOT performed the TSR test, per Illinois modified AASHTO T-283, on all asphalt mixtures with the data presented in table 3

Table 3. Tensile Strength Ratio Test Results.

| | N50 OGFC w/GTR | N80 SMA w/GTR | N105 w/GTR | N105 Standard |
|---|---|---|---|---|
| Average Unconditioned Strength | 52.9 | 101.2 | 155.6 | 65.7 |
| Average Conditioned Strength | 47.6 | 98.3 | 131.1 | 57.6 |
| Tensile Strength Ratio (TSR) | 0.900 | 0.972 | 0.843 | 0.877 |

Based on these test results the following are noted:

- The highest strengths were on the N105 w/GTR but this mix had the worst TSR (0.843).
- The lowest strength was on the OGFC w/GTR (less than 60 psi minimum on both conditioned and unconditioned) but this mix had a good TSR.
- The second highest strength and the best TSR was on the SMA mix.

- The second lowest strength (unconditioned was above 60 psi and the conditioned was below 60 psi) was on the N105 standard mix. This mix had a passing TSR.

### *Stability (4" and 6" Samples)*

A mixture's stability is the ability to resist deformation from imposed loads. Stability is dependent upon both internal friction and cohesion. This is the traditional test of the performance of an asphalt mixture. The Illinois DOT performed stability tests, per Illinois Modified AASHTO T-245, on both 4-in and 6-in samples. The test result data is noted in table 4.

**Table 4. Laboratory test results for stability**

| | 4" Average Stability | 6" Average Stability |
|---|---|---|
| N50 OGFC w/GTR | 863 | 1,675 |
| N80 SMA w/GTR | 2,829 | 4,833 |
| N105 w/GTR | 4,363 | 9,000 |
| N105 Standard | 1,367 | 2,533 |

Based on these test results the following are noted:

- The mixes are ranked the same as the tensile strength (both conditioned and unconditioned) – N105 w/GTR, SMA, N105 Standard, & OGFC (highest to lowest).
- The 6" stability value is roughly twice the 4" value, which is consistent with previous IDOT tests.

### *Asphalt Pavement Analyzer*

The Asphalt Pavement Analyzer (APA) is a multifunctional Loaded Wheel Tester (LWT) used for evaluating permanent deformation (rutting), fatigue cracking and moisture susceptibility of asphalt mixes. The Illinois DOT performed APA testing, per Illinois Modified AASHTO TP 63-03 on all of the project mixtures with the rutting results presented in table 5. The test was performed using both a pressurized hose and a steel wheel. The number of cycles per millimeter of rut depth is reported to compare the results from all types of testing. Higher values are better results in this test.

**Table 5. Asphalt Pavement Analyzer test results.**

| | Hose Man Cycles / mm | Hose Auto Cycles / mm | SW Man Cycles / mm | SW Auto Cycles / mm |
|---|---|---|---|---|
| N50 OGFC w/GTR | 3,862 | 4,147 | 3,165 | 3,450 |
| N80 SMA w/GTR | 2,974 | 3,319 | 2,127 | 2,432 |
| N105 w/GTR | 9,302 | 7,576 | 3,383 | 5,352 |
| N105 Standard | 3,553 | 4,062 | 966 | 999 |

Based on these test results the following are noted:

- Hoses: The N105 w/ GTR was the best value, then the OGFC, followed by the N105 Standard, and the SMA.
- Steel Wheel: The N105 w/GTR was the best value, then the OGFC, followed by the SMA, and then the N105 Standard.

## USE OF DIABASE STONE AS OGFC AGGREGATE

At this time, no problems have been encountered with the use of Diabase Stone (Trap Rock) in the OGFC. The mineral filler content was increased 0.5% during the first test strip to offset low percentage in the 200 sieve of the traprock samples. No further changes were required. An additional 0.5% was added to the mineral filler on the last night of OGFC paving. The pavement yields a dark black appearance due to the high AC content and black color of the traprock. The pavement is intact and shows no signs of accelerated deterioration.

## CONCLUSIONS

- GTR has been successfully incorporated into a range of asphalt pavements providing improvements to material test results.
- Diabase Stone (Trap Rock) appears to be suitable aggregate for use in OGFC pavements and should be considered a high-type aggregate.
- The OGFC pavement appears to be stable and functioning as an OGFC mix. Continued monitoring will be required to determine the performance over time.
- Further investigation is required to explain the discrepancy between near-field noise measurement at the tire/pavement interface and the wayside noise measurements for the SMA with GTR section.
- Further investigation is required to determine what affect the addition of GTR to the SMA had on texture and pavement noise. Comparisons to the SMA placed on the Kennedy Expressway can be made after the next round of testing.

## DISCLAIMER

The contents of this report reflect the view of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Illinois Tollway or the Illinois Department of Transportation. This report does not constitute a standard, specification, or regulation.

# Appendix I. Asphalt Mix Design Information

DATE: 12-Sep-06

**Bituminous Mixture Design**

Design Number : ---------> 30BIT0548

SEQ NO:

Lab preparing the design ? (PP,PL,IL,etc) IL

Producer Name & Number --> 716-07 Gallagher Asphalt, Thornton

Material Code Number ----> 19544 BIT CONC SC N105 D 12.5 mm

| Agg No. | #1 | #2 | #3 | #4 | #5 | RAP #6 | ASPHALT |
|---|---|---|---|---|---|---|---|
| Size | CM00 | 032CM16 | 038FM20 | | 004MF01 | | 10131 GTR |
| Source ( PROD # ) | 50312-04 | 50312-04 | 50312-04 | | 50312-04 | | 1757-05 |
| ( NAME ) | MS | MS | MS | | MS | | Seneca |
| ( LOC ) | Thornton | Thornton | Thornton | | Thornton | | Lemont |
| | | | | | | | <--%AC in RAP |
| Total Mix Blend | 16.0 | 49.0 | 33.0 | | 2.0 | | <--% RAP |
| Aggregate Blend | 16.0 | 49.0 | 33.0 | | 2.0 | 0.0 | |

100.0 <--Blend Total 100.0

100.0 <--Blend Total; IDOT Verification, Lab #

MD Prepared By ; Lab #" "

| Agg No. / Sieve Size | #1 | #2 | #3 | #4 | #5 | #6 | Aggregate Blend | Mixture Composition Specification | FORMULA | FORMULA RANGE Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1" ( 25.0mm ) | 100.0 | 100.0 | 100.0 | | 100.0 | | 100.0 | | 100 | | |
| 3/4"( 19.0mm ) | 100.0 | 100.0 | 100.0 | | 100.0 | | 100.0 | 100 | 100 | | |
| 1/2" (12.5mm ) | 75.0 | 100.0 | 100.0 | | 100.0 | | 96.0 | 90-100 | 96 | | |
| 3/8" ( 9.5mm ) | 43.0 | 97.0 | 100.0 | | 100.0 | | 89.4 | 89 | 89 | | |
| No.4 (4.75mm ) | 9.0 | 29.0 | 97.0 | | 100.0 | | 49.7 | 24-65 | 50 | 45 | 55 |
| No.8 ( 2.36mm ) | 8.0 | 8.0 | 81.0 | | 100.0 | | 33.9 | 16-40 | 34 | 29 | 39 |
| No.16 ( 1.18mm ) | 4.0 | 4.0 | 50.0 | | 100.0 | | 21.1 | 10-32 | 21 | | |
| No.30 ( 600µm ) | 3.5 | 4.0 | 31.0 | | 100.0 | | 14.8 | | 15 | | |
| No.50 ( 300µm ) | 3.4 | 4.0 | 19.0 | | 100.0 | | 10.8 | 4-15 | 11 | 7 | 15 |
| No.100 ( 150µm ) | 3.0 | 4.0 | 10.0 | | 95.0 | | 7.6 | 3-10 | 8 | | |
| No.200( 75µm ) | 2.8 | 3.2 | 4.0 | | 90.0 | | 5.1 | 4-6 | 5.1 | 3.6 | 6.6 |

| | | | | | | | | Dust/AC Ratio |
|---|---|---|---|---|---|---|---|---|
| Bulk Sp Gr | 2.673 | 2.664 | 2.670 | | 2.900 | | 2.672 | |
| Apparent Sp Gr | 2.715 | 2.790 | 2.766 | | 2.900 | | 2.772 | |
| Absorption, % | 1.60 | 1.70 | 1.30 | | 1.00 | | 1.54 | |
| | | | | | | SP GR AC | 1.150 | 0.95 |

## SUMMARY OF SUPERPAVE GYRATORY DESIGN DATA

BITUMINOUS MIXTURE AGED ____ HOURS @ ____

DATA for N-initial 8

| | AC, %MIX | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Pba | Gse |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 4.2 | 2.092 | 2.543 | 17.8 | 25.0 | 29.0 | 7.24 | 3.98 | 0.23 | 2.686 |
| MIX 2 | 4.7 | 2.124 | 2.533 | 16.1 | 24.2 | 33.4 | 8.09 | 4.38 | 0.34 | 2.693 |
| MIX 3 | 5.2 | 2.137 | 2.513 | 15.0 | 24.2 | 38.0 | 9.20 | 4.95 | 0.27 | 2.688 |
| MIX 4 | 5.7 | 2.150 | 2.495 | 13.8 | 24.1 | 42.7 | 10.29 | 5.51 | 0.21 | 2.685 |

DATA for N-design 105

| | | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Gse | Pba |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 4.2 | 2.343 | 2.543 | 7.9 | 16.0 | 50.7 | 8.11 | 3.98 | 2.686 | 0.23 |
| MIX 2 | 4.7 | 2.373 | 2.533 | 6.3 | 15.3 | 58.9 | 9.04 | 4.38 | 2.693 | 0.34 |
| MIX 3 | 5.2 | 2.398 | 2.513 | 4.6 | 14.9 | 69.3 | 10.32 | 4.95 | 2.688 | 0.27 |
| MIX 4 | 5.7 | 2.413 | 2.495 | 3.3 | 14.8 | 77.9 | 11.55 | 5.51 | 2.685 | 0.21 |

| | NUMBER OF GYRATIONS | %AC | Gmb | Gmm | %VOIDS ( Pa ) Target | VMA | VFA | Gse | Gsb | TSR |
|---|---|---|---|---|---|---|---|---|---|---|
| OPTIMUM DESIGN DATA @Ndes: ----> | 105 | 5.4 | 2.407 | 2.507 | 4.0 | 14.8 | 73.0 | 2.688 | 2.672 | 0.88 |

REMARKS: GTR PG 76-22 used.

DATE: 19-Sep-06

**Bituminous Mixture Design**

Design Number : ---------> 30BIT0549

SEQ NO:

Lab preparing the design ? (PP,PL,IL,etc) IL

Producer Name & Number --> 716-07 Gallagher Asphalt Thornton

Material Code Number ----> 18436 BIT SMA SURFACE 12.5

| Agg No. | #1 | #2 | #3 | #4 | #5 | RAP #6 | ASPHALT |
|---|---|---|---|---|---|---|---|
| Size | 039CM11 | 039CM13 | 038FM20 | | 004MF01 | | 10131 GTR |
| Source ( PROD # ) | 52103-23 | 52103-23 | 50312-04 | | 50312-04 | | 1757-05 |
| ( NAME ) | Heritage | Heritage | M.S. | | M.S. | | Seneca |
| ( LOC ) | Inland | Inland | Thornton | | Thornton | | Lemont |
| | | | | | | 0.0 | <--%AC in RAP |
| Total Mix Blend | 32.7 | 51.0 | 9.8 | | 6.5 | 0.0 | <--% RAP |
| Aggregate Blend | 32.7 | 51.0 | 9.8 | 0.0 | 6.5 | 0.0 | |

100.0 <--Blend Total 100.0

100.0 <--Blend Total; IDOT Verification, Lab #

MD Prepared By ; Lab #" "

| Agg No. / Sieve Size | #1 | #2 | #3 | #4 | #5 | #6 | Aggregate Blend | Mixture Composition Specification | FORMULA | FORMULA RANGE Min | Max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1" ( 25.0mm ) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | | 100 | | |
| 3/4"( 19.0mm ) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100 | 100 | | |
| 1/2" (12.5mm ) | 32.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 77.8 | 82-100 | 78 | | |
| 3/8" ( 9.5mm ) | 6.1 | 81.5 | 100.0 | 100.0 | 100.0 | 100.0 | 59.9 | 60 max | 60 | | |
| No.4 (4.75mm ) | 3.4 | 23.0 | 98.0 | 100.0 | 100.0 | 100.0 | 28.9 | 20-30 | 29 | 24 | 34 |
| No.8 ( 2.36mm ) | 2.5 | 5.6 | 81.0 | 100.0 | 100.0 | 100.0 | 18.1 | 14-24 | 18 | 13 | 23 |
| No.16 ( 1.18mm ) | 1.9 | 4.2 | 50.0 | 100.0 | 100.0 | 100.0 | 14.2 | | 14 | | |
| No.30 ( 600µm ) | 1.5 | 3.4 | 31.0 | 100.0 | 100.0 | 100.0 | 11.8 | 12-16 | 12 | | |
| No.50 ( 300µm ) | 1.8 | 3.0 | 19.0 | 100.0 | 100.0 | 100.0 | 10.5 | 10-15 | 10 | 6 | 14 |
| No.100 ( 150µm ) | 1.8 | 2.7 | 10.0 | 100.0 | 100.0 | 100.0 | 9.4 | | 9 | | |
| No.200( 75µm ) | 1.2 | 2.1 | 4.0 | 100.0 | 100.0 | 100.0 | 8.4 | 8-10 | 8.4 | 6.9 | 9.9 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Bulk Sp Gr | 3.412 | 3.409 | 2.670 | 0.000 | 2.900 | 1.000 | 3.283 | |
| Apparent Sp Gr | 3.609 | 3.632 | 2.766 | 0.000 | 2.900 | 1.000 | 3.462 | Dust/AC |
| Absorption, % | 1.60 | 1.80 | 1.30 | 0.00 | 1.00 | 1.00 | 1.63 | Ratio |
| | | | | | | SP GR AC | 1.031 | 1.37 |

## SUMMARY OF SUPERPAVE GYRATORY DESIGN DATA

BITUMINOUS MIXTURE AGED 2 HOURS @ 305

DATA for N-initial 8

| | AC, %MIX | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Pba | Gse |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 5.5 | 2.554 | 2.976 | 14.2 | 26.5 | 46.5 | 12.33 | 4.98 | 0.56 | 3.343 |
| MIX 2 | 6.0 | 2.567 | 2.943 | 12.8 | 26.5 | 51.8 | 13.73 | 5.52 | 0.51 | 3.338 |
| MIX 3 | 6.5 | 2.577 | 2.916 | 11.6 | 26.6 | 56.3 | 14.98 | 5.99 | 0.54 | 3.341 |
| MIX 4 | 7.0 | 2.583 | 2.884 | 10.4 | 26.9 | 61.1 | 16.41 | 6.55 | 0.48 | 3.335 |

DATA for N-design 80

| | | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Gse | Pba |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 5.5 | 2.817 | 2.976 | 5.3 | 18.9 | 71.8 | 13.59 | 4.98 | 3.343 | 0.56 |
| MIX 2 | 6.0 | 2.832 | 2.943 | 3.8 | 18.9 | 80.0 | 15.15 | 5.52 | 3.338 | 0.51 |
| MIX 3 | 6.5 | 2.843 | 2.916 | 2.5 | 19.0 | 86.8 | 16.53 | 5.99 | 3.341 | 0.54 |
| MIX 4 | 7.0 | 2.851 | 2.884 | 1.1 | 19.2 | 94.1 | 18.12 | 6.55 | 3.335 | 0.48 |

| | NUMBER OF GYRATIONS | %AC | Gmb | Gmm | %VOIDS ( Pa ) Target | VMA | VFA | Gse | Gsb | TSR |
|---|---|---|---|---|---|---|---|---|---|---|
| OPTIMUM DESIGN DATA @Ndes: ----> | 80 | 6.1 | 2.835 | 2.938 | 3.5 | 18.9 | 81.5 | 3.339 | 3.283 | 0.00 |

REMARKS:

Bituminous Mixture Design

DATE: Sep-12-06

Design Number : ----------> STATE06001

SEQ NO:

Lab preparing the design ? (PP,PL,IL,etc) IL

Producer Name & Number -->

Material Code Number ---->

OPEN - GRADED FRICTION COURSE

| Agg No. | #1 | #2 | #3 | #4 | #5 RAP | #6 | ASPHALT |
|---|---|---|---|---|---|---|---|
| Size | 022CM13 | | | | 004MF01 | | 10131(GTR) |
| Source ( PROD # ) | 52402-14 | | | | 50312-04 | | 1757-05 |
| ( NAME ) | RME | | | | M.S. | | Seneca |
| ( LOC ) | Athens, WI | | | | Thornton | | Lemont |
| | | | | | | 0.0 | <--%AC In RAP |
| Total Mix Blend | 99.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | <--% RAP |
| Aggregate Blend | 99.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | |

100.0 <--Blend Total 100.0

100.0 <--Blend Total; IDOT Verification, Lab #

MD Prepared By ; Lab #" "

| Agg No. Sieve Size | #1 | #2 | #3 | #4 | #5 | #6 | Aggregate Blend |
|---|---|---|---|---|---|---|---|
| 1" ( 25.0mm ) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 3/4"( 19.0mm ) | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1/2" (12.5mm ) | 97.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 97.0 |
| 3/8" ( 9.5mm ) | 74.3 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 74.6 |
| No.4 (4.75mm ) | 19.2 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 20.0 |
| No.8 ( 2.36mm ) | 4.7 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 5.7 |
| No.16 ( 1.18mm ) | 3.4 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 4.4 |
| No.30 ( 600µm ) | 3.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 4.0 |
| No.50 ( 300µm ) | 2.8 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 3.8 |
| No.100 ( 150µm ) | 2.6 | 100.0 | 100.0 | 100.0 | 95.0 | 100.0 | 3.5 |
| No.200( 75µm ) | 2.2 | 100.0 | 100.0 | 100.0 | 90.0 | 100.0 | 3.1 |

| Mixture Composition Specification | FORMULA | FORMULA RANGE Min | Max |
|---|---|---|---|
| | 100 | | |
| 100 | 100 | | |
| 85-100 | 97 | | |
| 70-90 | 75 | | |
| 10-35 | 20 | 15 | 25 |
| 5-10 | 6 | 1 | 11 |
| | 4 | | |
| | 4 | | |
| | 4 | 0 | 8 |
| | 4 | | |
| 2.0-4.0 | 3.1 | 1.6 | 4.6 |

| | | | | | | | Dust/AC Ratio |
|---|---|---|---|---|---|---|---|
| Bulk Sp Gr | 2.858 | 1.000 | 1.000 | 1.000 | 2.900 | 1.000 | 2.858 |
| Apparent Sp Gr | 2.888 | 1.000 | 1.000 | 1.000 | 2.900 | 1.000 | 2.888 |
| Absorption, % | 0.37 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.38 |
| | | | | | | SP GR AC | 1.032 |

## SUMMARY OF SUPERPAVE GYRATORY DESIGN DATA

BITUMINOUS MIXTURE AGED [ ] HOURS @ [ ]

DATA for N-initial 6

| | AC, %MIX | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Pba | Gse |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 5.0 | 0.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.00 | #DIV/0! | #DIV/0! | 0.000 |
| MIX 2 | 5.5 | 0.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.00 | #DIV/0! | #DIV/0! | 0.000 |
| MIX 3 | 6.0 | 0.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.00 | #DIV/0! | #DIV/0! | 0.000 |
| MIX 4 | 6.5 | 0.000 | 0.000 | 0.0 | 0.0 | 0.0 | 0.00 | #DIV/0! | #DIV/0! | 0.000 |

DATA for N-design 50

| | | ( Gmb ) | ( Gmm ) | ( Pa ) | VMA | VFA | Vbe | Pbe | Gse | Pba |
|---|---|---|---|---|---|---|---|---|---|---|
| MIX 1 | 5.0 | 2.001 | 2.652 | 24.5 | 33.5 | 26.7 | 8.94 | 4.61 | 2.891 | 0.41 |
| MIX 2 | 5.5 | 2.033 | 2.630 | 22.7 | 32.8 | 30.8 | 10.09 | 5.12 | 2.890 | 0.40 |
| MIX 3 | 6.0 | 2.077 | 2.599 | 20.1 | 31.7 | 36.6 | 11.60 | 5.77 | 2.878 | 0.25 |
| MIX 4 | 6.5 | 2.125 | 2.575 | 17.5 | 30.5 | 42.7 | 13.00 | 6.31 | 2.874 | 0.20 |

| | |
|---|---|
| VCAdrc | 40.8 |
| VCAmix | 35.6 |

| | NUMBER OF GYRATIONS | %AC | Gmb | Gmm | %VOIDS ( Pa ) Target | VMA | VFA | Gse | Gsb | Pbe | Pba |
|---|---|---|---|---|---|---|---|---|---|---|---|
| OPTIMUM DESIGN DATA @Ndes: ----> | 50 | 6.0 | 2.077 | 2.599 | 20.1 | 31.7 | 36.6 | 2.878 | 2.858 | 5.77 | 0.25 |

REMARKS: FIBERS = 0.3% DRAINDOWN = 0.0% STABILITY = 1737.5 FLOW = 29.5 TSR = N/A

Tested by :

Reviewed by : X

Final Approval :

## Appendix II. Construction Quality Control Results and Comments

# S.T.A.T.E. TESTING, LLC

**PROJECT DATA COLLECTION**
**SPECIALTY MIXES**

**S.T.A.T.E. TESTING** Project Number: RR-06-5398

Specialty Mix: Type: GTR IL-12.5 N105 Surface

Unique features:

- Terminal Blend GTR AC, blended by Seneca.
- Night Construction

Owner/Agency: ISTHA
Project Number: RR-06-5398
Mix Designer: CTL 90BIT0613
QC Agency: CTL
QA Agency: S.T.A.T.E. Testing
Location: I-294 Southbound, Mile 6.4 – 7.38
Quantity: 2,399.3 Tons 2,571 Plan
Contractor Gallagher Asphalt
Mix Producer: Gallagher Asphalt
Production Dates, Notes:
Production Dates: October 15, 17, and 19, 2006

## IDOT Friction Results – Smooth 40, Treaded 45

Attach when notified that a report will be published

☒ Mix Specification
☒ Mix Design Cover Sheet – Number:
☒QC/QA Tests
☐ Pictures
☐ CD to file

Reported by: Matt Galloy

# S.T.A.T.E. TESTING, LLC

## QC/QA DATA COLLECTION
## SPECIALTY MIXES

**Mix Description: GTR IL-12.5 N105 Surface**

**Project: ISTHA I-294 GTR Demonstration**

**SPECIFICATION:**

| $N_{DES}$ | PG Grade | AC% | Fibers | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 105 | 64-22 + GTR | | | 4.0 | 14.0 | 65-75 |

**MIX DESIGN DATA:** **Number: 90BIT0613**

| $N_{DES}$ | AC% | $G_{MB}$ | $G_{MM}$ | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 105 | 5.4 | 2.407 | 2.507 | 4.0 | 14.8 | 73.0 |

| PG Grade | $G_{SE}$ | $G_{SB}$ | TSR | P200:AC | Fibers |
|---|---|---|---|---|---|
| 64-22 + GTR | 2.688 | 2.672 | 0.88 | 0.895 | |

**MIX ADJUSTMENTS:** 10/15/06 Test Strip: Change was made prior to production first 150 tons A.C. @ 5.5; second 150 tons A.C. @ 5.7. Bin percentages were as follows CMOO- 16.0, CM 16- 49.0, FM20- 33.0, and Mineral Filler- 2.0. Air void results are as follows on TS 1 QC 3.8% QA *5.1%* TS2 QC 5.7% QA 6.5%

10/17/06 Change was made prior to production 0.5% added to Mineral Filler taken from CMOO, A.C. up by .10%. Bin percentages were as follows CMOO- 15.5, CM1649.0, FM20- 33.0, Mineral Filler — 2.5, A.C. 5.5. (36 bags were sampled)
Air void results are as follows TS 1 QC 2.9% QA 3.3% TS2 QC 2.8%

10/19/06 Change was made prior to production by Q.C. 0.5% from Mineral Filler added to CM16, A.C. cut by .1%. Bin percentages were as follows CMOO- 15.5, CM16 - *49.5,* FM20- 33.0, Mineral Filler- 2.0, and A.C. 5.4. Air void results are as follows QC 4.3% QA6.1%

**QC/QA PLANT TESTS:**

| Date | QC/QA/IA | $G_{MB}$ | $G_{MM}$ | Voids | AC% | Tons |
|---|---|---|---|---|---|---|
| 10-15 TS1 | QC | 2.383 | 2.476 | 3.8 | 5.7 | 310.4 |
| | QA | 2.366 | 2.494 | 5.1 | 5.3 | |
| TS2 | QC | 2.364 | 2.508 | 5.7 | 5.5 | |
| | QA | 2.355 | 2.520 | 6.5 | 5.25 | |
| | | | | | | |
| 10-17 TS1 | QC | 2.421 | 2.492 | 2.9 | 5.9 | 1,277.4 |
| | QA | 2.409 | 2.490 | 3.3 | 5.77 | |
| TS2 | QC | 2.427 | 2.499 | 2.8 | 5.5 | |
| | | | | | | |
| 10-19 TS1 | QC | 2.378 | 2.486 | 4.4 | 5.8 | 811.5 |
| | QA | 2.355 | 2.509 | 6.1 | 5.8 | |

**DENSITY TESTS:**

| Date | QC | QA | IA |
|---|---|---|---|
| 10-15 | 93.9 | 94.5 | |
| 10-17 | 94.4 | 94.5 | |

# S.T.A.T.E. TESTING, LLC

**PROJECT DATA COLLECTION**
**SPECIALTY MIXES**

**S.T.A.T.E. TESTING** Project Number: RR-06-5398

Specialty Mix: Type: **GTR Stone Matrix Asphalt (SMA) Surface**

Unique features (ingredient materials, performance, etc,)
This is one of 3 GTR mixes placed under the same contract. The others are a N105 dense graded Superpave mix and a new Open Graded Friction Course (OGFC). ISTHA sponsored this demonstration project to determine if Ground Tire Rubber (GTR) provides improved physical properties to HMA mixes. They are particularly interested in potential noise reduction.

This mix incorporated terminal-blended GTR. Past GTR projects in Illinois incorporated the rubber modifier either as a dry mix ingredient or liquid AC additive. A local AC supplier, Seneca Petroleum, has developed a terminal blending process that reduces much of the complexity, uncertainty, and cost of incorporating GTR into virgin AC.

Owner/Agency: ISTHA
Project Number: RR-06-5398
Mix Designer: CTL 90BIT0612
QC Agency: CTL
QA Agency: S.T.A.T.E. Testing
Location: I-294 Southbound Lanes MP 7.38 – 8.38
Quantity: 2,174 Tons
Contractor Gallagher Asphalt
Mix Producer: Gallagher Asphalt
Production Dates, Notes:
Production Dates: Cotober 8, 9, 10, and 15, 2006
IDOT Friction results Smooth 40, Treaded 40

Attach when notified that a report will be published
☒ Mix Specification
☐ Mix Design Cover Sheet – Number:
☐ QC/QA Tests
☐ Pictures
☐ CD to file

Reported by: Matt Galloy

# S.T.A.T.E. TESTING, LLC

**QC/QA DATA COLLECTION**
**SPECIALTY MIXES**

**Mix Description: SMA Surface 12.5, $N_{105}$ , GTR Binder**

**Project: ISTHA I-294 GTR Demonstration**

**SPECIFICATION:**

| $N_{DES}$ | PG Grade | AC% | Fibers | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 80 | GTR | | Y | 3.50 | 17.0 | 75-85 |

**MIX DESIGN DATA:** **Number:**

| $N_{DES}$ | AC% | $G_{MB}$ | $G_{MM}$ | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 80 | 6.1 | 2.835 | 2.938 | 3.5 | 19.0 | 81.5 |

| PG Grade | $G_{SE}$ | $G_{SB}$ | TSR | P200:AC | Fibers |
|---|---|---|---|---|---|
| GTR | 3.339 | 3.285 | 0.90 | 1.33 | |

**MIX ADJUSTMENTS:**
**10-15 Mix w/o fibers; Draindown = 0.003 (Spec = 0.3)**

10/8/06 Test Strip: Change was made prior to test strip by Q.C.; 1.0% from mineral filler added to CM 11. Bin percentages were as follows CM 11- 33.7, CM13- 51.0, FM209.3, Mineral Filler- 6.0, and A.C. - 6.1. Air void results are as follows on TS 1 QC 4.2% QA *3.9%* TS2 QC 5.6% QA *5.5%*

10/9/06 Change was made prior to production by Q.C. 1.0% mineral filler added from CM 11 A.C. up .1%. Bin percentages were as follows CM 11- 32.7, CM13- 51.0, FM20- 9.3, Mineral Filler- 7.0, and A.C. - 6.2. Air voids were out of specification. Change was made @ approximately 680 tons. The changes were as follows A.C. raised by 0.2%, Mineral Filler up by 1.0%. Bin percentages were as follows CM 11- 31.7, CM13- 51.0, FM20- 9.3, Mineral Filler- 8.0, and A.C.-6.4. Air void results were as follows on re-sample QC 3.5% QA 4.6%

10/10/06 Change prior to production 1.0% from Mineral Filler added to CM13 A.C. added 0.2%. Bin percentages were as follows CM 11- 32.7, CM13- 52.0, FM20- 9.3, Mineral Filler - 6.0%, A.C. - 6.6%. (36 bags were sampled). Air void results were as follows QC 3.0% QA 3.5%

**QC/QA PLANT TESTS:**

| Date | QC/QA/IA | $G_{MB}$ | $G_{MM}$ | Voids | AC% | Tons |
|---|---|---|---|---|---|---|
| 10-8 TS1 | QC | 2.889 | 3.015 | 4.2 | 5.6 | 378.4 |
| Split | QA | 2.875 | 2.992 | 3.9 | 5.87 | |
| TS2 | QC | 2.867 | 3.036 | 5.6 | 5.3 | |
| Split | QA | 2.865 | 3.032 | 5.5 | 5.76 | |
| | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **10-9 TS1** | **QC** | **2.861** | **3.009** | **5.0** | **5.6** | **902.9** |
| **TS2** | **QC** | **2.875** | **2.979** | **3.6** | **6.8** | |
| **Split** | **QA** | **2.867** | **3.006** | **4.6** | **5.94** | |
| | | | | | | |
| **10-10 TS1** | **QC** | **2.854** | **2.943** | **3.0** | **5.7** | **626.7** |
| **Split** | **QA** | **2.850** | **2.953** | **3.5** | **5.69** | |
| **TS2** | **QC** | **2.842** | **2.965** | **4.1** | **6.0** | |
| | | | | | | |
| **10-15 TS1** | **QC** | **2.838** | **2.924** | **3.0** | **6.6** | **266.3** |
| **Split** | **QA** | **2.781** | **2.934** | **5.2** | **6.10** | |

**DENSITY TESTS:**

| Date | QC | QA | IA |
|---|---|---|---|
| **10-8** | **94.1** | **94.8** | |
| **10-9** | **96.3** | **94.0** | |
| **10-10** | **95.1** | **95.4** | |

# S.T.A.T.E. TESTING, LLC

**PROJECT DATA COLLECTION**
**SPECIALTY MIXES**

**S.T.A.T.E. TESTING** Project Number: RR-06-5398

Specialty Mix: Type: GTR Open Graded Friction Course (OGFC)

Unique features: A first use of Terminal Blend GTR in Illinois. One of the first attempts at an OGFC with modified AC. Coarse Aggregate was RME Diabase (Trap Rock).

Owner/Agency: ISTHA
Project Number: RR-06-5398
Mix Designer: S.T.A.T.E. Testing 90Bit0611
QC Agency: CTL
QA Agency: S.T.A.T.E. Testing
Location: I-294 Southbound MP 8.38 – 9.26
Quantity: 2,114.8 T Tons (2,744 Plan)
Contractor Gallagher Asphalt
Mix Producer: Gallagher Asphalt
Production Dates, Notes:
10/3, 10/4, and 10/5/06

IDOT Friction Smooth 44, Treaded 49
Attach when notified that a report will be published
☒ Mix Specification
☒ Mix Design Cover Sheet – Number: 90BIT0611
☒ QC/QA Tests
☐ Pictures
☐ CD to file

Reported by: Matt Galloy

# S.T.A.T.E. TESTING, LLC

## QC/QA DATA COLLECTION
## SPECIALTY MIXES

**Mix Description: Open Graded Friction Course GTR**

**Project: ISTHA GTR Demonstration Project 2006**

**SPECIFICATION:**

| $N_{DES}$ | PG Grade | AC% | Fibers | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 50 | 64-22 +GTR | 6.0 min. | Y | 18.0 min. | | |

**MIX DESIGN DATA:** **Number:**

| $N_{DES}$ | AC% | $G_{MB}$ | $G_{MM}$ | Voids | VMA | VFA |
|---|---|---|---|---|---|---|
| 50 | 6.0 | 2.077 | 2.599 | 20.1 | 31.7 | 36.6 |

| PG Grade | $G_{SE}$ | $G_{SB}$ | TSR | P200:AC | Fibers |
|---|---|---|---|---|---|
| 64-22 +GTR | 2.878 | 2.858 | N/A | 0.51 | 0.3% |

**MIX ADJUSTMENTS:**

10/3/06 Test Strip: Change was made prior to test strip; 0.5% from mineral filler added to CM13 due to the 200 sieve on the CM13 @ 2.8%. Bin percentages were as follows CM13- 99.5, Mineral Filler- 0.5, A.C. - 6.0. Air void results were as follows on TS 1 QC 19.1% QA 18.2% TS2 QC 22.8% QA 22.9%

10/4/06 No changes to mix (36 bags were sampled). Bin percentages same as

10/3/06 Air void results were as follows QC 20.4% QA 20.4%

10/5/06 Change to mix; 0.5% from CM13 added 0.5% to mineral filler. Change was made for informational purpose only. Bin percentages were as follows CM1 3- 99.0 Mineral Filler- 1.0, A.C. - 6.0 Air void results were as follows QC 20.9 % QA 21.1 %

**QC/QA PLANT TESTS:**

| Date | QC/QA/IA | $G_{MB}$ | $G_{MM}$ | Voids | AC% | Tons |
|---|---|---|---|---|---|---|
| 10-3 TS1 | QC | 2.101 | 2.600 | 19.2 | 6.3 | 436.5 |
| | QA | 2.114 | 2.585 | 18.2 | 5.77 | |
| TS2 | QC | 2.043 | 2.645 | 22.8 | 4.8 | |
| | QA | 2.043 | 2.649 | 22.8 | 5.81 | |
| | | | | | | |
| 10-4 TS1 | QC | 2.075 | 2.604 | 20.2 | 6.2 | 841.9 |
| | QA | 2.077 | 2.607 | 20.4 | 5.79 | |
| | | | | | | |
| 10-5 TS1 | QC | 2.064 | 2.608 | 20.9 | 5.7 | 836.4 |
| | QA | 2.063 | 2.616 | 21.1 | 5.90 | |

**DENSITY TESTS: Density monitored via percent-growth curve method.**

## Appendix III. GTR Noise and Surface Texture Memorandums

APPLIED RESEARCH ASSOCIATES, INC.
An Employee Owned Company

# PROJECT MEMORANDUM

| | | | |
|---|---|---|---|
| To: | Steve Gillen | From: | Paul Littleton/Mike Harrell/Bill Vavrik |
| | | Date: | 16 January 2007 |
| | | ARA No: | 16436-06D1 |

Contract: RR-03-9091
Pavement/Infrastructure Management Services, System-wide

Re: South Tri-State Noise and Texture Survey

## NOISE BACKGROUND

Sources of highway noise include vehicle engines, drive train and exhaust, wind turbulence, and tire/pavement noise. The following sections presents findings from noise testing at the tire/pavement interface on the south Tri-State HMA overlay test sections constructed in fall of 2006.

## NOISE STUDY METHODOLOGY

This study utilized near-field tire/pavement noise measurement method. Readings are taken very close to the tire/pavement interface by a pair of sound intensity microphones mounted to the test vehicle via a specialized bracket adjacent to a low-mileage Goodyear Aquatred tire commonly used by other researchers in the field. Figures 1 and 2 show the microphone bracket assembly.

Figures 1 and 2 show the sound intensity microphones mounted to the test vehicle.

This method of tire/pavement noise evaluation was developed by General Motors to collect directional measurements from the point where the tire contacts the pavement. Sound measured by this method is the rate of sound energy (Watt) flow through a unit area (square meter), which provides sound intensity ($W/m^2$) from a single source. Unlike the NCAT CPX trailer which utilizes free field microphones to measure sound pressure (Pascal), the intensity microphone pair are positioned closer to the source of the tire/pavement noise and do not require an acoustical chamber to shield outside noises such as wind, powertrain, or passing vehicles.

## NOISE RESULTS AND ANALYSIS

Sound intensity measurements were taken from the following five test sections on the south Tri-State, southbound:

1. Standard dense graded HMA located between the Crawford (MP 10.3) and Rexford (MP 9.7) bridges.
2. Open-graded friction course (OGFC) HMA located between the Rexford (MP 9.7) and Kedzie (MP 9.0) bridges.
3. Stone matrix asphalt located between Kedzie (MP 9.0) and Route 147 (MP 8.4) bridges.
4. Dense graded HMA with 10 percent recycled tire rubber located between Route 147 (MP 8.4) and I-57 (MP 7.8) bridges.
5. Standard dense graded HMA located between I-57 (MP 7.8) and plaza 41 (MP 5.2).

Noise data from lanes 1 and 3 make up the average for each section. Test results from lane 2 were considerably higher and variable and were excluded from this analysis. Testing was conducted at 60 mph, on dry pavement. For comparison, noise data was collected from new CRCP on the Reagan Tollway just west of the Naperville Road interchange and from JPCP on the North-South Tollway between Maple Avenue and 83rd Street. Figure 3 graphically shows the mean sound intensity levels.

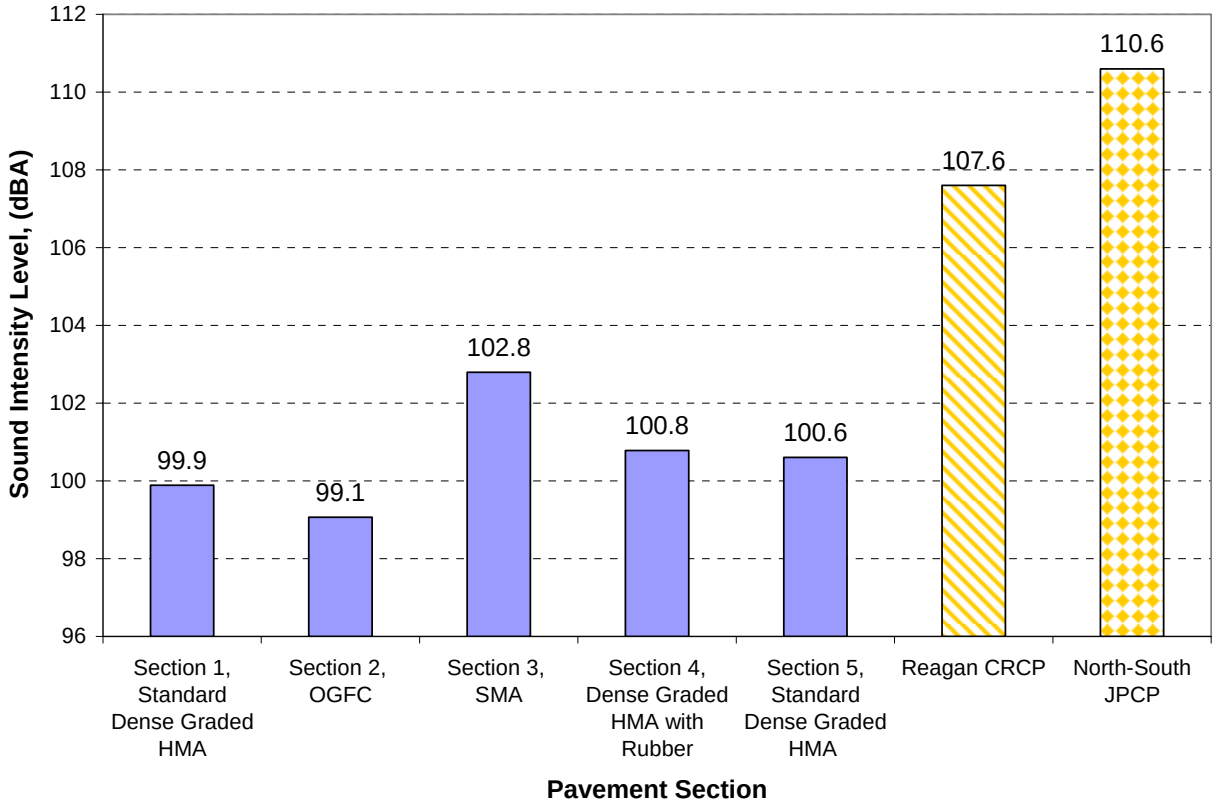



Figure 3. Mean sound intensity values for the south Tri-State test sections, Reagan and North-South Tollway.

Sound intensity values are reported in decibel (dB) logarithm and normalized to the typical range of human hearing or "A" weighted scale (noted as dBA). For reference, an increase of 10 dB represents a doubling of sound intensity. In general, a difference of 2.0 to 3.0 decibels is considered noticeable to the human ear; therefore, the difference between the SMA section and the other asphalt sections are significant. Sections 1, 4, and 5 are relatively close in intensity. There is a discernable difference between the OGFC of section 2 having the lowest value (99.1 dBA) and the SMA having the highest value (102.8 dBA). The standard dense graded mix in section 1 and section 5 are fairly consistent, varying by less than 1.0 dBA.

As expected, the regularly spaced, transversely tined concrete pavements are much noisier than the south Tri-State asphalt test sections. Unlike HMA surfaces, tires on tined concrete pavements generate extra sound from the tire impacting the grooves. In the case of JPCP, additional noise is generated from the slapping of the tire against the joints.

## PAVEMENT TEXTURE

A high-speed optical profiler was utilized to collect macrotexture measurements at the same time as the noise recordings. Macrotexture is the range of roughness between 0.02 and 2.00-in (0.05 to 50.00 mm). This range excludes microtexture texture of the smallest aggregates and megatexture associated with any major bump or waviness in the road. The distribution of large-size aggregate in HMA surfaces and finishing techniques in PCC pavements have the most influence on macrotexture which in turn influence tire/pavement noise and friction.

The macrotexture data is reported as the estimated mean texture depth (MTD) in accordance to ASTM E 1845. Figure 4 shows the MTD for the same sections described for the noise survey. A change of 0.25 mm in MTD is considered significant.

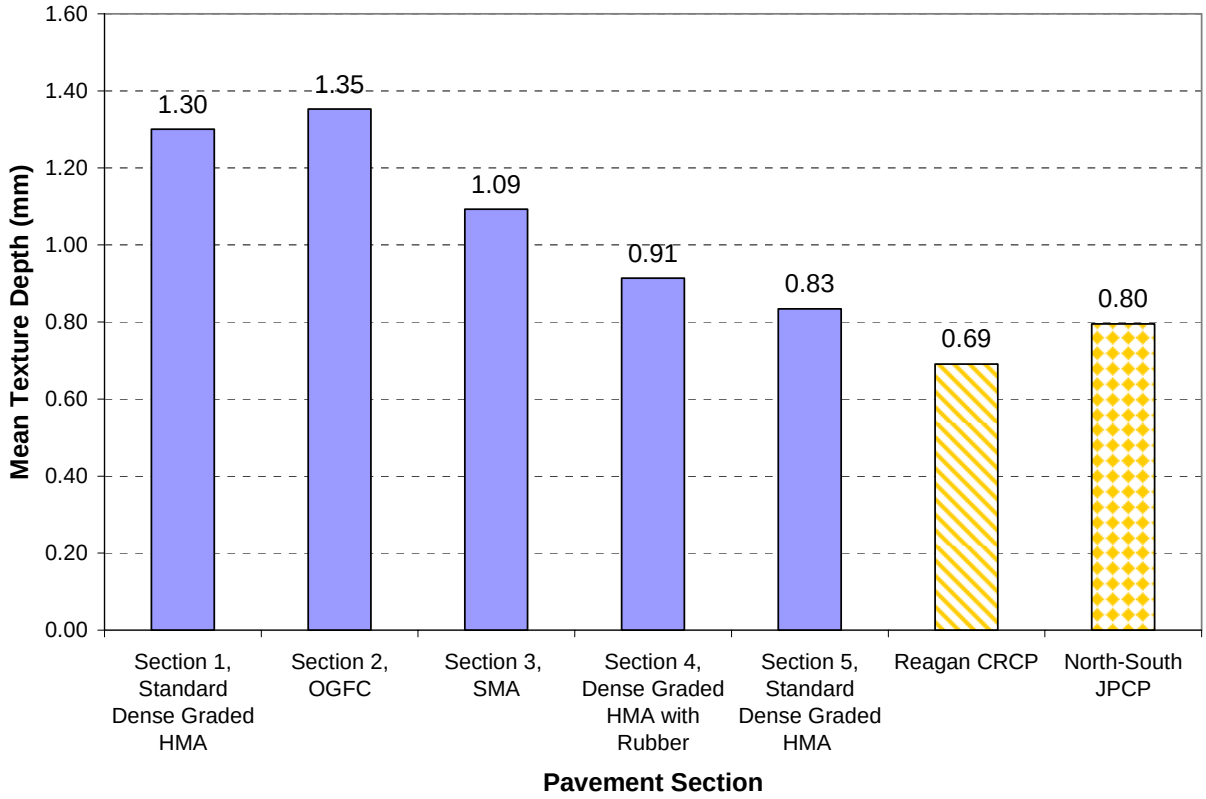



Figure 4. Mean texture depths for the south Tri-State test sections, Reagan and North-South Tollway.

The small cavities that make up macrotexture have the ability to absorb tire/pavement noise by trapping sound under the advancing tire. This relationship between macrotexture and noise level is evident in the OGFC having the lowest sound intensity level and the highest mean texture depth. The standard HMA in section 1 shows the same inverse relationship whereas the SMA does not follow this trend entirely, as it had the highest sound intensity level of the HMA sections but the MTD value was closer to the median value of all the HMA sections. Sections 4 and 5 both have moderate MTD and sound intensity values. The standard dense graded HMA in sections 1 and 5 should be closer in texture, assuming they are in fact the same material. PCC MTD is lower than the asphalt sections and is heavily influenced by the transverse tining and not so much by the material texture as with the asphalt pavements.

## CONCLUSION

- The SMA section was the noisiest of Tri-State asphalt test sections.
- The OGFC section was the quietest and had the highest texture value.
- The dense graded HMA with ground tire rubber had about the same sound intensity level as standard dense graded HMA.
- Both the CRCP and JPCP are much louder and had lower MTD compared to the asphalt sections.

APPLIED RESEARCH ASSOCIATES, INC.
An Employee Owned Company

# PROJECT MEMORANDUM

| | | | |
|---|---|---|---|
| To: | Steve Gillen | From: | Paul Littleton/Mike Harrell/Bill Vavrik |
| | | Date: | 14 February 2007 |
| | | ARA No: | 16436-06D1 |

Contract: RR-03-9091
Pavement/Infrastructure Management Services, System-wide

Re: South Tri-State Wayside Noise Measurements

## WAYSIDE NOISE MEASUREMENT BACKGROUND

ARA collected wayside noise measurements on Thursday the 9th of November 2006 between the hours of 10:30 AM and 2:00 PM in conjunction with sound intensity and pavement texture measurements on the south Tri-State HMA overlay test sections. Sound intensity and texture test results can be found in ARA's memorandum "South Tri-State Noise and Texture Survey" dated 01/16/07. The following sections present findings from wayside noise testing.

## WAYSIDE STUDY METHODOLOGY

Measurements were taken from the following four test sections on the south Tri-State, southbound:

1. Standard dense graded HMA located between the Crawford (MP 10.3) and Rexford (MP 9.7) bridges.
2. Open-graded friction course (OGFC) HMA located between the Rexford (MP 9.7) and Kedzie (MP 9.0) bridges.
3. Stone matrix asphalt (SMA) located between Kedzie (MP 9.0) and Route 147 (MP 8.4) bridges.
4. Dense graded HMA with 10 percent recycled tire rubber located between Route 147 (MP 8.4) and I-57 (MP 7.8) bridges.

Wayside measurements were not collected on the Standard dense graded HMA located between I-57 (MP 7.8) and plaza 41 (MP 5.2) due to time constrains.

Wayside measurements capture not only noise from tire/pavement interaction but noise produced by vehicle aerodynamics and powertrain plus local background noise. Samples were recorded via computer program and free field microphone stationed 5 ft above and 25 ft offset from the right wheelpath of the outer most drive lane. A plywood platform was placed at the edge of the paved shoulder to provide a hard, level surface between the passing traffic and the microphone. Where guard rail was present the microphone was placed 5 ft above the guardrail at 12 ft offset from the right wheelpath (near the edge of the paved shoulder). Traffic was free flowing at an estimated 60-65 mph. For comparison, measurements were taken at the right-of-way fence line via a handheld sound meter.

The data collected is in the form normal human hearing or sound pressure and is reported in Pascal (Pa) as opposed to sound intensity which was reported in power per area (Watt/$m^2$). Both sound pressure and sound intensity are presented in decibel (dB) logarithm and normalized to the typical range of human hearing or "A" weighted scale (noted as dBA). Figure 1 is an image of the wayside microphone set up on the plywood platform.

Figure 1. microphone and laptop computer set up on the plywood platform.

## WAYSIDE RESULTS AND ANALYSIS

Multiple noise recordings were collected for 15 minutes and averaged to produce a single wayside mean value for each location. Measurements were normalized for atmospheric conditions and to simulate listening to traffic at the edge of the shoulder. Figure 2 graphically shows the wayside mean sound pressure levels accompanied by sound pressure levels at the fence line.

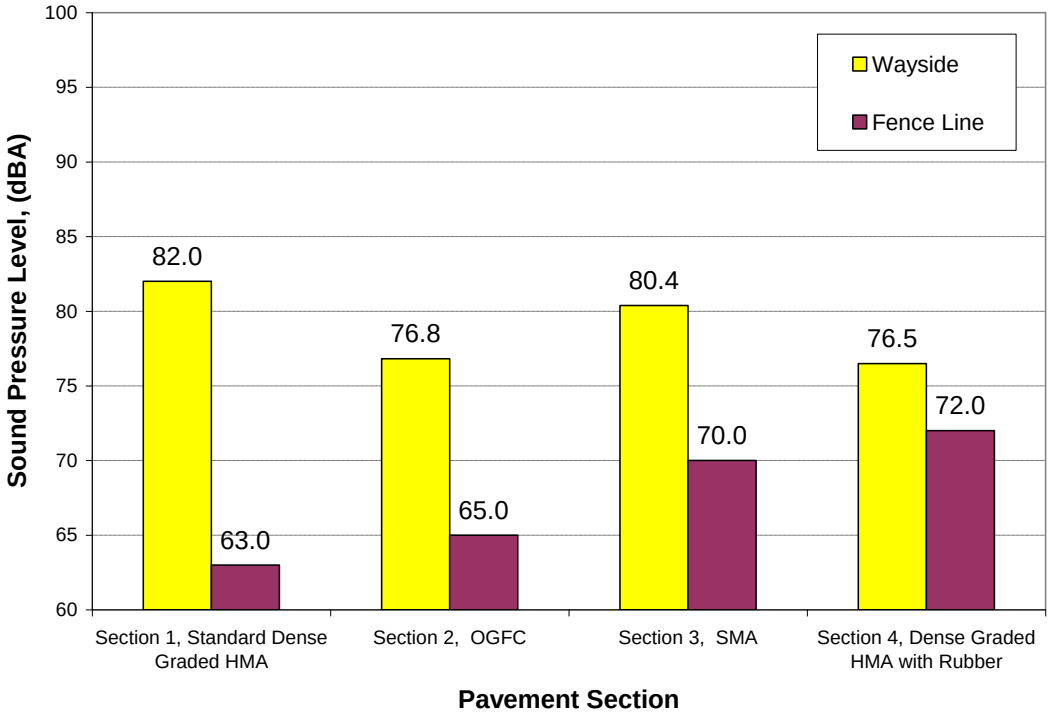



Figure 2. Mean sound pressure levels.

Wayside levels were highest for the standard dense graded mix (82.0 dBA) and the SMA section (80.4 dBA). The OGFC (76.8 dBA) and dense graded HMA with rubber (76.5 dBA) sections were nearly the same and were considerably lower than the standard mix by over 5.0 decibels. For perspective, the human ear can detect as low as a 2.0 to 3.0 dBA change in sound level.

Noise levels at the fence line varied considerably. The standard dense graded HMA was 9.0 decibels lower than the dense graded HMA with rubber. Bear in mind the fence line readings were taken with a hand held device and the elevation between the pavement and fence varied by several feet at each location. Differences in elevation and hence the path sound travels to the fence line affect the noise level. Nevertheless, fence line measurements are presented to give some idea as to the attenuation effects between traffic and adjacent properties. The most pronounced example is a 19.0 dBA drop in noise level in the standard dense graded HMA section between the pavement and fence line.

Despite efforts to collect noise sample at each section under identical conditions, traffic remains somewhat of a variable. This was reduced by averaging several 15 minute samples at each location. Sound intensity by contrast is measured solely from pavement/tire interaction and not subject to variations in traffic and should be considered a more suitable means for comparing relative noise differences in pavement surfaces. Nevertheless, the sound levels presented give a good idea of the actual traffic noise levels.

## CONCLUSION

- Wayside measurements indicate the standard dense graded HMA was the noisiest section.
- Wayside measurements indicate the dense graded HMA with rubber was the quietest.
- Wayside measurements indicate the OGFC section was nearly the same as the dense graded HMA with rubber section.
- Noise levels at the fence line varied greatly among test sections and showed as much as a 19.0 dBA drop in noise level.

## Appendix IV. GTR Binder Laboratory Test Results

Lab analysis of PG Binder on behalf of Seneca Petroleum Company.

**Asphalt Cement Laboratory Analysis**

| **PG 76-22GTR** | | | |
|---|---|---|---|
| Producer Company Name: | Seneca - Lemont | | |
| ATL Sample Number: | 06-0917 | | |
| Date Sampled: | 10/6/2006 | | |
| Tank Number: | 211 TK (Lemont) | | |
| | | | |
| Procedure | Method | *Specification* | Result |
| Flash Point Cleveland Open Cup, Deg C | D 92 / T 48 | *230 min* | 313 |
| Rotational Viscosity @ 135ºC, Pa·s | D 4402 / T 316 | *3.00 max* | 1.775 |
| Dynamic Shear Original Binder, G*/Sin Delta, kPa | T 315 | *1.000 min* | 1.441 |
| | | | |
| | | | |
| RTFOT Mass Loss @ 163ºC, % | D 2872 / T 240 | *1.00 max* | 0.297 |
| Dynamic Shear RTFOT Residue, G*/Sin Delta, kPa | T 315 | *2.200 min* | 3.343 |
| Elastic Recovery @ 25ºC, % | D 6084 | *60 min* | 75 |
| | | | |
| DSR PAV Residue, G* Sin Delta @ 31ºC, kPa | T 315 | *5000 max* | 1150 |
| BBR Measurements PAV Residue: | | | |
| Creep Stiffness, Mpa | T 313 | *300 max* | 104 |
| m-Value | T 313 | *0.300 min* | 0.315 |
| Penetration, dmm | T49 | *n/a* | 61 |
| | | | |

Tested by: _____

Certified by: _____

Date: _____

## Appendix V. Illinois DOT Preliminary Friction Data

ISTHA GTR Mixes
Initial IDOT Friction Data
October 2006

| Section | IDOT Number | Mile | Location | Initial Friction |
|---|---|---|---|---|
| Control N105 | T16004 | Mile 10.13 to 9.26 | Crawford Street Bridge to Metra RR Bridge structure | Smooth 40<br>Treaded 39 |
| OGFC GTR | T16005 | Mile 9.26 to 8.38 | Metra RR Bridge to 147th Street Bridge | Smooth 44<br>Treaded 49 |
| SMA GTR | T16006 | Mile 8.38 to 7.38 | 147th Street Bridge to Just south of I-57 overpass | Smooth 40<br>Treaded 40 |
| Dense N105 GTR | T16007 | Mile 7.38 to 6.4 | South of I-57 overpass to MP 6.4 | Smooth 40<br>Treaded 45 |

## Appendix VI. Illinois DOT Laboratory Data & Plots

# Materials for Tollway (I-294) Mixes

**OGFC with GTR**
Design #: STATE 06001
50 gyrations
Aggregate

| | |
|---|---|
| **022CM13** | 99.00% |
| Diabase | |
| 52402-14 | |
| RME | |
| Athens, Wisconsin | |
| **004MF01** | 1.00% |
| Mineral Filler | |
| 50312-04 | |
| MS Thornton | |

Asphalt

| | |
|---|---|
| **10131 (GTR)** | 6.00% |
| GTR 76-22 | |
| 1757-05 | |
| Seneca | |
| Lemont | |

**SMA**
Design #: 30BIT0549

Bit SMA Surface 12.5mm
80 gyrations
Gallagher Asphalt, Thornton, 716-07
18436
Aggregate

| | |
|---|---|
| **039CM11** | 32.70% |
| Slag | |
| 52103-23 | |
| Heritage, Inland | |
| **039CM13** | 51.00% |
| Slag | |
| 52103-23 | |
| Heritage, Inland | |
| **038FM20** | 9.30% |
| 50312-04 | |
| MS Thornton | |
| **004MF01** | 7.00% |
| 50312-04 | |
| MS Thornton | |

Asphalt

| | |
|---|---|
| **10131 GTR** | 6.10% |
| GTR 76-22 | |
| 1757-05 | |
| Seneca | |
| Lemont | |

**N105 w/ GTR**
Design #. 30Bit0548

Bit Conc SC N105D 12.5mm
105 Gyrations
Gallagher Asphalt, Thornton, 716-07
18436
Aggregate

| | |
|---|---|
| **CM00** | 16.00% |
| 50312-04 | |
| MS Thornton | |
| **032CM16** | 49.00% |
| 50312-04 | |
| MS Thornton | |
| **038FM20** | 33.00% |
| 50312-04 | |
| MS Thornton | |
| **004MF01** | 2.00% |
| 50312-04 | |
| MS Thornton | |

Asphalt

| | |
|---|---|
| **10131 GTR** | 5.40% |
| GTR 76-22 | |
| 1757-05 | |
| Seneca | |
| Lemont | |

**N105 Neet**
Design #. 30Bit0547

Bit Conc SC N105D 12.5mm
105 Gyrations
Gallagher Asphalt, Thornton, 716-07
19544
Aggregate

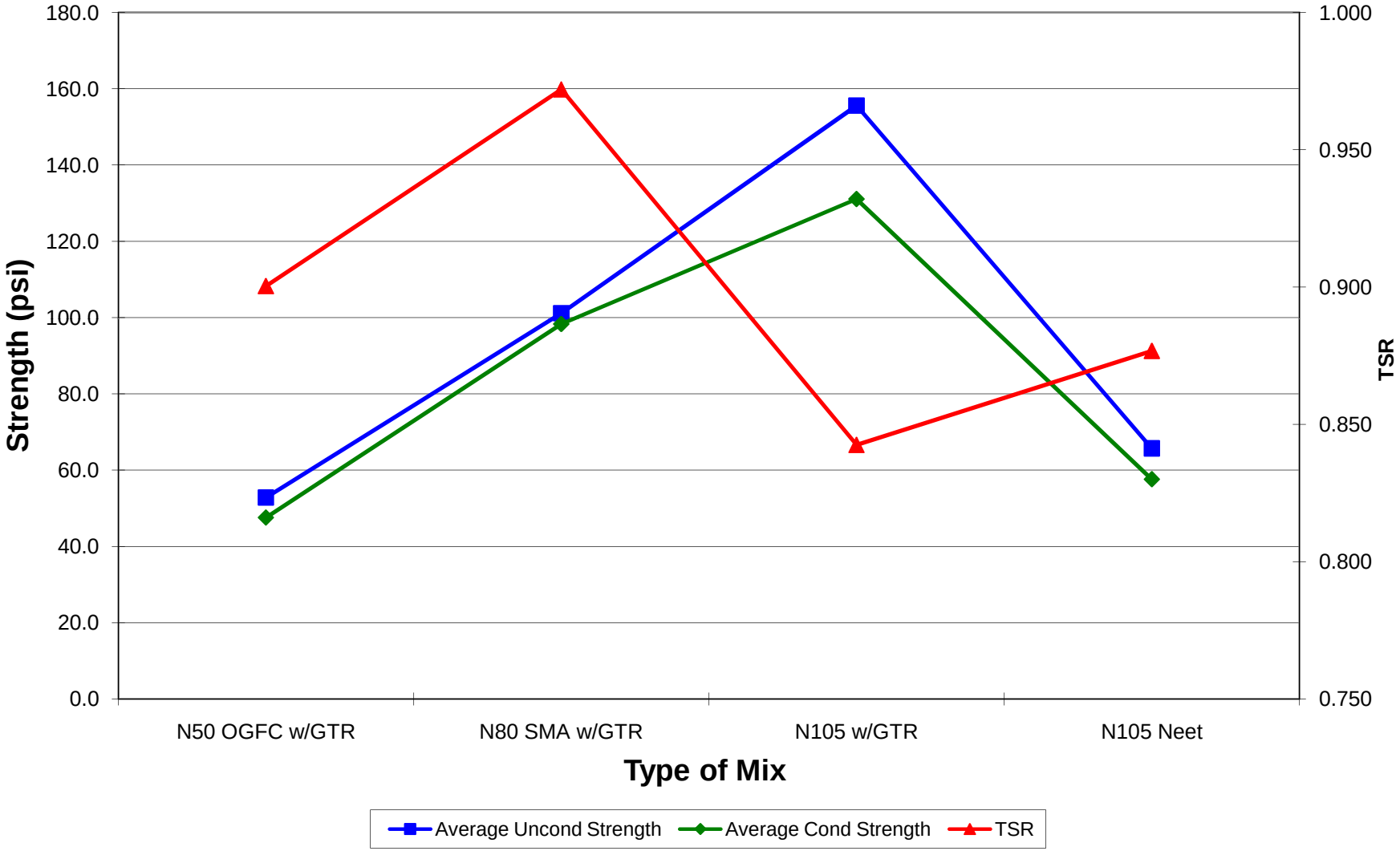
| | |
|---|---|
| **CM00** | 16.00% |
| 50312-04 | |
| MS Thornton | |
| **032CM16** | 49.00% |
| 50312-04 | |
| MS Thornton | |
| **038FM20** | 33.00% |
| 50312-04 | |
| MS Thornton | |
| **004MF01** | 2.00% |
| 50312-04 | |
| MS Thornton | |

Asphalt

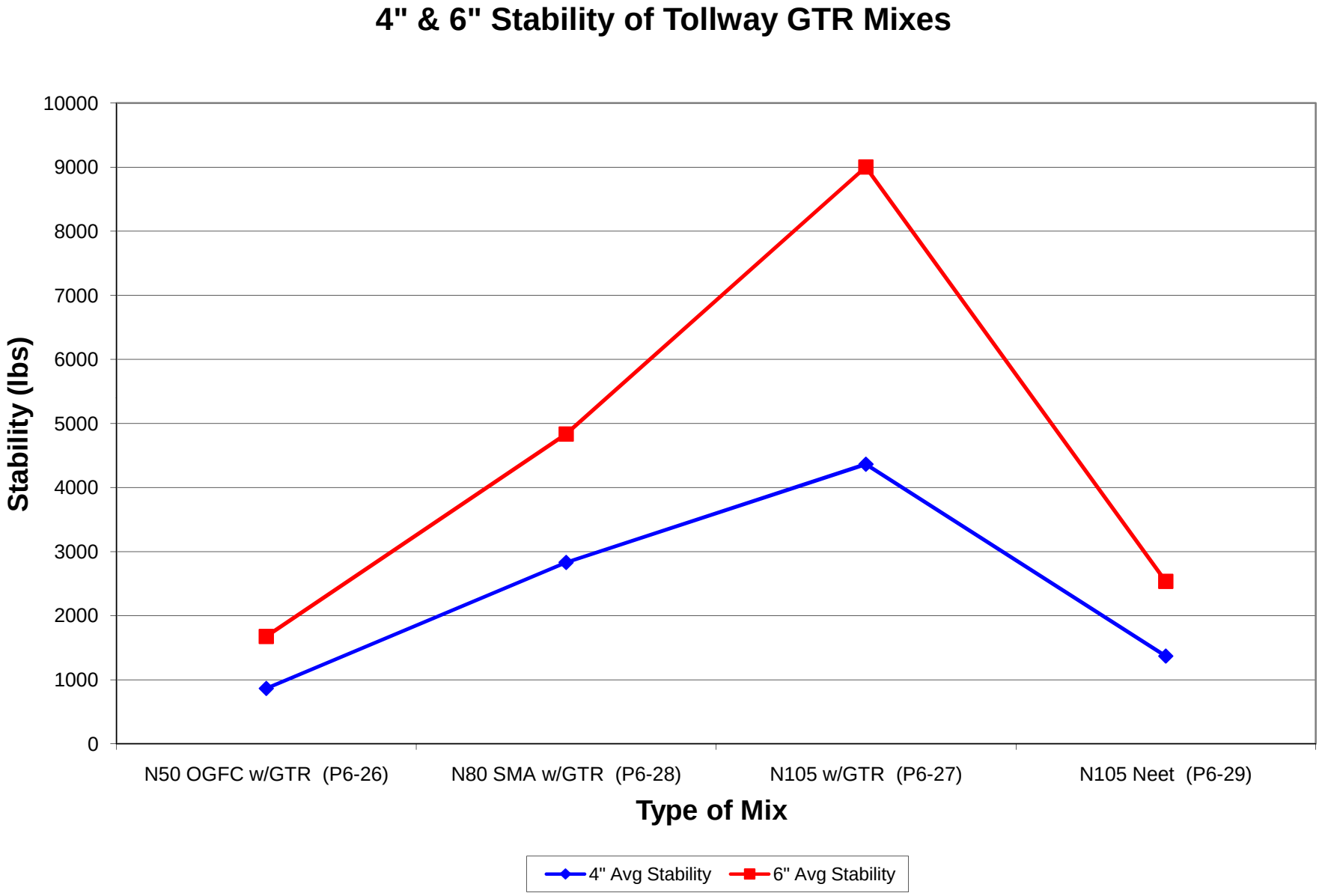
| | |
|---|---|
| **10127** | 5.20% |
| PG 64-22 | |
| 5627-02 | |
| BP Amoco | |
| Whiting | |

| Tollway Mixes - BMPR TSR Lab Results | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Lab Number** | **P6-26** | | **P6-28** | | **P6-27** | | **P6-29** | |
| **Mix Description** | **N50 OGFC w/GTR** | | **N80 SMA w/GTR** | | **N105 w/GTR** | | **N105 Neet** | |
| **Set A or Set B** | **Control** | **140 Bath** | **Control** | **140 Bath** | **Control** | **140 Bath** | **Control** | **140 Bath** |
| **Gmb, Sample 1** | 2.074 | | 2.697 | | 2.347 | | 2.350 | |
| **Gmb, Sample 2** | 2.080 | | 2.734 | | 2.343 | | 2.348 | |
| **Gmb, Sample 3** | 2.072 | | 2.754 | | 2.349 | | 2.355 | |
| **Gmb, Sample 4** | | 2.069 | | 2.713 | | 2.345 | | 2.350 |
| **Gmb, Sample 5** | | 2.070 | | 2.732 | | 2.345 | | 2.349 |
| **Gmb, Sample 6** | | 2.082 | | 2.731 | | 2.345 | | 2.357 |
| **Gmb, Average** | **2.075** | **2.074** | **2.728** | **2.725** | **2.346** | **2.345** | **2.351** | **2.352** |
| **BMPR Gmm** | 2.589 | | 2.886, 2.917, 2.938 | | 2.520 | | 2.533 | |
| **Voids, Sample 1** | 19.9 | | 6.5 | | 6.9 | | 7.2 | |
| **Voids, Sample 2** | 19.7 | | 6.3 | | 7.0 | | 7.3 | |
| **Voids, Sample 3** | 20.0 | | 6.3 | | 6.8 | | 7.0 | |
| **Voids, Sample 4** | | 20.1 | | 6.4 | | 6.9 | | 7.2 |
| **Voids, Sample 5** | | 20.1 | | 6.3 | | 6.9 | | 7.3 |
| **Voids, Sample 6** | | 19.6 | | 6.4 | | 6.9 | | 6.9 |
| **Voids, Average** | **19.9** | **19.9** | **6.4** | **6.4** | **6.9** | **6.9** | **7.2** | **7.1** |
| **% Saturated, Sample 4** | | | | 71.5 | | 72.0 | | 72.2 |
| **% Saturated, Sample 5** | | | | 77.7 | | 71.9 | | 74.7 |
| **% Saturated, Sample 6** | | | | 71.7 | | 78.7 | | 74.8 |
| **Average % Saturation** | | | | **73.6** | | **74.2** | | **73.9** |
| **Cond or Uncond, Sample 1** | Uncond | | Uncond | | Uncond | | Uncond | |
| **Cond or Uncond, Sample 2** | Uncond | | Uncond | | Uncond | | Uncond | |
| **Cond or Uncond, Sample 3** | Uncond | | Uncond | | Uncond | | Uncond | |
| **Cond or Uncond, Sample 4** | | Cond | | Cond | | Cond | | Cond |
| **Cond or Uncond, Sample 5** | | Cond | | Cond | | Cond | | Cond |
| **Cond or Uncond, Sample 6** | | Cond | | Cond | | Cond | | Cond |
| **Uncond Strength, Sample 1** | 51.9 | | 87.5 | | 155.6 | | 63.3 | |
| **Uncond Strength, Sample 2** | 51.9 | | 109.4 | | 155.6 | | 66.2 | |
| **Uncond Strength, Sample 3** | 54.8 | | 106.6 | | 155.6 | | 67.7 | |
| **Cond Strength, Sample 4** | | 47.6 | | 97.7 | | 131.1 | | 57.6 |
| **Cond Strength, Sample 5** | | 47.6 | | 100.9 | | 131.1 | | 54.8 |
| **Cond Strength, Sample 6** | | 47.6 | | 96.4 | | 131.1 | | 60.5 |
| **Average Uncond Strength** | **52.9** | | **101.2** | | **155.6** | ` | **65.7** | |
| **Average Cond Strength** | | **47.6** | | **98.3** | | **131.1** | | **57.6** |
| **TSR** | **0.900** | | **0.972** | | **0.843** | | **0.877** | |
| **Design TSR** | **N/A** | | **0.90** | | **0.88** | | **0.85** | |

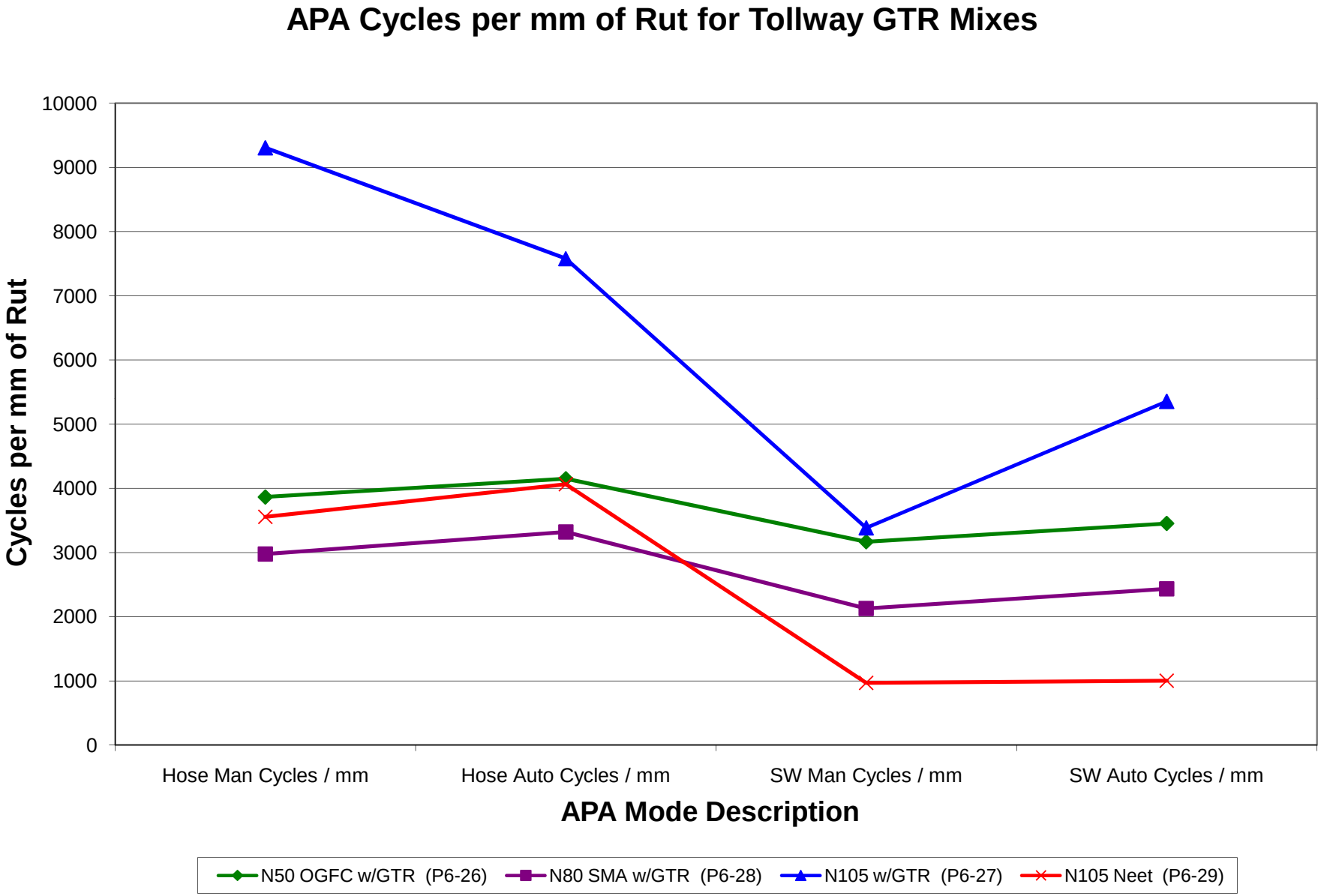
# Strength & TSR of Tollway GTR Mixes



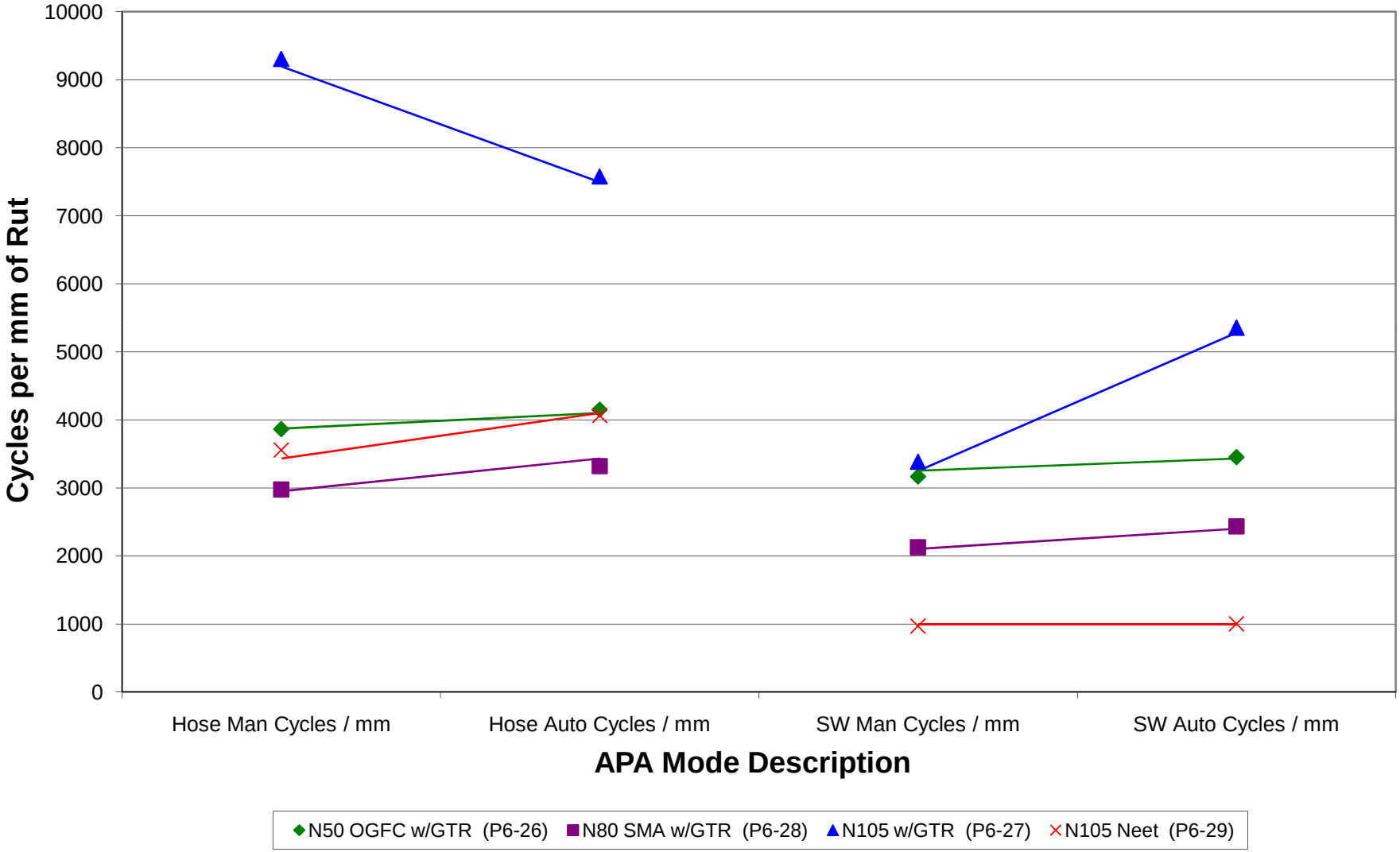
| | Stability Testing | | | | Stability Testing | | | |
|---|---|---|---|---|---|---|---|---|
| | 4" Stability | | | | 6" Stability | | | |
| | 4" Stability | 4" Avg Stability | Actual Voids | 4" Avg Voids | Stability | 6" Avg Stability | Actual Voids | 6" Avg Voids |
| **N50 OGFC w/GTR (P6-26)** | 800 | 863 | 16.5 | 19.3 | 1675 | 1675 | 19.8 | 19.9 |
| | 875 | | 18.4 | | 1575 | | 20.4 | |
| | 950 | | 20.7 | | 1775 | | 19.6 | |
| | 850 | | 18.9 | | | | | |
| | 875 | | 20.8 | | | | | |
| | 825 | | 20.7 | | | | | |
| **N80 SMA w/GTR (P6-28)** | 3100 | 2829 | 2.9 | 3.2 | 4800 | 4833 | 3.4 | 3.3 |
| | 2850 | | 2.9 | | 4900 | | 3.4 | |
| | 2800 | | 3.5 | | 4800 | | 3.2 | |
| | 2700 | | 3.6 | | | | | |
| | 2725 | | 2.8 | | | | | |
| | 2800 | | 3.2 | | | | | |
| **N105 w/GTR (P6-27)** | 4400 | 4363 | 4.4 | 4.5 | 9500 | 9000 | 4.0 | 4.0 |
| | 4325 | | 4.4 | | 8800 | | 3.9 | |
| | 4275 | | 4.7 | | 8700 | | 4.0 | |
| | 4350 | | 4.5 | | | | | |
| | 4275 | | 4.6 | | | | | |
| | 4550 | | 4.4 | | | | | |
| **N105 Neet (P6-29)** | 1350 | 1367 | 4.3 | 4.4 | 2550 | 2533 | 4.3 | 4.3 |
| | 1400 | | 4.4 | | 2600 | | 4.3 | |
| | 1325 | | 4.3 | | 2450 | | 4.4 | |
| | 1400 | | 4.3 | | | | | |
| | 1400 | | 4.5 | | | | | |
| | 1325 | | 4.4 | | | | | |


4" & 6" Stability of Tollway GTR Mixes
Stability (lbs)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
N50 OGFC w/GTR (P6-26)
N80 SMA w/GTR (P6-28)
N105 w/GTR (P6-27)
N105 Neet (P6-29)
Type of Mix
4" Avg Stability
6" Avg Stability

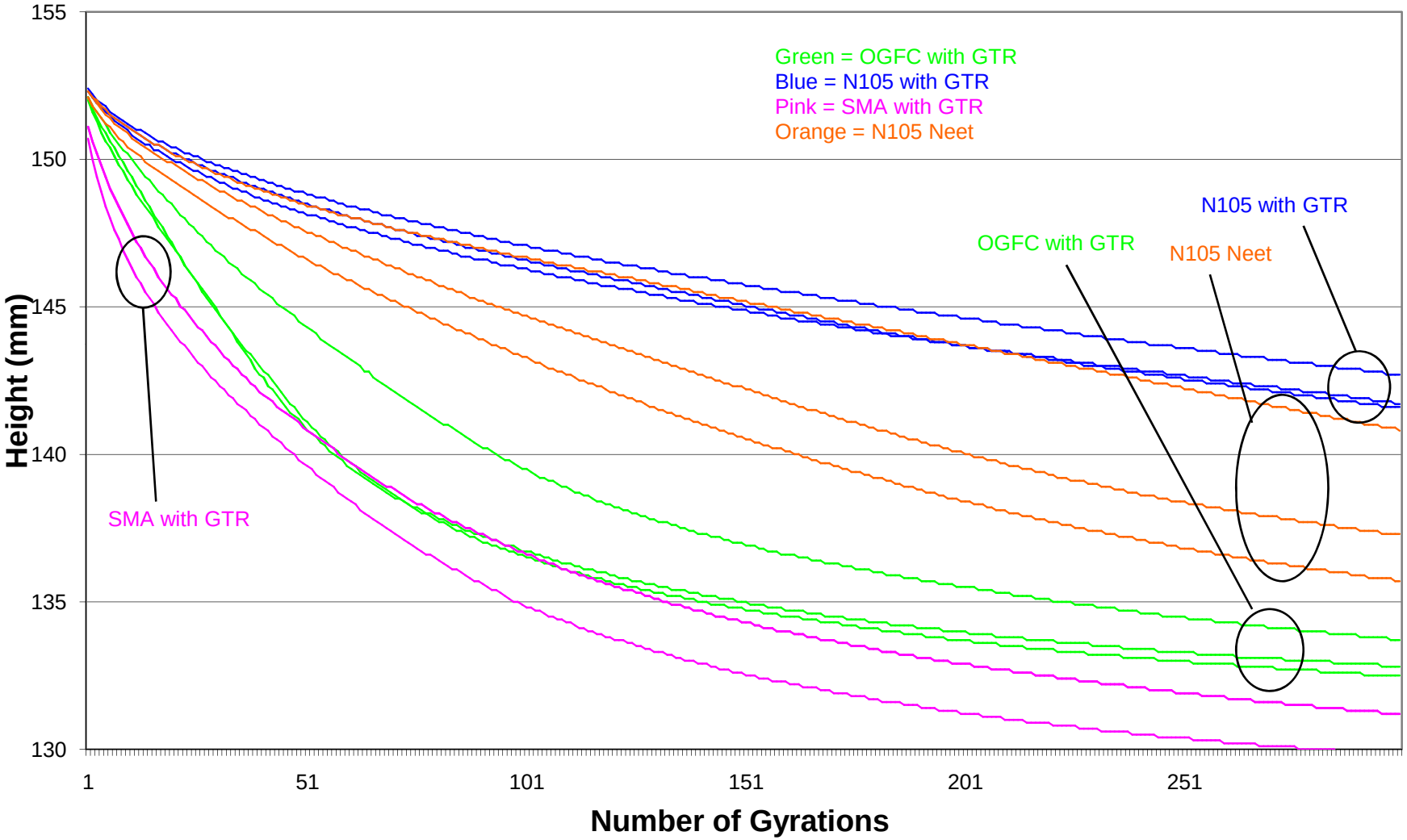
| | APA with Hoses | | | | | | | APA Steel Wheel | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APA Manual Rut (mm) | | | APA Automatic Rut (mm) | | | Manual Rut Depth (mm) | | | Automatic Rut Depth (mm) | | | |
| | Number of Cycles | APA Manual Individual Rut (mm) | APA Manual Average Rut (mm) | APA Hose, Manual, Cycles per mm of Rut | APA Automatic Individual Rut (mm) | APA Automatic Average Rut (mm) | APA Hose, Auto, Cycles per mm of Rut | APA S.W. Man Ind | APA S.W. Man Avg | APA Steel, Manual, Cycles per mm of Rut | APA S.W. Auto Ind | APA S.W. Auto Avg | APA Steel, Auto, Cycles per mm of Rut | # of Cycles |
| **N50 OGFC w/GTR (P6-26)** | **8000** | 2.120 | 2.072 | **3862** | 1.852 | 1.929 | **4147** | 4.68 | 6.320 | **3165** | | | **3450** | **20000** |
| | | 1.820 | | | | | | 8.45 | | | | | | |
| | | 2.630 | | | 1.820 | | | | | | | | | *Test 1* |
| | | 1.640 | | | | | | 7.45 | | | 5.797 | | | |
| | | 2.310 | | | 2.115 | | | 4.70 | | | | | | *Test 2* |
| | | 1.910 | | | | | | | | | | | | 20000 |
| **N80 SMA w/GTR (P6-28)** | **8000** | 2.950 | 2.690 | **2974** | 2.671 | 2.411 | **3319** | 7.73 | 9.405 | **2127** | 9.604 | 8.914 | **2432** | **20000** |
| | | 3.180 | | | | | | 11.38 | | | | | | |
| | | 2.270 | | | 2.536 | | | | | | | | | *Test 1* |
| | | 2.890 | | | | | | 8.99 | | | 8.224 | | | 20000 |
| | | 2.460 | | | 2.025 | | | 9.52 | | | | | | *Test 2* |
| | | 2.390 | | | | | | | | | | | | 20000 |
| **N105 w/GTR (P6-27)** | **8000** | 0.550 | 0.860 | **9302** | 0.940 | 1.056 | **7576** | 5.48 | 5.913 | **3383** | 7.379 | 5.558 | **5352** | **20000** |
| | | 0.880 | | | | | | 9.52 | | | | | | |
| | | 1.060 | | | 1.101 | | | | | | | | | *Test 1* |
| | | 0.750 | | | | | | 4.23 | | | 3.737 | | | 20000 |
| | | 0.980 | | | 1.127 | | | 4.42 | | | | | | *Test 2* |
| | | 0.940 | | | | | | | | | | | | 20000 |
| **N105 Neet (P6-29)** | **8000** | 2.190 | 2.252 | **3553** | 2.071 | 1.970 | **4062** | 17.33 | 17.043 | **966** | 16.692 | 16.586 | **999** | **16466** |
| | | 2.350 | | | | | | 17.51 | | | | | | |
| | | 1.860 | | | 1.742 | | | | | | | | | *Test 1* |
| | | 2.050 | | | | | | 15.58 | | | 16.480 | | | 17966 |
| | | 2.750 | | | 2.096 | | | 17.75 | | | | | | *Test 2* |
| | | 2.310 | | | | | | | | | | | | 14966 |

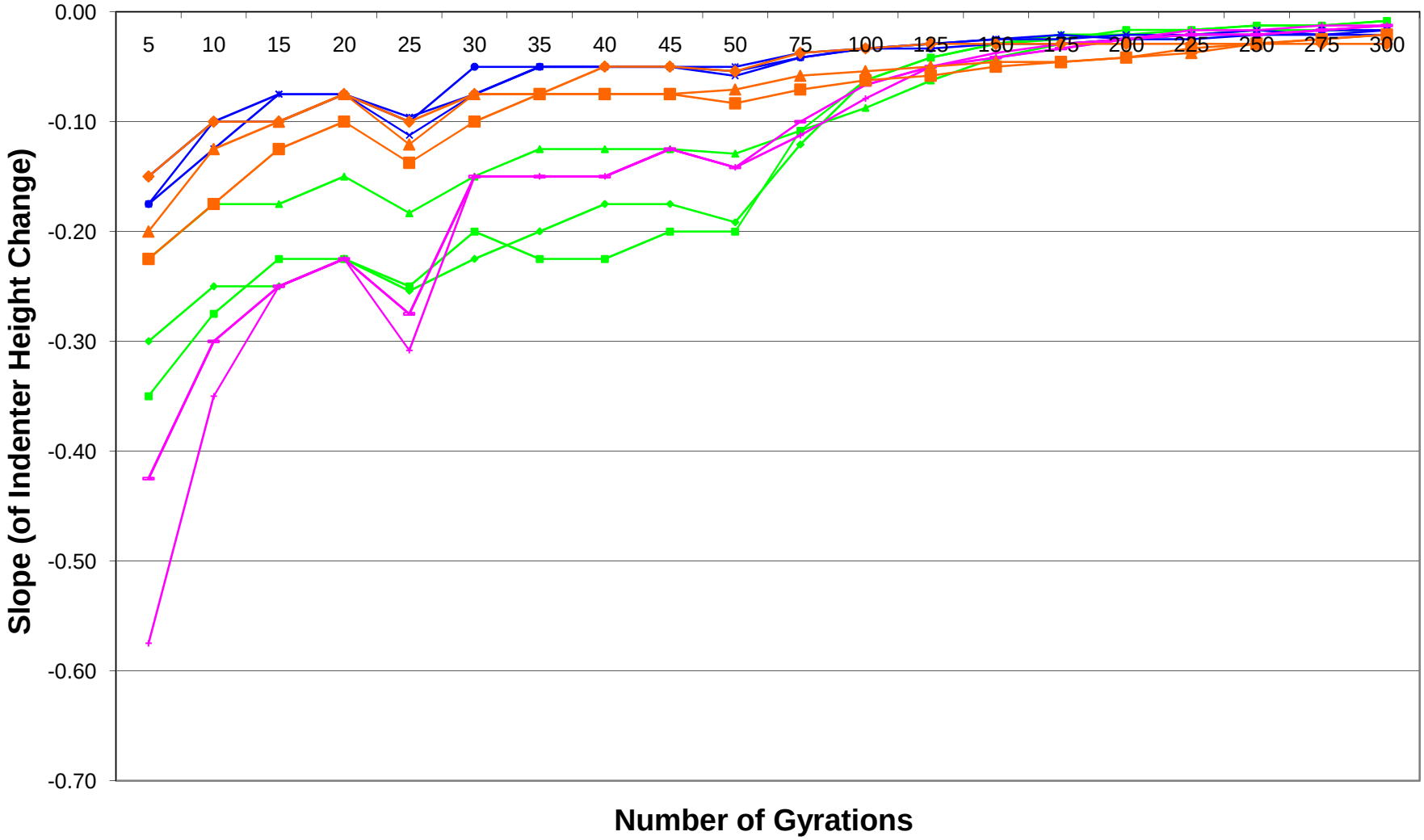

APA Cycles per mm of Rut for Tollway GTR Mixes
Cycles per mm of Rut
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Hose Man Cycles / mm
Hose Auto Cycles / mm
SW Man Cycles / mm
SW Auto Cycles / mm
APA Mode Description
N50 OGFC w/GTR (P6-26)
N80 SMA w/GTR (P6-28)
N105 w/GTR (P6-27)
N105 Neet (P6-29)

# APA Cycles per mm of Rut for Tollway GTR Mixes



# Indenter: Height vs Number of Gyrations




Indenter Slope of Height Change
Slope (of Indenter Height Change)
0.00
-0.10
-0.20
-0.30
-0.40
-0.50
-0.60
-0.70
5
10
15
20
25
30
35
40
45
50
75
100
125
150
175
200
225
250
275
300
Number of Gyrations

## Appendix VII. Bid Tabulation Summary & Unit Prices

# Illinois State Toll Highway Authority - Bid Tabulation Report

## Project Number: RR-06-5398

**Project Description: Intermittent Pavement Repairs and Re-Surfacing**
**S/B Tri-State Tollway (I-294) M.P. 5.0 to M.P. 23.8**
**Bid Open Date: 7/24/2006**
**Begin Date: 8/3/2006**
**End Date: 11/17/2006**

**Gallagher Asphalt Corp/C**

Bidder 1 7774589.9
Auth Tot 7774589.9

| Item | Description | Unit | Quantity | Price | Amount |
|---|---|---|---|---|---|
| 215 | EXPLORATION TR | LIN FT | 100 | 40 | 4000 |
| 402AN105B | IDOT BIT CONC BND CSE SPRPV IL-19.0, | TON | 165 | 100 | 16500 |
| 402B1 | BIT MATL TACK | GAL | 145884 | 0.1 | 14588.4 |
| **403AN105D** | **IDOT BIT CONC SRFC CSE SPRPV IL-12.5** | **TON** | **48737** | **85** | **4142645** |
| 403BA | CONSTRUCTION TST STRIP GTR MOD SU | EACH | 1 | 12000 | 12000 |
| **403BN105R** | **GTR MOD BIT CONC SRFC CSE SPRPV IL** | **TON** | **2571** | **130** | **334230** |
| 403CA | TST STR (GRND TIRE RUB MOD GAP GRI | EACH | 1 | 12000 | 12000 |
| **403CN100SC** | **GRND TIRE RUB MOD GAP ASPHALT SR** | **TON** | **2262** | **165** | **373230** |
| 403DA | TST STRP (MOD OPEN GRDED FRICTION | EACH | 1 | 12000 | 12000 |
| **403DN50SC** | **MOD OPEN GRDED FRICTION CSE** | **TON** | **2744** | **150** | **411600** |

## Appendix VIII. Project Special Provisions

## S.P. 403B GROUND TIRE RUBBER (GTR) MODIFIED SUPERPAVE BITUMINOUS CONCRETE MIXTURES

### S.P. 403B.1 DESCRIPTION

This work shall consist of constructing Bituminous Concrete Surface Course Superpave mixtures containing ground tire rubber (GTR) modified asphalt cement. Work shall be according to Section 406 of the IDOT Standard Specifications and the IDOT special provision "Quality Control/Quality Assurance of Bituminous Concrete Mixtures", except as modified herein.

### S.P. 403B.2 MATERIALS

(a) Fine Aggregate Blend Requirement. The Contractor may be required to provide FA 20 manufactured sand to meet the design requirements. For mixtures with Ndesign ≥ 90, at least 50 percent of the required fine aggregate fraction shall consist of either stone sand, slag sand, or steel slag sand meeting the FA/FM 20 gradation.

(b) Reclaimed Asphalt Pavement (RAP). RAP will not be permitted in the mixture.

(c) Bituminous Material. The base asphalt cement (AC) that is blended with the GTR, shall be a PG 64-22 performance-graded (PG) meeting the requirements of Article 1009.05 of the IDOT Standard Specifications. At the start of the project, a sample of the GTR modified asphalt cement shall be obtained at the plant and submitted to the Tollway for verification of the asphalt grade.

(d) Ground Tire Rubber (GTR). The GTR shall be produced from processing automobile and/or truck tires by the ambient grinding method. Heavy equipment tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 2 mm (1/16 in.) in length and shall contain no free metal particles. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 50 gram sample. Metal embedded in rubber particles will be permitted.

The GTR shall be stored in a dry location protected from the rain. When the GTR is combined with the asphalt cement, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance with ASTM C-136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, (Illinois-modified AASHTO T-27, Sieve Analysis of Fine and Coarse Aggregates) a 50 gram sample of the GTR shall conform to the following gradation requirements:

| Sieve Size | Percent Passing |
|---|---|
| 2.36 mm (No. 8) | 100 |
| 1.18 mm (No. 16) | 98 ± 2 |
| 600 μm (No. 30) | 95 ± 5 |
| 300 μm (No. 50) | 50 ± 10 |
| 150 μm (No. 100) | 10 ± 5 |
| 75 μm (No. 200) | 2 ± 2 |

A mineral powder (such as talc) meeting AASHTO M17, Mineral Filler for Bituminous Paving Mixtures, requirements may be added, up to a maximum of 4% by weight of GTR particles, to reduce sticking and caking of the GTR particles.

GTR shall have a specific gravity of 1.15 ± 0.05 when tested in accordance with ASTM D-1817, Standard Test Method for Rubber Chemicals-Density.

The GTR may be provided in bulk or in whole plastic containers. Plastic containers shall be made from low density polyethylene having a melting point less than 115° C (240° F). The manufacturer shall ship along with the GTR, certificates of compliance which certify that all requirements of this specification are complied with for each production lot number or shipment.

(e) Extender Oils or Polymeric Processing Aid. With approval of the Engineer, compatible extender oils and/or polymers may be added to the GTR or to the asphalt-rubber blend. The additional costs for the extender oils and/or polymer additions shall be borne by the Contractor. The Contractor shall provide material product information along with usage rates for approval.

**S.P.403B.3 EQUIPMENT**

Articles 406.03 through 406.22 of the IDOT Standard Specifications and the IDOT Special Provision, "Superpave Bituminous Concrete Mixtures" shall govern the requirements for equipment; the preparatory work; mix design criteria; and the preparation, transportation, placement and compaction of IDOT Superpave Bituminous Concrete Mixtures, except as modified herein.

Add the following to the list of specific references to IDOT Article 406.03.

"Material Transfer Device ..... ISTHA Subsection 1202.8"
"Pavement Surface Test Equipment ..... ISTHA Special Provision SP 1203.5"

**S.P.403B.4 GROUND TIRE RUBBER BLENDING**

The GTR shall be blended with the asphalt cement, forming a consistent, homogeneous blend, prior to being added to aggregates. The Terminal Blend method, where the GTR is blended and reacted with the asphalt cement at the asphalt refinery, shall be used. The minimum amount of GTR for asphalt-rubber blends shall be as follows:

| Specified PG Grade stated on the Plans | Minimum GTR (by weight of asphalt cement) |
|---|---|
| GTR PG 70-22 | 10% |
| GTR PG 76-22 | 15% |

The GTR shall be blended with the asphalt cement and reacted for a minimum of 45 minutes at a temperature of 163°C to 191°C (325°F to 375°F).

The mixing temperature of the HMA mixture shall be 149-177°C (300-350°F).

**S.P. 403B.5 HOT MIX PLANT**

The type of plant used for the manufacture of GTR modified asphalt cement mixtures may be either a batch or drier drum plant meeting the requirements of 406.12 & 1102.01, with the following exceptions:

**General**

a) Storage and Conveyance. Silo storage of rubber modified asphalt mixtures shall not exceed 4 hours.

b) Plant modification. Introduction of GTR into rubber modified asphalt mixtures may require additional plant modifications. The Engineer will have final approval of the plant.

c) Plant Calibration. The asphalt plant shall be calibrated and approved by The Illinois Department of Transportation Bureau of Materials and Physical Research or the Tollway before production of the rubber modified asphalt mixture.

**Terminal Processing and Storage**

(a) At the asphalt production facility for Terminal Processing, a separate agitated shipping storage tank shall be required, with continuous mixing and recirculation of the asphalt-rubber blend to react the GTR with the asphalt cement. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 163°C to 191°C (325°F to 375°F) for a minimum of 45 minutes.

(b) Once the Terminal Processing of GTR and asphalt cement produces a homogeneous blend at the production facility, test samples shall be obtained and submitted to the Tollway for testing.

(c) Terminal Blended GTR modified asphalt may be stored at the production facility for up to 30 days at 149°C to 177°C (300°F to 350°F) with continuous mixing.

(d) A dedicated storage tank for "terminal blended GTR" shall be required at the hot mix plant. This tank shall be capable of providing continuous mixing and/or recirculation of the asphalt-rubber blend. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 150°C to 177°C (300°F to 350°F) for a maximum of 3 days.

**S.P. 403B.6 MIXTURE DESIGN**

The Contractor shall submit mix designs for approval, for each required mixture. Mix designs shall be developed by Level III personnel who have successfully completed the course, "Superpave Mix Design Upgrade". Articles 406.10 and 406.13 of the Standard Specifications shall not apply. The mixtures shall be designed according to the respective Illinois Modified AASHTO references listed below.

AASHTO MP 2 Standard Specification for Superpave Volumetric Mix Design

AASHTO R 30 Standard Practice for Mixture Conditioning of Hot-Mix Asphalt (HMA)

AASHTO PP 28 Standard Practice for Designing Superpave HMA

AASHTO T 209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

AASHTO T 312 Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

AASHTO T 308 Determining the Asphalt Content of Hot Mix Asphalt (HMA) by the Ignition Method

(a) Mixture Composition. The job mix formula (JMF) shall fall within the following limits:

(1) High ESAL Mixtures. The Job Mix Formula (JMF) shall fall within the following limits.

| High ESAL, MIXTURE COMPOSITION (% PASSING)[1/] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sieve Size | IL-25.0 mm | | IL-19.0 mm | | IL-12.5 mm[4/] | | IL-9.5 mm[4/] | |
| | min | max | min | max | min | max | min | max |
| 1 1/2 in (37.5 mm) | | 100 | | | | | | |
| 1 in. 25 mm) | 90 | 100 | | 100 | | | | |
| 3/4 in. (19 mm) | | 90 | 82 | 100 | | 100 | | |
| 1/2 in. (12.5 mm) | 45 | 75 | 50 | 85 | 90 | 100 | | 100 |
| 3/8 in. (9.5 mm) | | | | | | 89 | 90 | 100 |
| #4 (4.75 mm) | 24 | 42[2/] | 24 | 50[2/] | 28 | 65 | 28 | 65 |
| #8 (2.36 mm) | 16 | 31 | 20 | 36 | 28 | 48[3/] | 28 | 48[3/] |
| #16. (18 mm) | 10 | 22 | 10 | 25 | 10 | 32 | 10 | 32 |
| #50 (300 μm) | 4 | 12 | 4 | 12 | 4 | 15 | 4 | 15 |
| #100 (150 μm) | 3 | 9 | 3 | 9 | 3 | 10 | 3 | 10 |
| #200 (75 μm) | 3 | 6 | 3 | 6 | 4 | 6 | 4 | 6 |
| Ratio: Dust/Asphalt Binder | | 1.0 @ design | | 1.0 @ design | | 1.0 @ design | | 1.0 @ design |

1/ Based on percent of total aggregate weight.

2/ The mixture composition shall not exceed 40 percent passing the #4 (4.75 mm) sieve for binder courses with Ndesign $\geq$ 90.

3/ The mixture composition shall not exceed 40 percent passing the #8 (2.36 mm) sieve for surface courses with Ndesign $\geq$ 90.

(2) Low ESAL Mixtures. The job mix formula (JMF) shall fall within the following limits.

| Low ESAL, MIXTURE COMPOSITION (% PASSING) | | | | |
|---|---|---|---|---|
| Sieve Size | IL-9.5L | | IL-19.0L | |
| | min | max | min | max |
| 1 in. (25.0mm) | | | | 100 |
| 3/4 in. (19.0 mm) | | | 95 | 100 |
| 1/2 in. (12.5 mm) | | 100 | | |
| 3/8 in. (9.5 mm) | 95 | 100 | | |
| #4 (4.75 mm) | 52 | 80 | 38 | 65 |
| #8 (2.36 mm) | 38 | 65 | | |
| #30 (600 µm) | | <50% of the percentage passing the #4 | | <50% of the percentage passing the #4 |
| #200 (75 µm) | 4.0 | 8.0 | 3.0 | 7.0 |
| Asphalt Binder % | 4.0 | 8.0 | 4.0 | 8.0 |
| Ratio Dust/Asphalt Binder | | 1.0 @ design | | 1.0 @ design |

It is recommended that the selected combined aggregate gradation not pass through the restricted zones specified in Illinois Modified AASHTO MP 2.

(b) Volumetric Requirements.

(1) High ESAL Mixtures. The target value for the air voids of the hot mix asphalt (HMA) shall be 4.0 percent at the design number of gyrations. The VMA and VFA of the HMA design shall be based on the nominal maximum size of the aggregate in the mix and shall conform to the following requirements.

| VOLUMETRIC REQUIREMENTS<br>High ESAL | | | | | |
|---|---|---|---|---|---|
| | Voids in the Mineral Aggregate (VMA), % minimum | | | | Voids Filled with Asphalt Binder (VFA), % |
| Ndesign | IL-25.0 | IL-19.0 | IL-12.5 | IL-9.5 | |
| 50 | 12.0 | 13.0 | 14.0 | 15 | 65 - 78 |
| 70 | 12.0 | 13.0 | 14.0 | 15 | 65 - 75 |
| 90 | | | | | |
| 105 | | | | | |

(2) Low ESAL Mixtures.

| VOLUMETRIC REQUIREMENTS<br>Low ESAL | | | | |
|---|---|---|---|---|
| Mixture Composition | Design Compactive Effort | Design Air Voids Target (%) | VMA (Voids in the Mineral Aggregate) (min.) | VFA (Voids Filled with Asphalt Binder) |
| IL-9.5L | $N_{DES}$ =30 | 3.0% | 14.0% | 70-80% |
| IL19.0L | $N_{DES}$ =30 | 4.0% | 13.0% | N/A |

(3) All Other Mixtures.

| VOLUMETRIC REQUIREMENTS<br>All Other | | |
|---|---|---|
| Mixture Composition | Design Compactive Effort | Design Air Voids Target (%) |
| All Other | $N_{DES}$ =30 | 2.0 |

**S.P. 403B.7 PERSONNEL**

The QC Manager and Level I technician shall have successfully completed the Department's "Superpave Field Control Course".

**S.P. 403B.8 REQUIRED TESTS**

Testing shall be conducted to control the production of the bituminous mixture. The Contractor shall use the test methods identified to perform the following mixture tests at a frequency not less than that indicated.

| REQUIRED PLANT TESTS for SUPERPAVE | | | |
|---|---|---|---|
| Parameter | Frequency of Tests<br><br>High ESAL Mixture<br>Low ESAL Mixture | Frequency of Tests<br><br>All Other Mixtures | Test Method<br>See Manual of Test Procedures for Materials |
| Aggregate Gradation<br><br>(% passing sieves:<br>1/2 in. (12.5 mm),<br>No. 4 (4.75 mm),<br>No. 8 (2.36 mm),<br>No. 30 (600 μm)<br>No. 200 (75 μm)<br><br>Note 1. | 2 washed ignition oven tests on the mix per day of production (conduct one in the morning and one in the afternoon). | 1 washed ignition oven test on the mix per day of production. | Illinois Procedure |
| Asphalt Binder Content by Ignition Oven<br><br>Note 2 | 1 per half day of production | 1 per day | Illinois-Modified AASHTO T 308 |
| Air Voids<br><br>Bulk Specific Gravity of Gyratory Sample<br><br>Maximum Specific Gravity of Mixture | 1 per half day of production for first 2 days and 1 per day thereafter (first sample of the day) | 1 per day<br><br>1 per day | Illinois-Modified AASHTO T 312<br><br>Illinois-Modified AASHTO T 209 |

Note 1. The No. 8 (2.36 mm) and No. 30 (600 μm) sieves are not required for All Other mixtures.

Note 2. The Engineer may waive the ignition oven requirement for AC content if the aggregates to be used are known to have ignition AC content calibration factors which exceed 1.5 percent. If the ignition oven requirement is waived, other Department approved methods shall be used to determine the AC content.

During production, the ratio of minus 75 μm (#200) sieve material to total asphalt cement shall be not less than 0.6 or more than 1.2, and the moisture content of the mixture at discharge from the mixer shall not exceed 0.5 percent. If at any time the ratio of minus 75 μm (#200) material to asphalt or moisture content of the mixture falls outside the stated limits, production of mix shall cease. The cause shall be determined and corrective action satisfactory to the Engineer shall be initiated prior to resumption of production.

During production, any mixture containing an anti-stripping additive will be tested by the Engineer for stripping according to Illinois Modified T 283. If the mixture fails to meet the TSR criteria for acceptance, no further mixture will be accepted until the Contractor takes such action as is necessary to furnish a mixture meeting the criteria.

Control Charts/Limits. Control charts/limits shall be according to QC/QA requirements, except density shall be plotted on the control charts within the following control limits:

| DENSITY CONTROL LIMITS | | |
|---|---|---|
| | | |
| Mixture Composition | Parameter | Individual Test |
| IL-9.5, IL-12.5 | Ndesign $\geq$ 90 | 92.0 – 96.0 % |
| IL-9.5,IL-9.5L, IL-12.5 | Ndesign < 90 | 92.5 – 97.4 % |
| IL-19.0, IL-25.0 | Ndesign $\geq$ 90 | 93.0 – 96.0 % |
| IL-19.0, IL-19.0L, IL-25.0 | Ndesign < 90 | 93.0 – 97.4 % |
| All Other | | Average 95-102 % Target |

**S.P.403B.9 CONSTRUCTION REQUIREMENTS**

**S.P.403B.9.1 TEST STRIP / START-UP**

A test strip and start-up for the rubber modified asphalt mixture shall be conducted in accordance with the Department's "Bituminous Concrete QC/QA Start-Up Procedures".

**S.P.403B.9.2 PLACING**

Add the following to IDOT Article 406.15, Material Transfer Device:

"(d) A material transfer device shall be used for the placement of this material on those portions of the mainline pavement, shoulders, the deceleration and acceleration portions of ramps, and at other locations as shown on the Contract Documents and/or as directed by the Engineer. The material transfer device shall be operated in such a fashion to maximize the distance from the wheel to any free edge of HMA pavement and shall not be operated close to an unsupported edge of HMA pavement. Prior to traveling over structures, the material transfer device shall be emptied of bituminous material, so as to minimize the weight of the vehicle. The tires of the vehicle shall travel directly on or in close proximity and parallel to the beam and/or girder lines of all structures."

The rubber modified asphalt mixtures shall be delivered at a temperature of 149° C (300° F) to 177° C (350° F). The mixture shall not be placed when the ambient (or surface) temperature is below 13°C (55°F), during wet weather, or when local conditions indicate rain is imminent.

Breakdown compaction should be done while the mat is between 130°C and 149°C (265°F and 300°F). Finish compaction should be completed before the mat reaches a temperature of 115°C (240°F).

Pneumatic-tired rollers will not be permitted.

The addition of a non-foaming detergent to the roller water will be allowed to prevent sticking, if necessary.

The minimum compacted thickness of each lift shall be according to the following table:

| MINIMUM COMPACTED LIFT THICKNESS | |
|---|---|
| Mixture | Thickness, mm (in.) |
| IL-9.5 | 32 (1 1/4) |
| IL-12.5 | 38 (1 1/2) |
| IL-19.0 | 57 (2 1/4) |
| IL-25.0 | 76 (3) |

During laydown, the Engineer will periodically determine the mat density in accordance with Illinois-modified ASTM D 2950, Standard Test Method for Determination of Density of Bituminous Concrete in Place by Nuclear Methods. Final acceptance of mat density shall be based on cores obtained by the Contractor at locations specified by the Engineer. Core densities will be determined by the Engineer in accordance with Departmental procedures.

**S.P.403B.9.3 SURFACE TESTS**

Revise Article 406.21 of the IDOT Standard Specifications to read:

**"406.21 Surface Tests.** The finished surface of the pavement shall be tested for smoothness within three days of paving. Testing shall be performed in the presence of the Engineer.

Prior to testing, a copy of the approval letter and recorded settings from the Profile Equipment Verification Program shall be submitted to the Engineer; and all objects and debris shall be removed from the pavement.

(a) Test Sections/Equipment.

(1) High-Speed Mainline Pavement. High-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed greater than 75 km/hr (45 mph). These sections shall be tested using a California Profilograph or an approved equivalent.

(2) Low-Speed Mainline Pavement. Low-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed of 75 km/hr (45 mph) or less. These sections shall be tested using a California Profilograph or an approved equivalent.

(3) Miscellaneous Pavement. Miscellaneous pavement shall consist of:

a. pavement on horizontal curves with a centerline radius of curvature of less than or equal to 300 m (1000 ft) and pavement within the superelevation transition of such curves;

b. the first or last 4.5 m (15 ft) of a pavement section where the Contractor is not responsible for the adjoining surface;

c. intersections;

d. variable width pavements;

e. side street returns;

f. crossovers;

g. connector pavement from mainline pavement expansion joint to the bridge approach pavement;

h. bridge approach pavement; and

i. other miscellaneous pavement surfaces (i.e. a turn lane) as determined by the Engineer.

Miscellaneous pavement shall be tested using a 5 m (16 ft) straightedge set to a 10 mm (3/8 in.) tolerance.

(b) Lots/Sublots. Mainline pavement test sections will be divided into lots and sublots.

(1) Lots. A lot will be defined as a continuous strip of pavement 1600 m (1 mile) long and one lane wide. When the length of a continuous strip of pavement is less than 1600 m (1 mile), that pavement will be included in an adjacent lot. Structures will be omitted when measuring pavement length.

(2) Sublots. Lots will be divided into 160 m (0.1 mile) sublots. A partial sublot resulting from an interruption in the pavement will be subject to the same evaluation as a whole sublot.

(c) Testing Procedure. One wheel track shall be tested per lane for bituminous concrete overlays. Testing shall be performed 1 m (3 ft) from and parallel to the edge of the lane away from traffic. Two wheel tracks shall be tested per lane for bituminous concrete pavement (full depth). Testing shall be performed 1 m (3 ft) from and parallel to each lane edge. A guide shall be used to maintain the proper distance.

The profile trace generated shall have stationing indicated every 150 m (500 ft) at a minimum. Both ends of the profile trace shall be labeled with the following information: contract number, beginning and ending stationing, which direction is up on the trace, which direction the profilograph was pushed, and the profilograph operator name(s). The top portion of the Contractor supplied profilograph report form shall be completed and secured around the trace roll.

Although surface testing of intermediate lifts will not be required, they may be performed at the Contractor's option. When this option is chosen, the testing shall be performed and the profile traces shall be generated as described above.

The Engineer may perform his/her own testing at any time for monitoring and comparison purposes.

(d) Trace Reduction and Bump Locating Procedure. All traces shall be reduced. Traces produced by a mechanical recorder shall be reduced using an electronic scanner and computer software. This software shall calculate the profile index of each sublot in mm/km (in./mile) and indicate any high points (bumps) in excess of 8 mm (0.30 in.) with a line intersecting the profile on the printout. Computerized recorders shall provide the same information.

The profile index of each track, average profile index of each sublot, average profile index of the lot and locations of bumps shall be recorded on the form.

All traces and reports shall be provided to the Engineer for the project file. Traces from either a computerized profilograph or analysis software used with a manual profilograph shall display the settings used for the data reduction. The Engineer will compare these settings with the settings used during verification testing. If the settings do not match, the results will be rejected and the section shall be retested/reanalyzed with the appropriate settings.

The Engineer will use the results of the testing to evaluate paving methods and equipment. If the average profile index of a lot exceeds 635 mm/km (40.0 in./mile) for high-speed mainline pavement or 1025 mm/km (65.0 in./mile) for low-speed mainline pavement, the paving operation will be suspended until corrective action is taken by the Contractor.

(e) Corrective Work. All bumps in excess of 8 mm (0.30 in.) in a length of 8 m (25 ft) or less shall be corrected. If the bump is greater than 13 mm (0.50 in.), the pavement shall be removed and replaced to the satisfaction of the Engineer at the Contractor's expense. The minimum length of pavement to be removed shall be 900 mm (3 ft.).

(1) High-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 475 (30.0) to 635 (40.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace. Any sublot having a profile index greater than 635 mm/km (40.0 in./mile) including bumps, shall be corrected to reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(2) Low-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 710 (45.0) to 1025 (65.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace. Any sublot having a profile index greater than 1025 mm/km (65.0 in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(3) Miscellaneous Pavement. Surface variations which exceed the 10 mm (3/8 in.) tolerance will be marked by the Engineer and shall be corrected by the Contractor.

Corrective work shall be completed using either an approved grinding device consisting of multiple saws or by removing and replacing the pavement. Corrective work shall be applied to the full lane width. When completed, the corrected area shall have uniform texture and appearance, with the beginning and ending of the corrected area squared normal to the centerline of the paved surface.

Upon completion of the corrective work, the surface of the sublot(s) shall be retested. The Contractor shall furnish the profilograph tracing(s) and the completed form(s) to the Engineer within two working days after corrections are made. If the profile index and/or bumps still do not meet the requirements, additional corrective work shall be performed.

Corrective work shall be at the Contractor's expense.

(f) Smoothness Assessments. Assessments will be paid to or deducted from the Contractor for each sublot of mainline pavement, per the Smoothness Assessment Schedule. Assessments will be based on the average profile index of each sublot prior to performing any corrective work unless the Contractor has chosen to remove and replace the sublot. For sublots that are replaced, assessments will be based on the profile index determined after replacement.

Assessments will not be paid or deducted until all other contract requirements for the pavement are satisfied. Pavement that is corrected or replaced for reasons other than smoothness shall be retested as stated herein.

A full-depth bituminous concrete pavement structure shall be comprised of one or more bituminous concrete binder courses and a bituminous concrete surface course on a prepared subgrade.

| **SMOOTHNESS ASSESSMENT SCHEDULE (Bituminous Concrete Overlays)** | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | 240 (15.0) or less | +$150.00 |
| >95 (6.0) to 160 (10.0) | >240 (15.0) to 400 (25.0) | +$80.00 |
| >160 (10.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | - $300.00 |

| **SMOOTHNESS ASSESSMENT SCHEDULE (Full-Depth Bituminous)** | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | | +$800.00 |
| >95 (6.0) to 175 (11.0) | 240 (15.0) or less | +$550.00 |
| >175 (11.0) to 270 (17.0) | >240 (15.0) to 400 (25.0) | +$350.00 |
| >270 (17.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | -$500.00 |

**S.P.403B.10 OPENING TO TRAFFIC**

Traffic shall not be permitted on the new surface until the temperature of the mat has dropped below 60° C (140° F). After compaction, sand may be applied to the mat at a rate of 1-2 lb. per square yard, as determined by the Engineer, to prevent pick-up or tracking.

**S.P.403B.11 MEASUREMENT**

IDOT Superpave bituminous concrete surface course mixtures will be measured in accordance with the provisions of Subsection 403.18 of the ISTHA Standard Specifications except as herein modified.

The second paragraph of Subsection 402.19 of the ISTHA Standard Specifications shall read as follows:

"Payment will not be made for bituminous concrete mixtures in excess of 103 percent of the quantity specified by the Engineer. When the Engineer performs a daily yield check of the material placed, the specified amount shall be calculated utilizing the actual area placed times the thickness of bituminous concrete material shown on the contract plans times the average in-place density as determined by the daily density tests when performed by the Contractor in accordance with the applicable provisions of ISTHA special provision S.P.150, "Quality Control/Quality Assurance of Bituminous Concrete Mixtures". Should the field density test results not be available, the specified amount shall be calculated by multiplying the actual area placed times the thickness of bituminous concrete material shown on the contract plans times the bulk specific gravity ("G") value, from the IDOT approved mix design.

**S.P.403B.12 PAYMENT**

Payment for BITUMINOUS CONCRETE SURFACE COURSE SUPERPAVE, RUBBER MODIFIED measured as specified, will be made at the Contract unit price per ton, which payment shall constitute full compensation for preparation of the base or existing pavement, furnishing, placing, and compacting bituminous concrete mixtures, construction of joints, protection from traffic or other damage, handling field samples, filling core holes, and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work as specified.

Unless otherwise specified, BITUMINOUS MATERIAL (TACK) and AGGREGATE FOR BLOTTING will be measured and paid for in accordance with the provisions of Subsections 402.19 and 402.20 of the ISTHA Standard Specifications.

Test strips constructed for the purpose of evaluating the properties of a bituminous concrete mixture will be paid for at the contract unit price each for CONSTRUCTING TEST STRIP FOR GTR MODIFIED SURFACE COURSE. A test strip will be considered as having been constructed when a satisfactory test strip has been obtained for a specific bituminous concrete mixture. If the Contractor requests and is granted approval for a mix design change, he/she shall construct a test strip for the new mix design at his/her own expense, and no additional compensation will be allowed.

| PAY ITEM NUMBER | DESCRIPTION | UNIT OF MEASURE |
|---|---|---|
| 403C1 | CONSTRUCTING TEST STRIP FOR GTR MODIFIED SURFACE COURSE | EACH |
| 403BN105R | GTR MODIFIED BITUMINOUS CONCRETE SURFACE COURSE, SUPERPAVE, IL-12.5, N105 | TON |

## S.P. 403C GROUND TIRE RUBBER (GTR) MODIFIED STONE MATRIX ASPHALT (SMA) SURFACE COURSE, SPECIAL

### S.P. 403C.1 DESCRIPTION

This Special Provision establishes and describes the responsibilities of the Contractor in producing and constructing GTR Modified SMA Surface Course, Special. This work shall be according to the applicable portions of Section 406 of the IDOT Standard Specifications and the IDOT special provision "Quality Control/Quality Assurance of Bituminous Concrete Mixtures", except as modified herein.

### S.P. 403C.2 MATERIALS

(a) Aggregates.

(1) The coarse aggregate shall be crushed steel slag or Crushed Diabase / Trap Rock aggregate and shall meet the following additional requirements:

Gradation. No individual coarse aggregate gradation is specified. The coarse aggregate gradation(s) used shall be capable of being combined with FA 20 stone sand and mineral filler to meet the approved mix design and the mix requirements noted herein.

Quality. The coarse aggregate shall be “B” quality or better in accordance with Article 1004.1 of the IDOT Standard Specifications.

Water Absorption. 1.5 % maximum based on the AASHTO T85-91 test method as performed by an AAP accredited laboratory.
Steel Slag sources shall follow the “Slag Producer Self-Testing Program” as established by the Illinois Department of Transportation.

(2) Fine Aggregate. Fine aggregate shall be Class B Quality stone sand meeting gradation FA 20 in accordance with Section 1003 of the IDOT Standard Specifications.

(3) Mineral Filler. Mineral filler shall be commercially manufactured mineral filler meeting Article 1011.01 of the IDOT Standard Specifications.

(b) Fiber Additive. A fiber additive shall be included in the SMA mixture. The fiber additive shall comply with the requirements of AASHTO MP-8.

The dosage rate for cellulose shall be approximately 0.4% by total mixtures mass and sufficient to prevent draindown. For mineral fiber, the dosage rate shall be approximately 0.5% by total mixture mass.

(c) Reclaimed Asphalt Pavement (RAP). RAP will not be permitted.

(d) Bituminous Material. The base asphalt cement (AC) that is blended with the GTR shall be a PG 64-22 performance-grade (PG) meeting the requirements of Article 1009.05 of the IDOT Standard Specifications. At the start of the project, a sample of the GTR modified asphalt cement shall be obtained at the plant and submitted to the Tollway for verification of the asphalt grade.

(e) Ground Tire Rubber (GTR). The GTR shall be produced from processing automobile and/or truck tires by the ambient grinding method. Heavy equipment

tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 2 mm (1/16 in.) in length and shall contain no free metal particles. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 50 gram sample. Metal embedded in rubber particles will be permitted.

The GTR shall be stored in a dry location protected from the rain. When the GTR is combined with the asphalt cement, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance with ASTM C-136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, (Illinois-modified AASHTO T-27, Sieve Analysis of Fine and Coarse Aggregates) a 50 gram sample of the GTR shall conform to the following gradation requirements:

| Sieve Size | Percent Passing |
|---|---|
| 2.36 mm (No. 8) | 100 |
| 1.18 mm (No. 16) | $98 \pm 2$ |
| 600 μm (No. 30) | $95 \pm 5$ |
| 300 μm (No. 50) | $50 \pm 10$ |
| 150 μm (No. 100) | $10 \pm 5$ |
| 75 μm (No. 200) | $2 \pm 2$ |

A mineral powder (such as talc) meeting AASHTO M17, Mineral Filler for Bituminous Paving Mixtures, requirements may be added, up to a maximum of 4% by weight of GTR particles, to reduce sticking and caking of the GTR particles.

GTR shall have a specific gravity of $1.15 \pm 0.05$ when tested in accordance with ASTM D-1817, Standard Test Method for Rubber Chemicals-Density.

The GTR may be provided in bulk or in whole plastic containers. Plastic containers shall be made from low density polyethylene having a melting point less than 115° C (240° F). The manufacturer shall ship along with the GTR, certificates of compliance which certify that all requirements of this specification are complied with for each production lot number or shipment.

(e) Extender Oils or Polymeric Aid. With approval of the Engineer, compatible extender oils and/or polymers may be added to the GTR or to the asphalt-rubber blend. The additional costs for the extender oils and/or polymer additions shall be borne by the Contractor. The Contractor shall provide material product information along with usage rates for approval.

**S.P. 403C.3 EQUIPMENT**

Articles 406.03 through 406.22 of the IDOT Standard Specifications and the IDOT Special Provision, "Superpave Bituminous Concrete Mixtures" shall govern the requirements for equipment; the preparatory work; mix design criteria; and the preparation, transportation, placement and compaction of IDOT Superpave Bituminous Concrete Mixtures, except as modified herein.

Add the following to the list of specific references to IDOT Article 406.03.

"Material Transfer Device ..... ISTHA Subsection 1202.8"
"Pavement Surface Test Equipment ..... ISTHA Special Provision SP 1203.5"

Rollers. The Contractor shall provide a minimum of two steel-wheeled tandem rollers for breakdown (TB) and one finish steel-wheeled roller (TF) meeting the requirements of Article 406.16(a) and 1101.01(e) of the Standard Specifications except the minimum compression for all of the rollers shall be 49 N/mm (280 lb/in.) of roller width. Pneumatic-tired and vibratory rollers will not be permitted.

**S.P. 403C.4 GROUND TIRE RUBBER BLENDING**

The GTR shall be blended with the asphalt cement, forming a consistent, homogeneous blend, prior to being added to aggregates. The Terminal Blend method, where the GTR is blended and reacted with the asphalt cement at the asphalt refinery, shall be used. The minimum amount of GTR for asphalt-rubber blends shall be as follows:

| Specified PG Grade stated on the Plans | Minimum GTR (by weight of asphalt cement) |
|---|---|
| GTR PG 70-22 | 10% |
| GTR PG 76-22 | 15% |

The GTR shall be blended with the asphalt cement and reacted for a minimum of 45 minutes at a temperature of 163°C to 191°C (325°F to 375°F).

The mixing temperature of the HMA mixture shall be 149-177°C (300-350°F).

**S.P. 403C.5 HOT MIX PLANT**

The type of plant used for the manufacture of GTR modified asphalt cement mixtures may be either a batch or drier drum plant meeting the requirements of 406.12 & 1102.01, with the following exceptions:

**General**

(a) Storage and Conveyance. Silo storage of GTR modified SMA shall not exceed 4 hours.

(b) Plant modification. Introduction of GTR into rubber modified asphalt mixtures may require additional plant modifications. The Engineer will have final approval of the plant.

(c) Plant Calibration. The asphalt plant shall be calibrated and approved by The Illinois Department of Transportation Bureau of Materials and Physical Research or the Tollway before production of the rubber modified asphalt mixture.

(d) Mineral Filler System. The mineral filler system shall accurately proportion the large amounts of mineral filler required for the mixture. Alteration or adjustment of the current system may be required.

Mineral filler shall not be stored in the same silo as collected dust. Collected dust shall not be used as mineral filler.

(e) Mineral Fiber Additive. Adequate dry storage shall be provided for the fiber additive. A separate feed system shall be provided to proportion the fiber into the mixture uniformly and in desired quantities. The feed system shall be interlocked with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled

accurately to within ± 10% of the amount of fibers required. Flow indicators or sensing devices for the fiber system shall be provided and interlocked with plant controls so mix production shall be interrupted if fiber introduction fails.

(1) Batch Plant. Loose fiber shall be pnuematically added through a separate inlet directly into the weigh hopper above the pugmill. The addition of fiber shall be timed to occur during the hot aggregate charging of the hopper. Adequate mixing time will be required to ensure proper blending of the aggregate and fiber additive. Both the wet and dry mixing times shall each be increased a minimum of 5 seconds. The actual mixing time increase shall be determined by the Engineer based on individual plant characteristics. The batch size shall not exceed 75% of pugmill size as rated by the Department..

(2) Drum Mix Plant. Loose fiber shall be introduced using specialized equipment which mixes asphalt cement with the loose fiber at the time of introduction into the drum mixer. This equipment shall be approved by the Engineer. Care shall be taken to ensure the loose fiber does not become entrained in the exhaust system of the drier or plant.

(3) Fiber Supply System: When fiber stabilizing additives are required as an ingredient of the mixture, a separate feed system shall be utilized to accurately proportion by weight the required quantity into the mixture in such a manner that uniform distribution will be obtained. The fiber system shall be interlocked with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled accurately to within plus or minus 10 percent of the amount of fibers required and the fiber system shall automatically adjust the feed rate to maintain the material within this tolerance at all times. The fiber system shall provide in-process monitoring consisting of either a digital display or output or a printout of feed rate, in pounds per minute to verify feed rate. Flow indicators or sensing devices for the fiber system shall be provided and interlocked with plant controls so that mixture production will be interrupted if introduction of the fiber fails, or if the output rate is not within the tolerances given above.

When a batch type plant is used, the fiber shall be added to the aggregate in the weigh hopper or as approved and directed by the Engineer. The fibers are to be uniformly distributed prior to the injection of asphalt cement into the mixes.

When a continuous or drier-drum type plant is used, the fiber shall be added to the aggregate and uniformly dispersed prior to the injection of asphalt cement. The fiber shall be added in such a manner that it will not become entrained in the exhaust system of the drier or plant.

**Terminal Processing and Storage**

(a) At the asphalt production facility for Terminal Processing, a separate agitated shipping storage tank shall be required, with continuous mixing and recirculation of the asphalt-rubber blend to react the GTR with the asphalt cement. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 163°C to 191°C (325°F to 375°F) for a minimum of 45 minutes.

(b) Once the Terminal Processing of GTR and asphalt cement produces a homogeneous blend at the production facility, test samples shall be obtained and submitted to the Tollway for testing.

(c) Terminal Blended GTR modified asphalt may be stored at the production facility for up to 30 days at 149°C to 177°C (300°F to 350°F) with continuous mixing.

(d) If Terminal Blended GTR modified asphalt cement is used, a dedicated storage tank for "terminal blended GTR" shall be required at the hot mix plant. This tank shall be capable of providing continuous mixing and/or recirculation of the asphalt-rubber blend. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 150°C to 177°C (300°F to 350°F) for a maximum of 3 days.

**S.P. 403C.6 MIX DESIGN**

The Contractor will provide mix designs for each required mixture. Mix designs shall be developed by a QC/QA Level III Techincian in accordance with all IDOT Superpave mix design procedures and the following:

The draindown shall be determined at the JMF AC content at the mixing temperature plus 30ºF. Draindown shall be masured using AASHTO T 305.

Each specific GTR Modified SMA mixture design shall be submitted to and verified by the Tollway as detailed in the Illinois Department of Transportation's current "Bituminous Mixture Design Verification Procedure". The Contractor shall submit samples of all appropriate materials to the Tollway at least four weeks prior to production for mixture design verification.

The Contractor shall supply the average gradation and the gradation ranges (including the Master Band on the critical sieve, if required) for each aggregate designated for use in the mixture. This information shall be used to judge whether the aggregates are compatible to produce an acceptable mix.

The mix design shall meet the following Gyratory Design parameters:

| | |
|---|---|
| Design Air Voids | 3.50 % @ 80 Gyrations |
| VFA | 75-85 |
| VMA | 17.0 minimum |
| Draindown (%) | 0.3 maximum |

The SMA surface mixture gradation shall be according to the following requirements for the mixture specified on the plans.

GTR Modified SMA Asphalt Gradation

| Mixture Gradation Target Value Range | |
|---|---|
| Sieve | Percent Passing |
| 19.0 mm (3/4") | 100 |
| 12.5 mm (1/2") | 82 – 100 |
| 9.5 mm (3/8") | 60 max |
| 4.75 mm (No. 4) | 20 – 30 |
| 2.36 mm (No. 8) | 14 – 24 |
| 600 μm (No. 30) | 12 - 16 |
| 300 μm (No. 50) | 10 – 15 |
| 75μm (No. 200) | 8 – 10 |

**S.P. 403C.7 CONSTRUCTION REQUIREMENTS**

**S.P. 403C.7.1 WEATHER REQUIREMENTS**

The mixtures shall be placed on a dry surface when the temperature of the roadbed is above 15 °C (60 °F).

**S.P. 403C.7.2 MIX PRODUCTION**

The mixtures shall be produced at a temperature range recommended by the GTR asphalt supplier and approved by the Engineer to allow adequate compaction. The actual production temperature will be selected from the range by the Engineer based on individual plant characteristics and modifier used in the mixtures.

**S.P. 403C.7.3 TEST STRIPS**

A QC/QA mixture test strip will be required. The test strip shall be constructed at a location approved by the Engineer to determine the mix properties, density, and laydown characteristics. These test results and visual inspections on the mixture shall be used to make corrective adjustments if necessary.

Prior to the start of mix production and placement, The Engineer will review and approve all test strip results and rolling pattern.

The test strip will be performed as follows:

(a) Team Members. The start-up team, if required, shall consist of the following:
- (1) Resident Engineer
- (2) Tollway Project Manager, or representative
- (3) Tollway Materials Engineer, or representative
- (4) Construction Manager's Nuclear Density Gauge Specialist
- (5) Contractor's QC Manager
- (6) Construction Manager's QA representative
- (7) Contractor's Density Tester
- (8) AC Supplier representative

(b) Communication. The Contractor shall advise the team members of the anticipated start time of production for the test strip. The QC Manager shall direct the activities of the test strip team. A Tollway-appointed representative from the start-up team will act as spokesperson for the Tollway.

(c) The Test Strip shall consist of approximately 300 tons (280 M tons). It shall contain two growth curves which shall be compacted by a static steel-wheeled roller and tested as outlined herein.

(1) Mix Information. On the day of construction of the Test strip, the Contractor shall provide the start-up team documentation of test data showing the combined hot-bin or the combined aggregate belt sample and mineral filler at a drier-drum plant.

(2) Mix and Gradation Test Strip Samples. The first and second sets of mixture and gradation samples shall be taken by the Contractor at such times as to represent the mixture between the two growth curves and the rolling pattern area, respectively. All test strip samples shall be processed by the Contractor for determination of mix composition and Superpave properties including air voids. This shall include washed gradation tests. This information shall then be compared to the JMF and required design criteria.

(3) Compaction Equipment. It shall be the responsibility of the start-up team to verify roller compliance before commencement of growth curve construction.

All paving and rolling equipment intended for use on a project shall be utilized on the test strip.

(4) Constructing of the Test Strip. After the Contractor has produced the mix, transported the mix, and placed approximately 70 to 110 metric tons (80 to 120 tons) of mix, placement of the mix shall stop, and a growth curve shall be constructed. After completion of the first growth curve, paving shall resume for 45 to 70 metric tons (50 to 80 tons) of mix, placement shall stop, and the second growth curve shall be constructed within this area. Additional growth curves may be required if an adjustment/plant change is made during the test strip. The Contractor shall use the specified rolling procedures for all portions of the test strip except for the growth curve areas which shall be compacted as directed by the Engineer.

(5) Location of Test Strip. The test strip shall be located on a pavement type similar to the contract pavement and acceptable to the Engineer. It shall be on a relatively flat portion of the roadway. Descending/Ascending grades or ramps shall be avoided.

(6) Compaction Temperature. In order to make an accurate analysis of the density potential of the mixture, the temperature of the mixture on the pavement at the beginning of the growth curve shall be 152 °C (325 °F).

(7) Compaction and Testing. The Engineer will specify the roller(s) speed and number of passes required to obtain a completed growth curve. The nuclear gauge shall be placed near the center of the hot mat and the position marked for future reference. With the bottom of the nuclear gauge and the source rod clean, a 15 seconds nuclear reading (without

mineral filler) shall be taken after each pass of the roller. Rolling shall continue until the maximum density is achieved and three consecutive passes show no appreciable increase in density or no evidence of destruction of the mat. The growth curve shall be plotted. No testing of initial passes shall be taken until the fourth pass is completed.

(8) Final Testing. After the growth curve information is obtained, a final one minute nuclear reading, using mineral filler to eliminate surface voids, shall be taken at the marked position. This reading is used to adjust the maximum density reading obtained during the growth curve.

(9) Evaluation of Growth Curves. Mixtures which exhibit density potential less than 94 percent or greater than 97 percent of the maximum theoretical density (D) shall be considered as sufficient cause for mix adjustment. If a mix adjustment is made, an additional test strip may be constructed. The Tollway will pay half the cost of the contract unit price for a test strip if additional one is required. The information shall then be compared to the AJMF and required design criteria.

If the nuclear density potential of the mixture does not exceed 91 percent, the operation will cease until all test data is analyzed or a new mix design is produced.

In addition, other aspects of the mixture, such as appearance, segregation, texture, or other evidence of mix problems, should be noted and corrective action taken at this time.

(d) Documentation. The Test Strip and rolling pattern information (including growth curves) will be tabulated by the contractor with copies provided to each team member, and the original submitted to the Engineer. Any change to the rolling pattern shall be approved by the Engineer.

(e) Density. For the GTR Modified SMA asphalt surface course, only the core method of density will be accepted.

**S.P. 403C.7.4 MIX PLACEMENT AND COMPACTION**

Add the following to IDOT Article 406.15, Material Transfer Device:

"(d) A material transfer device shall be used for the placement of this material on those portions of the mainline pavement, shoulders, the deceleration and acceleration portions of ramps, and at other locations as shown on the Contract Documents and/or as directed by the Engineer. The material transfer device shall be operated in such a fashion to maximize the distance from the wheel to any free edge of HMA pavement and shall not be operated close to an unsupported edge of HMA pavement. Prior to traveling over structures, the material transfer device shall be emptied of bituminous material, so as to minimize the weight of the vehicle. The tires of the vehicle shall travel directly on or in close proximity and parallel to the beam and/or girder lines of all structures."

The GTR Modified SMA asphalt mixture shall be delivered at a temperature of 149°C (300°F) to 177°C (350°F). The mixture shall not be placed when the roadbed temperature is below 15°C (60°F), during wet weather, or when local conditions indicate rain is imminent.

The paver speed shall not exceed 7 m/min (20 ft/min) during placement.

Breakdown compaction should be done while the mat is between 130°C and 149°C (265°F and 300°F). Finish compaction should be completed before the mat reaches a temperature of 115°C (240°F).

The addition of a non-foaming detergent to the roller water will be allowed to prevent sticking, if necessary.

The minimum compacted thickness of each lift shall be according to the following table:

| MINIMUM COMPACTED LIFT THICKNESS | |
|---|---|
| Mixture | Thickness, mm (in.) |
| IL-9.5 | 32 (1 1/4) |
| IL-12.5 | 38 (1 1/2) |
| IL-19.0 | 57 (2 1/4) |
| IL-25.0 | 76 (3) |

During laydown, the Engineer will periodically determine the mat density in accordance with Illinois-modified ASTM D 2950, Standard Test Method for Determination of Density of Bituminous Concrete in Place by Nuclear Methods.

Final acceptance of mat density shall be based on cores obtained by the Contractor at locations specified by the Engineer. Core densities will be determined by the Engineer in accordance with Departmental procedures.

Compaction shall continue until the required density range has been achieved. The required density range shall be 94% to 97% of theoretical maximum specific gravity ($G_{mm}$). Care shall be taken to avoid excessive aggregate breakage.

**Hauling/Laydown Equipment**

The Contractor shall provide a release agent that minimizes sticking to equipment and is acceptable to the Engineer. The Contractor shall furnish a laborer to ensure that all truck beds are clean and no excess release agent is used prior to being loaded. All trucks shall be insulated and tarped when hauling the mixture to the paver.

**S.P. 403C.7.5 SURFACE TESTS**

Revise Article 406.21 of the IDOT Standard Specifications to read:

**"406.21 Surface Tests.** The finished surface of the pavement shall be tested for smoothness within three days of paving. Testing shall be performed in the presence of the Engineer.

Prior to testing, a copy of the approval letter and recorded settings from the Profile Equipment Verification Program shall be submitted to the Engineer; and all objects and debris shall be removed from the pavement.

(a) Test Sections/Equipment.

(1) High-Speed Mainline Pavement. High-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed greater than 75 km/hr (45 mph). These sections shall be tested using a California Profilograph or an approved equivalent.

(2) Low-Speed Mainline Pavement. Low-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed of 75 km/hr (45 mph) or less. These sections shall be tested using a California Profilograph or an approved equivalent.

(3) Miscellaneous Pavement. Miscellaneous pavement shall consist of:

a. pavement on horizontal curves with a centerline radius of curvature of less than or equal to 300 m (1000 ft) and pavement within the superelevation transition of such curves;

b. the first or last 4.5 m (15 ft) of a pavement section where the Contractor is not responsible for the adjoining surface;

c. intersections;

d. variable width pavements;

e. side street returns;

f. crossovers;

g. connector pavement from mainline pavement expansion joint to the bridge approach pavement;

h. bridge approach pavement; and

i. other miscellaneous pavement surfaces (i.e. a turn lane) as determined by the Engineer.

Miscellaneous pavement shall be tested using a 5 m (16 ft) straightedge set to a 10 mm (3/8 in.) tolerance.

(b) Lots/Sublots. Mainline pavement test sections will be divided into lots and sublots.

(1) Lots. A lot will be defined as a continuous strip of pavement 1600 m (1 mile) long and one lane wide. When the length of a continuous strip of pavement is less than 1600 m (1 mile), that pavement will be included in an adjacent lot. Structures will be omitted when measuring pavement length.

(2) Sublots. Lots will be divided into 160 m (0.1 mile) sublots. A partial sublot resulting from an interruption in the pavement will be subject to the same evaluation as a whole sublot.

(c) Testing Procedure. One wheel track shall be tested per lane for bituminous concrete overlays. Testing shall be performed 1 m (3 ft) from and parallel to the edge of the lane away from traffic. Two wheel tracks shall be tested per lane for bituminous concrete pavement (full depth). Testing shall be performed 1 m (3 ft) from and parallel to each lane edge. A guide shall be used to maintain the proper distance.

The profile trace generated shall have stationing indicated every 150 m (500 ft) at a minimum. Both ends of the profile trace shall be labeled with the following information: contract number, beginning and ending stationing, which direction is up on the trace, which direction the profilograph was pushed, and the

profilograph operator name(s). The top portion of the Contractor supplied profilograph report form shall be completed and secured around the trace roll.

Although surface testing of intermediate lifts will not be required, they may be performed at the Contractor's option. When this option is chosen, the testing shall be performed and the profile traces shall be generated as described above.

The Engineer may perform his/her own testing at any time for monitoring and comparison purposes.

(d) Trace Reduction and Bump Locating Procedure. All traces shall be reduced. Traces produced by a mechanical recorder shall be reduced using an electronic scanner and computer software. This software shall calculate the profile index of each sublot in mm/km (in./mile) and indicate any high points (bumps) in excess of 8 mm (0.30 in.) with a line intersecting the profile on the printout. Computerized recorders shall provide the same information.

The profile index of each track, average profile index of each sublot, average profile index of the lot and locations of bumps shall be recorded on the form.

All traces and reports shall be provided to the Engineer for the project file. Traces from either a computerized profilograph or analysis software used with a manual profilograph shall display the settings used for the data reduction. The Engineer will compare these settings with the settings used during verification testing. If the settings do not match, the results will be rejected and the section shall be retested/reanalyzed with the appropriate settings.

The Engineer will use the results of the testing to evaluate paving methods and equipment. If the average profile index of a lot exceeds 635 mm/km (40.0 in./mile) for high-speed mainline pavement or 1025 mm/km (65.0 in./mile) for low-speed mainline pavement, the paving operation will be suspended until corrective action is taken by the Contractor.

(e) Corrective Work. All bumps in excess of 8 mm (0.30 in.) in a length of 8 m (25 ft) or less shall be corrected. If the bump is greater than 13 mm (0.50 in.), the pavement shall be removed and replaced to the satisfaction of the Engineer at the Contractor's expense. The minimum length of pavement to be removed shall be 900 mm (3 ft.).

(1) High-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 475 (30.0) to 635 (40.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace. Any sublot having a profile index greater than 635 mm/km (40.0 in./mile) including bumps, shall be corrected to reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(2) Low-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 710 (45.0) to 1025 (65.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace. Any sublot having a profile index greater than 1025 mm/km (65.0 in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(3) Miscellaneous Pavement. Surface variations which exceed the 10 mm (3/8 in.) tolerance will be marked by the Engineer and shall be corrected by the Contractor.

Corrective work shall be completed using either an approved grinding device consisting of multiple saws or by removing and replacing the pavement. Corrective work shall be applied to the full lane width. When completed, the corrected area shall have uniform texture and appearance, with the beginning and ending of the corrected area squared normal to the centerline of the paved surface.

Upon completion of the corrective work, the surface of the sublot(s) shall be retested. The Contractor shall furnish the profilograph tracing(s) and the completed form(s) to the Engineer within two working days after corrections are made. If the profile index and/or bumps still do not meet the requirements, additional corrective work shall be performed.

Corrective work shall be at the Contractor's expense.

(f) Smoothness Assessments. Assessments will be paid to or deducted from the Contractor for each sublot of mainline pavement, per the Smoothness Assessment Schedule. Assessments will be based on the average profile index of each sublot prior to performing any corrective work unless the Contractor has chosen to remove and replace the sublot. For sublots that are replaced, assessments will be based on the profile index determined after replacement.

Assessments will not be paid or deducted until all other contract requirements for the pavement are satisfied. Pavement that is corrected or replaced for reasons other than smoothness, shall be retested as stated herein.

A full-depth bituminous concrete pavement structure shall be comprised of one or more bituminous concrete binder courses and a bituminous concrete surface course on a prepared subgrade.

| **SMOOTHNESS ASSESSMENT SCHEDULE (Bituminous Concrete Overlays)** | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | 240 (15.0) or less | +$150.00 |
| >95 (6.0) to 160 (10.0) | >240 (15.0) to 400 (25.0) | +$80.00 |
| >160 (10.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | - $300.00 |

| SMOOTHNESS ASSESSMENT SCHEDULE (Full-Depth Bituminous) | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | | +$800.00 |
| >95 (6.0) to 175 (11.0) | 240 (15.0) or less | +$550.00 |
| >175 (11.0) to 270 (17.0) | >240 (15.0) to 400 (25.0) | +$350.00 |
| >270 (17.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | -$500.00 |

**S.P. 403C.8 CONTROL CHARTS / LIMITS**

Control Charts/Limits. Control charts/limits shall be according to QC/QA requirements except as follows:

| Parameter | Individual Test | Moving Average |
|---|---|---|
| 9.5 mm (3/8 in.) | ± 4% | ± 3% |
| 2.36 mm (No. 8) | ± 4% | ± 2% |
| Asphalt Content | ± 0.2% | ± 0.1% |
| Density | 93.5 – 97.4% | |
| Air Voids | ± 1.2% (of design) | ± 1.0% (of design) |

**S.P. 403C.9 OPENING TO TRAFFIC**

Traffic shall not be permitted on the new surface until the temperature of the mat has dropped below 60° C (140° F). After compaction, sand may be applied to the mat at a rate of 1-2 lb. per square yard, as determined by the Engineer, to prevent pick-up or tracking.

**S.P. 403C.10 MEASUREMENT**

(a) Contract Quantities. The requirement for the use of contract quantities shall be according to Subsection 203.7(a) of the ISTHA Standard Specifications.

(b) Measured Quantities. BITUMINOUS MATERIALS (TACK) will be measured in gallons in accordance with Subsection 109.1.4 of the ISTHA Standard Specifications. AGGREGATE FOR BLOTTING will be measured by weight in tons. The aggregate shall be weighed on scales conforming to the requirements of Subsection 109.1.2 of the ISTHA Standard Specifications.

Payment will not be made for bituminous concrete mixtures in excess of 103 percent of the quantity specified by the Engineer.

**S.P. 403C.11 PAYMENT**

Payment for GROUND TIRE RUBBER MODIFIED SMA SURFACE COURSE, SPECIAL measured as specified, will be made at the Contract unit price per ton, which payment shall constitute full compensation for preparation of the base or existing pavement, furnishing, placing, and compacting GTR Modified SMA surface mixtures, construction of joints, protection from traffic or other damage, handling field samples, filling core holes,

and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work as specified.

Unless otherwise specified, BITUMINOUS MATERIAL (TACK) and AGGREGATE FOR BLOTTING will be measured and paid for in accordance with the provisions fo Subsections 402.19 and 402.20 of the ISTHA Standard Specifications.

The test strip will be paid for at the contract unit price each for TEST STRIP (GROUND TIRE RUBBER MODIFIED SMA SURFACE COURSE, SPECIAL), which price shall not include the 300 tons (280 M tons) of mix, as well as the appropriate testing, which will be paid for at the unit price in the contract for the item being placed.

| **PAY ITEM NUMBER** | **DESCRIPTION** | **UNIT OF MEASURE** |
|---|---|---|
| 403CA | TEST STRIP (GROUND TIRE RUBBER MODIFIED SMA SURFACE COURSE, SPECIAL) | EACH |
| 403CN80SC | GROUND TIRE RUBBER MODIFIED SMA SURFACE COURSE, SPECIAL | TON |

## S.P. 403D GROUND TIRE RUBBER (GTR) MODIFIED OPEN GRADED FRICTION COURSE

### S.P. 403D.1 DESCRIPTION

This Special Provision establishes and describes the responsibilities of the Contractor in producing and constructing a GTR modified open graded friction course (OGFC). This work shall be according to the applicable portions of Section 406 of the IDOT Standard Specifications and the IDOT special provision "Quality Control/Quality Assurance of Bituminous Concrete Mixtures", except as modified herein.

### S.P. 403D.2 MATERIALS

(a) Aggregates.

(1) The coarse aggregate shall be crushed steel slag or Crushed Diabase / Trap Rock aggregate and shall meet the following additional requirements:

Gradation. No individual coarse aggregate gradation is specified. The coarse aggregate gradation(s) used shall be capable of being combined with FA 20 stone sand and mineral filler to meet the approved mix design and the mix requirements noted herein.

Quality. The coarse aggregate shall be “B” quality or better in accordance with Article 1004.1 of the IDOT Standard Specifications.

Water Absorption. 1.5 % maximum based on the AASHTO T85-91 test method as performed by an AAP accredited laboratory.

Steel Slag sources shall follow the “Slag Producer Self-Testing Program” as established by the Illinois Department of Transportation.

(2) Fine Aggregate. Fine aggregate shall be Class B Quality stone sand meeting gradation FA 20 in accordance with Section 1003 of the IDOT Standard Specifications.

(3) Mineral Filler. Mineral filler shall be commercially manufactured mineral filler meeting Article 1011.01 of the Standard Specifications.

(b) Fiber Additive. A fiber additive shall be included in the OGFC mixture. The fiber additive shall comply with the requirements of AASHTO MP-8.

The dosage rate for cellulose shall be approximately 0.3% by total mixture mass. For mineral fiber, the dosage rate shall be approximately 0.5% by total mixture mass and sufficient to prevent draindown.

(c) Reclaimed Asphalt Pavement (RAP). RAP will not be permitted.

(d) Bituminous Material. The base asphalt cement (AC) that is blended with the GTR shall be a PG 64-22 performance-graded (PG) meeting the requirements of Article 1009.05 of the IDOT Standard Specifications. At the start of the project, a sample of the GTR modified asphalt cement shall be obtained at the plant and submitted to the Tollway for verification of the asphalt grade.

(e) Ground Tire Rubber (GTR). The GTR shall be produced from processing automobile and/or truck tires by the ambient grinding method. Heavy equipment

tires, uncured or de-vulcanized rubber will not be permitted. The GTR shall not exceed 2 mm (1/16 in.) in length and shall contain no free metal particles. Detection of free metal particles shall be determined by thoroughly passing a magnet through a 50 gram sample. Metal embedded in rubber particles will be permitted.

The GTR shall be stored in a dry location protected from the rain. When the GTR is combined with the asphalt cement, the moisture content of the GTR shall not cause foaming of the blend.

When tested in accordance with ASTM C-136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates, (Illinois-modified AASHTO T-27, Sieve Analysis of Fine and Coarse Aggregates) a 50 gram sample of the GTR shall conform to the following gradation requirements:

| Sieve Size | Percent Passing |
|---|---|
| 2.36 mm (No. 8) | 100 |
| 1.18 mm (No. 16) | $98 \pm 2$ |
| 600 μm (No. 30) | $95 \pm 5$ |
| 300 μm (No. 50) | $50 \pm 10$ |
| 150 μm (No. 100) | $10 \pm 5$ |
| 75 μm (No. 200) | $2 \pm 2$ |

A mineral powder (such as talc) meeting AASHTO M17, Mineral Filler for Bituminous Paving Mixtures, requirements may be added, up to a maximum of 4% by weight of GTR particles, to reduce sticking and caking of the GTR particles.

GTR shall have a specific gravity of $1.15 \pm 0.05$ when tested in accordance with ASTM D-1817, Standard Test Method for Rubber Chemicals-Density.

The GTR may be provided in bulk or in whole plastic containers. Plastic containers shall be made from low density polyethylene having a melting point less than 115° C (240° F). The manufacturer shall ship along with the GTR, certificates of compliance which certify that all requirements of this specification are complied with for each production lot number or shipment.

(f) Extender Oils or Polymeric Aids. With approval of the Engineer, compatible extender oils and/or polymers may be added to the GTR or to the asphalt-rubber blend. The additional costs for the extender oils and/or polymer additions shall be borne by the Contractor. The Contractor shall provide material product information along with usage rates for approval.

**S.P. 403D.3 EQUIPMENT**

Articles 406.03 through 406.22 of the IDOT Standard Specifications and the IDOT Special Provision, "Superpave Bituminous Concrete Mixtures" shall govern the requirements for equipment; the preparatory work; mix design criteria; and the preparation, transportation, placement and compaction of IDOT Superpave Bituminous Concrete Mixtures, except as modified herein.

Add the following to the list of specific references to IDOT Article 406.03.

"Material Transfer Device ..... ISTHA Subsection 1202.8"
"Pavement Surface Test Equipment ..... ISTHA Special Provision SP 1203.5"

Rollers. The Contractor shall provide a minimum of two steel-wheeled tandem rollers for breakdown ($T_B$) and one finish steel-wheeled roller ($T_F$) meeting the requirements of Article 406.16(a) and 1101.01(e) of the Standard Specifications except the minimum compression for all of the rollers shall be 49 N/mm (280 lb/in.) of roller width. Pneumatic-tired and vibratory rollers will not be permitted.

**S.P. 403D.4 GROUND TIRE RUBBER BLENDING**

The GTR shall be blended with the asphalt cement, forming a consistent, homogeneous blend, prior to being added to aggregates. The Terminal Blend method, where the GTR is blended and reacted with the asphalt cement at the asphalt refinery, shall be used. The minimum amount of GTR for asphalt-rubber blends shall be as follows:

| Specified PG Grade stated on the Plans | Minimum GTR (by weight of asphalt cement) |
|---|---|
| GTR PG 70-22 | 10% |
| GTR PG 76-22 | 15% |

The GTR shall be blended with the asphalt cement and reacted for a minimum of 45 minutes at a temperature of 163°C to 191°C (325°F to 375°F).

The mixing temperature of the HMA mixture shall be 149-177°C (300-350°F).

**S.P. 403D.5 HOT MIX PLANT**

The type of plant used for the manufacture of GTR modified OGFC mixtures may be either a batch or drier drum plant meeting the requirements of 406.12 & 1102.01, with the following exceptions:

**General**

(a) Storage and Conveyance. Silo storage of GTR modified OGFC shall not exceed 4 hours.

(b) Plant modification. Introduction of GTR into rubber modified asphalt mixtures may require additional plant modifications. The Engineer will have final approval of the plant.

(c) Plant Calibration. The asphalt plant shall be calibrated and approved by The Illinois Department of Transportation Bureau of Materials and Physical Research or the Tollway before production of the rubber modified asphalt mixture.

(d) Mineral Filler System. The mineral filler system shall accurately proportion the large amounts of mineral filler required for the mixture. Alteration or adjustment of the current system may be required.

Mineral filler shall not be stored in the same silo as collected dust. Collected dust shall not be used as mineral filler.

(e) Mineral Fiber Additive. Adequate dry storage shall be provided for the fiber additive. A separate feed system shall be provided to proportion the fiber into the mixture uniformly and in desired quantities. The feed system shall be interlocked with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled accurately to within $\pm$ 10% of the amount of fibers required. Flow indicators or sensing devices for

the fiber system shall be provided and interlocked with plant controls so mix production shall be interrupted if fiber introduction fails.

(1) Batch Plant. Loose fiber shall be pnuematically added through a separate inlet directly into the weigh hopper above the pugmill. The addition of fiber shall be timed to occur during the hot aggregate charging of the hopper. Adequate mixing time will be required to ensure proper blending of the aggregate and fiber additive. Both the wet and dry mixing times shall each be increased a minimum of 5 seconds. The actual mixing time increase shall be determined by the Engineer based on individual plant characteristics. The batch size shall not exceed 75% of pugmill size as rated by the Department.

(2) Drum Mix Plant. Loose fiber shall be introduced using specialized equipment which mixes asphalt cement with the loose fiber at the time of introduction into the drum mixer. This equipment shall be approved by the Engineer. Care shall be taken to ensure the loose fiber does not become entrained in the exhaust system of the drier or plant.

(3) Fiber Supply System. When fiber stabilizing additives are required as an ingredient of the mixture, a separate feed system shall be utilized to accurately proportion by weight the required quantity into the mixture in such a manner that uniform distribution will be obtained. The fiber system shall be interlocked with the aggregate feed or weigh system so as to maintain the correct proportions for all rates of production and batch sizes. The proportion of fibers shall be controlled accurately to within plus or minus 10 percent of the amount of fibers required and the fiber system shall automatically adjust the feed rate to maintain the material within this tolerance at all times. The fiber system shall provide in-process monitoring consisting of either a digital display or output or a printout of feed rate, in pounds per minute to verify feed rate. Flow indicators or sensing devices for the fiber system shall be provided and interlocked with plant controls so that mixture production will be interrupted if introduction of the fiber fails, or if the output rate is not within the tolerances given above.

When a batch type plant is used, the fiber shall be added to the aggregate in the weigh hopper or as approved and directed by the Engineer. The fibers are to be uniformly distributed prior to the injection of asphalt cement into the mixes.

When a continuous or drier-drum type plant is used, the fiber shall be added to the aggregate and uniformly dispersed prior to the injection of asphalt cement. The fiber shall be added in such a manner that it will not become entrained in the exhaust system of the drier or plant.

**Terminal Processing and Storage**

(a) At the asphalt production facility for Terminal Processing, a separate agitated shipping storage tank shall be required, with continuous mixing and recirculation of the asphalt-rubber blend to react the GTR with the asphalt cement. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 163°C to 191°C (325°F to 375°F) for a minimum of 45 minutes.

(b) Once the Terminal Processing of GTR and asphalt cement produces a homogeneous blend at the production facility, test samples shall be obtained and submitted to the Tollway for testing.

(c) Terminal Blended GTR modified asphalt may be stored at the production facility for up to 30 days at 149°C to 177°C (300°F to 350°F) with continuous mixing.

(d) A dedicated storage tank for "terminal blended GTR" shall be required at the hot mix plant. This tank shall be capable of providing continuous mixing and/or recirculation of the asphalt-rubber blend. This tank shall be heated and capable of maintaining the temperature of the homogeneous blend of asphalt cement and GTR at 150°C to 177°C (300°F to 350°F) for a maximum of 3 days.

**S.P. 403D.6 OGFC MIX DESIGN**

The Contractor will provide mix designs for each required mixture. Mix designs shall be developed by a QC/QA Level III Techincian in accordance with all IDOT Superpave mix design procedures and the following:

The draindown shall be determined at the JMF AC content at the mixing temperature plus 30ºF. Draindown shall be measured using AASHTO T 305.

The contractor has the option for the Tollway to provide the mix design for them. The contractor exercising this option will provide the aggregates, asphalt binder, fiber additive, and mineral filler to meet the material and mix design requirements.

**Gradation**

Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

| Sieve Size | OGFC |
|---|---|
| ½ in. (12.5 mm) | 100 |
| 3/8 in. (9.5 mm) | 85 – 100 |
| No. 4 (4.75 mm) | 10 – 35 |
| No. 8 (2.36 mm) | 5 – 10 |
| No. 200 (75µm) | 2.0 – 4.0 |

**Volumetric Design Criteria**

When compacted in accordance with AASHTO T312, the mixture the air voids shall be a minimum of 18.0 percent at $N_{Design}$ of 50, base on volumetric measurements determined from specimen diameter, height, weight and mixture theoretical maximum specific gravity ($G_{mm}$).

The mix shall have a minimum total AC content of 6.0 %, by-weight.

**Draindown**

AASHTO T 305 shall be performed on all mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight (mass) of mixture.

**Voids in Coarse Aggregate**

The percent $VCA_{MIX}$ of the OGFC mixture shall be less than or equal to the $VCA_{DRC}$ as determined using AASHTO T 19. This may be calculated using the following equations:

$VCA_{DRC} = 100 \times (G_{CA}\gamma_w - \gamma_s) / G_{CA}\gamma_w$

$VCA_{MIX} = 100 - (P_{bp} \times G_{mb} / G_{CA})$

$P_{bp} = P_s \times PA_{bp}$

Where: $G_{CA}$ = bulk specific gravity of the combined coarse aggregate (AASHTO T 85),

$\gamma_s$ = unit weight (mass) of coarse aggregate, plus #8 (2.36mm) in the dry-rodded condition (DRC) ($lb/ft^3$) ($kg/m^3$) (AASHTO T 19),

$\gamma_w$ = unit weight (mass) of water (62.34 lb/ft3) ($1000kg/m^3$),

$P_{bp}$ = percent aggregate by total mixture weight (mass) retained on No. 8 (2.36 mm) sieve and

$PA_{bp}$ = percent aggregate by total aggregate weight (mass) retained on No. 8 (2.36 mm) sieve.

**S.P. 403D.7 REQUIRED TESTS**

Testing shall be conducted to control the production of the bituminous mixture. The Contractor shall use the test methods identified to perform the following mixture tests at a frequency not less than that indicated.

| REQUIRED PLANT TESTS for OGFC | | |
|---|---|---|
| Parameter | Frequency of Tests | Test Method (See IDOT Manual of Test Procedures for Materials) |
| Aggregate Gradation<br><br>(% passing sieves:<br>1/2 in. (12.5 mm),<br>No. 4 (4.75 mm),<br>No. 8 (2.36 mm),<br>No. 30 (600 μm)<br>No. 200 (75 μm) | 2 washed ignition oven tests on the mix per day of production (conduct one in the morning and one in the afternoon). | Illinois Procedure |
| Asphalt Binder Content by Ignition Oven<br><br>Note 1 | 1 per half day of production | Illinois-Modified AASHTO T 308 |
| Air Voids<br><br>Bulk Specific Gravity of Gyratory Sample<br><br>Maximum Specific Gravity of Mixture | 1 per half day of production for first 2 days and 1 per day thereafter (first sample of the day) | Illinois-Modified AASHTO T 312<br><br>Illinois-Modified AASHTO T 209 |

Note 1. The Engineer may waive the ignition oven requirement for AC content if the aggregates to be used are known to have ignition AC content calibration factors which exceed 1.5 percent. If the ignition oven requirement is waived, other Department approved methods shall be used to determine the AC content.

## S.P. 403D.8 CONSTRUCTION REQUIREMENTS

### S.P. 403D.8.1 GENERAL

Fuel oil, kerosene, or solvents shall not be transported in open containers on equipment. Cleaning of equipment and small tools shall not be accomplished on the pavement or shoulder areas.

Draindown of OGFC mixtures will not be permitted. Corrective action shall be taken to prevent continuation of these conditions. Segregated, flushed or bleeding of OGFC mixtures shall be removed if directed by the Engineer. All areas showing an excess or deficiency of binder shall be removed and replaced.

All mixtures that become loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced.

### S.P. 403D.8.2 PREPARATION OF SURFACES TO BE OVERLAID

Surfaces on which a mixture is placed shall be free from objectionable or foreign materials at the time of placement. A milled transverse joint will be made at any end of a OGFC section including bridge approach slabs.

Milled asphalt surfaces and asphalt surfaces shall be tacked in accordance with Section 406 of the IDOT Standard Specifications. Contact surfaces of curbing, gutters, and other structures shall be tack coated.

### S.P. 403D.8.4 MIX PRODUCTION

The mixtures shall be produced at a temperature range recommended by the GTR asphalt supplier and approved by the Engineer to allow adequate compaction. The actual production temperature will be selected from the range by the Engineer based on individual plant characteristics and modifier used in the mixtures.

### S.P. 403D.8.5 TEST STRIPS

A QC/QA mixture test strip will be required. The test strip shall be constructed at a location approved by the Engineer to determine the mix properties, density, and laydown characteristics. These test results and visual inspections on the mixture shall be used to make corrective adjustments if necessary.

Prior to the start of mix production and placement, The Engineer will review and approve all test strip results and rolling pattern.

The test strip performed as follows:

(a) Team Members. The start-up team, if required, shall consist of the following:

(1) Resident Engineer
(2) Tollway Materials Engineer or representative
(3) Contractor's QC Manager
(4) Contractor’s Density Tester
(5) Tollway CM Material Coordinator
(6) Tollway CM Density Tester

(b) Communication. The Contractor shall advise the team members of the anticipated start time of production for the test strip. The QC Manager shall direct the activities of the test strip team. A Tollway-appointed representative from the start-up team will act as spokesperson for the Tollway.

(c) The Test Strip shall consist of approximately 100 tons of OGFC. It shall contain two growth curves which shall be compacted and tested as outlined herein.

(1) Mix Information. On the day of construction of the Test strip, the Contractor shall provide the start-up team documentation of test data showing the combined hot-bin or the combined aggregate belt sample and mineral filler at a drier-drum plant.

(2) Mix and Gradation Test Strip Samples. One set of mixture and gradation samples shall be taken by the Contractor. All test strip samples shall be processed by the Contractor for determination of mix composition and Superpave properties including air voids. This shall include washed gradation tests. This information shall then be compared to the JMF and required design criteria.

(3) Compaction Equipment. It shall be the responsibility of the start-up team to verify roller compliance before commencement of growth curve construction.

All paving and rolling equipment intended for use on a project shall be utilized on the test strip.

(4) Location of Test Strip. The test strip shall be located on a shoulder within the pavement section that is to receive the OGFC pavement, at a location acceptable to the Engineer. It shall be on a relatively flat portion of the roadway. Descending/ascending grades shall be avoided.

(5) Constructing of the Test Strip. After the Contractor has produced, transported, and placed approximately 50 tons of mix, placement of the mix shall stop, and a growth curve shall be constructed. It is anticipated that 2 or 3 roller passes will be sufficient to achieve compaction of the OGFC mixture, although additional passed will be made to evaluate the growth curve. After completion of the first growth curve, paving shall resume for the remainder of the 100 tons of mix, and a second growth curve shall be constructed within this area. Additional growth curves may be required if an adjustment/plant change is made during the test strip.

(6) Compaction Temperature. In order to make an accurate analysis of the compaction of the mixture, the temperature of the mixture on the pavement at the beginning of the growth curve shall be 152°C (325°F).

(7) Compaction and Testing. The Engineer will specify the roller(s) speed and number of passes required to obtain a completed growth curve. The nuclear gauge shall be placed near the center of the hot mat and the position marked for future reference. With the bottom of the nuclear gauge and the source rod clean, a 15 seconds nuclear reading (without mineral filler) shall be taken after each pass of the roller. Rolling shall continue until the maximum density is achieved. The growth curve shall be plotted.

In addition, other aspects of the mixture, such as appearance, segregation, texture, or other evidence of mix problems, should be noted and corrective action taken at this time.

(d) Documentation. The Test Strip and rolling pattern information (including growth curves) will be tabulated by the contractor with copies provided to each team member, and the original submitted to the Engineer. Any change to the rolling pattern shall be approved by the Engineer.

**S.P. 403D.8.6 PLACEMENT AND COMPACTION**

Add the following to IDOT Article 406.15, Material Transfer Device:

"(d) A material transfer device shall be used for the placement of this material on those portions of the mainline pavement, shoulders, the deceleration and acceleration portions of ramps, and at other locations as shown on the Contract Documents and/or as directed by the Engineer. The material transfer device shall be operated in such a fashion to maximize the distance from the wheel to any free edge of HMA pavement and shall not be operated close to an unsupported edge of HMA pavement. Prior to traveling over structures, the material transfer device shall be emptied of bituminous material, so as to minimize the weight of the vehicle. The tires of the vehicle shall travel directly on or in close proximity and parallel to the beam and/or girder lines of all structures."

The OGFC shall be delivered at a temperature of 149°C (300°F) to 177°C (350°F). The mixture shall not be placed when the roadway temperature is below 16°C (60°F), during wet weather, or when local conditions indicate rain is imminent.

The paving train speed shall not exceed (50 ft/min) during placement. Compaction shall commence immediately after the mixture has been placed. Rollers shall be operated at speeds not to exceed 5 mph. The addition of a non-foaming detergent to the roller water will be allowed to prevent sticking, if necessary.

Compaction should be done while the mat is between 130°C and 177°C (265°F and 350°F).

The addition of a non-foaming detergent to the roller water will be allowed to prevent sticking, if necessary.

**Hauling/Laydown Equipment**

The Contractor shall provide a release agent that minimizes sticking to equipment and is acceptable to the Engineer. The Contractor shall furnish a laborer to ensure that all truck beds are clean and no excess release agent is used prior to being loaded. All trucks shall be insulated and tarped when hauling the mixture to the paver.

**S.P. 403D.8.7 SURFACE TESTS**

Revise Article 406.21 of the IDOT Standard Specifications to read:

**"406.21 Surface Tests.** The finished surface of the pavement shall be tested for smoothness within three days of paving. Testing shall be performed in the presence of the Engineer.

Prior to testing, a copy of the approval letter and recorded settings from the Profile Equipment Verification Program shall be submitted to the Engineer; and all objects and debris shall be removed from the pavement.

(a) Test Sections/Equipment.

(1) High-Speed Mainline Pavement. High-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed greater than 75 km/hr (45 mph). These sections shall be tested using a California Profilograph or an approved equivalent.

(2) Low-Speed Mainline Pavement. Low-speed mainline pavement shall consist of pavements, ramps and loops with a posted speed of 75 km/hr (45 mph) or less. These sections shall be tested using a California Profilograph or an approved equivalent.

(3) Miscellaneous Pavement. Miscellaneous pavement shall consist of:

a. pavement on horizontal curves with a centerline radius of curvature of less than or equal to 300 m (1000 ft) and pavement within the superelevation transition of such curves;

b. the first or last 4.5 m (15 ft) of a pavement section where the Contractor is not responsible for the adjoining surface;

c. intersections;

d. variable width pavements;

e. side street returns;

f. crossovers;

g. connector pavement from mainline pavement expansion joint to the bridge approach pavement;

h. bridge approach pavement; and

i. other miscellaneous pavement surfaces (i.e. a turn lane) as determined by the Engineer.

Miscellaneous pavement shall be tested using a 5 m (16 ft) straightedge set to a 10 mm (3/8 in.) tolerance.

(b) Lots/Sublots. Mainline pavement test sections will be divided into lots and sublots.

(1) Lots. A lot will be defined as a continuous strip of pavement 1600 m (1 mile) long and one lane wide. When the length of a continuous strip of pavement is less than 1600 m (1 mile), that pavement will be included in an adjacent lot. Structures will be omitted when measuring pavement length.

(2) Sublots. Lots will be divided into 160 m (0.1 mile) sublots. A partial sublot resulting from an interruption in the pavement will be subject to the same evaluation as a whole sublot.

(c) Testing Procedure. One wheel track shall be tested per lane for bituminous concrete overlays. Testing shall be performed 1 m (3 ft) from and parallel to the edge of the lane away from traffic. Two wheel tracks shall be tested per lane for bituminous concrete pavement (full depth). Testing shall be performed 1 m (3 ft) from and parallel to each lane edge. A guide shall be used to maintain the proper distance.

The profile trace generated shall have stationing indicated every 150 m (500 ft) at a minimum. Both ends of the profile trace shall be labeled with the following information: contract number, beginning and ending stationing, which direction is up on the trace, which direction the profilograph was pushed, and the profilograph operator name(s). The top portion of the Contractor supplied profilograph report form shall be completed and secured around the trace roll.

Although surface testing of intermediate lifts will not be required, they may be performed at the Contractor's option. When this option is chosen, the testing shall be performed and the profile traces shall be generated as described above.

The Engineer may perform his/her own testing at any time for monitoring and comparison purposes.

(d) Trace Reduction and Bump Locating Procedure. All traces shall be reduced. Traces produced by a mechanical recorder shall be reduced using an electronic scanner and computer software. This software shall calculate the profile index of each sublot in mm/km (in./mile) and indicate any high points (bumps) in excess of 8 mm (0.30 in.) with a line intersecting the profile on the printout. Computerized recorders shall provide the same information.

The profile index of each track, average profile index of each sublot, average profile index of the lot and locations of bumps shall be recorded on the form.

All traces and reports shall be provided to the Engineer for the project file. Traces from either a computerized profilograph or analysis software used with a manual profilograph shall display the settings used for the data reduction. The Engineer will compare these settings with the settings used during verification testing. If the settings do not match, the results will be rejected and the section shall be retested/reanalyzed with the appropriate settings.

The Engineer will use the results of the testing to evaluate paving methods and equipment. If the average profile index of a lot exceeds 635 mm/km (40.0 in./mile) for high-speed mainline pavement or 1025 mm/km (65.0 in./mile) for low-speed mainline pavement, the paving operation will be suspended until corrective action is taken by the Contractor.

(e) Corrective Work. All bumps in excess of 8 mm (0.30 in.) in a length of 8 m (25 ft) or less shall be corrected. If the bump is greater than 13 mm (0.50 in.), the pavement shall be removed and replaced to the satisfaction of the Engineer at the Contractor's expense. The minimum length of pavement to be removed shall be 900 mm (3 ft.).

(1) High-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 475 (30.0) to 635 (40.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace. Any sublot having a profile index greater than 635 mm/km (40.0 in./mile) including bumps, shall be corrected to

reduce the profile index to 475 mm/km (30.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(2) Low-Speed Mainline Pavement. Any sublot having a profile index within the range of, greater than 710 (45.0) to 1025 (65.0) mm/km (in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace. Any sublot having a profile index greater than 1025 mm/km (65.0 in./mile) including bumps, shall be corrected to reduce the profile index to 710 mm/km (45.0 in./mile) or less on each trace, or replaced at the Contractor's option.

(3) Miscellaneous Pavement. Surface variations which exceed the 10 mm (3/8 in.) tolerance will be marked by the Engineer and shall be corrected by the Contractor.

Corrective work shall be completed using either an approved grinding device consisting of multiple saws or by removing and replacing the pavement. Corrective work shall be applied to the full lane width. When completed, the corrected area shall have uniform texture and appearance, with the beginning and ending of the corrected area squared normal to the centerline of the paved surface.

Upon completion of the corrective work, the surface of the sublot(s) shall be retested. The Contractor shall furnish the profilograph tracing(s) and the completed form(s) to the Engineer within two working days after corrections are made. If the profile index and/or bumps still do not meet the requirements, additional corrective work shall be performed.

Corrective work shall be at the Contractor's expense.

(f) Smoothness Assessments. Assessments will be paid to or deducted from the Contractor for each sublot of mainline pavement, per the Smoothness Assessment Schedule. Assessments will be based on the average profile index of each sublot prior to performing any corrective work unless the Contractor has chosen to remove and replace the sublot. For sublots that are replaced, assessments will be based on the profile index determined after replacement.

Assessments will not be paid or deducted until all other contract requirements for the pavement are satisfied. Pavement that is corrected or replaced for reasons other than smoothness shall be retested as stated herein.

A full-depth bituminous concrete pavement structure shall be comprised of one or more bituminous concrete binder courses and a bituminous concrete surface course on a prepared subgrade.

| SMOOTHNESS ASSESSMENT SCHEDULE (Bituminous Concrete Overlays) | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | 240 (15.0) or less | +$150.00 |
| >95 (6.0) to 160 (10.0) | >240 (15.0) to 400 (25.0) | +$80.00 |
| >160 (10.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | - $300.00 |

| SMOOTHNESS ASSESSMENT SCHEDULE (Full-Depth Bituminous) | | |
|---|---|---|
| High-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Low-Speed Mainline Pavement Average Profile Index mm/km (in./mile) | Assessment per sublot |
| 95 (6.0) or less | | +$800.00 |
| >95 (6.0) to 175 (11.0) | 240 (15.0) or less | +$550.00 |
| >175 (11.0) to 270 (17.0) | >240 (15.0) to 400 (25.0) | +$350.00 |
| >270 (17.0) to 475 (30.0) | >400 (25.0) to 710 (45.0) | +$0.00 |
| >475 (30.0) to 635 (40.0) | >710 (45.0) to 1025 (65.0) | +$0.00 |
| Greater than 635 (40.0) | Greater than 1025 (65.0) | -$500.00 |

**S.P. 403D.9 CONTROL CHARTS / LIMITS**

Control Charts/Limits. Control charts/limits shall be according to QC/QA requirements except density and air voids shall be plotted on the control charts within the following control limits:

| Parameter | Individual Test Tolerance |
|---|---|
| Air Voids | 18 ± 1.2 percent |
| Gradation - 1/2 in. | ± 4 percent |
| - 3/8 in. | ± 4 percent |
| - No. 4 | ± 3 percent |
| - No. 8 | ± 3 percent |
| - No. 200 | ± 2.0 percent |
| Asphalt content | ± 0.3 percent |

**S.P.403D.10 OPENING TO TRAFFIC**

Traffic shall not be permitted on the new surface until the temperature of the mat has dropped below 60°C (140°F).

**S.P. 403D.11 MEASUREMENT**

(a) Contract Quantities. The requirement for the use of contract quantities shall be according to Subsection 203.7(a) of the ISTHA Standard Specifications.

(b) Measured Quantities. BITUMINOUS MATERIALS (TACK) will be measured in gallons in accordance with Subsection 109.1.4 of the ISTHA Standard Specifications. AGGREGATE FOR BLOTTING will be measured by weight in tons.

The aggregate shall be weighed on scales conforming to the requirements of Subsection 109.1.2 of the ISTHA Standard Specifications.

Payment will not be made for bituminous concrete mixtures in excess of 103 percent of the quantity specified by the Engineer.

**S.P. 403D.12 PAYMENT**

Payment for MODIFIED OPEN GRADED FRICTION COURSE COURSE measured as specified, will be made at the Contract unit price per ton, which payment shall constitute full compensation for preparation of the base or existing pavement, furnishing, placing, and compacting OGFC mixtures, construction of joints, protection from traffic or other damage, handling field samples, filling core holes, and for furnishing all labor, equipment, tools, and incidentals necessary to complete the work as specified.

Unless otherwise specified, BITUMINOUS MATERIAL (TACK) and AGGREGATE FOR BLOTTING will be measured and paid for in accordance with the provisions fo Subsections 402.19 and 402.20 of the ISTHA Standard Specifications.

Test strips constructed for the purpose of evaluating the properties of a bituminous concrete mixture will be paid for at the contract unit price each for TEST STRIP (MODIFIED OPEN GRADED FRICTION COURSE COURSE). A test strip will be considered as having been constructed when a satisfactory test strip has been obtained for a specific bituminous concrete mixture. If the Contractor requests and is granted approval for a mix design change, he/she shall construct a test strip for the new mix design at his/her own expense, and no additional compensation will be allowed.

| **PAY ITEM NUMBER** | **DESCRIPTION** | **UNIT OF MEASURE** |
|---|---|---|
| 403DA | TEST STRIP (MODIFIED OPEN GRADED FRICTION COURSE) | EACH |
| 403DN50SC | MODIFIED OPEN GRADED FRICTION COURSE COURSE | TON |