EVALUATION OF
OPEN-GRADED FRICTION COURSE MIXTURE

LOUISIANA TRANSPORTATION RESEARCH CENTER
Technical Assistance Report Number 04-1TA

State Project No. 009-02-0018
US 71 Friction Course (CM)
Route US 71
Grant Parish

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October 2004
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Introduction

Open-graded friction course (OGFC) is a porous, gap-graded, predominantly single size aggregate bituminous mixture that contains a high percentage of air voids. The high air void content and the open structure of this mix promote the effective drainage of rainwater, which also minimizes hydroplaning during wet weather. This characteristic also reduces splash and spray behind vehicles and improves wet weather skid resistance. Other purported benefits of this type mix are lower pavement noise and reduced roadway glare during wet weather, which improves the night visibility of pavement markings.

OGFCs have been used throughout the United States since 1950 [1, 2]. Some state departments of transportation have reported good performance, but many others have reported poor performance [1, 2]. Louisiana first developed an OGFC in the late 1960s and early 1970s to provide a skid resistant surface [3, 4]. The open texture of the friction course reduced water spray and increased critical hydroplaning speeds. Louisiana’s OGFC was developed prior to the initiation of the Federal Highway Safety Program Management Guide, Highway Safety Program 12, and Instructional Memorandum 211-3-73 of 1973 dealing with the establishment of a Skid Accident Reduction Program. Louisiana had already placed several OGFCs prior to the Instructional Memorandum. After receiving the Instructional Memorandum, the Louisiana Department of Transportation and Development (LADOTD) issued an Engineering Directive to use Plant Mix Seal (PMS) (used interchangeably with OGFC and asphaltic concrete friction course (ACFC)) on all roads with an ADT greater than 4,000. In 1980, the ADT limit was revised to require the friction course on all roads with an ADT greater than 3,000.

In late 1980, problems with the OGFCs were encountered. Many of these surfacings had reached their end-of-life, having lasted much longer than the original life expectancy of five years, typically 10 - 12 years. The end-of-life was signaled by severe raveling in the wheel paths due to oxidized asphalt binders and subsequent decrease in serviceability. This, in conjunction with numerous OGFC failures during the construction phase or shortly thereafter, led to a moratorium on its use.

Inspection of the failed construction projects and project records indicated that the problems encountered with the OGFC were related to moisture and temperature. The temperature problems were related to both mix and weather; the moisture problems were generally associated with a particular aggregate type. To address these issues, changes were made to the specifications, including a maximum moisture content for the aggregate, institution of a
construction season from May to September, and an increased minimum ambient air temperature. Based on these changes, the moratorium was lifted.

It should also be noted the design asphalt content of OGFCs was significantly decreased in 1979. This decrease in asphalt content along with the use of asphalt cements composed of base asphalt that oxidized rapidly contributed to all of these construction problems although it was not recognized at the time. Typical deterioration consisted of raveling in the wheel path.

In the next 1½ years, 12 OGFCs were placed without incidence. However, because the winters of 1982 and 1983 were extremely severe, the previously placed friction courses were reaching their end-of-life at approximately 8 to 11 years of age. Additionally, because of several oil boycotts and increases in the cost of crude, asphalt cement contents were reduced. In the beginning of 1984, with hundreds of miles of OGFC at end-of-life and raveling, a public and political uproar forced the imposition of a second moratorium which is still in effect today.

In 1984, a final experimental polymer modifying OGFC was placed on LA 48, Poydras-Reggio ten mile construction project. Two experimental sections (4 lane miles each) were constructed using a latex modified asphalt (similar to the current PG 70-22m) and an elastomeric polymer modified asphalt (similar to the current PG 76-22m). These sections were placed with an asphalt content 0.7 percent higher (similar to the 1960/70 binder levels) than the control sections with AC-30 which used the 1979 binder content. It was polymer modified asphalt along with fibers that permit additional asphalt creating greater film thickness and reduced draindown. Within one year the control sections raveled in the crossovers and turn lanes; within two years the control sections had raveled in the inside and outside wheel paths. The polymer modified section was still performing without raveling when the entire project was rehabilitated circa 1999-2001. This 15-17 year lifespan is consistant with design models used today.

This paper documents Louisiana’s first use of this type mix since the suspension of OGFC mixes in 1984.

**Project Description**

Figure 1 illustrates the project location, which is on US 71 in Grant Parish and begins 4.041 miles (Log Mile 4.041) north of the beginning of the control section (Rapides Parish line, SE of Rock Hill) and commences northward for 0.157 miles to its project ending limits (Log
Mile 4.198). This highway is 24 feet wide (2 12-foot travel lanes) with 2 10-foot improved hot mix shoulders. The contract was bid under State Project No. 009-02-0018 and was awarded to the low bidder, Diamond B. Construction Co., LLC. The work order date for this project was June 7, 2003, and the final inspection date was June 26, 2003. The OGFC was placed on June 15, 2003 and was completed in one day. The OGFC was placed at approximately three-fourths of an inch compacted thickness, and the area covered was minimal at 2181.30 square yards. Approximately 94.0 tons of OGFC was placed during construction. This project site was selected because District 08 wanted to improve the existing surface characteristics at this location, and the placement of the OGFC was applicable in this area.

![Project Location](image)

**Figure 1**
Project Location

**Materials**

**Asphalt Cement**

An elastomeric type of polymer modified asphalt cement was specified for this project, meeting the LADOTD specification for PG76-22m. The PG76-22m asphalt cement was listed on QPL #41 and was supplied by Marlin Asphalt, LTD. The polymer modified asphalt
cement content was 6.6 percent as designed by the contractor, Diamond B. Construction Co., LLC.

**Aggregates**

The final aggregate blend, Design 2, was composed of 67.2 percent - #78 sandstone, Friction Rating I; 7.4 percent - #11 sandstone, Friction Rating I; and 18.7 percent - #89 siliceous limestone, Friction Rating III (see tables 1 and 2). The sandstone was supplied by Pine Bluff Sand & Gravel Co. (Source Code AB13). The limestone was supplied by Vulcan Material Company (Source Code AA50). The aggregates used complied with the requirements set forth in Subsection 1003.06(b) of the Standard Specifications.

**Fibers**

A mineral fiber in pellet form was added to the mix at a mix percentage of 0.1 by weight to protect against drain down. The fiber was supplied by Interfibe. The contract specifications required that drain down testing be conducted in accordance with Section 508 of the 2000 Edition of the Louisiana Standard Specifications [5] on the loose mix at a temperature 60°F (15°C) higher than normal mixing temperatures. A maximum drain down of 0.3 percent is required. The approved Job Mix Formula (JMF) indicated that the maximum drain down for the OGFC mixture tested was 0.08 percent using the minimum dosage of fiber specified.

**Antistrip**

The contractor was required to perform the Boil Test and modified Lottman test to evaluate the mixture’s susceptibility to moisture damage. An Ad-Here LA 2 from Arr-Maz Products, Inc. was added at mix percentage of 0.6 by weight. The Lottman test was modified to require five freeze thaw cycles.

**Tack Coat**

The contractor elected to use the unmodified SS-1 emulsion for tack coat as allowed by Section 504 of the Standard Specifications [5]. The SS-1 emulsion was listed on QPL #41 and supplied by Asphalt Products Unlimited. The tack coat rate to be applied was 0.07 gallons/square yards, as required by the Special Provisions of the contract. The tack coat rate was not measured; however, the tack coat coverage was uniform and covered 100 percent of the existing dense graded asphalt surface, which was approximately 3 years old.
Open-graded Friction Course Mixture Design

The mix design procedures for this project were detailed in the Special Provisions of the contract. The specified OGFC design requirements followed the recommendations as outlined in the 2000 Edition of the Journal of the Association of Asphalt Paving Technologists (AAPT) [6]. The contractor was required to use approved PG76-22m asphalt cement complying with Section 1002 in the Standard Specifications and listed in QPL #41 [5]. It was further specified that the aggregates, coarse and fine, should be 100 percent crushed stone with a Friction Rating of I, thus complying with the requirements set forth in Subsection 1003.06(b) of the Standard Specifications [5]. A Cellulose fiber or mineral filler may also be used to ensure protection against drain down. Also, an anti-strip additive was required to prevent stripping. The OGFC Special Provisions of the contract and the approved JMF are in Appendix B and Appendix C, respectively.

During the mix design process, the contractor evaluated two designs. See tables 1 and 2. The first mixture design, Design 1, incorporated a blend of two sandstone gradations that subsequently failed during the Hamburg rut testing performed by LTRC. The samples obtained from the Design 1 mix disintegrated or fell apart during testing in the Hamburg. In the second mixture design, Design 2, the contractor was allowed to blend less than 25 percent of a #89 siliceous limestone meeting a Friction Rating III. The incorporation of the #89 stone was necessary to introduce some intermediate fine material into the design blend to ensure the stability of the mix during Hamburg rut testing. This particular aggregate was allowed because its availability facilitated the timely completion of the project. It should be noted that Design 2, which Diamond B. Construction Company selected as the JMF and submitted to LADOTD, was subsequently used to construct the OGFC layer.

The Design 1 and Design 2 mixtures were tested for rutting characteristics at LTRC utilizing the Precision Machine and Welding version of the Hamburg Type Wheel Tester. The designs were also tested for drainage characteristics using the Karol-Warner falling head permeability device. The Instrotek CoreLok device was also utilized for Bulk Specific Gravity of mix, \( G_{mb} \), measurements for the compacted specimens.

Table 1 indicates the aggregates and additives used for each trial design of the OGFC mixture. The PG76-22m, fiber, and anti-strip rate remained constant in both mix designs. The only variations between both mix designs were the incorporation of the #89 siliceous limestone and the actual percentages of aggregate blended to achieve a composite blend.
Table 1
Composition of mix design blends

<table>
<thead>
<tr>
<th>Material</th>
<th>Percentage</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>#78 Sandstone,</td>
<td>84.0</td>
<td>Pine Bluff Sand &amp; Gravel</td>
</tr>
<tr>
<td>FR I</td>
<td>67.2</td>
<td></td>
</tr>
<tr>
<td>#11 Sandstone,</td>
<td>9.3</td>
<td>Pine Bluff Sand &amp; Gravel</td>
</tr>
<tr>
<td>FR I</td>
<td>7.4</td>
<td></td>
</tr>
<tr>
<td>#89 Limestone,</td>
<td>18.7</td>
<td>Vulcan Materials</td>
</tr>
<tr>
<td>FR III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PG76-22m Fibers</td>
<td>6.6</td>
<td>Marlin Asphalt</td>
</tr>
<tr>
<td>Ad-Here LA 2</td>
<td>0.1</td>
<td>Interfibe</td>
</tr>
<tr>
<td>0.6 by Wt. of AC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arr-Maz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 indicates the composite blend and mixture properties for the contractors’ Design 1 and Design 2 composite blends. This table also presents the quality assurance (QA) data from the actual plant-produced mix during construction.

The LTRC gradation data indicated in table 2 are based on samples taken from the second truck during production. This data does not match the JMF or the District’s QA data. The Design AC and Maximum Theoretical Specific Gravity, $G_{num}$, however, correspond with the QA data. It is suspected that because the samples were acquired from the second truck, the hot mix plant had not had sufficient time to stabilize production. One hypothesis is that a purging of the bag house fines resulted in the finer gradation. The District’s QA samples were acquired at a later time during production.
Table 2
Composite blends and mixture properties

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Design 1</th>
<th>Design 2</th>
<th>QA Data</th>
<th>LTRC 2nd Truck</th>
<th>Required Gradation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; (19mm)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>1/2&quot; (12.5mm)</td>
<td>90</td>
<td>92</td>
<td>93</td>
<td>91</td>
<td>85 - 100</td>
</tr>
<tr>
<td>3/8&quot; (9.5mm)</td>
<td>58</td>
<td>64</td>
<td>68</td>
<td>66</td>
<td>55 - 75</td>
</tr>
<tr>
<td>No. 4 (4.75mm)</td>
<td>14</td>
<td>16</td>
<td>21</td>
<td>26</td>
<td>10 - 25</td>
</tr>
<tr>
<td>No. 8 (2.36mm)</td>
<td>9</td>
<td>8</td>
<td>11</td>
<td>18</td>
<td>5 - 10</td>
</tr>
<tr>
<td>No. 16 (1.18mm)</td>
<td>7</td>
<td>6</td>
<td>9</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>No. 30 (.600mm)</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>No. 50 (.300mm)</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>No. 100 (.150mm)</td>
<td>3.8</td>
<td>3.4</td>
<td>6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>No. 200 (.075mm)</td>
<td>2.8</td>
<td>2.3</td>
<td>3.9</td>
<td>6.1</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Gmb</td>
<td>1.916</td>
<td>2.173</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gmm</td>
<td>2.374</td>
<td>2.368</td>
<td>2.381</td>
<td>2.389</td>
<td></td>
</tr>
<tr>
<td>VCA</td>
<td>33.0</td>
<td>23.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Air Voids, AASHTO T166</td>
<td>19.3</td>
<td>8.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gsh</td>
<td>2.558</td>
<td>2.604</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ges</td>
<td>2.619</td>
<td>2.612</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pba</td>
<td>0.9</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pbe</td>
<td>5.9</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permeability, ft/day</td>
<td>276</td>
<td>453</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permeability, ft/day, LTRC Results</td>
<td>235</td>
<td>278</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain Down</td>
<td>0.08</td>
<td>0.08</td>
<td>0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design AC</td>
<td>6.6</td>
<td>6.6</td>
<td>7.0</td>
<td>6.8</td>
<td></td>
</tr>
</tbody>
</table>
Table 3 shows the rut measurements taken from the Precision Machine and Welding version of the Hamburg Type Wheel Tester (PMW Wheel Tracker). The PMW Wheel Tracker tests mixtures for rutting properties and moisture susceptibility. Samples pass if they attain no more than 6.0 mm of rutting after 20,000 passes of the PMW Wheel Tracker. Also, the PMW Wheel Tracker will stop the measurement process if the samples have attained more than 20.0 mm at 20,000 passes. Two samples each from mixture Design 1 and mixture Design 2 were subjected to these tests. The tests were conducted at 50 °C. Both sets of samples were tested at 56 passes per minute. Prior to testing, the samples were submerged under water for 90 minutes at the required testing temperature. The rut depths indicated in table 3 are an average of the center 5 of 11 measuring points taken from each sample. The distance between each measuring point is approximately 1.14 inches. As indicated in table 3, Design 1 did not pass the required criteria, nor did it perform as well as Design 2. Design 2 had an average rut measurement of 3.32 mm after 20,000 passes.

Table 3
Rut measurements (mm)

<table>
<thead>
<tr>
<th>Number of Passes</th>
<th><strong>Design 1</strong></th>
<th>Design 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sample #1</td>
<td>Sample #2</td>
<td>Sample #1</td>
<td>Sample #2</td>
</tr>
<tr>
<td>14,981</td>
<td>21.98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4591</td>
<td>23.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design 1 failed. Samples fell apart during testing or failed to make the 20,000 pass criteria.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20,000</td>
<td>3.50</td>
<td>3.14</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average = 3.32

Figures 2 and 3 are the graphical illustrations of the deformation under loading vs. number of passes for mixture designs 1 and 2 as tested in the PMW Wheel Tracker.
Figure 2
Mixture Design 1, rut measurements (mm) vs. number of passes

Figure 3
Mixture Design 2, rut measurements (mm) vs. number of passes

Table 4 is a comparison of the percent air voids of the contractor’s mix Design 1, mix Design 2, and roadway cores as measured by the CoreLok device versus the contractor’s results that were determined by AASHTO T166. It is noted that there is a considerable variance between
results. The percent air voids measured by the CoreLok device is significantly greater than the results determined by AASHTO T166.

Table 4
CoreLok vs. AASHTO T166 air voids

<table>
<thead>
<tr>
<th></th>
<th>Percent Air Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design 1</td>
</tr>
<tr>
<td>Contractor's Results</td>
<td>19.3</td>
</tr>
<tr>
<td>Sample 1</td>
<td>19.4</td>
</tr>
<tr>
<td>Sample 2</td>
<td>14.3</td>
</tr>
<tr>
<td>LTRC (CoreLok)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>19.4</td>
</tr>
<tr>
<td>LTRC (T166)</td>
<td>11.2</td>
</tr>
</tbody>
</table>

Table 5 is a comparison of permeability results between the contractor’s mix Design 1, mix Design 2, LTRC-prepared samples based on the contractor’s mix design blends, and roadway cores. LTRC prepared two samples for each design and obtained the average coefficient of permeability. The falling head permeability (K-value) of the OGFC mixtures was calculated based on Darcy’s Law. Each sample was tested twice and the average was reported. Design 2 resulted in a higher coefficient of permeability because of the decrease in material passing the No. 200 sieve.

Table 5
Coefficient of permeability (feet/day)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient of Permeability (feet/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Design 1</td>
</tr>
<tr>
<td>Sample 1</td>
<td></td>
</tr>
<tr>
<td>Sample 2</td>
<td></td>
</tr>
<tr>
<td>LTRC Results</td>
<td>212.95</td>
</tr>
<tr>
<td>Average</td>
<td>235</td>
</tr>
<tr>
<td>Contractor Results</td>
<td>276</td>
</tr>
</tbody>
</table>
**Profilograph**

A smoothness specification was not required on this section of roadway because of the small quantity of material placed. The total length of the project paved was approximately 800 feet.

**Cost**

This project was estimated at $50,000 for the construction of the OGFC layer on the 0.157-mile stretch of a 2-lane, 12-feet wide roadway, (approximately 2,210 square yards). The low bid by Diamond B. Construction Co., LLC was $54,508.02. This bid included all items for project completion, i.e. striping, signs and barricades, mobilization, etc. The pay item for the OGFC was Item S-001, and it was paid for by the square yard at a unit price of $19.64/sq.yd. The quantity used to date was 2,181.30 square yards, which equates to a cost of $42,841.

When this square yard cost value is converted to a price per ton of mix placed at a lift thickness of ¾” (~ 94.0 tons), it equates to approximately $455/ton. Therefore, this project does not have a sufficient quantity to do a proper evaluation of cost comparisons between hot mix and a specialty mix such as the OGFC. Based on a material square yard cost method, we would estimate a budget value of $3.00 to $3.50 per square yard for 10-mile-long projects.
COMMENTS

The high air void content and the open structure of this mix promoted the effective drainage of rainwater as intended. Since roadway drainage is enhanced, splash and spray behind vehicles should be reduced and ponding of water should be minimized, thus minimizing hydroplaning during wet weather. Future performance evaluations of the roadway will be performed.
**Recommendations**

OGFC’s are recommended for immediate use to further enhance safety by improving roadway surface drainage, minimizing hydroplaning, reducing splash/spray and roadway glare, improving wet weather visibility and visibility of traffic markings.

Prior to full implementation use of OGFC’s, it is recommended to construct at least one OGFC project in each District to familiarize LADOTD and industry with the OGFC specifications and mix design procedure.
References


Appendix A

Hotmix Plant and Roadway Pictures
OGFC
Appendix B

Contract Specifications
STATE OF LOUISIANA
DEPARTMENT OF TRANSPORTATION AND
DEVELOPMENT

DOTD

CONTRACT
FOR
STATE PROJECT NO. 009-02-0018
US 71 OPEN GRADED FRICTION COURSE (CM)
ROUTE US 71
GRANT PARISH
DISTRICT 08
This agreement, is made and executed in TWO original copies, between the Louisiana Department of Transportation and Development acting through its Secretary, hereafter designated as the "Department", and Diamond B Construction Company, LLC, hereafter designated as the "Contractor."

The Department did advertise for, receive and accept a bid from the Contractor for work on a Department construction project identified as,

State Project No. 009-02-0918, US 71 OPEN GRADED FRICITION COURSE (CM), US 71, GRANT PARISH, consisting generally of OPEN GRADED FRICITION COURSE, PAINTED TRAFFIC STRIPING, REFLECTORIZED RAISED PAVEMENT MARKERS, AND RELATED WORK ON US 71 IN GRANT PARISH.

The Contractor's submission is evidenced by a copy of the "Construction Proposal Signature and Execution Form" incorporated herein as part of the Contract Documents defined hereafter.

In consideration of the agreements herein contained, to be performed by the parties hereto and of the payments hereafter agreed to be made, it is mutually agreed by both parties that:

CONTRACT DOCUMENTS
The contract consists of the "Contract Documents" including but not limited to the following:

a. Agreement (This Instrument)
b. Construction Proposal Signature and Execution Form
d. Project Construction Proposal (Notice to Contractors, Special Provisions, Supplemental Specifications, Schedule of Items)
e. Plans
f. Plan revisions
g. ZERO (0) Addenda made or issued prior to receipt of bids
h. Payment, Performance and Retainage Bonds or Retainage Agreement

For these purposes, all of the provisions contained in the listed Contract Documents are incorporated herein by reference with the same force and effect as though said Contract Documents were herein set out in full. The Contract Documents are kept in the official file at the Department together with the acknowledgment of receipt correspondence signed by the Contractor.
INTENT OF CONTRACT
In accordance with the 2000 Standard Specifications and the Contract Documents, the Contractor agrees to the terms and requirements for the intent of the contract to provide all materials, equipment and labor and perform the work required to complete the project in a thorough and workmanlike manner, to the satisfaction of the appropriate official of the Department.

CONTRACT AMOUNT
The Contractor did submit as advertised with his (her) bid, a dollar value amount for each of the items designated in the construction proposal on the "Schedule of Items" and that the "Schedule of Items," attached hereto and incorporated herein as part of the Contract Documents, submitted by the contractor, establish that the total contract amount for this project is FIFTY-FOUR THOUSAND, FIVE HUNDRED EIGHT AND 02/100 dollars ($54,508.02), as obtained by a summation of the product of the unit bid price submitted by the contractor for each item multiplied by the item quantity as estimated by the Department. The Contractor agrees to accept and the Department agrees to pay for the work at the prices stipulated in this contract in lawful money of the United States in a timely manner as set forth in the 2000 Standard Specifications.

CONTRACT TIME
The entire contract shall be completed in all details and ready for final acceptance within FIFTEEN (15) WORKING days. Performance of work on this contract shall begin on the date stipulated in the "Notice to Proceed" and shall be completed within the time specified in the Contract Documents, subject to such extensions as may be authorized.

ALTERATION OF CONTRACT
In accordance with the 2000 Standard Specifications and the Contract Documents, the Contractor agrees to the terms and requirements for alteration of the contract.

STIPULATED DAMAGES
Contractor agrees to the assessment of Stipulated Damages as provided in the Subsection 108.08 of the 2000 Standard Specifications as amended by the Contract Documents.

DAMAGE CLAIMS
Contractor acknowledges that he/she has reviewed and understands Subsection 107.17 of the 2000 Standard Specifications and specifically agrees to be bound by the terms and conditions thereof.

JOINT EFFORT
This Agreement shall be deemed for all purposes prepared by the joint efforts of the parties hereto and shall not be construed against one party or the other as a result of the preparation, drafting, submission or other event of negotiation, drafting or execution of the Agreement.
LOUISIANA
DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT

CONTRACT

This contract shall become effective on the date all parties hereto have signed the same.

Diamond B Construction Company, LLC
CONTRACTOR

72-08V970
(Federal Identification Number)

By: Jere T. Room, Sr.
(Signature of Authorized Agent)
04-29-03
(Date)

BRYAN L. BOSSIER SR., PRES
(Typed or Printed Name and Title)

LOUISIANA DEPARTMENT OF
TRANSPORTATION AND DEVELOPMENT

By: Wm. Wayne Marchand, P.E.
District Administrator, District 08
5-8-03
(Date)

Witness

Witness
BIDDER SIGNATURE REQUIREMENTS

THIS BID FOR THE CAPTIONED PROJECT IS SUBMITTED BY:

Diamond B Construction Company, LLC

Name of Principal (Individual, Firm, Corporation, or Joint Venture)

If Joint Venture, Name of First Partner

12487

(Louisiana Contractor's License Number of First Partner to Joint Venture)

5796 Gone Bugg Nut

(Po Box Address)

Acadiana, LA 70502

(Po Box Address, if different)

318) 443-5686

(Phone Number and Name of Contact Person)

(318) 443-4443

(Telephone Number, if any)

ACTING ON BEHALF OF THE BIDDER, THIS IS TO ATTEST THAT THE UNDERSIGNED DEPUTY AUTHORIZED REPRESENTATIVE OF THE ABOVE CAPTIONED FIRM, CORPORATION OR BUSINESS, BY SUBMISSION OF THIS BID, AGREES AND CERTIFIES THE TRUTH AND ACCURACY OF ALL PROVISIONS OF THIS PROPOSAL, INCLUSIVE OF THE REQUIREMENTS, STATEMENTS, DECLARATIONS AND CERTIFICATIONS ABOVE AND IN THE SCHEDULE OF ITEMS AND PROPOSAL QUANTITY. EXECUTION AND SIGNATURE OF THIS FORM AND SUBMISSION OF THE SCHEDULE OF ITEMS AND PROPOSAL QUANTITY SHALL CONSTITUTE AN IRREVOCABLE AND LEGALLY BINDING OFFER BY THE BIDDER.

(Authorized Signature)

Printed Name: Rosalind Bernier

Date: 4/24/03

ISSUED FOR BID

ISSUED FOR BID

APR 17 2003

Page 6 of 9

IT IS AGREED THAT THIS TOTAL, DETERMINED BY THE BIDDER, IS FOR PURPOSES OF OPENING AND READING BIDS ONLY, AND THAT THE LOW BID FOR THIS CONTRACT WILL BE DETERMINED FROM THE EXTENSION AND TOTAL OF THEアジMET ITEMS BY DOT.

CS-14AA

04/01

54,506.02
LOUISIANA DEPARTMENT OF TRANSPORTATION AND DEVELOPMENT
PAYMENT, PERFORMANCE, AND RETAINAGE BONDS

Be it known that Diamond B Construction Company, LLC, as Principal, and
Hartford Accident and Indemnity Company, as Surety, are authorized to do business in
Louisiana, hereby bind themselves, in solidum, to the Louisiana Department of Transportation and Development, and
other potential claimants, for all obligations incurred by the Principal under its contract for the construction of STATE
PROJECT NO. 008-02-0018, US 71 OPEN GRADED FRICTION COURSE (CM), US 71, GRANT Parish, in the
full contract amount of FIFTY-FOUR THOUSAND, FIVE HUNDRED EIGHT AND 02/100 DOLLARS ($54,508.02). The obligations of the Principal and Surety under these payment, performance, and retainage bonds shall
continue in full force and effect until all materials, equipment, and labor have been provided, AND all requirements
contained in the contract, plans, and specifications have been completed in a timely, thorough, and workmanlike manner.
The parties acknowledge that these bonds are given under the provisions and limitations contained in La. R.S. 48:250 et
seq.

By this instrument(s), the Principal and Surety specifically bind themselves, their heirs, successors, and assigns, in
solidum, under the following bonds:

PAYMENT BOND. To the Louisiana Department of Transportation and Development and all "Claimants," as
defined in La. R.S. 48:256.5 in the full contract amount of FIFTY-FOUR THOUSAND, FIVE HUNDRED
EIGHT AND 02/100 DOLLARS ($54,508.02), in order to secure all and timely claims under the project.
The parties agree this bond is statutory in nature and governed by La. R.S. 48:256.3.
Claims pursuant to La. R.S. 48:256.3 shall be made to the Undersecretary, DOTD, Headquarters Administration
Building, Rm 226, 1201 Capitol Access Road, Baton Rouge, LA 70802.

PERFORMANCE BOND. To the Louisiana Department of Transportation and Development in the full
contract amount of FIFTY-FOUR THOUSAND, FIVE HUNDRED EIGHT AND 02/100 DOLLARS
($54,508.02), in order to secure the full and faithful performance and timely completion of the project according
to its plans and specifications, inclusive of overpayments to the contractor and stipulated damages as assessed.

RETAINAGE BOND. To the Louisiana Department of Transportation and Development in the full
sum of Ten percent (10%) of the contract amount, in lieu of the sums required to be withheld from progress
payments under the provisions of La. R.S. 48:256.1, inclusive of overpayments to the contractor and
stipulated damages as assessed.

CONTRACTOR OPTION: RETAINAGE

1. Principal, elect to exercise my option to have ten percent retainage withheld from all payments in lieu
of the above retainage bond.

By ____________________________
Principal

8/01
Form CS-16A

Page 8 of 9
POWER OF ATTORNEY

HARTFORD FIRE INSURANCE COMPANY
HARTFORD CASUALTY INSURANCE COMPANY
HARTFORD ACCIDENT AND INDEMNITY COMPANY
HARTFORD UNDERWRITERS INSURANCE COMPANY
TWIN CITY FIRE INSURANCE COMPANY
HARTFORD INSURANCE COMPANY OF ILLINOIS
HARTFORD INSURANCE COMPANY OF THE MIDWEST
HARTFORD INSURANCE COMPANY OF THE SOUTHEAST

KNOW ALL PERSONS BY THESE PRESENTS THAT the Hartford Fire Insurance Company, Hartford Accident and Indemnity Company and Hartford Underwriters Insurance Company, corporations duly organized under the laws of the State of Connecticut; Hartford Casualty Insurance Company, a corporation duly organized under the laws of the State of Illinois; Twin City Fire Insurance Company and Hartford Insurance Company of the Midwest, corporations duly organized under the laws of the State of Indiana; and Hartford Insurance Company of the Southeast, a corporation duly organized under the laws of the State of Florida having their home office in Hartford, Connecticut, hereinafter collectively referred to as the "Companies") do hereby make, constitute and appoint, up to the amount of unlimited:


of

Baton Rouge, LA

their true and lawful Attorney(s)-in-Fact, each in their separate capacity if more than one is named above, to sign its name as surety only as delineated above by ☑, and to execute, seal and acknowledge any and all bonds, undertakings, contracts and other written instruments in the nature thereof, on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any acts or proceed allowed by law.

In Witness Whereof, and as authorized by a Resolution of the Board of Directors of the Companies on September 12th, 2000, the Companies have caused these presents to be signed by its Assistant Vice President and its corporate seals to be hereto affixed, attested by its Assistant Secretary. Further, pursuant to Resolution of the Board of Directors of the Companies, the Companies hereto unambiguously affirm that they are and will be bound by any mechanically applied signatures applied to this Power of Attorney.

Paul A. Bergentholtz, Assistant Secretary

John P. Hyland, Assistant Vice President

STATE OF CONNECTICUT

COUNTY OF HARTFORD

On the 19th day of September, 2000, before me personally came John P. Hyland, to me known, who being by me duly sworn, depose and say that he resides in the County of Hartford, State of Connecticut, that he is the Assistant Vice President of the Company; the corporations described in and which executed the above instrument; that he know the seals of the said corporations; that the said seals are affixed to the said instrument; and that the same are corporate seals; that they were so affixed by authority of the Boards of Directors of the said corporations and that he signed his name thereto by like authority.

[Signature]

I, the undersigned, Assistant Vice President of the Companies, DO HEREBY CERTIFY that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which is still in full force and effect as of

Signed and sealed at the City of Hartford.

[Signature]

Coleen Mastroianni, Assistant Vice President
IMPORTANT NOTICE TO OBLIGEES/POLICYHOLDERS - TERRORISM RISK INSURANCE ACT OF 2002

You are hereby notified that, under the Terrorism Risk Insurance Act of 2002, effective November 26, 2002, we must make terrorism coverage available in your bond/policy. However, the actual coverage provided by your bond/policy for acts of terrorism, as is true for all coverages, is limited by the terms, conditions, exclusions, limits, other provisions of your bond/policy, and any endorsements to the bond/policy and generally applicable rules of law.

Any terrorism coverage provided by this bond/policy is partially reinsured by the United States government. The United States government will pay 90% of covered terrorism losses exceeding a statutory-estABLished deductible paid by reinsurers until such time as insured losses under the program reach $100 billion. If that occurs, Congress will determine the procedures for, and the source of, any payments for losses excess of $100 billion.

The premium charge that has been established for terrorism coverage under this bond/policy is either shown on this form or elsewhere in the bond/policy. If there is no premium shown for terrorism on this form or elsewhere in the bond/policy, there is no premium for the coverage.

Terrorism premium: $0
ITEM S-001, OPEN GRADED FRICTION COURSE (03/03): This item consists of furnishing and constructing an Open Graded Friction Course in accordance with plan details, and these specifications.

General: This thin surface asphaltic concrete overlay material is intended to resist permanent deformation, reduce overspray by moving water freely through the layer and improve friction while providing a 10 year maintenance surface. This material shall be placed in thickness shown on the plans, otherwise the thickness shall be 3/4 inch (19 mm) minimum and 2.0 inch (50 mm) maximum.

Materials: Materials shall comply with the following:

(a) Asphalt Binder: The asphalt binder shall be PG 76-22m asphalt cement complying with Section 1002 and listed on QPL 41.

(b) Aggregate: Aggregates shall be 100% crushed stone, with a Friction Rating of 1 complying with the requirements of Subsection 1003.06(b), except that aggregate gradation shall be as follows:

<table>
<thead>
<tr>
<th>Aggregate Gradation</th>
<th>US Sieve (Metric)</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3/4 inch (19 mm)</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1/2 inch (12.5 mm)</td>
<td>85-100</td>
</tr>
<tr>
<td></td>
<td>3/8 inch (9.5 mm)</td>
<td>55-75</td>
</tr>
<tr>
<td></td>
<td>No. 4 (4.75 mm)</td>
<td>10-25</td>
</tr>
<tr>
<td></td>
<td>No. 8 (2.36 mm)</td>
<td>5-10</td>
</tr>
<tr>
<td></td>
<td>No. 200 (75 μm)</td>
<td>2-4</td>
</tr>
</tbody>
</table>

(c) Fiber: Cellulose fiber or mineral fiber when required shall comply with Section 508 and will be required to assure protection against draindown.

(d) Anti-strip: Anti-strip shall comply with Subsection 1002.02 and be applied according to Section 502.

(e) Tack Coat: The tack coat shall conform to Section 504 and shall be applied at a minimum rate of 0.07 gallons per square yard (0.32 L/sq m).

Equipment: Equipment shall conform to Section 503.

Design Procedure: The contractor shall provide the required mixture using the following design procedures:

1. Select three trial blends of aggregate within the specification bands above.
2. Determine dry-roded voids in coarse aggregate, plus No. 4 (4.75 mm) sieve, of the coarse aggregate fraction (VCA_{DR})
3. Add between 6 percent to 6.5 percent asphalt to each trial blend and compact to 50 gyrations of a Superpave gyratory compactor.
   (Note: At this stage of design, fiber should be added at manufacturer’s recommended rate. Fibers are required when draindown is observed, typical rates are 0.2 percent to 0.5 percent.)
4. Determine the voids in the coarse aggregate, VCA, for each compacted mix.
5. VCA must be equal to or less than the VCA_{DR} (this indicates stone on stone contact).
6. Select the trial gradation that produces stone on stone contact and a minimum 22 percent VCA.
7. Using selected design from Step 6, prepare two additional mixtures using 0.5 percent and 1.0 percent additional asphalt content and compact using 50 gyrations of the Superpave gyratory compactor.

8. Conduct drainage test in accordance with Section 508 on the loose mix at a temperature 60°F (15°C) higher than normal mixing temperatures. (A maximum drainage of 0.3 percent is required.)

9. Conduct laboratory permeability test described in ASTM PS 129, 246 feet/day (75 m/day) minimum is desired.

10. Report each step of the procedure. The report must show that the selected design meets drainage, VCA of 18 percent minimum and a minimum of 246 feet/day (75 m/day) permeability.

11. Perform boil test and Lottman test. The Lottman moisture sensitivity test, in accordance with AASHTO T 283, is modified to require 5 freeze/thaw cycles and the retained tensile strength, TSR, shall be 80 percent. A minimum of 90 percent coating is required for the boil test.

12. District Lab Engineer shall review and approve the design, verifying the aggregate gravities.

Plant Validation and Quality Assurance Tests: The validation lot is defined as the first four hours of production. Validation requires that the mixtures meet the minimum design criteria excluding Lottman and shall be based on the average of a minimum of two samples. Subsequent validation trials shall be limited to 500 tons (500 Mg) per day.

One set of plant Lottman tests shall be made during validation and reported within one week of production for verification.

A production lot is defined as the material produced in one day.

Two random acceptance samples shall be taken each day and the average shall be reported and shall meet the following:

- Gmm, maximum specific gravity ±0.020 from validation target;
- VCA, 18 percent minimum; after 50 gyrations of a Superpave gyratory compactor.
- Draindown; 0.3 percent;
- Boil Test; 90 percent coated
- Percent AC, meter; (<0.2 percent from design target)

Permeability; Validation only or when requested by the engineer.

Acceptance pay will be based on the percent deviations from the job mix formula tolerances for the lowest of the pay sieves listed below.

<table>
<thead>
<tr>
<th>US Sieve (Metric)</th>
<th>100% pay</th>
<th>95% pay</th>
<th>90% pay</th>
<th>50% pay or remove</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>±4%</td>
<td>±4.1 to 6.0%</td>
<td>±6.1 to 8.0%</td>
<td>&gt;8.0%</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
<td>±3%</td>
<td>±3.1 to 5.0%</td>
<td>±5.1 to 7.0%</td>
<td>&gt;7.0%</td>
</tr>
</tbody>
</table>

Weather Limitations: Weather limits shall comply with Section 502 except that the surface temperature shall be a minimum of 60°F (15°C) and air temperatures must be 60°F (15°C) and rising.
7. Using selected design from Step 6, prepare two additional mixtures using 0.5 percent and 1.0 percent additional asphalt content and compact using 50 gyrations of the Superpave gyratory compactor.

8. Conduct draindown test in accordance with Section 508 on the loose mix at a temperature 60°F (15°C) higher than normal mixing temperatures. (A maximum draindown of 0.3 percent is required.)

9. Conduct laboratory permeability test described in ASTM PS 129, 246 feet/day (75 m/day) minimum is desired.

10. Report each step of the procedure. The report must show that the selected design meets draindown, VCA of 18 percent minimum and a minimum of 246 feet/day (75 m/day) permeability.

11. Perform boil test and Lottman test. The Lottman moisture sensitivity test, in accordance with AASHTO T 283, is modified to require 5 freeze/thaw cycles and the retained tensile strength, TSR, shall be 80 percent. A minimum of 90 percent coating is required for the boil test.

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**Draindown; 0.3 percent;**

**Boil Test; 90 percent coated**

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<tr>
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<th>95% pay</th>
<th>90% pay</th>
<th>80% pay</th>
<th>50% pay</th>
<th>or remove</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4 (4.75 mm)</td>
<td>±4%</td>
<td>±4.1 to 6.0%</td>
<td>±6.1 to 8.0%</td>
<td>&gt;8.0%</td>
<td></td>
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</tr>
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<td>±3%</td>
<td>±3.1 to 5.0%</td>
<td>±5.1 to 7.0%</td>
<td>&gt;7.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Weather Limitations:** Weather limits shall comply with Section 502 except that the surface temperature shall be a minimum of 50°F (15°C) and air temperatures must be 60°F (15°C) and rising.
Placement and Compaction: Mixture shall be placed to plan thicknesses and compacted immediately after placement without excessive breakage of aggregate. Two or three passes of a vibratory roller is typical. Newly constructed sections shall be protected until it has cooled enough to develop sufficient strength to hold traffic.

Roadway Inspection and Smoothness Requirements: The inspector will record the average paver screed height settings every hour and will also report the yield hourly by adding the tons reported on the weigh tickets and dividing by the area placed. Smoothness will be measured before construction starts and again after each day of construction. The smoothness measurement after construction shall not exceed the measured smoothness before construction.

Measurement: Open Graded Friction Course will be measured per square yard (sq m). The quantities for payment will be the design quantities specified in the plans, based on horizontal dimensions, and adjustments thereto.

Payment: Payment for Open Graded Friction Course will be made on the accepted quantity at the contract unit price per square yard (sq m) subject to the acceptance payment adjustments contained herein.

Payment will be made under:

Item S-001, Open Graded Friction Course, per square yard (sq m).
DESIGN CONCEPT

PROJECT LOCATION AND LIMITS
This project is located on US 71 just south of Rock Hill. It begins at station 18+45, which is located 615' north of mile marker 89. It proceeds northward along US 71 for 0.157 mile. The project ends at station 26+75.

EXISTING ROADWAY
The existing roadway is a 24 ft. wide travelway with paved shoulders. The existing surfacing on the travelway is asphaltic concrete over stabilized base. Shoulders are 10' width asphaltic concrete over a soil cement base.

PROPOSED ROADWAY
Proposal is to place an open graded friction course on the existing travelway.

MISCELLANEOUS WORK
Additional work will consist of replacing the existing roadway markings (painted) and retroreflective markers.
1) **GENERAL REQUIREMENTS FOR "CM" PROJECTS:**
   The total funding for this contract is fixed, and cost cannot over run. The Engineer may adjust quantities of work herein to remain on budget.

2) **ITEM 713-01, TEMPORARY SIGNS AND BARRICADES:**
   The "Do Not Pass" and "Pass With Care" signs will be erected at the same time as the advance warning signs for the project.
## Surfacing

<table>
<thead>
<tr>
<th>STA.</th>
<th>STA.</th>
<th>DESCRIPTION</th>
<th>Length (ft.)</th>
<th>Width (ft.)</th>
<th>(Square yards)</th>
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Column Total: 2213  
Project Total: 2213
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<td>713-01</td>
<td>Temporary Signs and Barricades</td>
<td>Lump</td>
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<tr>
<td>727-01</td>
<td>Mobilization</td>
<td>Lump</td>
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<tr>
<td>731-02</td>
<td>Reflectors/raised Pavement Markers</td>
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<td>Open Graded Friction Course</td>
<td>Gt. Yd.</td>
<td>200 x 2.1</td>
</tr>
</tbody>
</table>
NOTES:

1. ALL SIGNING SHOWN IS FOR BEGINNING OF PROJECT. SIGNING FOR END OF PROJECT SHALL BE THE SAME SEQUENCE AS SHOWN.
2. ALL ADVANCE CONSTRUCTION SIGNS IN CONFLICT WITH IN-USE LANE CLOSURE SIGNS, DETOUR SIGNS, OR ROAD CLOSED SIGNS SHALL BE REMOVED OR COVERED.
3. CHANNELIZING DEVICES, BARRIERS, OR ALIGNMENT DELINERATION SHALL BE REQUIRED TO CORDON CONSTRUCTION AREAS ADJACENT TO THE ROADWAY AT THE DIRECTION OF THE PROJECT ENGINEER.
5. WHEN MOVING OPERATION SIGNAGE IS IN THE PROXIMITY OF CONSTRUCTION SEQUENCE SIGNAGE, EXCESS SIGNS SHALL BE TEMPORARILY COVERED.
6. THE FIRST ADVANCE WARNING SIGN IN A SERIES SHALL HAVE A HIGH INTENSITY FLASHING LIGHT AND 2 SAFETY ORANGE FLAGS INSTALLED ON SIGN.
7. SPEED REDUCTION SHALL BE REQUIRED AS FOLLOWS:
   a) ANY AREA BEING UTILIZED AS A CONSTRUCTION CROSSOVER,
   b) ANY AREA THAT HAS BEEN COLD PLANNED, UNTIL SURFACE CONDITIONS HAVE BEEN RESTORED,
   c) ANY AREA WHERE CONSTRUCTION OPERATIONS HAVE DEGRADED THE CONDITION OF THE ROADWAY
   d) ANY AREA OR MOVING OPERATION DEEMED HAZARDOUS BY THE PROJECT ENGINEER.

ADVANCE SIGNING SIGNING DETAIL
1. Flagger station shall be located such that at all times flagger will be clearly visible to motorists from a distance of at least 600 ft.

2. A lane of traffic to be open at the end of each day’s working hours.

3. Rolling barricade to be a Type III barricade, with a minimum width of 4 ft. If used, the reduced speed limit sign should be mounted on the rolling barricade. The speed limit shall be set to the side of passing traffic, if project engineer authorizes flagging without the rolling barricade device, the speed limit shall be set in a separate sign stand, 200 ft. to 400 ft. before the flagger station.

4. Single lane signs, flagger sign and reduced speed sign to be covered or removed at night and at all times lane closures is not in effect.

5. Rollinators and signs, such as “Low shoulder”, “Uneven pavement” or “Bump”, should be installed throughout the project as needed.

6. Signing details for lane closure at isolated locations, daytime operations.

The project engineer shall be installed at no additional cost.
NOTES:

1. Flagger station shall be located such that at all times flagger will be clearly visible to motorists from a distance of at least 500 ft.

2. Time of traffic to be opened at the end of each day’s working hours.

3. Rolling barricade to be a type III barricade, with a minimum width of 4 ft. If used, the reduced speed limit sign should be mounted on the rolling barricade, at least 36” from the ground and offset to the left of passing traffic. If project engineer authorizes flagging without the rolling barricade device, the speed limit shall be mounted on a separate sign stand, 200 ft. to 400 ft. before the flagger station.

4. Single lane signs, flagger sign and reduced speed sign to be covered or removed at night and at all times lane closure is not in effect.

5. Reflectors and signs, such as “Low Speed Dept.,” “Uneven Pavement,” or “Blow,” should be installed throughout the project as needed.

6. Minimum construction signage: Any additional signs shown in the “Manual on Uniform Traffic Control Devices” and required by the project engineer shall be installed at no additional cost.

SIGNING DETAIL FOR LANE CLOSURE
AT ISOLATED LOCATIONS
DAYTIME OPERATIONS
R.C. 3-1-02

46
Appendix C

Job Mix Formula
<table>
<thead>
<tr>
<th>Code</th>
<th>Source</th>
<th>Total CF</th>
<th>Mix Percent</th>
<th>SP. Grav.</th>
<th>Fr. Rate</th>
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<tbody>
<tr>
<td>680</td>
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<td>6.6</td>
<td>1.030</td>
<td>(14)</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Contractor's Results</th>
<th>MARSHALL TEST PROPERTIES</th>
<th>Department Validation</th>
<th>JMF Limits</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>% Void</td>
<td>% VMA</td>
<td>% VFA</td>
</tr>
<tr>
<td></td>
<td>8.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.172</td>
<td>2.388</td>
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<tr>
<td></td>
<td>18% Min</td>
<td></td>
<td></td>
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<tr>
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<td>3 max</td>
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<table>
<thead>
<tr>
<th>RECOMMENDED FORMULA</th>
<th>LOOSE MIX RESULTS</th>
<th>JMF LIMITS</th>
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<tr>
<td></td>
<td>Minimum</td>
<td>1</td>
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<tr>
<td></td>
<td>AC Extends</td>
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<tr>
<td></td>
<td>% Crushed</td>
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<tr>
<td></td>
<td>Mix Temp. (C)</td>
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<tr>
<td></td>
<td>[%AC (Marx)]</td>
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<tr>
<td></td>
<td>AS (Marx)</td>
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<thead>
<tr>
<th>ADJUSTMENT FACTOR</th>
<th>Tensile Str. Control (kPa)</th>
<th>Tensile Str. Ratio (TSR) %</th>
<th>Ross Count % (95)</th>
<th>% Asph. Coating (TR 3:7)</th>
<th>Effective AC %</th>
<th>Absorbed AC %</th>
<th>% Natural Sands</th>
<th>Sand Equivalent</th>
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<tbody>
<tr>
<td></td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>6.0</td>
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<tr>
<td></td>
<td>0.6 - 0.7</td>
<td>275</td>
<td>A111</td>
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Appendix D

Film Thickness Calculation
OGFC Film Thickness Calculations
Based on Surface Area

<table>
<thead>
<tr>
<th>Sieve Size, mm (in)</th>
<th>Percent Passing</th>
<th><strong>Surface Area Factor (m²/kg)</strong></th>
<th>Surface Area (m²/kg)</th>
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<tbody>
<tr>
<td>37.5 (1.5)</td>
<td>100</td>
<td>0.41</td>
<td>0.41000</td>
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<tr>
<td>25 (1)</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 (3/4)</td>
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<tr>
<td>12.5 (1/2)</td>
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<tr>
<td>9.5 (3/8)</td>
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<tr>
<td>4.75 (No. 4)</td>
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<td>0.41</td>
<td>0.06560</td>
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<tr>
<td>2.30 (No. 6)</td>
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<td>0.82</td>
<td>0.06560</td>
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<td>1.18 (No. 16)</td>
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<td>1.94</td>
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<td>0.6 (No. 30)</td>
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<td>2.87</td>
<td>0.14350</td>
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<tr>
<td>0.3 (No. 50)</td>
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<td>6.14</td>
<td>0.24560</td>
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<td>0.15 (No. 100)</td>
<td>3.4</td>
<td>12.29</td>
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<td>0.075 (No. 200)</td>
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<td>32.77</td>
<td>0.75371</td>
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<tr>
<td>Total Surface Area</td>
<td></td>
<td></td>
<td>2.20027</td>
</tr>
</tbody>
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% VMA = 22.1
% VTM = 8.2
P_m = 6.6%
P_h = 0.1%
G_{a_1} = 2.612
G_{o_1} = 2.173
G_{a_2} = 2.368
G_{o_2} = 2.604

Volume of Asphalt Binder = 13.9 %
Weight of Asphalt Binder = 142.17 kg
Weight of Aggregate = 2020.072 kg
Weight of Asphalt per kilogram of aggregate = 0.070664

Actual Asphalt Film Thickness = 31.2 microns
Appendix E

LADOTD & Contractor’s Project Personnel Comments
Nicholas F. Verret, Jr., LADOTD District 08 Design, Water Res. & Dev. Engineer

“It is obvious that this material is functioning as intended, since you can see water bleeding through it onto the shoulder after a rain…….”

Cephas Bowie, Jr., LADOTD District 08 Laboratory Engineer

“The mix design and application at this particular site on US 71 has eliminated the potential for hydroplaning. The mix provided drainage from the travel lanes and has performed well under traffic. This site is in a curve on a hill which allows the water from the travel lanes to either flow to the shoulders or down the travel lane edges during a heavy rain, however, it would be better to lay the OGFC on the travel lanes and shoulders or provide alternate drainage through the shoulders (I realize that our project was a CM job and the monies were limited). This project is performing very well.”

Mark Lacroix, Quality Control Manager, Diamond B. Construction Co., LLC

“1) Allow skid 2 and 3 aggregate in the mix. Follow current HM specs which allow 30% skid 1 and 50% skid 2 by weight of total mix. This would allow contractors to utilize commonly inventoried materials while not impacting safety.

2) Eliminate Lottman sensitivity test and evaluate agg/AC compatibility by performing a boil test. The coarse aggregate structure of the mix makes it difficult for the sample to hold together during the thaw cycle. The current spec called for 5 cycles. On the project we did, this was waived.

3) Run plant production at least 150 tons before sampling to allow the plant bag house to purge. The small project that we did showed a finer gradation than was designed as a result of this. Even so the material is functioning as intended.”