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I am submitting herewith a thesis written by Christopher David Baldwin entitled "Evaluation of the Asphalt Pavement Analyzer for Accelerated Testing of the Relative Rutting Susceptibility of Hot Mix Asphalt." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Civil Engineering.

N. Mike Jackson, Major Professor

We have read this thesis
And recommend its acceptance:

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Associate Vice Chancellor and
Dean of The Graduate School

EVALUATION OF THE ASPHALT PAVEMENT ANALYZER FOR ACCELERATED TESTING OF THE RELATIVE RUTTING SUSCEPTIBILITY OF HOT MIX ASPHALT

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Christopher David Baldwin
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DEDICATION

This thesis is dedicated to my wife

Allison Baldwin.

I could have never done this without you.

ACKNOWLEDGEMENTS

There are a number of people I would like to recognize as inspirations for my completion of this Master's degree. I would like to thank all of the faculty members at the University of Tennessee, Civil and Environmental Engineering Department who forced me to study hard and try my best. Special thanks goes to Dr. N. Mike Jackson for giving me the opportunity to prove that I had what it takes to successfully complete this degree. I would also like to thank the secretaries who provided valuable support when it was needed. Curtis Allin has been around the University inspiring students and maintaining laboratory facilities for thirty-nine years. Thanks Curtis for the memories and special lessons you taught me. The Department will never be the same without you. I would also like to thank the Tennessee Department of Transportation for their generous financial support.

Special thanks goes to my parents, Edward and Patricia Baldwin and the rest of my family for being there when I needed them the most. Without their support, this degree would not have been possible. Thanks Mom and Dad for all of your help.

Finally, but most importantly, I must acknowledge my wife for her endurance over the past two years. Without her limitless support and understanding, I would have never been able to return to school and fulfill this dream. Thank you Allison, I love you.

ABSTRACT

In the early 1990's, $50 million of asphalt related research was conducted as part of the Strategic Highway Research Program (SHRP). The SHRP researchers identified rutting as a major cause of distress in Hot Mix Asphalt (HMA). They developed the Superpave mixture design and analysis system in part to help reduce this mode of distress.

The Superpave procedure does not currently include a proof-test to assess the relative rutting susceptibility of HMA. Such a test would be very useful in the design and evaluation of HMA (Petros, 1999). The objective of this study was to evaluate the merits of the Pavement Technology, Inc. (PTI) Asphalt Pavement Analyzer (APA) as a proof-test to predict the relative rutting susceptibility of HMA in Tennessee.

Thirty-four mixes from various locations across the state of Tennessee were compacted into test specimens and tested in the APA. The Superpave Gyratory Compactor (SGC) was used to produce pill specimens and the PTI Asphalt Vibratory Compactor (AVC) was used to make beam specimens.

Based on the test results contained herein, the APA appears to be well suited for accelerated proof testing of HMA in the laboratory. The data also indicated that the APA is sensitive to several of the primary factors known to cause rutting of HMA. Either SGC pill or AVC beam specimens can be used in the APA. However, the AVC beams exhibited a high variability between specimens, primarily due to inconsistent compaction.

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1.0 INTRODUCTION

1.1 Objective

Permanent deformation, physically visible as rutting in the pavement surface, is a primary concern of asphalt mix designers, materials engineers, contractors, and federal, state, and local highway agencies. Surface rutting in excess of about 6 mm (¼-inch) is generally considered a hydroplaning safety hazard. Consequently, excessive rutting is often responsible for pre-mature maintenance and rehabilitation activities, reducing the service life of the pavement. In 1997, the Tennessee Department of Transportation (TDOT) spent approximately $250 million on new Hot Mix Asphalt (HMA) construction. TDOT typically designs pavements for a 20-year service life. Cost savings of around $2 million per year could be realized by increasing the life of all pavements by only one percent (Avera, 1998). Eliminating the occurrence of excessive rutting in HMA would go a long way toward realizing these life-cycle-cost savings.

In the early 1990's, $50 million of asphalt related research was conducted as part of the Strategic Highway Research Program (SHRP). From this extensive research effort, the Superior Performing Asphalt Pavements (Superpave) mixture design and analysis system was conceived. Superpave provides a new system for specifying component materials, design, and analysis of asphalt mixtures (McGennis, et al., 1995). The SHRP researchers identified rutting as a major cause of distress in HMA. This mode of distress is the result of consolidation of the mix after construction and plastic flow of the HMA in the wheel path over time (Roberts, et al., 1996). Excessive asphalt binder content,

excessive amounts of fine grained aggregate, and high percentages of natural, rounded aggregate particles are considered to be common causes of rutting (Button, et al., 1990).

The Superpave mixture design and analysis system does not currently include a proof-test to assess the relative rutting susceptibility of HMA. Such a test would be very useful in the design and evaluation of HMA (Petros, 1999). The objective of this study was to evaluate the merits of the Pavement Technology, Inc. (PTI) Asphalt Pavement Analyzer (APA) as a proof-test to predict the relative rutting susceptibility of HMA in Tennessee.

To accomplish this task, specimens of both pill and beam shapes were evaluated. The Superpave Gyratory Compactor (SGC) was used to produce the pill specimens and the PTI Asphalt Vibratory Compactor (AVC) was used to make the beam specimens. The two compactors were evaluated to determine which one produces the most representative and least variable HMA test specimen for rut testing.

1.2 Background

1.2.1 Rutting

The Superpave mix design system specifies asphalt binder properties as well as aggregate type and gradation. These specifications were developed to address specific pavement distress issues. One major problem in HMA mixes is rutting, a very complicated process affected by multiple factors. Aggregate properties and asphalt binder content are equally important considerations during material selection and mix design (Parker and Brown, 1994).

Several different mix characteristics are known to promote rutting in the asphalt concrete. Load, time and temperature act in conjunction to induce this form of distress. Large trucks affect rutting because of the stress imposed by the heavy axle loads (Gillespie and Karamihas, 1994). Temperature is an obvious controlling factor of rutting because of the visco-elastic nature of asphalt. At higher temperature, the pavement will be more likely to deform under loading than at lower temperatures. The more asphalt contained in a mix, the more fluid the HMA becomes. For this reason, the amount of asphalt contained in the mix will have a profound impact on the mix's performance. Most surface mixes are designed with a typical asphalt content of about 6 percent.

Historically, asphalt binder was categorized according to its viscosity at specific temperatures. The Superpave system grades asphalt binder based upon its ability to maintain specific physical properties at varying performance temperatures (Asphalt Institute, 1995). This Performance Graded (PG) specification allows the mix designer to select an asphalt binder depending on geographic region, air temperature, or the maximum and minimum design pavement temperatures. A PG 64-22, a typical asphalt binder used on Tennessee roadways, would be suitable for an environment where a seven-day average maximum pavement temperature of 64° C and a minimum pavement temperature of –22° C are experienced. The high-temperature specification addresses rutting in the asphalt concrete.

One way to improve the high-temperature performance of asphalt binder is to modify it with polymers. Latex, ethylene vinyl acetate, and styrene-butadiene-styrene, are some examples of additives that have been blended with neat asphalt binders to

improve the high temperature performance (Button, et al, 1996). Modifying the asphalt binder may decrease a mix's propensity to rut, but other properties of HMA have equal importance in controlling rutting potential.

Mix gradation and aggregate selection have been reported to have tremendous impacts on rutting. It has been documented that gradation can be more important in minimizing rutting than asphalt binder and additive properties (Hughes, 1990). Experimentation has also shown that the rutting susceptibility of a HMA mix increases dramatically when natural fine aggregate particles replace crushed particles in a given gradation (Button, et al., 1990). The amount of dust contained in HMA can impact its rutting potential because the dust will extend the asphalt (Roberts, et al., 1996).

The Superpave system attempts to control these factors by limiting the amount of dust in a mix to 6 % passing the 0.075 mm (# 200) sieve. SHRP researchers attempted to control the amount of natural, rounded sand contained in the HMA by specifying a restricted zone on the gradation curve between the 4.75 mm (# 4) and 0.30 mm (# 50) sieves. Figure 1 shows typical gradation control limits for a 19-mm Nominal Maximum Aggregate Superpave mix design. These limits are dependent upon the nominal maximum aggregate size (Asphalt Institute, 1996). Historically, many Tennessee and Georgia surface mixes containing angular sands passing through the restricted zone have been shown to perform adequately. The majority of mixes tested in this study have design gradations passing through the restricted zone. The quality of local aggregate also has an impact on HMA rutting susceptibility. Regions with quality crushed stone and

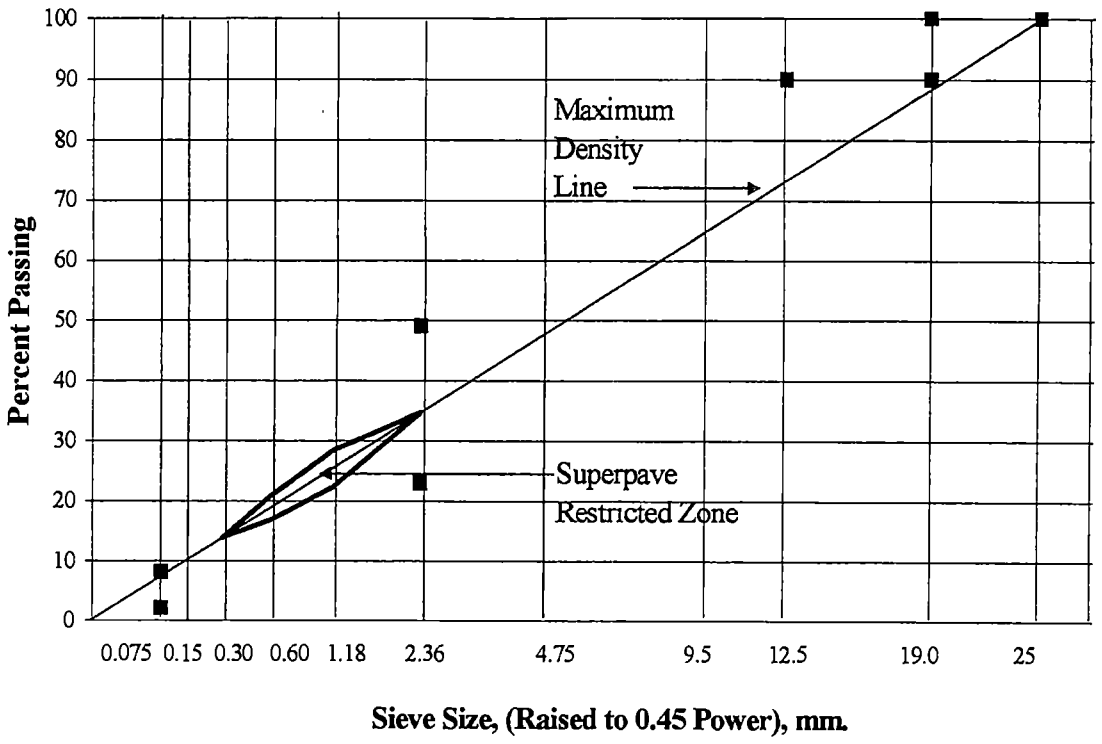


Figure 1. Illustration of Superpave Gradation Requirements for a Mix Design with a 19 mm Nominal Maximum Aggregate.

angular natural sand have been observed to exhibit a higher resistance to rutting (Parker and Brown, 1994). Further, it has been reported that medium graded mixtures provide significantly better resistance to rutting than coarse graded mixtures (Matthews and Monismith, 1993). Coarse graded mixes tend to be more difficult to work with; thus achieving maximum compacted density is often a problem. When density is not achieved, the mix will often compact excessively under traffic, leaving large ruts in the wheel path.

In summary, rutting is caused by a combination of many factors. Temperature, magnitude and duration of loading, asphalt binder grade, asphalt binder content, aggregate gradation and shape, and various combinations of these properties affect the

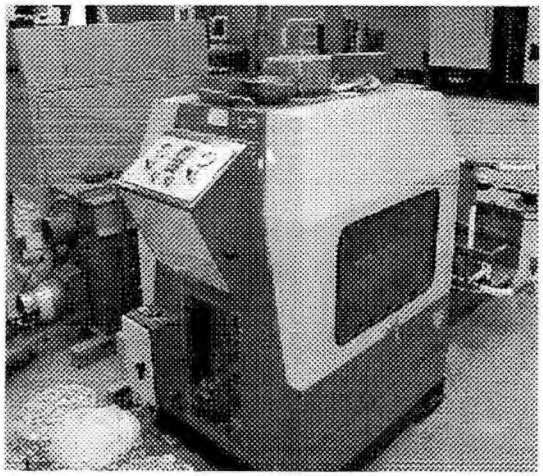
performance of HMA. A laboratory test is needed to identify mixes that are capable of resisting rutting before they are placed on the roadway.

1.2.2 Loaded Wheel Testers

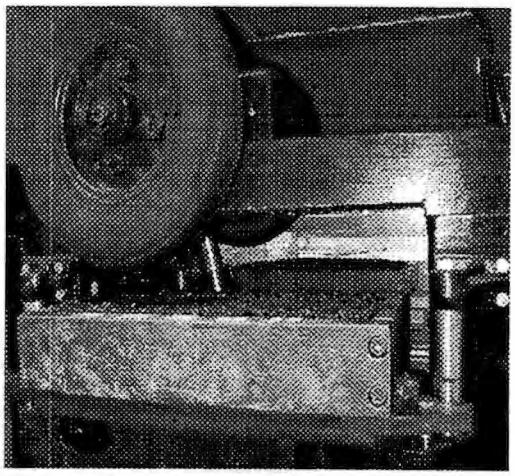
Since the implementation phase of Superpave, wheel-tracking devices have gained a great deal of attention as candidates for proof-testing the ability of HMA to resist rutting. Currently, there are number of different commercially available wheel-tracking devices. These include the French Pavement Rutting Tester (PRT), the German Hamburg Wheel Tracking Device (WTD), the Georgia Loaded Wheel Tester (LWT), the Pavement Technology Inc. Asphalt Pavement Analyzer (APA), and various different forms of these basic designs. Different views of each of these devices are pictured in Figures 2 through 5. These devices are somewhat similar in concept with slight differences in design and operation. Table 1 summarizes the similarities and differences between some of these devices. The APA is currently being considered for use in the State of Tennessee by TDOT and is the focus of this study.

In 1985, researchers at the Georgia Institute of Technology, under contract with the Georgia Department of Transportation (GDOT), designed the LWT. The LWT was developed to allow the HMA engineer to accurately predict the asphalt mix design's rutting potential, and to make adjustments in the laboratory before failure occurs on the roadway (Collins et al., 1995).

The LWT uses an articulating arm with a weight applying constant load to an aluminum wheel that cycles back and forth across a pressurized hose resting on an asphalt concrete test specimen (USDOT, 1991). The LWT concept is based upon



1



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Figure 2. Photographs of the French Pavement Rutting Tester. Photograph 1 is of the Whole Machine, and Photograph 2 is of the Inside of the Chamber.

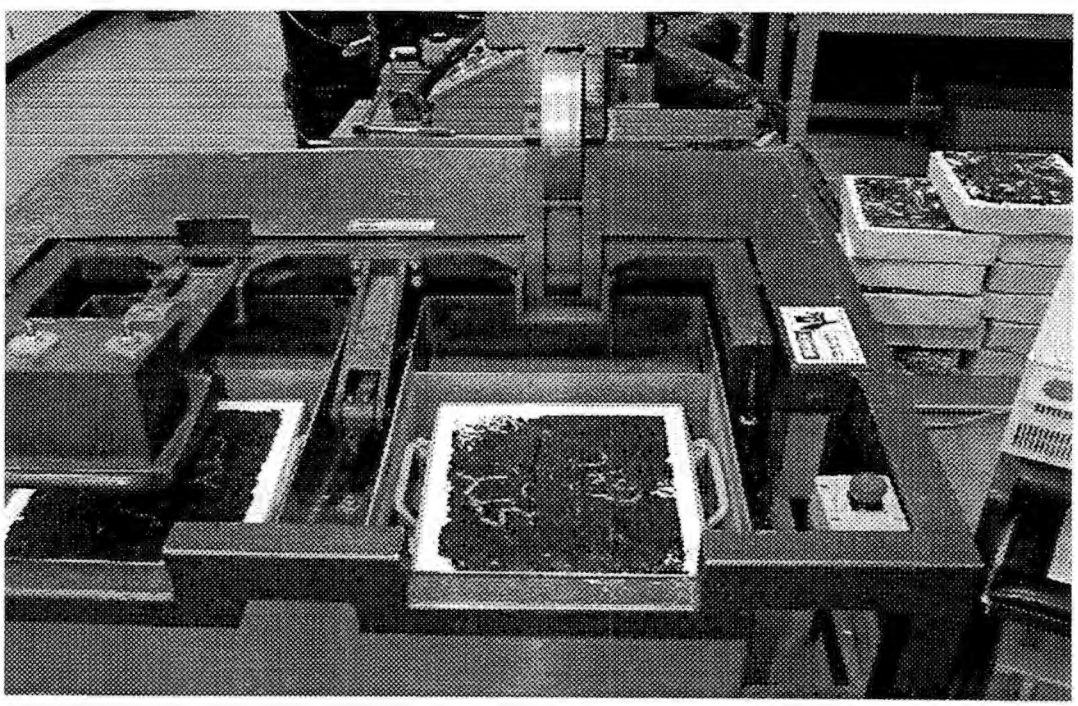


Figure 3. Photograph of the Hamburg Wheel Tracking Device.

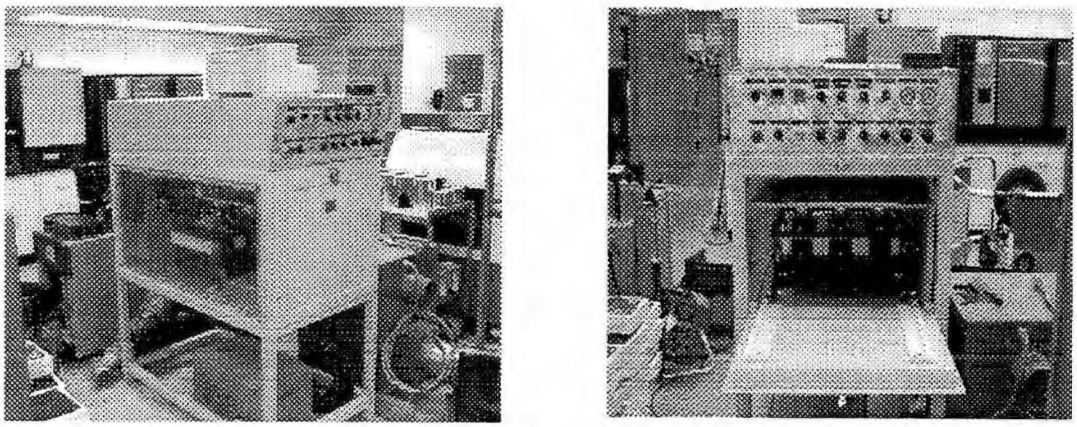


Figure 4. Photographs of the Georgia Loaded Wheel Tester from Two Different Perspectives.

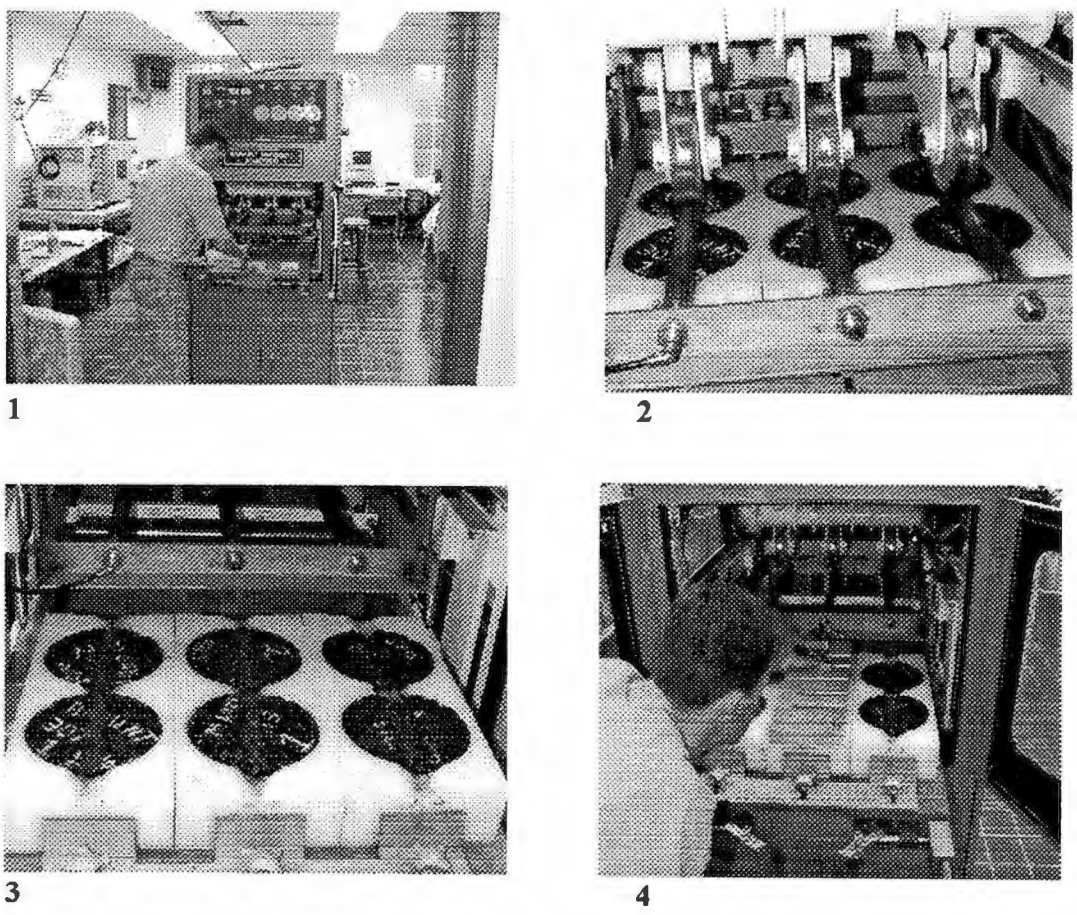


Figure 5. Photographs of the Asphalt Pavement Analyzer. Photographs 1 and 2 Show the Loading and Rutting Mechanisms, While Photographs 3 and 4 Demonstrate Rut Depth Measurement Procedure.

Table 1: Various Testing Parameters of Different HMA Wheel Tracking Devices (After Williams, 1998).

Typical Testing Parameters for Each Device				
Device	French	Hamburg	Georgia LWT	APA
Temperature, C	60	50	40	5 to 80
Environmental Condition	Hot/Dry	Hot/Wet	Hot/Dry	Hot/Dry, Hot/Wet
Specimen Size, Length, Width, Thickness, mm	500x180x100	320x260x80	300x125x75	300x125x75
Wheel Type	Pneumatic (600 kPa)	Solid Steel	Aluminum Wheel on Pressurized Hose (700 kPa)	Aluminum Wheel on Pressurized Hose (700 kPa)
Wheel Size	400 mm Diameter, 90 mm Width	203.5 mm Diameter, 47 mm Width	Hose Diameter 29 mm	Hose Diameter 29 mm
Load, N	Up to 5000	Up to 697	Up to 700	Up to 1200
Wheel Speed	1.6 m/s	Sinusoidal 0.33 m/s Max at Center	0.6 m/s	0.6 m/s
Maximum Cycles (1 Cycle = 2 Wheel Passes)	30,000	20,000	8,000	8,000
Maximum Rut Depth, mm	10	4	7.6	5 to 7

Source: Williams, R. C. and Prowell, B. (1999), *Comparison of Laboratory Wheel Tracking Test Results to WesTrack Performance*, A Paper Submitted for Presentation at the 78 th Annual Transportation Research Board, Session 418, 31 pgs.

similar wheel tracking devices used to study rutting and other modes of asphalt distress (Lai, 1986). The work performed on the LWT in Georgia during the late 1980's and early 1990's ultimately led to the development of the APA. After 10 years of use, GDOT indicates that the LWT, and its modified version, the APA, can predict the rutting susceptibility of specific asphalt mixes at relatively low costs per test (Collins et al., 1995).

1.2.3 Previous Studies

There have been a number of studies conducted on HMA using the various loaded-wheel testers. One study compared the rheometric properties of five asphalt binders with the rutting observed in several wheel-tracking devices. At constant stress, work dissipated per loading cycle is controlled by the complex shear modulus divided by the phase angle ($G^*/\sin\delta$). Therefore, SHRP researchers chose this parameter as part of the high temperature Superpave asphalt binder specification. It was reported that the LWT provided a very good relationship between the asphalt binder property of $G^*/\sin\delta$ and rutting susceptibility. It was also reported that the French and Hamburg devices provided reasonably good relationships with this asphalt binder property (Stuart and Izzo, 1995).

A different study was conducted by the Florida DOT to determine the ability of the LWT to accurately rank three mixes with known historical performance. The researchers fabricated beam samples and obtained rut depth measurements. The LWT ranked the HMA mixes from poor to good in the same order as their actual field performance. Marshall stability data failed to accurately rank the HMA mixes. This

study indicated that the LWT is a more accurate tool for evaluating HMA rutting susceptibility than Marshall stability alone (West et al., 1991).

A FHWA sponsored round-robin test program was conducted between six states to evaluate repeatability and variability of the LWT. All sample preparation was performed by the GDOT. Each laboratory used the same procedures to compact the test specimens. Results from the study indicated that within-laboratory rut depth repeatability was very good, however, the between laboratory variability was not good. The high variations between labs was attributed to densification variability during sample compaction (Lai, 1993).

Researchers from the Southeastern Asphalt User/Producer group, Stone Matrix Asphalt Technical Working Group (SMA TWG) conducted a study using the LWT and the French and Hamburg devices to evaluate the rutting effects of limiting draindown. All three devices showed a change in rutting propensity based on what polymers were used to control draindown (Mogawer and Stuart, 1995).

The use of the wheel test device to predict rutting susceptible hot mix asphalt has been demonstrated by the GDOT to be an effective practice. The LWT has evolved into the Asphalt Pavement Analyzer (APA), which can use multiple, user-defined environmental and loading parameters for the evaluation of HMA samples.
The repeatability of the APA has been shown to be good within labs, but a high variability between labs still exists (West, 1998). Sample fabrication and rut-depth measurement procedures seemed to be the roots of this variability. With automatic data collection currently available, this variability is expected to decrease.

The APA and the French and Hamburg devices were evaluated with respect to their ability to accurately predict the observed performance of HMA at WesTrack. The conclusions of the study indicated that each device provided a good correlation with actual rut depths measured on the test track. The devices did not rank the mixes in the exact order of failure observed in the field. However, they did exhibit a higher variability in average rut depths in the poor performing mixes (Williams and Prowell, 1999). This study concluded that the testing temperature and method of laboratory compaction of HMA need to reflect actual field conditions in order for the laboratory testing devices to be comparable to field performance.

In summary, previous research suggests that the APA is capable of distinguishing between mixes that are susceptible to rutting based on rut depth measurements. Tests performed have shown that the Asphalt Pavement Analyzer can predict a good or poor performing asphalt mixture at various environmental testing conditions (Brock et al., 1998). Consequently, the APA was chosen as the best device to determine rutting susceptibility of various Tennessee HMA.

The focus of this study was to determine if the APA could distinguish between various mix designs based on rutting susceptibility. In addition, the APA's sensitivity to various HMA properties and combinations of properties was evaluated. Sample fabrication was the main cause of rut depth variability in previous studies. For this reason, the Superpave Gyratory Compactor (SGC) pills and Asphalt Vibratory Compactor (AVC) beams were compacted and tested for rutting in the APA. The variability in compaction between the SGC pill specimens and the AVC beam specimens

was scrutinized. Air void differences as well as differences in rut depth measurements were investigated to determine the best method of sample fabrication. Repeatability of rut depth measurements was examined to determine how well the APA is suited for a laboratory mix design proof-test. The amount of time to run the test was investigated to determine the APA's usefulness as an accelerated testing apparatus.

2.0 TEST PROGRAM

In this study, the APA was evaluated primarily to determine if it readily distinguishes between differing properties of HMA. Typical mixes placed by the Tennessee Department of Transportation (TDOT) were sampled and tested. Mixes designed by both Marshall and Superpave mix design methods were evaluated. Approximately eight to ten different mixes from each of the four different regions of TDOT were tested to provide good variability between materials, contractors, and geography. Mixes with modified and unmodified asphalt binders were tested. The APA was evaluated in this study using pill specimens compacted with the Superpave Gyratory Compactor (SGC) and beam specimens compacted with the PTI Asphalt Vibratory Compactor (AVC). The two devices are pictured in Figures 6 and 7.

2.1 Test Specimen Preparation

Loose HMA samples from thirty-four projects across Tennessee were obtained at the time of paving and transported to the asphalt laboratory for testing and evaluation. The loose HMA samples were re-heated in the laboratory, split, and tested for theoretical maximum (Rice) specific gravity in accordance with ASTM and AASHTO procedures. Specimens were compacted in the SGC and AVC to achieve 7 +/- 1 percent air voids. According to previous research, this is the typical range of compaction in percent air voids achieved for flexible pavements in Tennessee roads immediately after construction (Jackson and Ownby, 1998). Bulk specific gravities were determined for the compacted specimens in accordance with ASTM procedures. The laboratory test methods followed in preparing and analyzing the HMA specimens are summarized in Table 2.

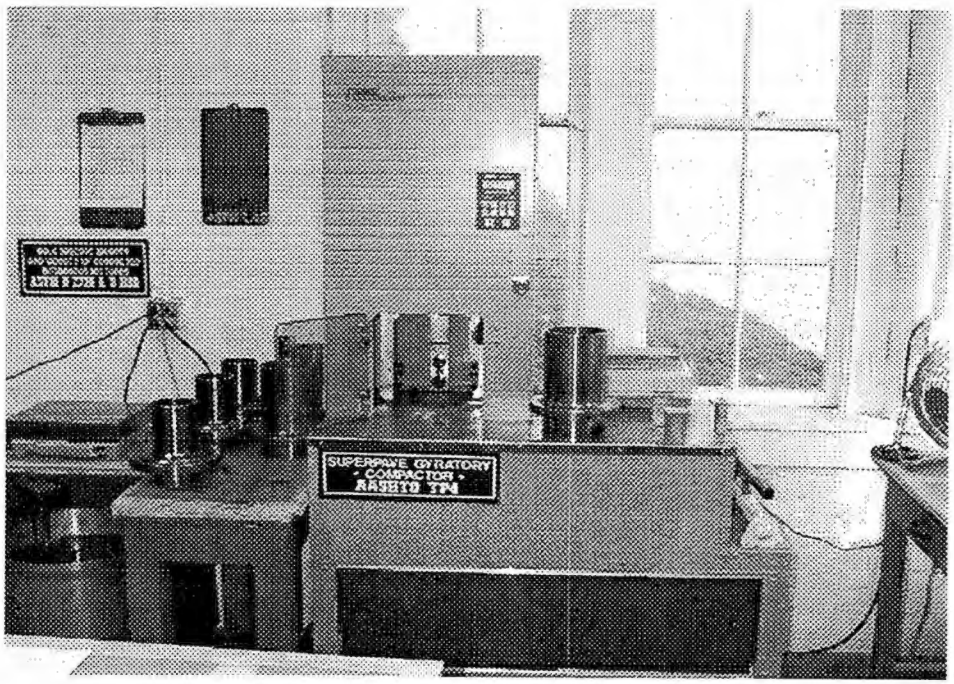


Figure 6. Photograph of the Superpave Gyratory Compactor (SGC).

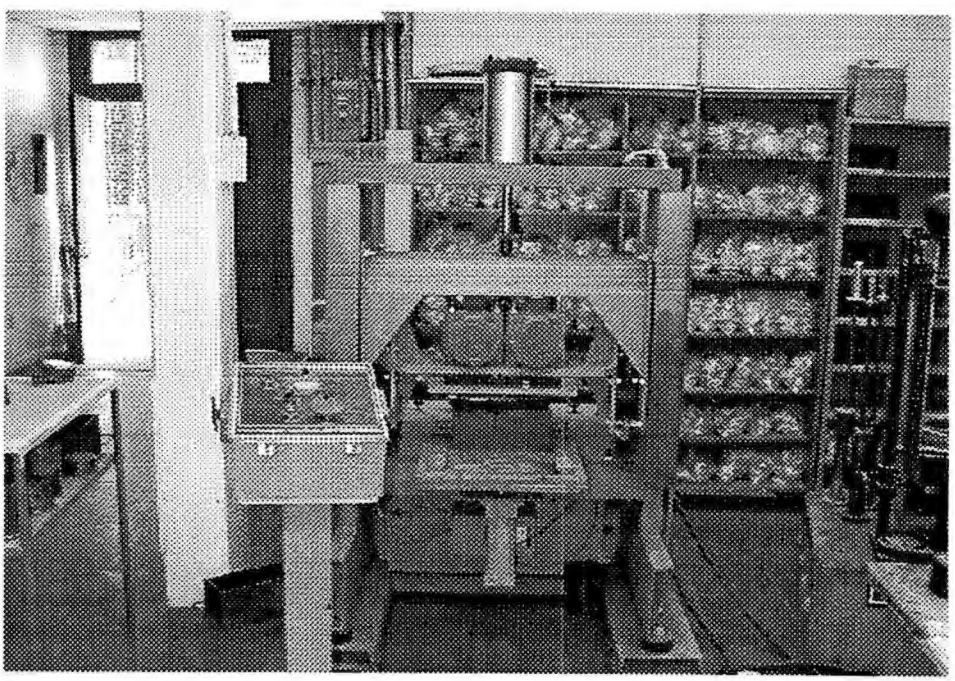


Figure 7. Photograph of the Asphalt Vibratory Compactor (AVC).

Table 2. Laboratory Test Methods Followed in Preparing Test Specimens.

HMA Sample Condition	HMA Evaluation Parameters	Testing Procedures Followed
Loose Mix	Bulk Sampling of Mix	ASTM D 979-89
	Sample Size Reduction	AASHTO T 248-83
	Theoretical Maximum Specific Gravity	ASTM D 2041-95
	Asphalt Content (NCAT Ignition Oven)	AASHTO TP 53-95
	Superpave Gyratory Compaction - Pills	AASHTO TP 4
	Asphalt Vibratory Compaction - Beams	Appendix B
Compacted Specimens	Bulk Specific Gravity (SSD)	ASTM D 2726-96
	Bulk Specific Gravity (Parafilm)	ASTM D 1188-96
	APA Rutting Susceptibility	Appendix C

2.2 SGC And AVC Compaction

As previously stated, the SGC pills and AVC beams were compacted to achieve a desired air void range of 7 +/- 1 percent. In order to do this, time in the oven and compaction temperature must be held constant. The HMA was allowed a maximum of two hours to come up to the compaction temperature of 150 ° C (300 ° F). All molds were heated in the oven for 1 hour at the compaction temperature. The SGC pills were compacted first, and then the AVC beams were compacted. The two machines are very different in operation and compaction methods.

The SGC is a very sophisticated machine with a stand-alone, menu driven computer program. Data collection of specimen height and number of gyrations can be

printed out or transmitted to a supplied laptop computer for further analysis. The device compacts specimens to either a given height or a specific number of gyrations. For this study, compaction was held to a specific height of 75 mm (3.0 in.) in order to achieve the estimated volume for the desired air-void range. Pressure was maintained at 600 kPa (90 psi). All thirty-four mixes had two SGC pills within the desired range. The only exceptions were the first two open-graded mixes that were compacted. The device would compact the specimens in a very predictable manner with minimal noise output. The complete procedure (AASHTO TP 4) was modified only by the mode of compaction and the sample size calculation.

The AVC is a new compaction device with many design concerns. Compacting mixes to the desired air-void range with this machine was more difficult. Appendix B outlines the complete compaction protocol followed for this device, but some basic parameters are summarized here. The pressure was set at 415 kPa (60 psi) down-pressure and 140 kPa (20 psi) back-pressure for most mixes. Vibration was set to start and stop automatically. Compaction time was initially set at 30 seconds. Various mixes would not compact under these conditions; so minor adjustments to down-pressure and compaction time were made to try to accommodate each specific mix. After many trials and errors, the AVC beams were completed. Out of sixty-eight AVC beams, only thirty-three were within the desired range. The AVC is very loud, and it does not have any computer outputs. The method of compaction has an unpredictable effect on different HMA mixes. All of the problems encountered with this machine are discussed in detail

in Appendix D. The problems identified during this project are currently being addressed by the manufacturer through design modifications.

2.3 APA Testing

The APA chamber temperature was set at 50 ° C (120 ° F) and the compacted samples were allowed four (4) hours to heat up to the testing temperature. The wheel loading conditions were held constant at 445 N (100 lbs.) downward force and a hose pressure of 690 kPa (100 psi). The compacted samples were subjected to 8000 cycles in the APA. Rut depth measurements were obtained at a seating load of 10 cycles, and at intervals of 500, 1000, 4000, and 8000 cycles. These criteria were selected based on prevailing industry practices (Watson, 1998). The APA protocol followed in this study is outlined in detail in Appendix C. All the durability problems encountered with the APA during this study are discussed in Appendix E.

Experience of this researcher and others indicates that the best test method utilizes all three location in the APA for each HMA mix (West, 1991). There could be potential problems with variability between specimens in different locations across the chamber. Also, the more replicate test specimens give a better average value for the mix tested. In this study, the amount of available mix prevented the utilization of all three locations in the APA. Only one location was used for each mix.

3.0 TEST RESULTS

3.1 SGC Pill Specimens

As previously noted, the APA was evaluated in this study to determine if it readily distinguishes between differing HMA mix properties. All test results are located in Appendix A. Some of the critical aggregate and asphalt binder properties of the mixes included in this study are summarized in Table 3. These include: asphalt binder type; asphalt binder content; dust content; dust to asphalt ratio; and whether or not the aggregate gradation passes through the Superpave restricted zone. The APA average rut depths for both SGC pill and AVC beam specimens of each mix after 500 and 8000 cycles are also presented in Table 3. Comparisons of the observed APA rut depths versus the above-referenced HMA mix properties are presented in the following paragraphs.

3.1.1 Compacted Test Specimen Air Voids

As previously noted, the SGC pill specimens were compacted to 7+/-1 percent air voids (SSD), except as noted otherwise. The APA rut depth after 8000 cycles is plotted versus percent air voids in the SGC pill specimens in Figures 8 and 9. Figure 8 illustrates that there is no apparent pattern in the APA rut depth data with respect to air voids within the established range. This comparison of data exhibits a very poor correlation, as evidenced by the nearly flat regression line and extremely low coefficient of determination value (R^2). This confirms that air voids ranging from 6 to 8 percent have very little effect on the observed rut depths in the APA.

As previously referenced, this is the typical air void range observed immediately after construction. The mix will consolidate to about four percent air voids under traffic

Table 3. Properties of the HMA Mixes Tested in This Study.

County	Mix Type	Mix ID	Asphalt Binder Grade	Mix Design Asphalt Binder Content, (%)	Mix Design Dust Content, % Passing 0.075 mm (# 200) Seive	Mix Design Dust-to-Asphalt Ratio	Aggregate Gradation Passing Through Restricted Zone	Rut Depth,mm. 500 Cycles		Rut Depth,mm. 8000 Cycles	
								Pills	Beams	Pills	Beams
Benton	307 BM/2	1MB	PMAC-20	4.6	5.4	1.2	YES	0.70	N/A	3.21	N/A
Benton	411 D	1MS	PMAC-20	6.5	6.0	0.9	YES	0.67	0.76	2.64	2.13
Blount	307 S - Fibers	1SBF	PG 76-22	5.1	5.2	1.0	YES	0.85	0.76	2.53	1.53
Blount	307 S - No Fibers	1SBNF	PG 76-22	4.4	5.2	1.2	YES	0.73	0.66	2.04	1.20
Blount	411 S - Fibers	1SSF	PG 76-22	6.1	5.4	0.9	NO	0.73	0.70	1.68	1.36
Blount	411 S - No Fibers	1SSNF	PG 76-22	6.0	5.4	0.9	NO	0.59	0.57	1.96	1.53
Blount/Loudon	307 BM/2	2MB	AC 20	4.5	4.8	1.1	YES	0.66	N/A	2.88	N/A
Campbell	307 BM/2	3MB	PG 64-22	4.2	5.0	1.2	YES	0.46	0.65	1.30	1.81
Campbell	411 D	2MS	PG 76-22	6.2	3.9	0.6	NO	0.72	0.72	2.04	1.41
Clinton Hwy	411 S	2SS	PG 76-22	5.5	4.7	0.8	NO	0.72	0.76	2.06	1.58
Coffee	307 BM	4MB	MG 20-40	4.4	4.9	1.2	NO	0.44	N/A	1.53	N/A
Coffee	411 D	3MS	MG 20-40	5.0	3.0	0.6	NO	0.88	N/A	3.89	N/A
Davidson	411 D	4MS	PG 76-22	5.3	4.9	0.9	YES	0.93	0.80	3.44	2.81
Davidson	411 D Latex	5MS	PG 64-22	5.7	4.3	0.8	YES	1.94	1.80	7.52	6.08
Davidson/Wilson	307 BM	5MB	AC-20	4.2	5.8	1.4	YES	0.78	N/A	3.05	N/A
Dickson	307 BM	6MB	PG 64-22	5.0	5.4	1.1	YES	0.81	N/A	3.73	N/A
Dickson	411 D	6MS	PG 64-22	5.9	5.2	0.9	YES	1.15	1.19	4.55	4.90
Giles	307 BM/2	7MB	PG 64-22	5.2	4.9	0.9	YES	1.13	N/A	4.15	N/A
Grundy	307 BM	8MB	PG 64-22	4.3	4.1	1.0	YES	1.22	N/A	3.93	N/A
Grundy	411 D	7MS	PG 64-22	6.6	5.4	0.8	YES	1.82	1.06	5.89	4.05
Hamilton	411 D	8MS	AC - 20	6.8	5.2	0.8	YES	3.01	N/A	8.93	N/A
Jackson	307 BM	9MB	PG 64-22	4.5	3.9	0.8	YES	1.23	N/A	5.00	N/A
Jackson	411 D	9MS	PG 64-22	5.4	3.7	0.7	YES	3.82	N/A	9.92	N/A
Marion	411 D	10MS	PG 64-22	6.9	4.2	0.6	YES	2.69	N/A	8.14	N/A
Maury	411 S	3SS	PG 64-22	5.8	6.1	1.1	NO	1.08	0.98	3.76	2.95
Montgomerey	307 S	2SB	PG 64-22	4.8	3.0	0.4	NO	0.87	0.99	2.52	3.12
Pickett	411 S	4SS	PG 64-22	4.9	3.2	0.7	YES	1.14	N/A	4.17	N/A
Polk	411 D	11MS	PG 64-22	6.3	3.5	0.6	YES	4.15	N/A	10.55	N/A
Putnam	411 S	5SS	PG 64-22	4.9	4.8	1.1	YES	2.16	N/A	6.48	N/A
Rutherford	307 BM/2	10MB	AC - 20	4.2	4.6	1.1	YES	0.92	N/A	3.55	N/A
Sequatchie	411 D	12MS	PG 64-22	6.6	5.4	0.8	YES	1.90	1.18	5.47	5.58
Sevier	307 S	3SB	PG 64-22	5.0	4.4	0.9	NO	1.41	1.16	4.24	3.36
Sevier	411 S	6SS	PG 64-22	5.4	4.6	0.9	NO	0.88	1.24	3.09	3.29
Shelby	411 S	7SS	PG 76-22	6.1	6.3	1.2	NO	0.67	0.52	2.42	1.35

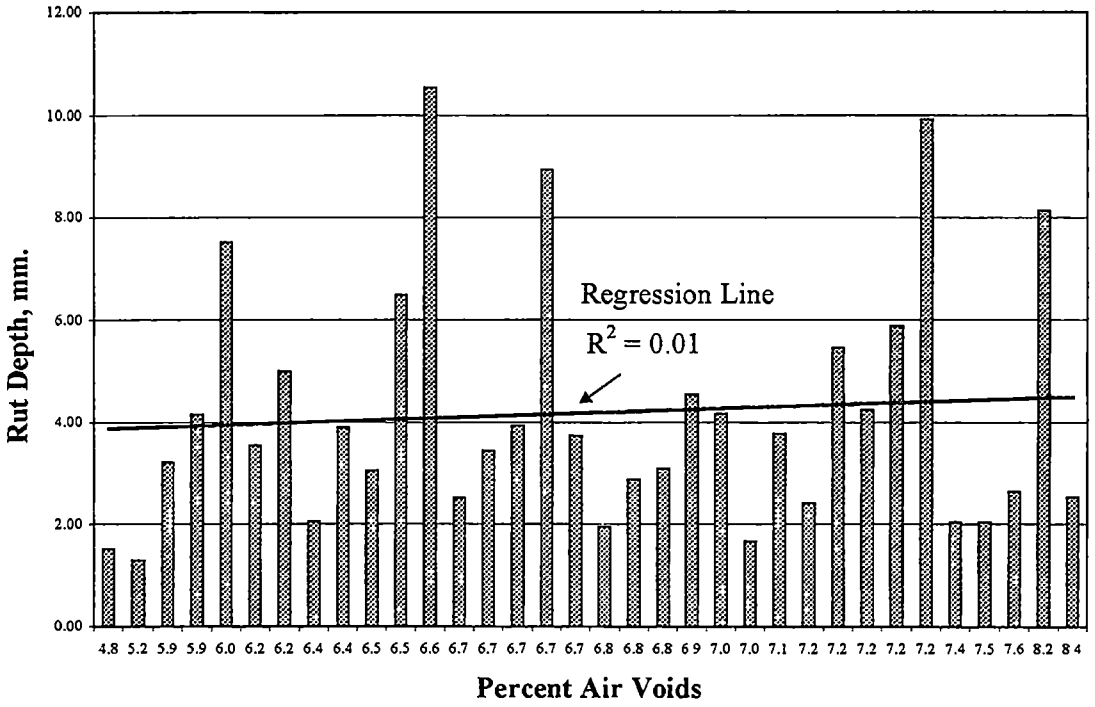


Figure 8. APA Rut Depth After 8000 Cycles vs. Percent Air Voids.

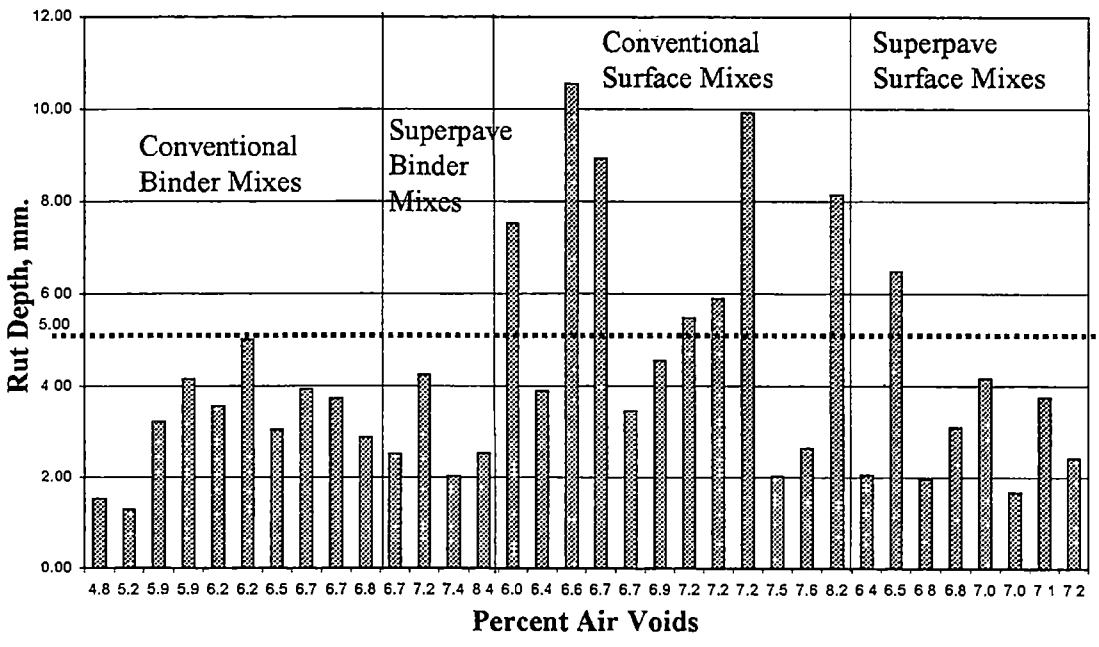


Figure 9. APA Rut Depth After 8000 Cycles vs. Percent Air Voids, Grouped According to Mix Type.

loading during the first year. If the mat of asphalt is thick enough, this could result in significant rutting. The further rutting damage over time is from plastic flow. The first 500 cycles of the APA test are thought to represent mix consolidation and the rest of the test appears to simulate long-term rutting. Section 3.1.8 *Reducing APA Testing Time* compares 500 and 8000 cycles in detail.

3.1.2 HMA Mix Design

Figure 9 presents the APA rut depth after 8000 cycles grouped according to mix type. Figure 9 suggests that there is a higher occurrence of excessive rutting (greater than 5 mm (0.20 in.) in the conventional Marshall surface mixes as opposed to the other mix types included in the study. Only one Superpave mix design had excessive rutting. Further, based on this data, it appears that the TDOT asphalt binder mixes perform better in the APA than the surface mixes.

Dense-graded mixes historically have had a higher potential for rutting. The Superpave system attempted to control rutting, and, according to the results, it appears to have addressed this problem. The more open-graded mixes with better gradation control have a lower affinity for rutting than the more dense-graded mixes. Gradation is discussed in detail in later sections.

3.1.3 Asphalt Binder Grade

Figure 10 presents a plot of APA rut depth after 8000 cycles versus mix I.D., grouped according to the asphalt binder grade. According to Superpave, asphalt binders are performance graded to reduce rutting susceptibility up to a specific temperature. As can be seen in Figure 10, every mix tested in this study that exhibited excessive rutting

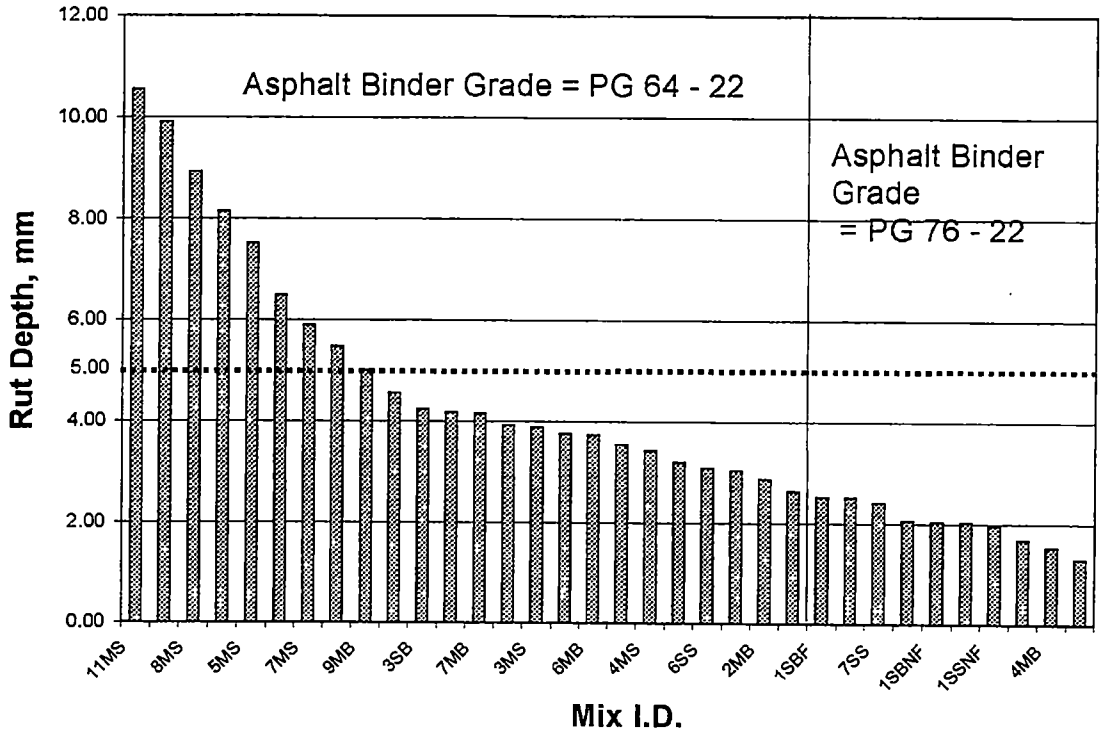


Figure 10. APA Rut Depth After 8000 Cycles vs. Mix I.D., Grouped By Asphalt Binder Grade.

in the APA (> 5 mm (0.20 in.)), whether designed by the Marshall or Superpave mix design methods, contained a PG 64 – 22 asphalt binder. This suggests that the APA is sensitive to the grade of asphalt binder used in HMA. It should be noted that over half of the mixes containing a PG 64 - 22 asphalt binder did not exhibit excessive rutting in the APA. However, none of the mixes with a modified PG 76 – 22 asphalt binder exhibited high amounts of rutting at the testing temperature.

It should be noted that the testing temperature of 50 °C (120 °F) is well below the design performance temperature for either the PG 64 – 22 or PG 76 – 22. These asphalt binders have a maximum performance temperature of 64 and 76 °C respectively. The testing temperature was chosen to simulate actual pavement temperatures experienced

during a typical summer in Tennessee. As previously referenced, testing temperature needs to accurately reflect field conditions.

3.1.4 Asphalt Binder Content

Figure 11 is a plot of APA rut depth after 8000 cycles versus asphalt binder content. This plot indicates that there is a slight tendency for increased rutting with increased asphalt binder content, especially above about 6.5 percent. The regression line and very low R^2 value presented in Figure 11 indicate that this correlation is relatively weak for mixes with reasonable asphalt binder contents.

3.1.5 Dust Content

Figure 12 is a plot of APA rut depth after 8000 cycles versus dust content (percent passing the 0.075 mm (# 200) sieve). This figure indicates that dust content alone, within reasonable limits, does not correlate well with performance of HMA in the APA. The relatively flat regression line and extremely low R^2 value presented in Figure 12 support this observation. The combined effect of dust and asphalt binder content, or dust-to-asphalt ratio, may be a better indicator of rutting susceptibility of HMA.

3.1.6 Dust-to-Asphalt Ratio

A plot of APA rut depth after 8000 cycles versus dust-to-asphalt ratio is presented in Figures 13 and 14. The improved correlation shown in Figure 13 versus those shown in Figures 11 and 12 suggests that the APA is more sensitive to the effects of dust-to-asphalt ratio than either asphalt binder content or dust content alone. It should be noted that this correlation is still relatively weak as evidenced by a relatively low R^2 value. The current Superpave specification limits this property to 0.6 to 1.2. According to Figure 13,

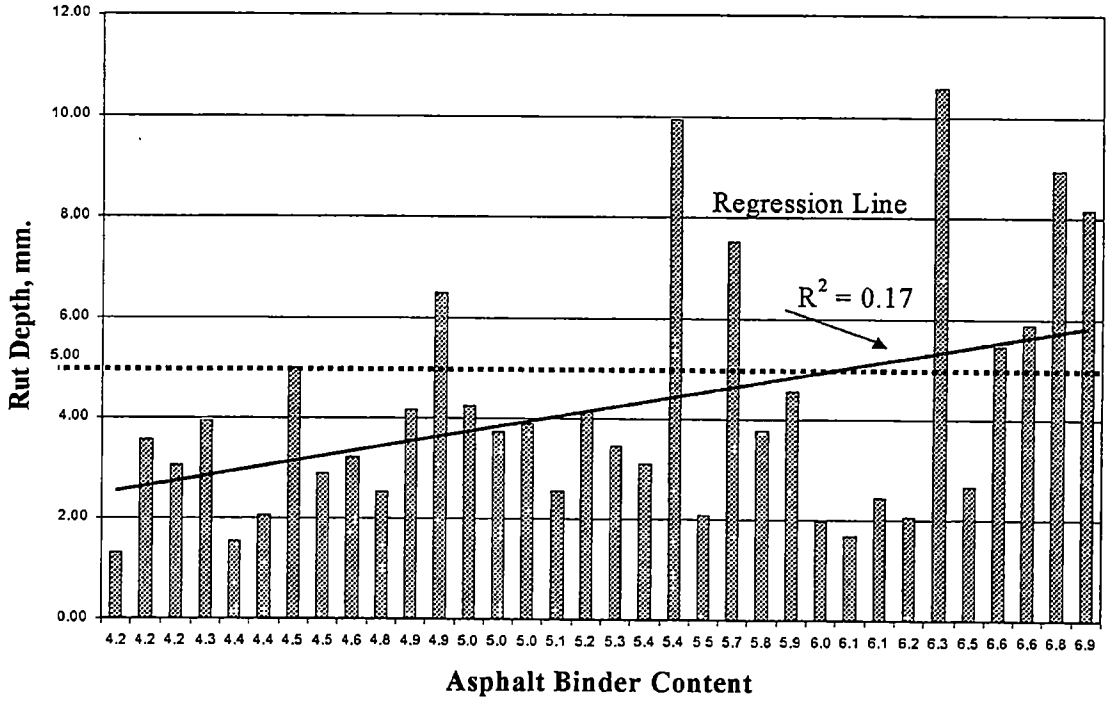


Figure 11. APA Rut Depth After 8000 Cycles vs. Asphalt Binder Content.

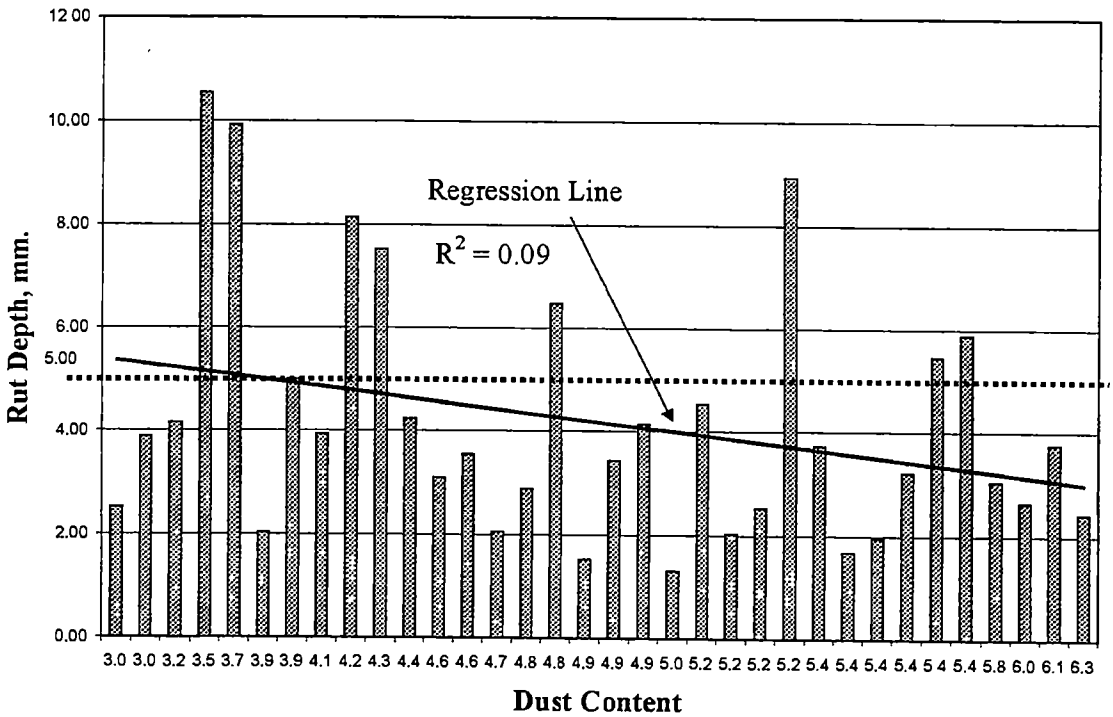


Figure 12. APA Rut Depth After 8000 Cycles vs. Dust Content.

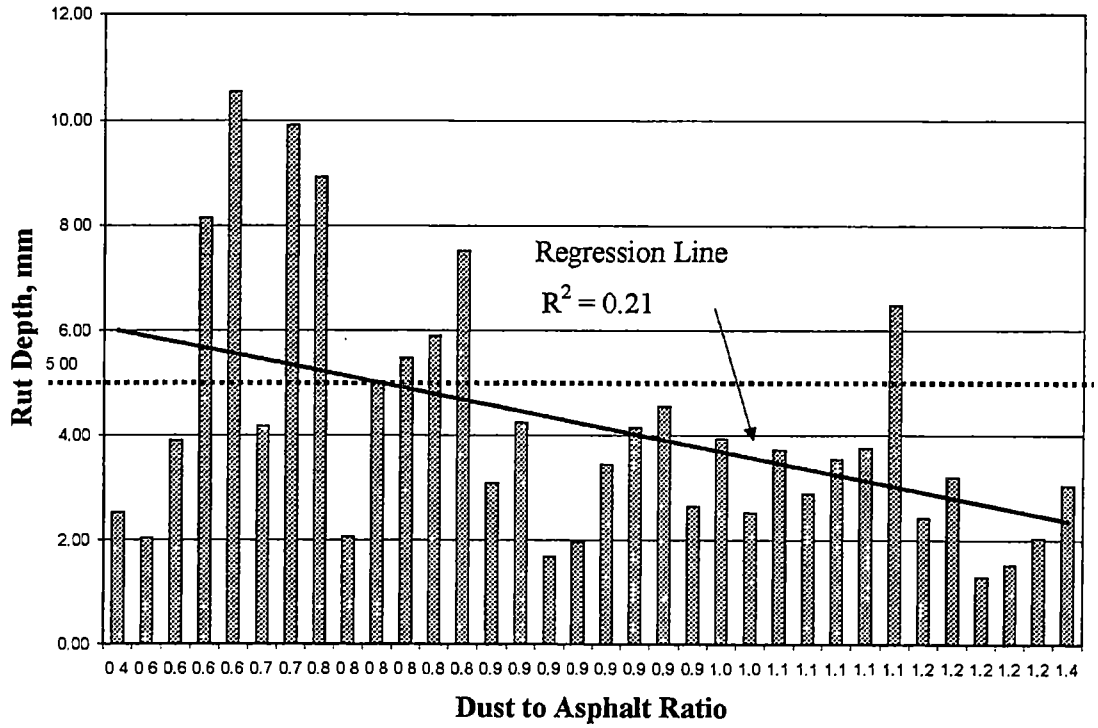


Figure 13. APA Rut Depth After 8000 Cycles vs. Dust-to-Asphalt Ratio.

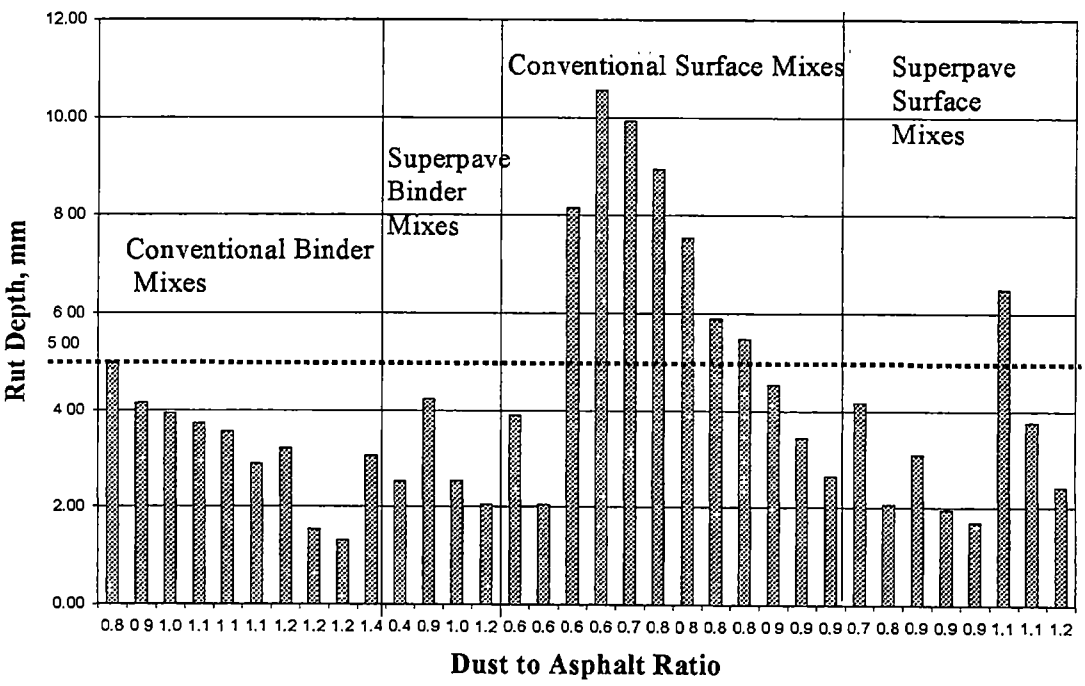


Figure 14. APA Rut Depth After 8000 Cycles vs. Dust-to-Asphalt Ratio, Grouped According to Mix Type.

the mixes with the most rutting in the APA had values on the low end of the current specification, between 0.6 and 0.8.

Figure 14 presents a plot of rut depth versus dust-to-asphalt ratio, re-grouped by mix type. This figure more clearly illustrates that, for the conventional surface mixes, the APA appears to be sensitive to dust-to-asphalt ratios approaching the lower limit of the Superpave specification. Figures 15 and 16 are described in the following paragraphs.

3.1.7 Superpave Restricted Zone

Figure 15 presents a plot of APA rut depth after 8000 cycles with respect to whether or not the aggregate gradation passes through the Superpave restricted zone. As stated earlier, SHRP researchers determined that HMA with gradations passing through the restricted zone have a relatively high propensity for rutting. As can be seen in Figure 15, every mix tested in this study that exhibited excessive rutting in the APA (> 5 mm (0.20 in.)), whether designed by the Marshall or Superpave criteria, had a gradation that passed through the restricted zone. This suggests that the APA is quite sensitive to the gradation of the HMA, especially on the fine sieves. It should be noted that over half of the mixes with gradations passing through the Superpave restricted zone did not rut excessively in the APA. None of the mixes with gradations falling outside of the Superpave restricted zone exhibited high amounts of rutting.

Some mixes with gradations passing through the restricted zone are not necessarily susceptible to rutting. Several Tennessee 411 D surface mixes and Georgia D mixes have historically good performance. In this study, half of the Marshal designed

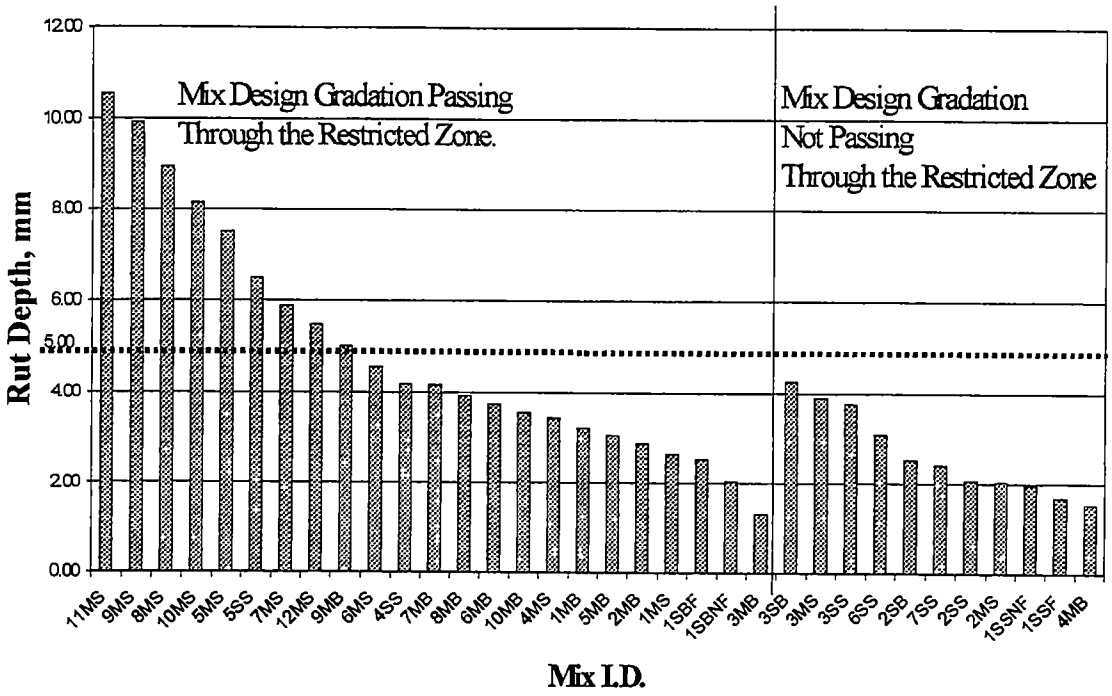


Figure 15. APA Rut Depth After 8000 Cycles With Respect to Whether or Not Aggregate Gradation Passes Through the Superpave Restricted Zone.

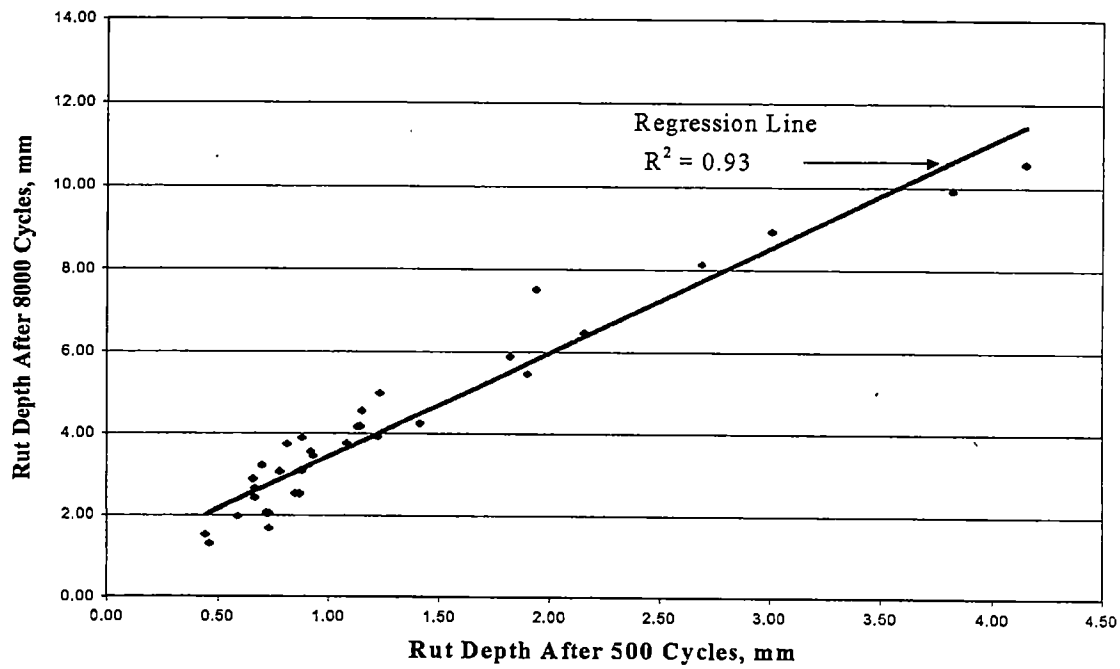


Figure 16. APA Rut Depth After 8000 Cycles vs. APA Rut Depth After 500 Cycles.

mixes rutted extensively and half did not. Such unpredictable results convinced SHRP researchers to limit this property after extensive scientific research.

3.1.8 Reducing APA Testing Time

In an attempt to evaluate the potential for reducing the time required to perform the APA rut test, rut depths after 500 cycles were compared with those obtained after the current standard test duration of 8000 cycles. Figure 16 illustrates that the APA results at 500 cycles correlate well with the results at 8000 cycles. Note the relatively large R^2 value presented in Figure 16. Figures 17 and 18 indicate that after 500 cycles, any mix with a rut depth greater that 1.5 mm (0.06 in.) experienced significant rutting (> 5 mm (0.20 in.)) at the end of the 8000 cycle test. Based on this observation, it may be possible to reduce the time required to perform the APA rut test in the laboratory. A 500 cycle rut test takes a total time (excluding sample preparation and conditioning) of about 10 minutes. An 8000 cycle rut test requires approximately 3.5 hours. The ability to terminate the test after 500 cycles would result in timesavings in excess of 3 hours and could make the APA rut test more acceptable to the HMA industry.

3.2 AVC Beam Specimens

Figures 19 and 20 demonstrate variability of the AVC beam specimens. Consequently, the APA exhibited a high variability in rut depth measurements between two AVC beams of the same mix tested. Figure 19 shows the average of two AVC beams tested with the 95% confidence interval as deviations. This implies that we are 95 % confident that the true mean of the sample lies within the range on the chart. Figure 19 emphasizes the fact that more data points are needed to accurately quantify certain HMA

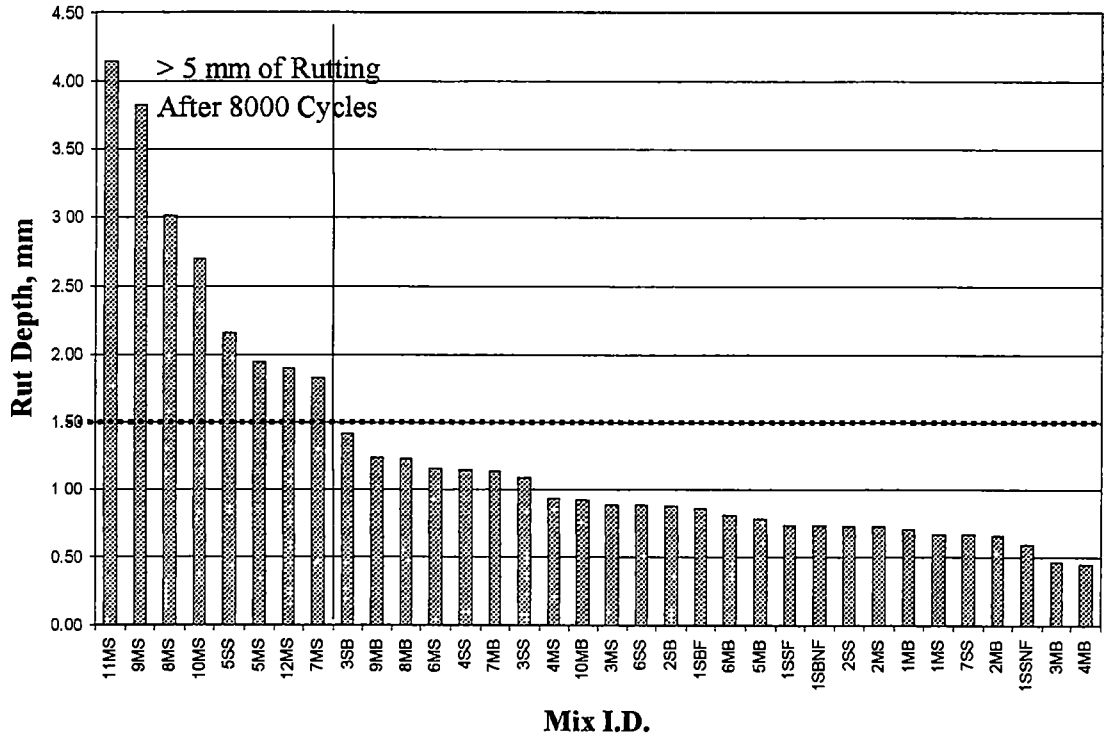


Figure 17. APA Rut Depth After 500 Cycles vs. Mix I.D.

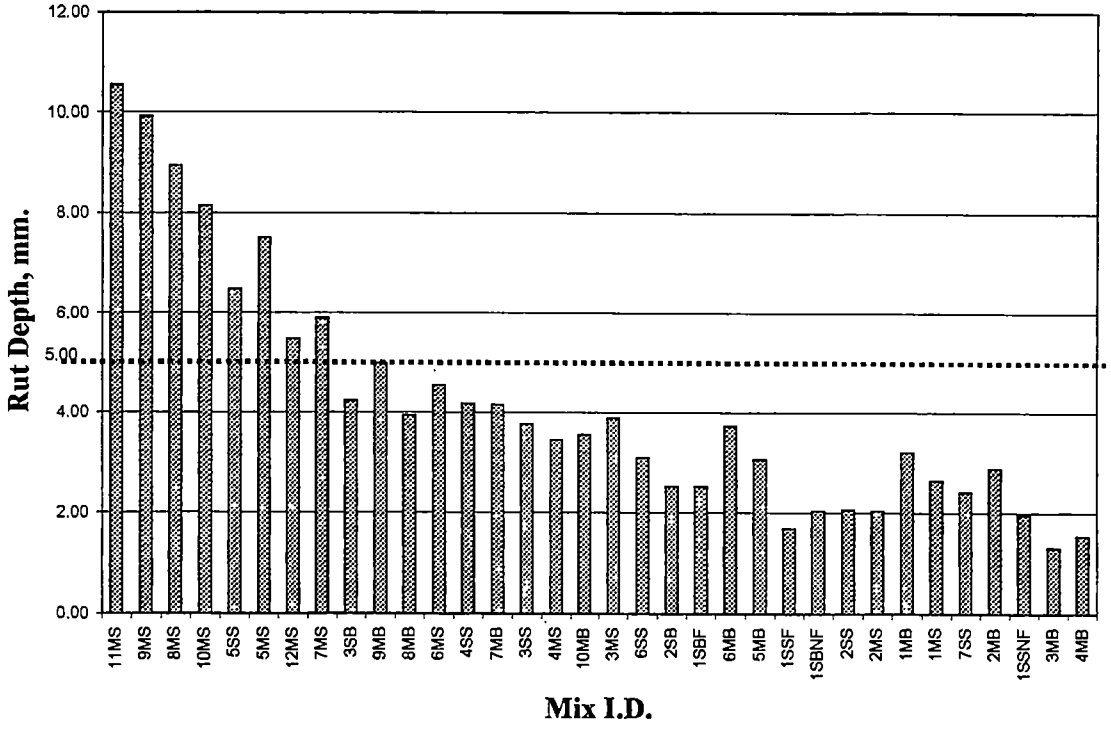


Figure 18. APA Rut Depth After 8000 Cycles vs. Mix I.D.

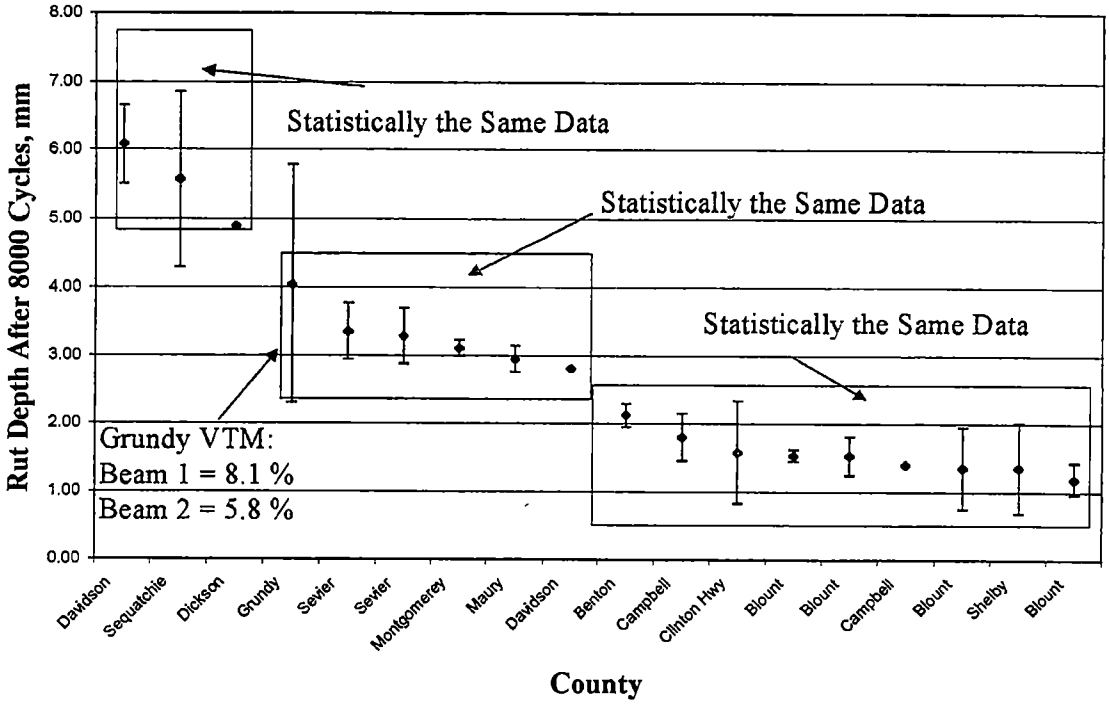


Figure 19. Average and 95% Confidence Intervals For APA Rut Depth After 8000 Cycles For AVC Beam Specimens.

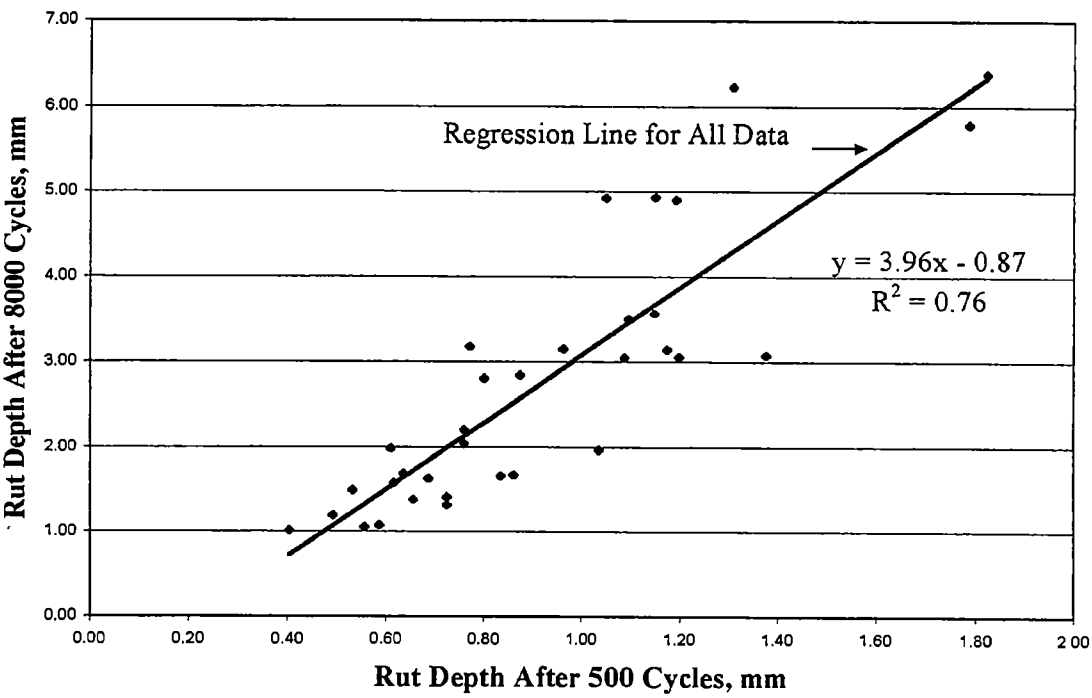


Figure 20. APA Rut Depth Values After 8000 Cycles vs 500 Cycles for AVC Beam Specimens.

mixes based on rutting using AVC beam specimens. The variability in rut depth is related to the repeatability problems with the AVC, which are discussed in detail in section 3.3 *Variability of Test Results*. The limited amount of mix available for this study prevented the required number of replicate tests needed to correctly describe these mixes based on rutting.

The three mixes that did exhibit a higher rutting potential as AVC beam specimens also exhibited high rut depths as SGC pill specimens. The three mixes that recorded high rut depths for the AVC beams also have designed gradations that fall within the Superpave restricted zone. As noted earlier, the restricted zone has been shown to have an impact on rutting in HMA.

Based on the experience of this researcher, compaction of many replicate AVC beams of the same mix is required to achieve the desired air voids with the AVC. Once sufficient replicate AVC beams are compacted to the target air voids, the APA can be used to accurately predict the rutting susceptibility of the HMA.

Figure 20 demonstrates that there is a relatively good correlation between the rut depths measured after 500 cycles and the rut depths measured after 8000 cycles. This observation is consistent with the conclusion developed based on the SGC pill specimens that the APA can predict the relative rutting potential of most HMA mixes after 500 cycles. Figure 20 indicates that a rut depth of 1.5 mm (0.06 in.) or more after 500 cycles will result in a total rut depth at the end of 8000 cycles to be in excess of the established 5 mm (0.20 in.) failure criteria.

Figure 21 illustrates that after 500 cycles, the SGC pills and AVC beams did not correlate very well, having a coefficient of determination, $R^2 = 0.28$. Figure 22 shows that the correlation increased after 8000 cycles, but was still relatively weak with a $R^2 = 0.48$. After removing Benton County 411 D, the correlation improved dramatically. After 500 cycles, the R^2 went up from 0.28 to 0.65. After 8000 cycles, the R^2 increased from 0.48 to 0.84. The reason for eliminating this data point was based on the large difference in rut depth measurements in SGC pills to AVC beams. The SGC pills rutted 8 mm while the AVC beams only had 2 mm of rutting. This observation suggests that something significantly different occurred during the compaction of the two different test specimens.

3.3 Variability In Test Results

Several sources of variability of the APA rut depths between SGC pill and AVC beam specimens were considered. The type of mix, either surface or base, and all of the previously mentioned asphalt properties were examined to determine if the observed variability could be explained. The main problem was difficulty in achieving and repeating the desired air void range using the AVC. At least one test AVC beam must be compacted before any accurate prediction of sample size is determined.

A comparison of Figures 23 and 24 demonstrates the variability in air voids between compacting SGC pills and AVC beams. It is clear that the AVC exhibited a greater amount of variability than the SGC. Compacting open-graded mixes in the SGC was more unpredictable than dense-graded mixes. However, much was learned after

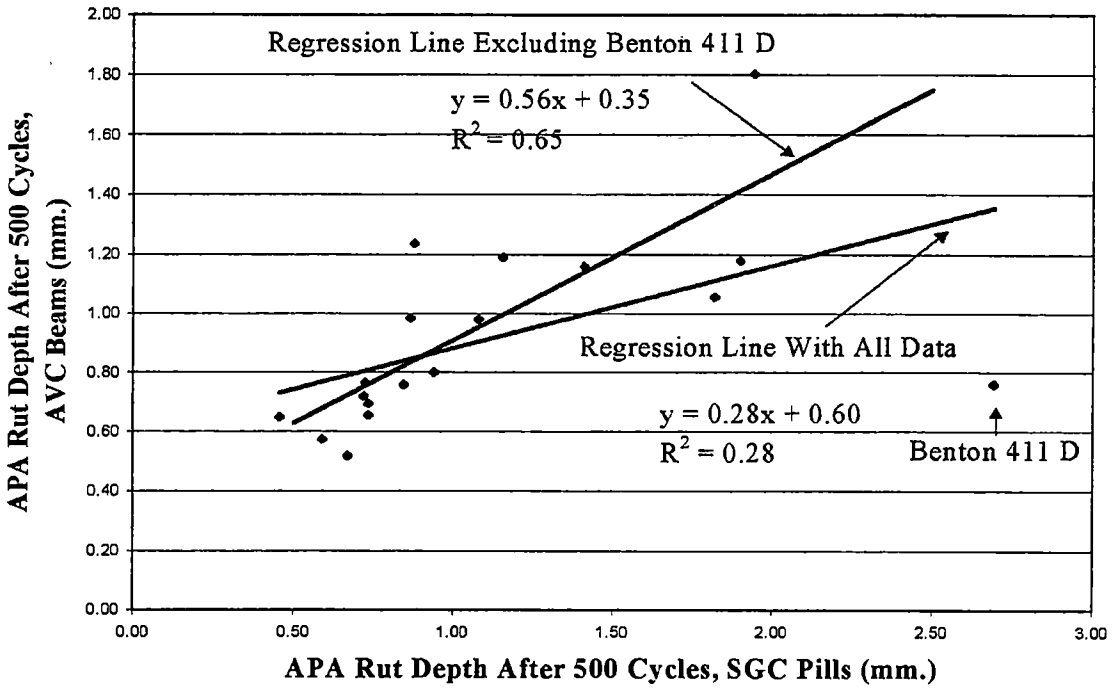


Figure 21. APA Rut Depth Values After 500 Cycles For AVC Beam Specimens vs. SGC Pill Specimens.

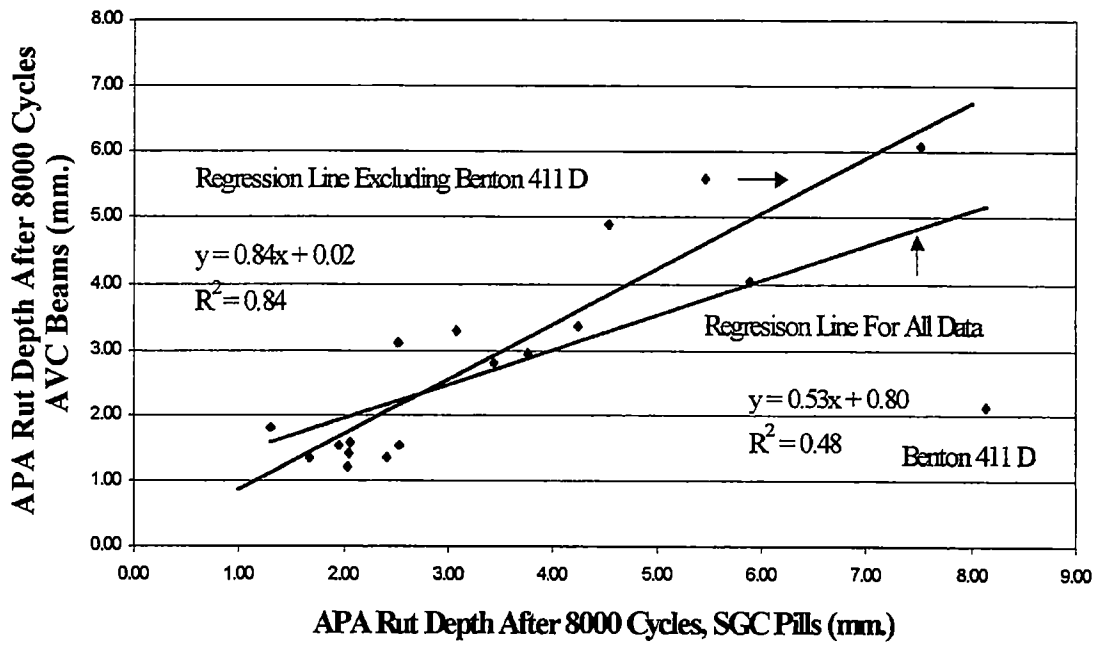


Figure 22. APA Rut Depth Values After 8000 Cycles For AVC Beam Specimens vs. SGC Pill Specimens.

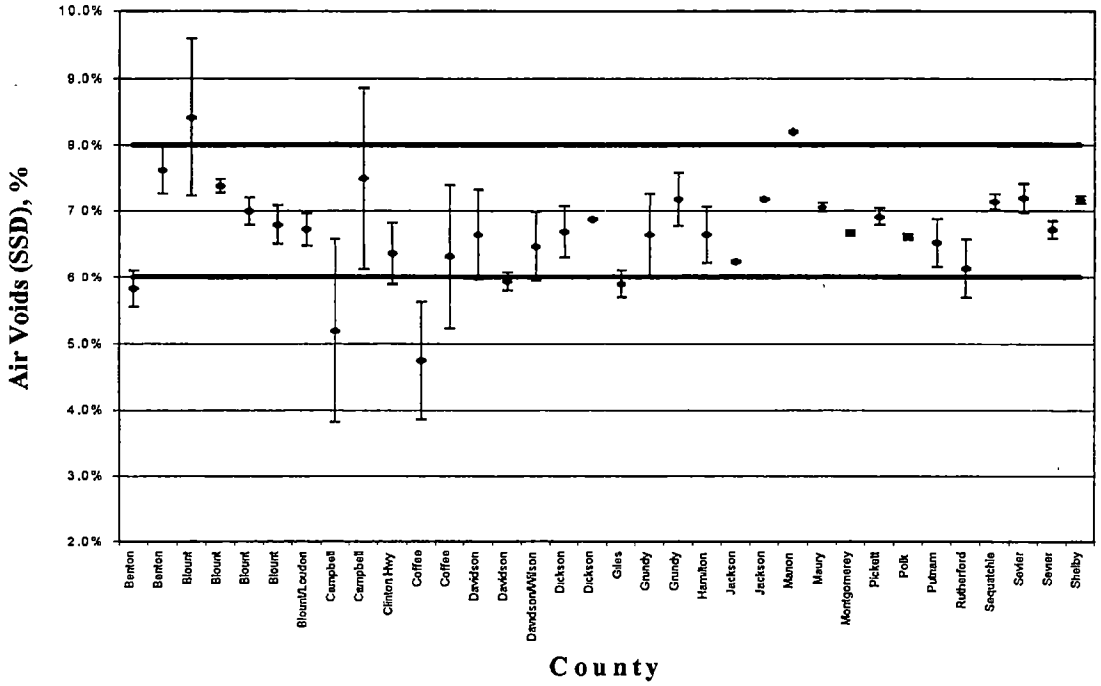


Figure 23. Average Percent Air Voids and 95% Confidence Inteval For SGC Pill Specimens For Each County.

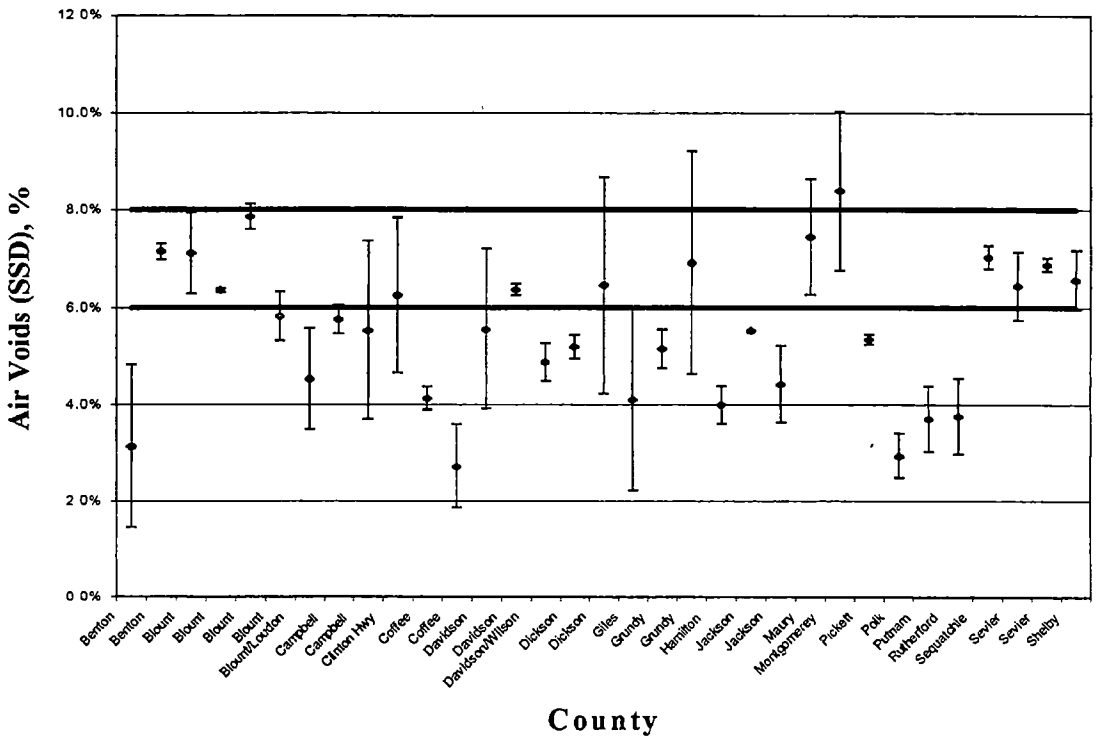


Figure 24. Average Percent Air Voids and 95% Confidence Interval For AVC Beam Specimens For Each County.

compacting the first open-graded mix that enabled the correct sample size to be more predictable.

The AVC did not show any patterns of compactability that could be used to accurately estimate the correct sample size to achieve the appropriate air voids. The gradation charts of each mix (located in Appendix A) were compared with AVC beams that compacted to the desired air void range. In contrast to the SGC, the AVC did give more repeatable results with coarser mixes than with the more dense graded mixes. A vast majority of the over-compacted mixes also had gradations passing through the Superpave restricted zone.

Vibration time was thought to be a reason for over compaction. It was adjusted but no predictable outcome was witnessed. Figure 25 shows the percent air

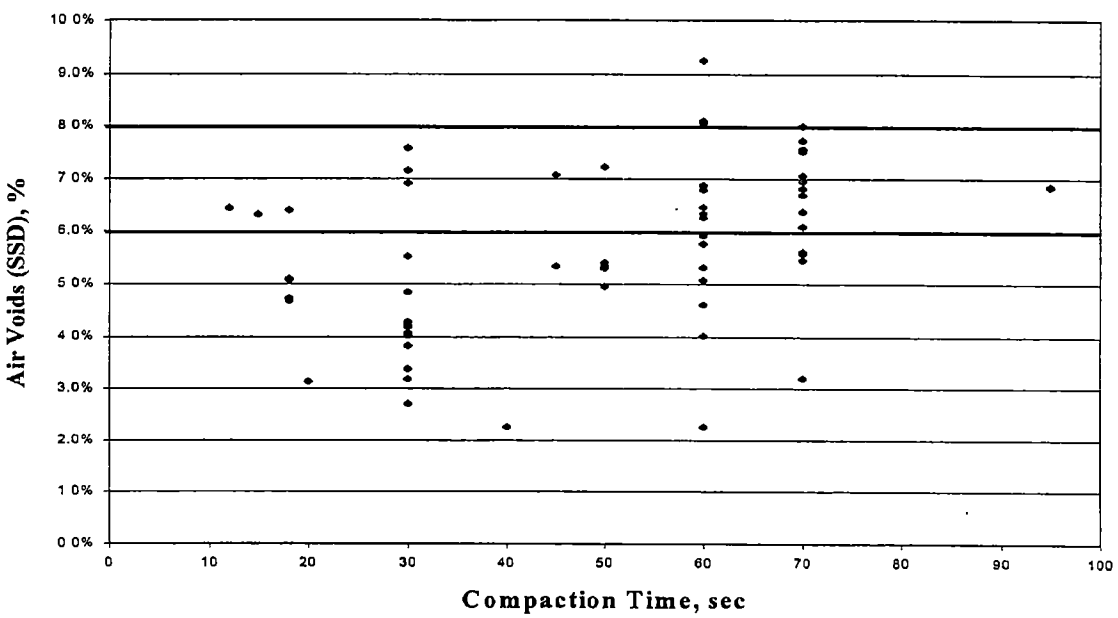


Figure 25. Percent Air Voids vs. Compaction Time For AVC Beam Specimens.

voids vs. the compaction time. Clearly, the amount of time the mix should be compacted to produce a desired density is too variable to be predicted before beginning the procedure. The Giles County 307 BM mix was compacted for 20 seconds and the resulting air voids were 3.1%. Conversely, Montgomery County 307 S was compacted for 60 seconds, resulting in 9.2% VTM. As described in previous sections, the variation in compaction time was necessary to achieve the appropriate compaction levels for the various mixes. The problem became predicting how long each mix should be compacted without first making a test specimen.

For rut testing, the SGC pills are the most efficient, predictable specimens to be formed and tested. The AVC beam specimens are simply too variable to be used in a rut test with limits on available mix. AVC beams can be used to test asphalt-rutting potential based on the majority of the results of this study. However, the AVC beams were demonstrated to be very difficult to achieve repeatable air voids. When time is a concern in the mix design process, the AVC beams are not very efficient to produce. Improvements to the AVC need to be considered to make it a more repeatable, user friendly device. To perform fatigue tests, the AVC beams are necessary, but the same compaction problems still exist.

4.0 CONCLUSIONS

The Superpave mix design and analysis system provides a good means of specifying asphalt binders and aggregates based on performance. However, the relationship of the laboratory versus actual field performance of the same HMA mix is not clearly understood at this time. Thirty-four mixes from various locations across the state of Tennessee were compacted into test specimens with the SGC and AVC and tested in the APA. Based on the results of this study and previous research, it appears that the APA is a promising candidate for the evaluation of the relative rutting susceptibility of HMA in the laboratory.

As documented in the preceding paragraphs, various properties of HMA, in some combination, are discernable based on the results of rut testing in the APA. The method of sample fabrication also exhibits some sensitivity to specific HMA properties. The essential findings of this study are summarized below:

1. It has been demonstrated that the APA is capable of differentiating between differing HMA mix types;

2. A higher occurrence of excessive rutting (> 5 mm (0.20 in.)) was observed for conventional surface mixes as opposed to all other mix types included in the study;

3. The APA seems to be sensitive to the type of asphalt binder used in the HMA at the testing temperature of 50° C (120° F);

4. A relatively weak correlation was found between APA rut depth and HMA asphalt binder content;

5. A slight tendency toward increased rutting was observed with increased asphalt binder content, greater than about 6.5 percent;

6. For conventional surface mixes, the APA appears to be more sensitive to dust-to-asphalt ratios approaching the lower limit of the Superpave specification;

7. The APA appears to be somewhat sensitive to gradations passing through the Superpave restricted zone;

8. In the APA, the AVC beam specimens exhibit more variability than the SGC pill specimens;

9. Achieving repeatable air voids with the AVC is the root cause of the observed variability;

10. A reasonable correlation exists between AVC beam and SGC pill specimens, but the SGC pills are much more efficient and give more reliable results; and

11. The APA seems to be capable of distinguishing between mix properties at as few as 500 cycles, thus reducing the required test time and effectively accelerating the test procedure.

Based on the test results contained herein, the APA appears to be well suited for accelerated proof testing of HMA in the laboratory. The data from this study indicates that the APA is sensitive to several of the primary factors known to cause rutting of HMA. SGC pill and AVC beam specimens can be used, but AVC beams have been demonstrated to exhibit high variability between specimens.

5.0 RECOMMENDATIONS

The APA can be used as an accelerated testing device to proof test an asphalt mix design in the laboratory before it is placed on the roadway. More research is needed to correlate the APA test results to actual roadway rutting and prediction models. The adaptability of the APA for field QA/QC testing should also be investigated. Specific points for rut testing HMA follow:

1. Test SGC pills until the AVC beam variability problems are resolved.
2. Testing can be stopped after 500 cycles for any HMA mix
3. Failure after 500 cycles should be defined as any mix with more than 1.5-mm of rutting.
4. Testing temperature should reflect actual field conditions.
5. Further research is needed to verify the failure definitions for all mixes.
6. Further research is also needed to establish a correlation between laboratory and actual field performance.
7. The adaptability for the APA's usefulness as a field QA/QC device should also be investigated.

REFERENCES

REFERENCES

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APPENDICES

APPENDIX A

HMA MIX DESIGN AND TESTING INFORMATION

Appendix A – 1

County & Mix Type: Benton 307 BM/2

Project Number: 5100

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA Form DT-0256

Re:Form T-118

C-91

Date 04/20/98

Time 15:36:25

Project Reference IME-40-2(76)-126 County BENTON Region 4

Project No. 03001-8167-44 Contract No. 5100

Type BPMB-(HM) Sec. No. 307-B(M)II/POLY Article No.

Contractor APAC-TN Subcontractor

State Rt. No. I-40 TOTAL MIX INCLUDING BITUMEN Date of Letting 2-6-98

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	Percent Used
C.A	31.25mm-Pan	Vulcan Mtls.--Parsons, TN	23.~~86~~% 85
MED. C.A.	19mm-Pan	Vulcan Mtls.--Parsons, TN	14.~~36~~% 31
Screenings	9.5mm-Pan	Vulcan Mtls.--Parsons, TN	19.~~06~~% 08
Sand	9.5mm-Pan	Tinker Sand and Gravel--Perryville, TN	19.~~06~~% 08
R.A.P.	25mm-Pan	I-40 Hickman Co.	19.~~06~~% 08
A.C. and Pen.	PMAC-20	KOCH--Memphis, TN VIR. AC. = 3.596 R.A.C. = 1.004 % VIR = 78.169	% 4.6
%Fractured Faces on Plus No. 4 Material			100% CK

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Design Range	Requested Percent	Tolerance Percent	C.A. Percent	Med C.A. Percent	Screening Percent	Sand ✓ Percent	R.A.P. Percent	Caculatec Mix
Temp	275-325	320							
% A.C.	4.20-6.20 ✓	4.6 ~~5.00%~~ (AC)		25.00%	15.00%	20.00%	20.00%	20.00%	100.0%
					Theo Mix	~~2.000~~ 2.491			
62.5mm				RAP has	5.0% AC	content			
50mm									
31.25mm	100	100	100	100	100	100	100	100	100
25mm									
19mm	81-93 ✓	93	87.3-98.7	77	100	100	100	92	92.65
12.5mm									
9.5mm	57-73 ✓	65	59.3-70.7	5	60	100	100	75	65.3
4.75mm	40-56 ✓	49	45-53	2	7	90	97	52	49.4
2.36mm	28-43 ✓	37	33.7-40.3	1.5	2	62	82	37	36.9
600um	13-25 ✓	22	18.7-25.3	1	1.5	35	53	20	22.1
300um	9-19 ✓	12	8.7-15.3	0.7	1	28	17	13	11.9
150um	6-10 ✓	7.2	5.6-8.8	0.5	0.7	22	4	9	7.2
75um	2.5-6.5 ✓	5.4	3.8-7 0	0.3	0.5	16	3	7	5.4

Requested Marilyn J Kildow APAC-TN Approved Allen P Duttau 5-1-9
Contractor Region Materials Engineer

Approved Scotty Plunk Approved
Region Construction [redacted] Engineer of Materials amd Tests

MARSHALL MIX DESIGN WORKSHEET

Date 4-13-98
Type mix 307-BM2Rap/Poly
Proj. IME-40-2(76)-126
WT.-GRAMS

Cont. # 5100
County Benton
Region 4

Contractor APAC-TN
No. Blows 75
SP.GR A.C. 1.031

SAMPLE NO.	% A.C.	% AGG.	IN AIR	S.S.D.	IN WATER	VOL. MAR.SP.	BULK MAR.	THEO. GRAV.	EFF. GRAV.	% VOIDS TL. MIX	V.M.A.	% VOIDS FILLED	UNIT WT.	STABILITY KNS	FLOW MM
1-A	4.5	95.5	1189.6	1192.2	689.5	502.7	2.366	2.494	2.673	5.1	15.5	66.6	2366	8 8	2 6
1-B			1196.8	1199.3	692.9	506.4	2.363							8.9	2.5
1-C			1192.4	1195	691.8	503.2	2.37							9.1	2.6
							2.366							9	2 6
	4.7	95 3					2 375	2.487	2.673	4.5	15.3	70.8	2375	9 2	2.8
2-A	5	95	1192.4	1193.8	695.3	498.5	2.392	2 476	2.673	3.5	15.1	76.7	2389	9.4	3 3
2-B			1193.7	1195.2	695.5	499.7	2.389							9.2	3
2-C			1195.9	1198	696.6	501.4	2.385							9.5	3.1
							2.389							9	3.1
3-A	5.5	94.5	1201.7	1203.2	704.1	499.1	2.408	2.458	2.673	2	14 8	86.8	2409	10.2	3 5
3-B			1197.6	1199.3	702.2	497.1	2.409							9.9	3.4
3-C			1194.4	1195.8	700.4	495.4	2.411							9.8	3.6
							2.409							10	3.5
4-A	6	94	1196.8	1197.9	703.6	494.3	2.421	2.44	2.673	0.9	14.9	94.5	2419	10	3.6
4-B			1201.9	1202.2	704.9	497.3	2.417							9.8	3.4
4-C			1197.1	1198	703.1	494.9	2.419							9.8	3.3
							2.419							10	3.4
	4.1	95.9					2.371	2.491		4.8	15.1	68.6			

AGG. L.O.I N/A

AGG. FRACTURED FASE N/A

AGG. GLASSY PART. N/A

AGG ABSORPTION 1 5

AGG BULK SP. GR 2.658

AGG. APP. SP. GR. 2 701

GRAMS FOR 2.5" SPEC. 1225

RECOMMENDED AC CONTENT 4.70%

THEO. GRAVITY ~~2.487~~ 2.491

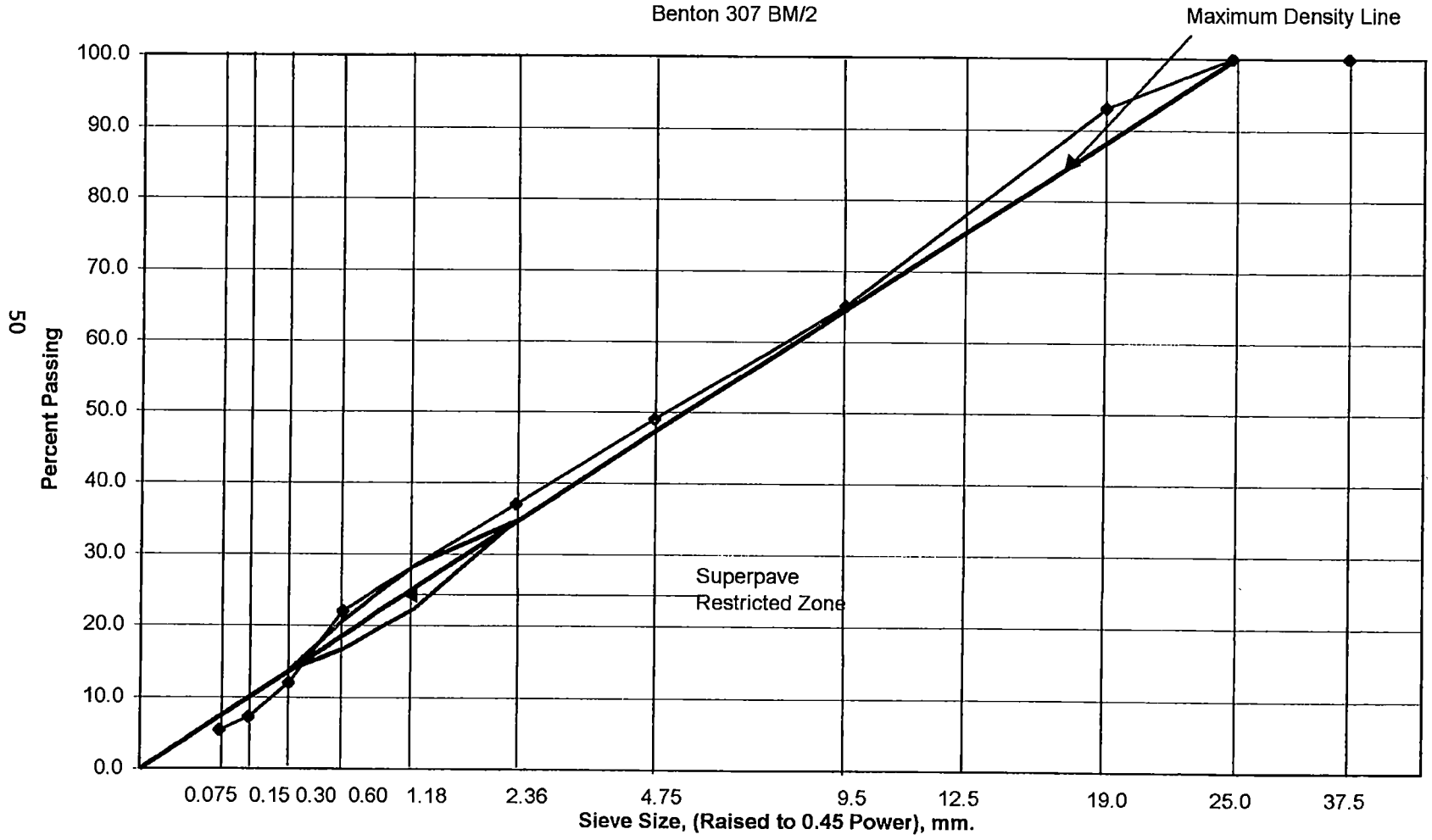
D A. R ~~1.15~~ 1.17

AMOUNT & TYPE ADDITIVE Pave Bond LT 0.3%

T. S. R. 86.8%

Mix Design Gradation
19 mm Nominal

Benton 307 BM/2



50

Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Benton 307 BM/2			
Theoretical Maximum (Rice) Specific Gravity =	2.486			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2965.0	2965.1	6715.2	6715.0
(lb)	6.5	6.5	14.8	14.8
Mold Temperature, ° C	123.9	129.4	126.7	132.2
(° F)	255.0	265.0	260.0	270.0
Mix Temperature, ° C	147.8	149.4	151.1	150.0
(° F)	298.0	301.0	304.0	302.0
Number of Gyrations	5	4	N/A	N/A
Compacted Height, mm	74.3	74.5	N/A	N/A
(in.)	2.9252	2.9331	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	448.2 / 137.9	448.2 / 137.9
(psi)	N/A	N/A	65 / 20	65 / 20
Compaction Time, sec.	N/A	N/A	30.0	40.0
Dry mass (A), g	2962.0	2958.1	6686.2	6683.3
(lb)	6.5	6.5	14.7	14.7
Dry mass with Parafilm (D), g	2970.8	2966.1	6697.6	6695.1
(lb)	6.5	6.5	14.8	14.8
Wet mass with Parafilm (E), g	1669.9	1662.4	3808.9	3885.6
(lb)	3.7	3.7	8.4	8.6
Wet mass w/o Parafilm (C), g	1712.3	1704.8	3896.2	3938.8
(lb)	3.8	3.8	8.6	8.7
Saturated Surface Dry mass (B), g	2975.7	2970.3	6698.1	6689.9
(lb)	6.6	6.5	14.8	14.7
Specific Gravity (Gmb), SSD	2.344	2.337	2.386	2.429
Specific Gravity (Gmb), Parafilm	2.303	2.292	2.330	2.396
VTM =[1-(Gmb/Gmm)], SSD (%)	5.7%	6.0%	4.0%	2.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	7.4%	7.8%	6.3%	3.6%
NCAT Asphalt Content (%)	5.1%	5.1%	5.1%	5.1%

APA Dial Gauge Readings, mm

Mix Type: Benton 307 BM/2

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.16	10.40	10.18	9.19	7.92	- N/A -				
Aft Front	11.20	10.49	10.23	9.17	7.91	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.72	10.13	9.91	8.95	7.60
Fwd Front	- N/A -					10.45	9.71	9.43	8.41	7.25

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.76	0.98	1.97	3.24
Aft Front	0.71	0.97	2.03	3.29
Average	**0.73**	**0.98**	**2.00**	3.27

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.59	0.81	1.77	3.12
Fwd Front	0.74	1.02	2.04	3.20
Average	**0.66**	**0.92**	**1.91**	3.16

Cycles	500	1000	4000	8000
Average Both Pills	0.70	0.95	1.95	3.21

Appendix A – 2

County & Mix Type: Benton 411 D

Project Number: 5100

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form RT-0004 Rev. Form T-112

Project Reference No. IME-40-2(76)-126 County Benton Region IV Date 5-29-98

Project No. 03001-8167-44 Contract No. 5100

Type A.C.S.-HM Sec. No. 411-D Poly Article No.

Contractor APAC-TN Subcontractor

State Rt. No. I-40 TOTAL MIX INCLUDING BITUMEN Date of Letting 2-6-98

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	Percent Used
C. A.			
Med. C. A.	16-PAN	Perry Decatur Gravel Perryville, TN	40.075
Screenings	9.5-PAN	Vulcan Mtls Parsons, TN	23.375
Sand	9.5-PAN	Tinker Sand + Gravel Perryville, TN	28.050
Asphalt Cement	PMAC-20	KOCH Memphis, TN	6.50
Anti-Strip	Type: Pave Bond Lite	Southern States Nashville, TN Dosage Rate: .3%	
% Fractured Faces on Plus No. 4 Material: 88.7		% Glassy Particles on Plus No. 4 Material: —	100%

100 PERCENT MINERAL AGGREGATE

SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent
Temp.	275-325	325°	
% A.C.	5.3-7.0	6.50	
2 "			
1 1/2"			
1 "			
3/4 "			
~~3/8~~ "/16	100	100	
~~1/2~~ 12.5	95-100	96	
~~#4~~ 9.5	80-93	89	
No. 4.75	54-76	71	
No. ~~8~~ 2.36	35-57	51	
No. ~~30~~ 600	17-29	29	
No. ~~50~~ 300	10-18	15	
No. ~~100~~ 150	0-10	8.5	
No. ~~200~~ 75	0-6.5	6.0	

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C. A. Percent	Med. C. A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
	45	25	30		100
	Theo = 2.285				
	LOT = 11.0				
	100	100	100		100
	92	100	100		96.4
	75	100	100		88.8
	42	90	97		70.5
	24	62	82		50.9
	9	35	53		28.7
	6	28	17		14.8
	4	22	4		8.5
	2.5	16	3		6.0

Requested Marty Jr. Kildow APAC-TN Contractor Approved Wallace F. Killebrew 6-11-98 Region Materials Engineer

Approved Region Construction Engineer Approved

MARSHALL MIX DESIGN

Date 3-25-98 | Contract No. 4846 | Contractor APAC-TN
Type of Mix 411-D polymer | County Hickman | No. Hammer Blows 75
Project Reference No. 41001-4137-04 | Region III | Sp.Gr. AC 1.031

Sample No.	% AC	% Agg.	Weight – Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mix. Spec.	Bulk Sp.Gr. Mix. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability lbs. KN	Flow (.01") mm
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D–E	C/F	See* below	See* below	100 −C/H x100	100− B×G I	A×G x100 / SP.GR. AC K	62.4×G		
1-1	5.5	94.5	1190.1	1194.3	642.9	551.4	2.159	2.315	2.496	6.3	17.4	64.6	2169	8.5	2.5
1-2			1189.5	1193.2	647.0	546.2	2.178							8.7	2.1
1-3			1176.1	1179.4	648.7	550.7	2.170							8.7	2.1
						Avg.	2.169						Avg.	8.7	2.1
2-1	6.0	94.0	1206.5	1209.7	655.9	553.8	2.184	2.352	2.503	5.2	17.9	70.9	2181	9.2	2.6
2-2			1196.3	1198.7	649.7	549.0	2.179							9.0	2.4
2-3			1198.7	1201.2	651.1	550.1	2.179							9.0	2.7
						Avg.	2.181						Avg.	9.1	2.6
3-1	6.5	93.5	1197.9	1199.6	651.5	547.8	2.187	2.265	2.494	4.0	17.7	77.5	2194	10.1	3.5
3-2			1203.6	1204.3	654.2	549.1	2.192							10.0	3.5
3-3			1200.7	1202.6	655.1	547.5	2.193							9.8	3.3
						Avg.	2.191						Avg.	10.0	3.4
4-1	7.0	93.0	1198.8	1201.1	656.7	544.4	2.204	2.270	2.496	2.8	17.8	84.1	2206	9.4	3.1
4-2			1196.3	1197.2	654.1	543.1	2.201							9.5	3.4
4-3			1201.0	1202.1	656.8	545.3	2.213							9.7	3.3
						Avg.	2.206						Avg.	9.5	3.3

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = B / (100 − A / Sp.Gr. AC) — H

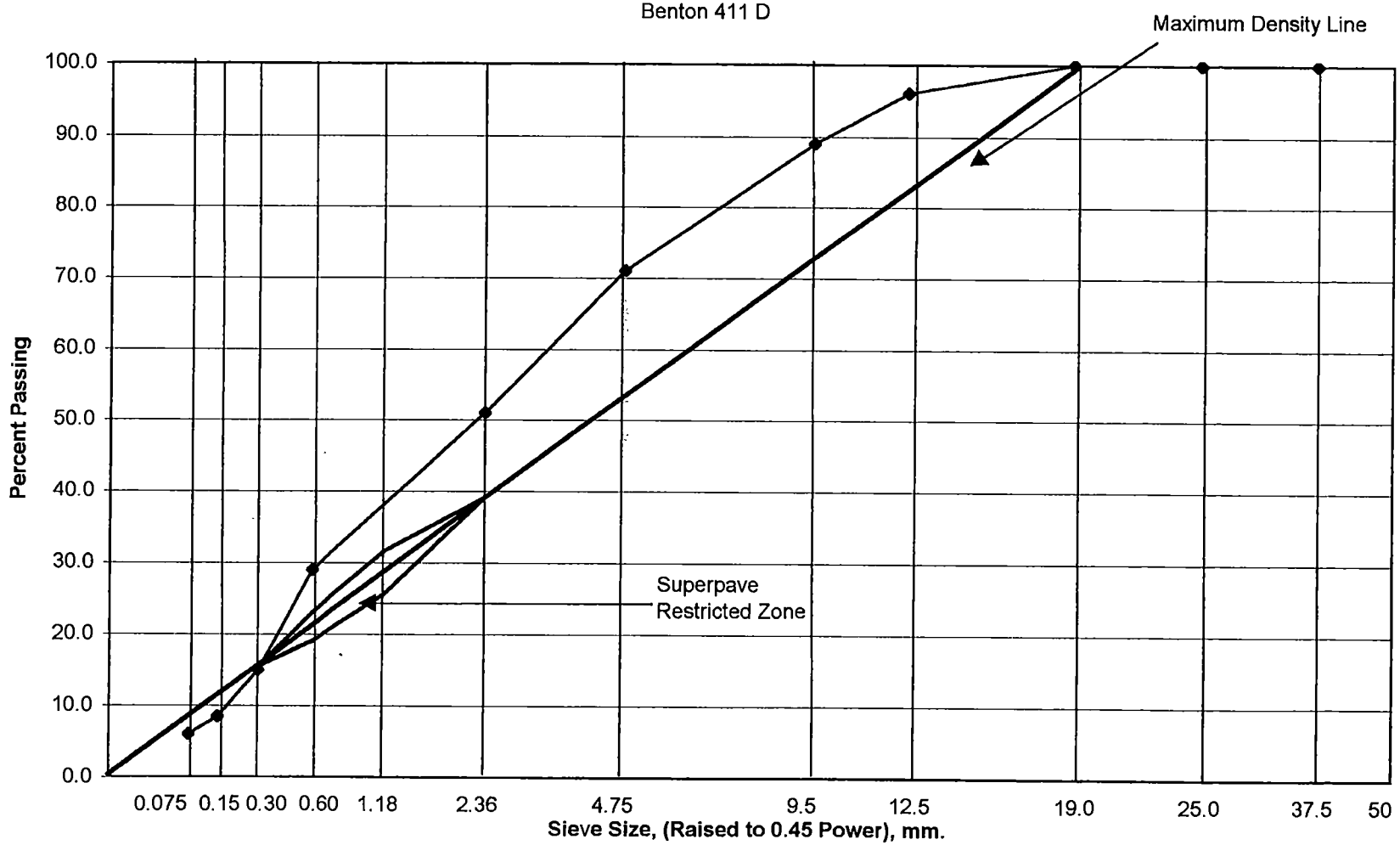
*Theo. Grav. (H) (At any AC content) = 100 / (A / Sp.Gr. AC + B / I)

Agg. Loss on Ignition (LOI) 11.0
Agg. Fractured Face Count 88.7
Agg. Glassy Particles —
Agg. Absorption 1.5
Agg. Bulk Sp. Gr. 2.711
Agg. Apparent Sp. Gr. 2.810
Grams for 2.5" Specimen 1144.3

Recommended AC Content 6.5
Theoretical Gravity 2.285
Dust to AC Ratio (DAR) .92
Amount & Type Additive PAVE Bond Lite 3%
Mix Tensile Strength Ratio (TSR) 77.2%

Approved

Mix Design Gradation
12.5 mm Nominal
Benton 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Benton 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.328			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2800.0	2800.0	6290.1	6290.1
(lb)	6.2	6.2	13.9	13.9
Mold Temperature, ° C	148.9	154.4	143.3	143.3
(°F)	300.0	310.0	290.0	290.0
Mix Temperature, ° C	149.4	150.6	147.2	147.2
(°F)	301.0	303.0	297.0	297.0
Number of Gyrations	21	26	N/A	N/A
Compacted Height, mm	75.3	75.1	N/A	N/A
(in.)	2.9646	2.9567	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	50.0	45.0
Dry mass (A), g	2790.5	2790.0	6259.3	6249.7
(lb)	6.2	6.2	13.8	13.8
Dry mass with Parafilm (D), g	2799.0	2800.3	6270.4	6260.6
(lb)	6.2	6.2	13.8	13.8
Wet mass with Parafilm (E), g	1472.0	1477.0	3320.9	3318.1
(lb)	3.2	3.3	7.3	7.3
Wet mass w/o Parafilm (C), g	1504.9	1510.1	3381.7	3385.5
(lb)	3.3	3.3	7.5	7.5
Saturated Surface Dry mass (B), g	2805.0	2804.9	6280.0	6274.2
(lb)	6.2	6.2	13.8	13.8
Specific Gravity (Gmb), SSD	2.146	2.155	2.160	2.163
Specific Gravity (Gmb), Parafilm	2.126	2.136	2.136	2.137
VTM =[1-(Gmb/Gmm)], SSD (%)	7.8%	7.4%	7.2%	7.1%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.7%	8.2%	8.3%	8.2%
NCAT Asphalt Content (%)	6.6%	6.6%	6.6%	6.6%

APA Dial Gauge Readings, mm

Mix Type: Benton 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	12.06	11.48	11.24	10.57	9.64	- N/A -				
Aft Front	12.57	11.97	11.79	11.12	10.33	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					13.19	12.45	12.18	11.18	10.17
Fwd Front	- N/A -					13.18	12.43	12.15	11.23	10.32

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.89	10.16	9.97	9.24	8.39	9.99	9.61	9.39	8.99	8.65
Aft Front	11.27	10.56	10.39	9.84	9.17	10.62	9.97	9.81	9.49	8.92
Middle	10.95	10.17	9.98	9.56	8.99	10.93	10.08	9.89	9.47	9.05
Fwd Rear	11.43	10.63	10.47	9.88	9.27	11.07	10.18	10.04	9.33	8.71
Fwd Front	11.24	10.46	10.29	9.68	8.90	11.24	10.21	9.92	9.02	8.31

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.58	0.82	1.49	2.42
Aft Front	0.60	0.78	1.45	2.24
Average	**0.59**	**0.80**	**1.47**	**2.33**

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.74	1.01	2.01	3.02
Fwd Front	0.75	1.03	1.95	2.86
Average	**0.75**	**1.02**	**1.98**	**2.94**

Cycles	500	1000	4000	8000
Average Both Pills	0.67	0.91	1.73	2.64

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.73	0.92	1.65	2.50	0.38	0.60	1.00	1.34
Aft Front	0.71	0.88	1.43	2.10	0.65	0.81	1.13	1.70
Middle	0.78	0.97	1.39	1.96	0.85	1.04	1.46	1.88
Fwd Rear	0.80	0.96	1.55	2.16	0.89	1.03	1.74	2.36
Fwd Front	0.78	0.95	1.56	2.34	1.03	1.32	2.22	2.93
Averages								
All 5	**0.76**	**0.94**	**1.52**	**2.21**	**0.76**	**0.96**	**1.51**	**2.04**
Middle 3	**0.76**	**0.94**	**1.46**	**2.07**	**0.80**	**0.96**	**1.44**	**1.98**
Middle Excluded	**0.75**	**0.93**	**1.55**	**2.28**	**0.74**	**0.94**	**1.52**	**2.08**

Appendix A – 3

County & Mix Type: Blount 307 S No Fibers

Project Number: 5267

SUPERPAVE

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

MIX DESIGN NO: DV-1(98) 251		SERIAL NO M-1(98)302	DATE: 7/15/98
REGION:	ONE	ARTICLE NO	
PROJECT REF	SP	CONTRACT NO.	5267
PROJECT:	05002-4219-04	COUNTY:	BLOUNT
TYPE:	BCHM S.P./19mm 307-S	SEC. NO:	
CONTRACTOR:	APAC-HARRISON CONST.	SUBCONTRACTOR	
STATE RT. NO:	S.R.:35 & 447	DATE OF LETTING	JUNE/98

Material	Total Percent Passing	Producer and Address		Percent Used
#57/67	25mm-.075mm	VULCAN MATERIALS,	MARYVILLE	28.68
#7	19mm-.075mm	VULCAN MATERIALS,	MARYVILLE	23.90
#10	9.5mm-.075mm	VULCAN MATERIALS,	MARYVILLE	21.99
NATL. SAND	9.5mm-.075mm	HIGHLAND SAND,	CRABORCHARD	9.56
WASH SAND	4.75mm-.075mm	VULCAN MATERIALS,	MARYVILLE	9.56
BAGHOUSE FINES	.150mm-.075mm	HARRISON ASPHALT PLANT,	MARYVILLE	1.91
Asphalt Cement :	PG 76-22	MARATHON/ASHLAND,	KNOXVILLE	4.40
Anti-Strip	PAVE-BOND	Dosage Rate	0.5%	100

				AGGREGATE ANALYSIS TOTAL PERCENT PASSING						
MIXING TEMP.		340 F	171 C							
COMP. TEMP		315 F	157 C	#57/67	#7	#10	NATL SAND	WASH SAND	BAGHOUSE FINES	Calculated
PERCENT AC	REQUESTED		4.4	%	%	%	%	%	%	Mix
	CONTROL POINTS	RESTRICTED ZONE	MIX BLEND	30%	25%	23%	10%	10%	2%	100.0%
25mm	100		100	100	100	100	100	100	100	100.0
19mm	90 / 100		97	89	100	100	100	100	100	98.7
12.5mm	90 max		79	42	84	100	100	100	100	78.6
9.5mm			67	27	56	100	100	100	100	67.1
4.75mm			49	9	11	92	99	100	100	46.5
2.36mm	.23 / 49	34.6	34	2	3	56	88	90	100	34.0
1.18mm		22.3 / 28.3	23	2	3	31	81	47	100	23.3
.600mm		16.7 / 20.7	17	1	2	20	70	22	100	16.6
.300mm		13.7	8	1	2	14	12	9	100	8.1
.150mm			6.3	1	2	12	4.0	3.8	100	6.3
075mm	2.0 / 8.0		5.2	1.0	1.0	10.0	2.0	2.1	98.3	5.2
					THEO GRAVITY	kg/m3	PCF	DAP	TSR	LOI
					2.619	2619.0	163.4	1.2		NA

REQUEST APAC-TN, HARRISON DIV. Bobby Everett
CONTRACTOR

APPROVED
REGION MATERIALS ENGINEER

APPROVED
REGION CONST. ENGINEER

APPROVED
ENGINEER OF MATERIALS AND TEST

Tennessee Department of Transportation
SHRP Mix Design Worksheet

Date 7/26/98

Mix Type 307-S Ignition Calabration Mix Description

Aggregate: Description: #57/67 Vulcan Material's, Maryville, Tenn.
Highland Natural Sand #7 Vulcan Material's, Maryville, Tenn.
Baghouse Fines #10 Screening's Vulcan Material's, Maryville
Mfg Sand, Vulcan Material's, Maryville, Tn.

SGblk= 2.795 SGeff= 2.818

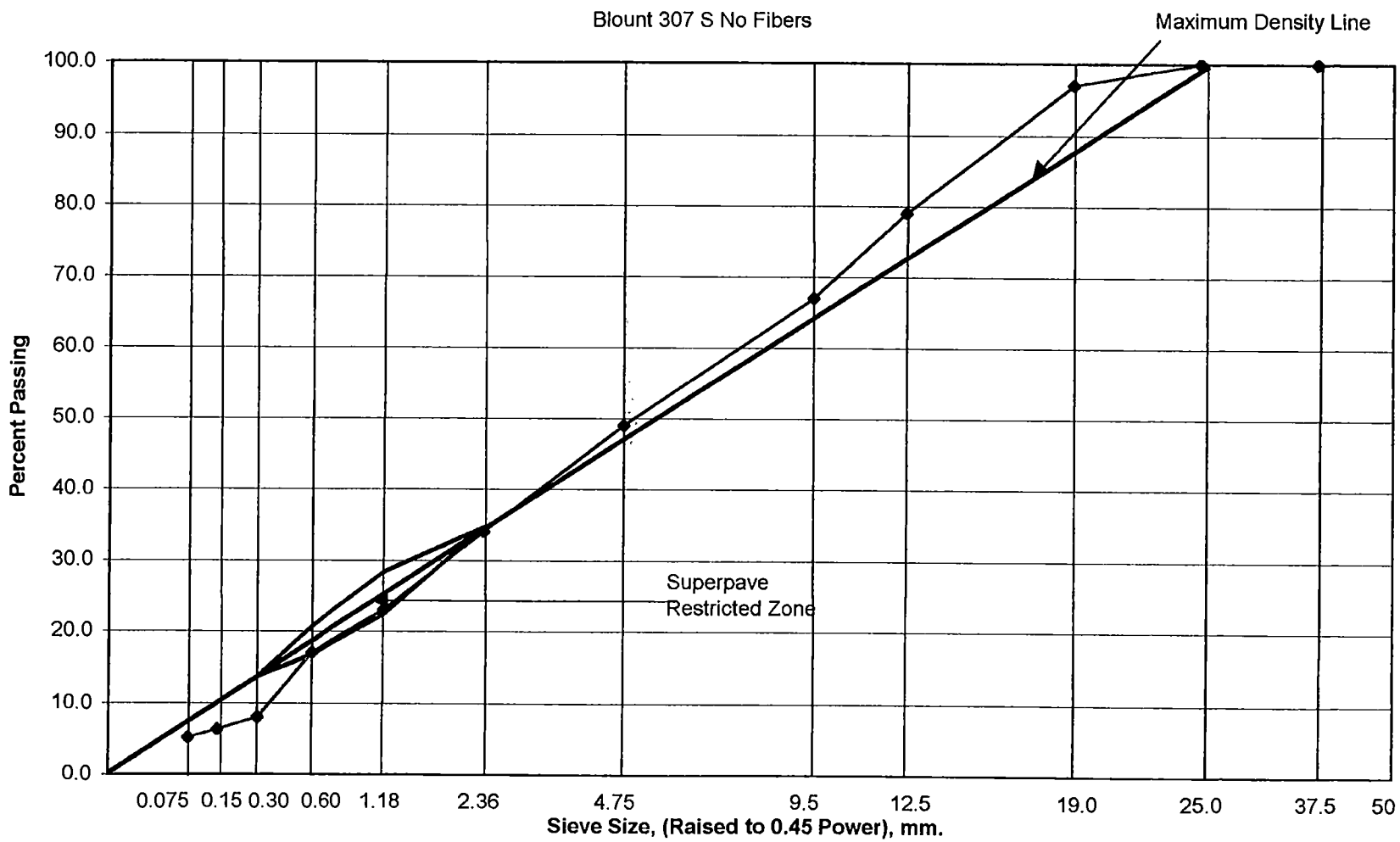
Asphalt: Description: PG-76/22 Marathon Ashland, Knoxville

SGas= 1.031

Specimen	% AC	Weight (g)	Height (mm) Ndes	Height (mm) Nmax	Bulk SG det.	C	Bulk SG est. @ des	TMD	VTM (%)	VMA blk (%)	VMA eff (%)	VFA blk (%)	VFA eff (%)
	4 2	4762.5	116.4	115.0	2.535	1.082	2.505	2.627	4.7	14.2	14.9	67.1	68.7
	4.2	4761.0	115.7	114.3	2.541	1.078	2.510	2.627	4.4	14.0	14.7	68.2	69.7
Avg.			116.1	114.7	2.538		2.507		4 5	14.1	14.8	67.7	69.2
Original	4.4	5076.1	117 2	115.7	2.540	1.023	2.507	2.618	4.2	14.2	14.9	70.3	71.7
Pill's	4.4	5081 7	117.0	115.5	2.546	1.023	2.513	2.618	4.0	14.0	14.7	71.4	72.8
Avg.			117.1	115.6	2.543		2.510		4.1	14.1	14.8	70.8	72.2
	4.9	5061 5	116.5	115.0	2.552	1.025	2 519	2.597	3.0	14.3	15.0	78.9	79.9
	4 9	5100 7	117.5	115.9	2.550	1.024	2.515	2.597	3.2	14.4	15.1	78.1	79.1
Avg.			117.0	115.5	2.551		2.517		3.1	14.4	15 1	78.5	79.5
Verification	4 4	5077 1	117 2	115.7	2.541	1.023	2.508	2.618	4.2	14.2	14.9	70.5	71.8
Pill's	4.4	5077 9	117.4	115.9	2.545	1.027	2.512	2.618	4.0	14.1	14.8	71.3	72.6
Avg.			117.3	115.8	2.543		2.510		4.1	14.1	14.8	70.9	72.2

N des 96

Mix Design Gradation
19 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Blount 307 S - No Fibers			
Theoretical Maximum (Rice) Specific Gravity =	2.61			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3078.0	3078.1	7055.0	7055.3
(lb)	6.8	6.8	15.6	15.6
Mold Temperature, ° C	104.4	101.7	137.8	137.8
(° F)	220.0	215.0	280.0	280.0
Mix Temperature, ° C	149.4	150.0	150.0	150.0
(° F)	301.0	302.0	302.0	302.0
Number of Gyrations	33	37	N/A	N/A
Compacted Height, mm	75.3	75.3	N/A	N/A
(in.)	2.9646	2.9646	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	70.0	60.0
Dry mass (A), g	3067.1	3067.9	7010.6	6992.7
(lb)	6.8	6.8	15.5	15.4
Dry mass with Parafilm (D), g	3075.6	3076.4	7021.9	7003.7
(lb)	6.8	6.8	15.5	15.4
Wet mass with Parafilm (E), g	1758.4	1758.6	4058.2	4050.7
(lb)	3.9	3.9	8.9	8.9
Wet mass w/o Parafilm (C), g	1823.2	1824.4	4161.6	4146.9
(lb)	4.0	4.0	9.2	9.1
Saturated Surface Dry mass (B), g	3091.4	3094.3	7030.6	7007.4
(lb)	6.8	6.8	15.5	15.4
Specific Gravity (Gmb), SSD	2.418	2.416	2.444	2.445
Specific Gravity (Gmb), Parafilm	2.354	2.353	2.381	2.383
VTM =[1-(Gmb/Gmm)], SSD (%)	7.3%	7.4%	6.4%	6.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.8%	9.8%	8.8%	8.7%
NCAT Asphalt Content (%)	4.7%	4.7%	4.7%	4.7%

APA Dial Gauge Readings, mm

Mix Type: Blount 307 S - No Fibers

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.64	11.21	11.09	10.64	10.28	- N/A -				
Aft Front	12.11	11.29	11.09	10.21	9.75	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.63	10.81	10.49	9.88	9.06
Fwd Front	- N/A -					11.20	10.35	10.19	9.69	9.33

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	7.99	7.49	7.40	7.10	6.83	9.25	7.88	7.86	7.51	7.09
Aft Front	8.18	7.49	7.35	7.13	6.98	8.64	8.26	8.26	8.13	7.98
Middle	8.93	8.18	8.03	7.73	7.56	8.62	8.29	8.19	8.14	8.04
Fwd Rear	9.25	8.50	8.37	8.09	7.93	9.50	8.95	8.84	8.58	8.39
Fwd Front	9.17	8.24	8.31	7.72	7.64	7.66	7.36	7.26	6.93	6.79

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.43	0.55	1.00	1.36
Aft Front	0.82	1.02	1.90	2.36
Average	**0.63**	**0.79**	**1.45**	**1.86**

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.82	1.14	1.75	2.57
Fwd Front	0.85	1.01	1.51	1.87
Average	**0.84**	**1.08**	**1.63**	**2.22**

Cycles	500	1000	4000	8000
Average Both Pills	0.73	0.93	1.54	2.04

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.50	0.59	0.89	1.16	1.37	1.39	1.74	2.16
Aft Front	0.69	0.83	1.05	1.20	0.38	0.38	0.51	0.66
Middle	0.75	0.90	1.20	1.37	0.33	0.43	0.48	0.58
Fwd Rear	0.75	0.88	1.16	1.32	0.55	0.66	0.92	1.11
Fwd Front	0.93	0.86	1.45	1.53	0.30	0.40	0.73	0.87
Averages								
All 5	**0.72**	**0.81**	**1.15**	**1.32**	**0.59**	**0.65**	**0.88**	**1.08**
Middle 3	**0.73**	**0.87**	**1.14**	**1.30**	**0.42**	**0.49**	**0.64**	**0.78**
Middle Excluded	**0.72**	**0.79**	**1.14**	**1.30**	**0.65**	**0.71**	**0.98**	**1.20**

Appendix A – 4

County & Mix Type: Blount 307 S With Fibers

Project Number: 5267

SUPERPAVE

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

MIX DESIGN NO:	DV-1 (98) 252	SERIAL NO	M-1 (98) 303
DATE	7/15/98		
REGION:	ONE	ARTICLE NO	
PROJECT REF	SP	CONTRACT NO:	5267
PROJECT :	05002-4219-04	COUNTY	BLOUNT
TYPE:	BCHM: S.P./19mm 307-S	SEC. NO:	
CONTRACTOR.	APAC-HARRISON CONST.	SUBCONTRACTOR:	
STATE RT. NO:	S.R..35 & 447	DATE OF LETTING:	JUNE/98

Material	Total Percent Passing	Producer and Address	Percent Used
#57/67	25mm-.075mm	VULCAN MATERIALS, MARYVILLE	26.47
#7	19mm-.075mm	VULCAN MATERIALS, MARYVILLE	23.73
#10	9.5mm-.075mm	VULCAN MATERIALS, MARYVILLE	21.83
NATL. SAND	9.5mm- 075mm	HIGHLAND SAND, CRABORCHARD	9.49
WASH SAND	4.75mm- 075mm	VULCAN MATERIALS, MARYVILLE	9.49
BAGHOUSE FINES	.150mm-.075mm	HARRISON ASPHALT PLANT, MARYVILLE	1.89
Asphalt Cement :	PG 76-22 (0.3% FIBERS)	MARATHON/ASHLAND, KNOXVILLE	5.10
Anti-Strip	PAVE-BOND	Dossage Rate: 0.5%	100

				AGGREGATE ANALYSIS TOTAL PERCENT PASSING						
MIXING TEMP.		340 F	171 C				NATL	WASH	BAGHOUSE	
COMP. TEMP		315 F	157 C	#57/67	#7	#10	SAND	SAND	FINES	Calculated
PERCENT AC	REQUESTED		5.1	%	%	%	%	%	%	Mix
	CONTROL POINTS	RESTRICTED ZONE	MIX BLEND	30%	25%	23%	10%	10%	2%	100.0%
25mm	100		100	100	100	100	100	100	100	100.0
19mm	90 / 100		97	89	100	100	100	100	100	96.7
12.5mm	90 max		79	42	84	100	100	100	100	78.6
9.5mm			67	27	56	100	100	100	100	67.1
4.75mm			49	9	11	92	99	100	100	48.6
2.36mm	23 / 49	34.6	34	2	3	56	88	90	100	34.0
1.18mm		22.3 / 28.3	23	2	3	31	81	47	100	23.3
.600mm		16.7 / 20.7	17	1	2	20	70	22	100	16.6
300mm		13.7	8	1	2	14	12	9	100	8.1
.150mm			6.3	1	2	12	4.0	3.8	100	6.3
.075mm	2.0 / 8.0		5.2	1.0	1.0	10.0	2.0	2.1	98.3	5.2

THEO GRAVITY	kg/m3	PCF	DAR	TSR	LOI
2.579	2579.0	160.9	1.0		NA

REQUEST APAC-TN.; HARRISON DIV. Bobby Everett
CONTRACTOR

APPROVED
REGION MATERIALS ENGINEER

APPROVED: Stan M Reed
REGION CONST ENGINEER

APPROVED
ENGINEER OF MATERIALS AND TEST

Tennessee Department of Transportation
SHRP Mix Design Worksheet

Date 7/26/98

Mix Type ~~[illegible]~~ 307-S | Ignition Calabration 0.72 | Mix Description Surface With FIBER'S .3%

Aggregate: Description: Highland Natural Sand, Baghouse Fines
#57/67 Vulcan Material's, Maryville, Tenn.
#7 Vulcan Material's, Maryville, Tenn.
#10 Screening's Vulcan Material's, Maryville
Mfg Sand, Vulcan Material's, Maryville, Tn.

SGblk= 2.795 SGeff= 2.818

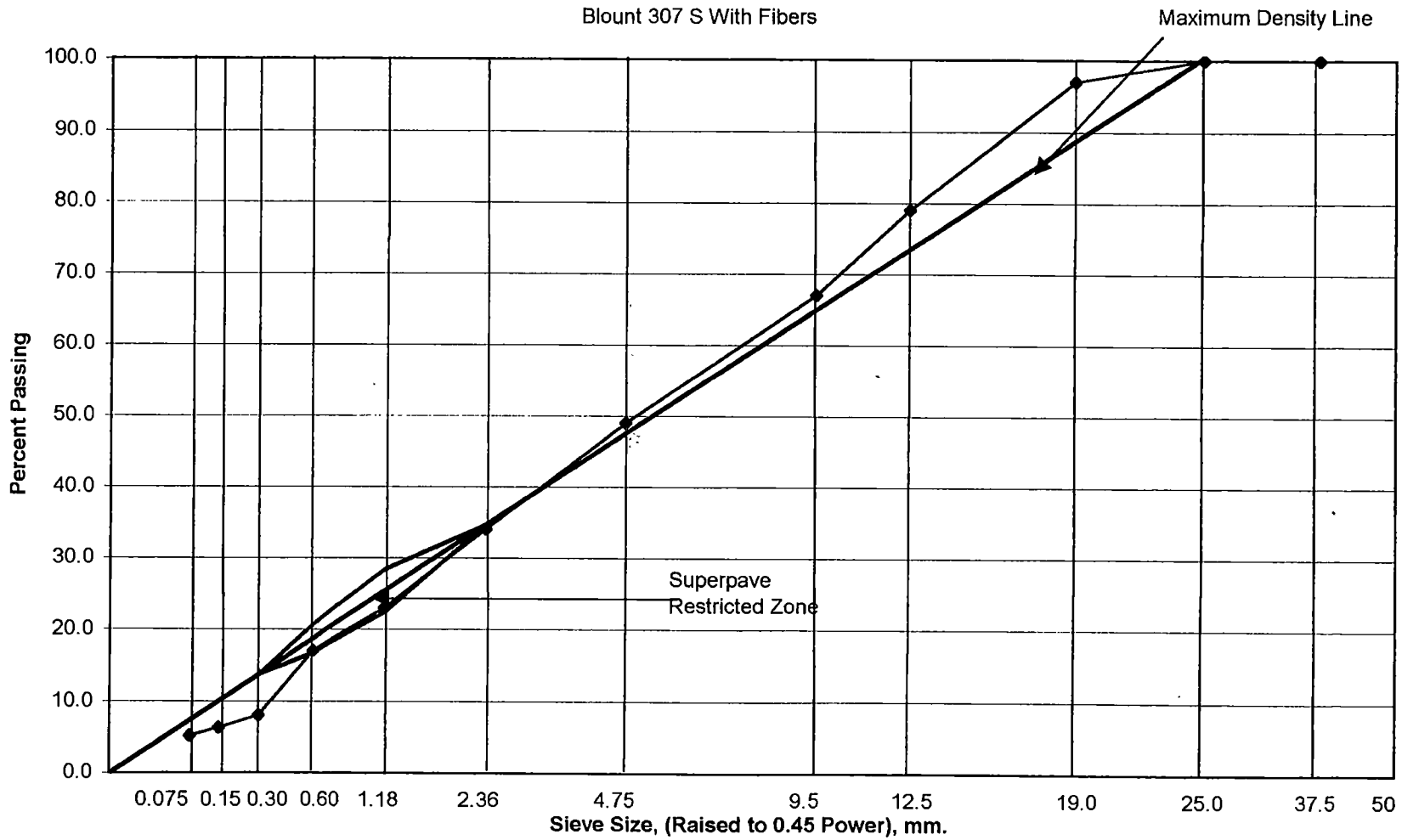
Asphalt: Description: PG-76/22 Marathon Ashland, Knoxville

SGas= 1.031

Specimen	% AC	Weight (g)	Height (mm) Ndes	Height (mm) Nmax	Bulk SG det.	C	Bulk SG est. @ des	TMD	VTM (%)	VMA blk (%)	VMA eff (%)	VFA blk (%)	VFA eff (%)
	4.6	5047.4	118.1	116.8	2.501	1.023	2.473	2.610	5 2	15.6	16.3	66.4	67.9
	4.6	5057 6	118 4	117 0	2.500	1.022	2.470	2.610	5.3	15.7	16.4	65 9	67.3
Avg			118.3	116.9	2.501		2 472		5 3	15.6	16.3	66 2	67.6
Original	5.1	5060.5	117.2	115 8	2 513	1.016	2 483	2.589	4.1	15.7	16.4	73.9	75.0
Pill's	5 1	5095.5	118 0	116.6	2 516	1.017	2 486	2 589	4.0	15.6	16.3	74.5	75.6
Avg.			117.6	116 2	2.515		2 485		4.0	15.6	16.3	74.2	75.3
	5 6	5061.5	116 5	115 0	2.552	1.025	2 519	2.569	1.9	14.9	15.6	87.1	87.6
	5.6	5100.7	117.5	115.9	2.550	1.024	2 515	2.569	2.1	15.0	15.7	86 2	86.8
Avg			117.0	115.5	2.551		2.517		2.0	15 0	15.7	86.6	87.2
Verification	5.1	5046.1	117.4	115.9	2.516	1.021	2.484	2.589	4.1	15.7	16.4	74.0	75.1
Pill's	5 1	5038 4	117.9	116 4	2 513	1.026	2 481	2.589	4.2	15 8	16.4	73.5	74 6
Avg.			117.7	116.2	2.515		2.482		4.1	15.7	16.4	73 8	74.9

N des 96

Mix Design Gradation
19 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Blount 307 S - With Fibers			
Theoretical Maximum (Rice) Specific Gravity =	2.582			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3050.1	3050.1	6975.1	6975.0
(lb)	6.7	6.7	15.4	15.4
Mold Temperature, ° C	154.4	115.6	137.8	137.8
(°F)	310.0	240.0	280.0	280.0
Mix Temperature, ° C	148.9	146.7	148.9	148.9
(°F)	300.0	296.0	300.0	300.0
Number of Gyrations	17	23	N/A	N/A
Compacted Height, mm	75.2	75.2	N/A	N/A
(in.)	2.9606	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	448.2 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	65 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	70.0	70.0
Dry mass (A), g	3033.6	3040.2	6949.3	6931.4
(lb)	6.7	6.7	15.3	15.3
Dry mass with Parafilm (D), g	3042.2	3048.7	6960.7	6941.1
(lb)	6.7	6.7	15.3	15.3
Wet mass with Parafilm (E), g	1709.0	1726.6	4007.5	3954.8
(lb)	3.8	3.8	8.8	8.7
Wet mass w/o Parafilm (C), g	1774.0	1789.7	4085.8	4066.7
(lb)	3.9	3.9	9.0	9.0
Saturated Surface Dry mass (B), g	3065.4	3067.0	6970.3	6970.0
(lb)	6.8	6.8	15.4	15.4
Specific Gravity (Gmb), SSD	2.349	2.380	2.409	2.387
Specific Gravity (Gmb), Parafilm	2.300	2.324	2.368	2.334
VTM =[1-(Gmb/Gmm)], SSD (%)	9.0%	7.8%	6.7%	7.5%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	10.9%	10.0%	8.3%	9.6%
NCAT Asphalt Content (%)	4.2%	4.2%	4.2%	4.2%

APA Dial Gauge Readings, mm

Mix Type: Blount 307 S W/ Fibers

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	12.24	11.47	11.17	10.02	9.41	- N/A -				
Aft Front	12.74	11.96	11.56	10.80	10.04	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					13.22	12.24	11.93	11.34	10.77
Fwd Front	- N/A -					12.96	12.10	11.83	11.31	10.81

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	9.93	9.14	8.98	8.54	8.23	9.69	8.49	8.28	7.75	7.14
Aft Front	10.06	9.20	9.00	8.68	8.51	10.63	9.77	9.62	9.28	8.94
Middle	9.66	9.17	9.00	8.71	8.52	10.30	9.60	9.30	8.97	8.75
Fwd Rear	9.17	8.51	8.34	7.99	7.72	10.02	9.13	8.98	8.72	8.60
Fwd Front	8.46	7.98	7.83	7.58	7.38	9.65	9.00	8.87	8.63	8.47

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.77	1.07	2.22	2.83
Aft Front	0.78	1.18	1.94	2.70
Average	0.77	1.13	2.08	2.77

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.98	1.29	1.88	2.45
Fwd Front	0.86	1.13	1.65	2.15
Average	0.92	1.21	1.77	2.30

Cycles	500	1000	4000	8000
Average Both Pills	0.85	1.17	1.92	2.53

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.79	0.95	1.39	1.70	1.20	1.41	1.94	2.55
Aft Front	0.86	1.06	1.38	1.55	0.86	1.01	1.35	1.69
Middle	0.49	0.66	0.95	1.14	0.70	1.00	1.33	1.55
Fwd Rear	0.66	0.83	1.18	1.45	0.89	1.04	1.30	1.42
Fwd Front	0.48	0.63	0.88	1.08	0.65	0.78	1.02	1.18
Averages								
All 5	0.66	0.83	1.16	1.38	0.86	1.05	1.39	1.68
Middle 3	0.67	0.85	1.17	1.38	0.82	1.02	1.33	1.55
Middle Excluded	0.70	0.87	1.21	1.45	0.90	1.06	1.40	1.71

Appendix A – 5

County & Mix Type: Blount 411 S No Fibers

Project Number: 5267

SUPERPAVE

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

MIX DESIGN NO: DM-1(58)246		SERIAL NO: M-1(58)257	DATE: 8/10/98
REGION:	ONE	ARTICLE NO	
PROJECT REF	SP	CONTRACT NO:	5267
PROJECT :	05002-4219-04	COUNTY:	BLOUNT
TYPE:	BCHM: S P./12.5mm 411-S	SEC. NO	
CONTRACTOR:	APAC-HARRISON CONST	SUBCONTRACTOR:	
STATE RT. NO:	S.R.:35 & 447	DATE OF LETTING:	JUNE/98

Material	Total Percent Passing	Producer and Address	Percent Used
GRANITE #7	19mm-.075mm	VULCAN MATERIALS, ENKA,N.C.	61.10
#10	9.5mm-.075mm	VULCAN MATERIALS, MARYVILLE	21.62
NATL. SAND	9.5mm-.075mm	HIGHLAND SAND, CRABORCHARD	9.40
BAGHOUSE FINES	.150mm-.075mm	HARRISON ASPHALT PLANT, MARYVILLE	1.88
Asphalt Cement :	PG 76-22	MARATHON/ASHLAND, KNOXVILLE	6.00
Anti-Strip	PAVE-BOND	Dossage Rate: 0.5%	100

				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
MIXING TEMP.		340 F	171 C						
COMP. TEMP.		315 F	157 C		#7	#10	NATL. SAND	BAGHOUSE FINES	Calculated
PERCENT AC	REQUESTED		6.0		%	%	%	%	Mix
	CONTROL POINTS	RESTRICTED ZONE	MIX BLEND		65%	23%	10%	2%	100.0%
25mm			0						0 0
19mm	100		100		100	100	100	100	100 0
12.5mm	90/100		95		93	100	100	100	96.5
9.5mm			79		68	100	100	100	79.2
4.75mm			50		26	92	99	100	60.0
2.36mm	28/58	39.1	29		9	56	86	100	29.3
1.18mm		25.6/31.6	20		5	31	81	100	20.5
.600mm		19.1/23.1	16		4	20	70	100	16.2
.300mm		15.5	8		3	14	12	100	8 4
.150mm			6.4		2	12	4.0	98.9	6.4
.075mm	2/10		5 4		1.5	10.0	2.0	98.3	5.4

THEO. GRAVITY	kg/m3	PCF	DAR	TSR	LOI
2.513	2513 0	156 8	0.9	85%	12

REQUEST APAC-TN.; HARRISON DIV. Bobby Everett
CONTRACTOR

APPROVED:
REGION MATERIALS ENGINEER

APPROVED: Steven M Bar
REGION CONST. ENGINEER

APPROVED:
ENGINEER OF MATERIALS AND TEST

Tennessee Department of Transportation
SHRP Mix Design Worksheet

Date 8/11/98

Mix Type 411-S
ANGULARITY 49.2%

Mix Description SHRP SUPER PAVE

Aggregate: Description:

Asphalt: Description: PG-64/22

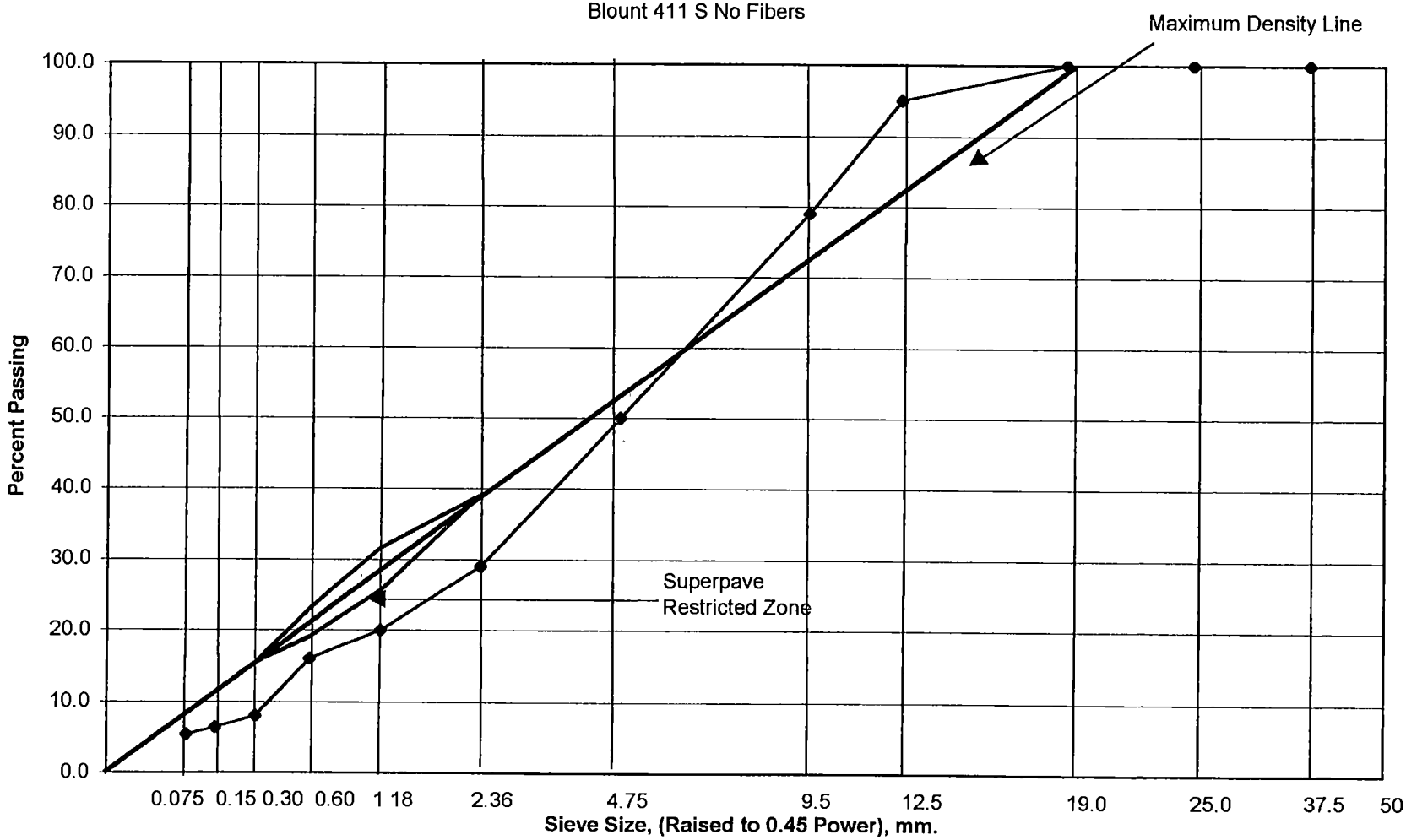
SGblk= 2.742 SGeff= 2.769

SGas= 1.031

Specimen	% AC	Weight (g)	Height (mm) Ndes	Height (mm) Nmax	Bulk SG det.	C	Bulk SG est. @ des	TMD	VTM (%)	VMA blk (%)	VMA eff (%)	VFA blk (%)	VFA eff (%)
	5.5	4827.5	116.2	114.4	2.440	1.022	2.402	2.534	5.2	17.2	18.0	69.8	71.1
	5.5	4829.5	115.8	114.0	2.446	1.020	2.408	2.534	5.0	17.0	17.8	70.8	72.1
Avg			116.0	114.2	2.443		2.405		5.1	17.1	17.9	70.3	71.6
Original	6.0	4874.3	117.0	115.2	2.451	1.024	2.413	2.515	4.0	17.3	18.1	76.7	77.7
Original	6.0	4895.0	117.2	115.2	2.455	1.021	2.413	2.515	4.0	17.3	18.1	76.6	77.7
Avg			117.1	115.2	2.453		2.413		4.0	17.3	18.1	76.6	77.7
	6.5	4964.7	117.8	116.0	2.464	1.017	2.426	2.496	2.8	17.3	18.1	83.9	84.7
	6.5	4954.3	117.7	115.9	2.464	1.019	2.426	2.496	2.8	17.3	18.1	83.9	84.6
Avg.			117.8	116.0	2.464		2.426		2.8	17.3	18.1	83.9	84.7
Verification	6.0	4868.2	115.9	114.1	2.452	1.016	2.414	2.515	4.0	17.2	18.1	76.8	77.8
Verification	6.0	4873.6	117.1	115.3	2.449	1.024	2.411	2.515	4.1	17.3	18.1	76.3	77.4
Avg.			116.5	114.7	2.451		2.413		4.1	17.3	18.1	76.5	77.6

N des 96

Mix Design Gradation
12.5 mm Nominal
Blount 411 S No Fibers



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Blount 411 S - No Fibers			
Theoretical Maximum (Rice) Specific Gravity =	2.512			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	2	3
Mass of Sample Before Compaction, g	3008.0	3008.1	6860.5	6860.4
(lb)	6.6	6.6	15.1	15.1
Mold Temperature, ° C	163.3	160.0	129.4	132.2
(° F)	326.0	320.0	265.0	270.0
Mix Temperature, ° C	149.4	148.3	150.6	149.4
(° F)	301.0	299.0	303.0	301.0
Number of Gyrations	18	20	N/A	N/A
Compacted Height, mm	75.2	75.2	N/A	N/A
(in.)	2.9606	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	70.0	70.0
Dry mass (A), g	2983.4	2988.0	6817.9	6808.9
(lb)	6.6	6.6	15.0	15.0
Dry mass with Parafilm (D), g	2992.6	2996.2	6830.1	6823.1
(lb)	6.6	6.6	15.1	15.0
Wet mass with Parafilm (E), g	1667.9	1675.9	3858.7	3853.5
(lb)	3.7	3.7	8.5	8.5
Wet mass w/o Parafilm (C), g	1716.1	1723.3	3940.3	3947.3
(lb)	3.8	3.8	8.7	8.7
Saturated Surface Dry mass (B), g	2992.4	2997.5	6830.3	6817.8
(lb)	6.6	6.6	15.1	15.0
Specific Gravity (Gmb), SSD	2.338	2.345	2.359	2.372
Specific Gravity (Gmb), Parafilm	2.279	2.287	2.310	2.311
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	6.6%	6.1%	5.6%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.3%	9.0%	8.0%	8.0%
NCAT Asphalt Content (%)	6.1%	6.1%	6.1%	6.1%

APA Dial Gauge Readings, mm

Mix Type: Blount 411 S No Fibers

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.96	11.24	10.86	10.20	10.02	- N/A -				
Aft Front	12.23	11.46	11.26	10.61	9.95	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					12.48	11.97	11.67	10.89	10.33
Fwd Front	- N/A -					10.82	10.47	10.28	9.84	9.35

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.78	11.59	11.43	10.96	10.82	8.06	7.46	7.10	6.49	6.24
Aft Front	11.99	11.11	10.98	9.94	9.87	8.29	7.80	7.24	7.08	6.88
Middle	11.25	11.09	10.75	10.55	10.47	8.46	7.83	7.69	7.15	6.98
Fwd Rear	11.31	10.58	10.38	9.78	9.62	8.44	8.08	7.88	7.49	7.19
Fwd Front	10.81	10.11	9.89	9.36	8.91	8.99	7.99	7.84	7.38	7.07

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.72	1.10	1.76	1.94
Aft Front	0.77	0.97	1.62	2.28
Average	0.75	1.04	1.69	2.11

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.51	0.81	1.59	2.15
Fwd Front	0.35	0.54	0.98	1.47
Average	0.43	0.68	1.29	1.81

Cycles	500	1000	4000	8000
Average Both Pills	0.59	0.86	1.49	1.96

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.19	0.35	0.82	0.96	0.60	0.96	1.57	1.82
Aft Front	0.88	1.01	2.05	2.12	0.49	1.05	1.21	1.41
Middle	0.16	0.50	0.70	0.78	0.63	0.77	1.31	1.48
Fwd Rear	0.73	0.93	1.53	1.69	0.36	0.56	0.95	1.25
Fwd Front	0.70	0.92	1.45	1.90	1.00	1.15	1.61	1.92
Averages								
All 5	0.53	0.74	1.31	1.49	0.62	0.90	1.33	1.58
Middle 3	0.59	0.81	1.43	1.53	0.49	0.79	1.16	1.38
Middle Excluded	0.63	0.80	1.46	1.67	0.61	0.93	1.34	1.60

Appendix A – 6

County & Mix Type: Blount 411 S With Fibers

Project Number: 5267

SUPERPAVE

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

MIX DESIGN NO: DUK 98) 247		SERIAL NO: M-7(98)258	DATE: 8/10/98
REGION:	ONE	ARTICLE NO:	
PROJECT REF	SP	CONTRACT NO:	5267
PROJECT :	95002-4219-04	COUNTY:	BLOUNT
TYPE	BCHM: S.P./12.5mm 411-5	SEC. NO:	
CONTRACTOR:	APAC-HARRISON CONST.	SUBCONTRACTOR:	
STATE RT. NO:	S.R.:35 & 447	DATE OF LETTING:	JUNE/98

Material	Total Percent Passing	Producer and Address	Percent Used
GRANITE #7	19mm-.075mm	VULCAN MATERIALS, ENKA,N.C.	61.04
#10	9.5mm-.075mm	VULCAN MATERIALS, MARYVILLE	21.69
NATL. SAND	9.5mm-.075mm	HIGHLAND SAND, CRABORCHARD	9.39
BAGHOUSE FINES	.150mm-.075mm	HARRISON ASPHALT PLANT, MARYVILLE	1.88
Asphalt Cement :	PG 76-22 0.3% FIBERS	MARATHON/ASHLAND, KNOXVILLE	6.10
Anti-Strip	PAVE-BOND	Dosage Rate: 0.5%	100

				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
MIXING TEMP.		340 F	171 C						
COMP. TEMP.		315 F	157 C		#7	#10	NATL. SAND		BAGHOUSE FINES	Calculated
PERCENT AC	REQUESTED		6.1		%	%	%		%	Mix
	CONTROL POINTS	RESTRICTED ZONE	MIX BLEND		65%	23%	10%		2%	100.0%
25mm			0							0 0
19mm	100		100		100	100	100		100	100.0
12.5mm	90/100		95		93	100	100		100	95.5
9.5mm			79		68	100	100		100	79.2
4.75mm			50		26	92	99		100	50.0
2.36mm	28/58	39.1	29		9	56	86		100	29.3
1.18mm		25.6/31.6	20		5	31	81		100	20.5
.600mm		19.1/23 1	16		4	20	70		100	16.2
.300mm		15.5	8		3	14	12		100	8.4
.150mm			6.4		2	12	4.0		98.9	6.4
.075mm	2/10		5 4		1.5	10.0	2.0		98.3	5.4

	THEO. GRAVITY	kg/m3	PCF	DAR	TSR	LOI
	2.507	2507.0	156.4	0.9	81%	12

REQUEST APAC-TN., HARRISON DIV. Bobby Everett
CONTRACTOR

APPROVED:
REGION MATERIALS ENGINEER

APPROVED: Steve M Bark
REGION CONST. ENGINEER

APPROVED
ENGINEER OF MATERIALS AND TEST

Tennessee Department of Transportation
SHRP Mix Design Worksheet

Date 8/11/98

Mix Type 411-2 W/FIBERS
ANGULARITY 49 2%

Mix Description SHRP

Aggregate: Description:

SGblk= 2.742 SGeff= 2 764

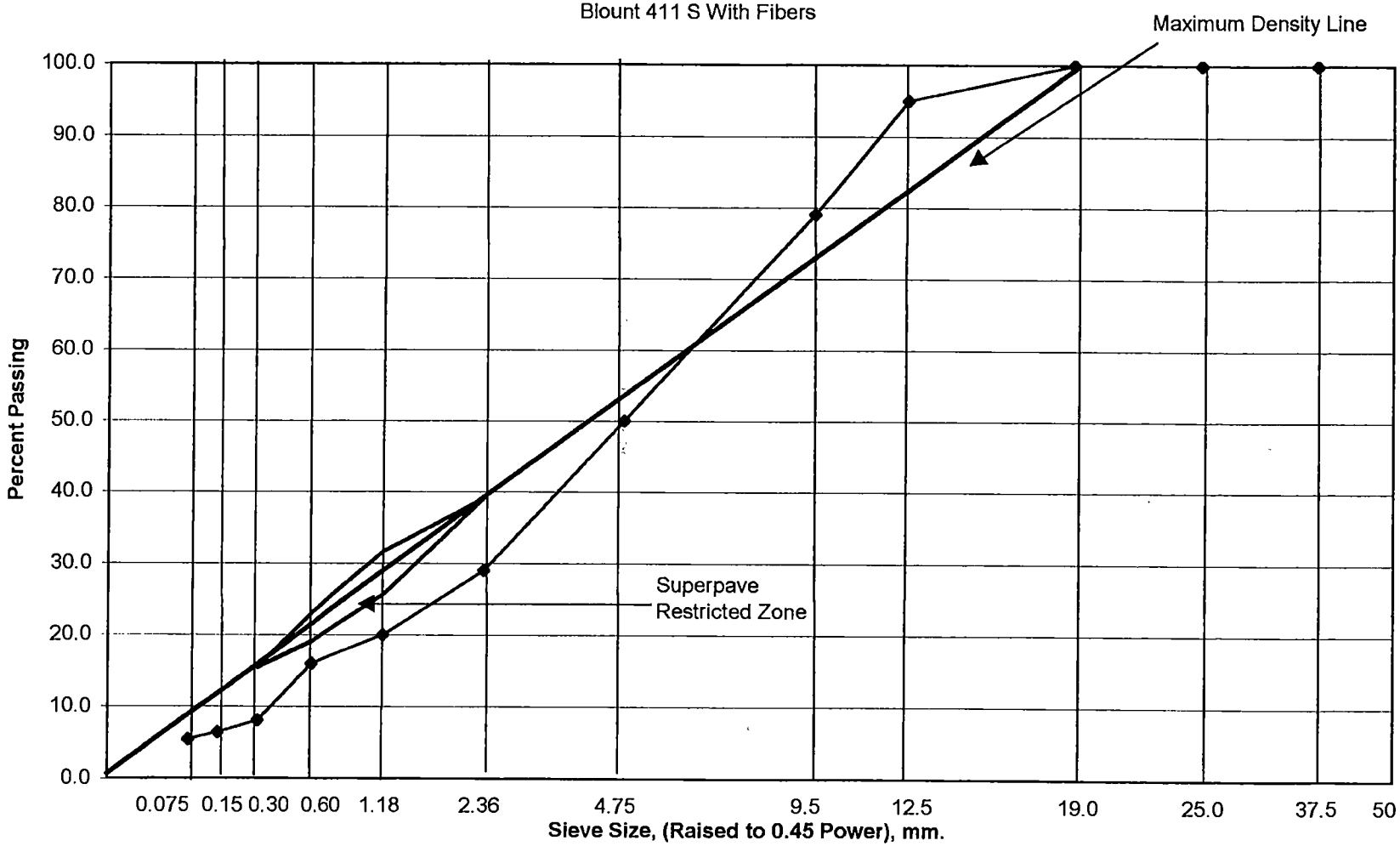
Asphalt: Description: PG 76-22

SGas= 1 031

Specimen	% AC	Weight (g)	Height (mm) Ndes	Height (mm) Nmax	Bulk SG det.	C	Bulk SG est. @ des	TMD	VTM (%)	VMA blk (%)	VMA eff (%)	VFA blk (%)	VFA eff (%)
	5 5	4897 7	117 7	116 1	2 430	1.018	2.397	2 530	5 3	17 4	18 0	69 7	70 8
	5 5	4892.7	118.2	116 5	2.425	1 020	2.390	2.530	5.5	17 6	18 3	68.6	69 7
Avg			118.0	116.3	2 428		2 394		5.4	17.5	18 2	69.2	70.3
	6.0	4841 6	116 5	114 8	2.430	1.018	2.395	2.511	4 6	17 9	18.6	74.2	75.1
	6.0	4883 6	116.3	115.2	2.435	1.015	2.412	2.511	3.9	17 3	18 0	77 3	78.1
Avg.			116 4	115.0	2.433		2.403		4.3	17.6	18.3	75 7	76.6
	6 5	4985 9	117.5	116.2	2 452	1.010	2.425	2 492	2.7	17.3	18 0	84 5	85.1
	6 5	4983 1	115 2	113.6	2.454	0.989	2.420	2.492	2.9	17.5	18 1	83 5	84 1
Avg			116 4	114.9	2 453		2.422		2.8	17.4	18.1	84.0	84.6
Optimum	6 1	4846.5	116.0	114.2	2.436	1 014	2.398	2.507	4.3	17.9	18 5	75.7	76 6
	6.1	4889.6	116 4	114.8	2.445	1.014	2.411	2.507	3.8	17 4	18.1	78.1	78.9
Avg.			116 2	114.5	2.441		2.405		4.1	17 6	18 3	76.9	77.8

N des 96

Mix Design Gradation
12.5 mm Nominal
Blount 411 S With Fibers



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Blount 411 S - With Fibers			
Theoretical Maximum (Rice) Specific Gravity =	2.512			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.0	6820.2	6820.0
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	133.3	134.4	148.9	148.9
(° F)	272.0	274.0	300.0	300.0
Mix Temperature, ° C	147.2	148.9	148.9	151.1
(° F)	297.0	300.0	300.0	304.0
Number of Gyrations	32	28	N/A	N/A
Compacted Height, mm	75.1	75.0	N/A	N/A
(in.)	2.9567	2.9528	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	70.0	70.0
Dry mass (A), g	2993.5	2987.2	6792.7	6790.9
(lb)	6.6	6.6	15.0	15.0
Dry mass with Parafilm (D), g	3003.7	2996.7	6803.6	6802.1
(lb)	6.6	6.6	15.0	15.0
Wet mass with Parafilm (E), g	1683.2	1676.2	3784.9	3786.8
(lb)	3.7	3.7	8.3	8.3
Wet mass w/o Parafilm (C), g	1728.6	1723.4	3907.3	3901.1
(lb)	3.8	3.8	8.6	8.6
Saturated Surface Dry mass (B), g	3008.5	3003.5	6838.0	6839.5
(lb)	6.6	6.6	15.1	15.1
Specific Gravity (Gmb), SSD	2.339	2.334	2.318	2.311
Specific Gravity (Gmb), Parafilm	2.297	2.290	2.264	2.266
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	7.1%	7.7%	8.0%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.6%	8.9%	9.9%	9.8%
NCAT Asphalt Content (%)	6.0%	6.0%	6.0%	6.0%

APA Dial Gauge Readings, mm

Mix Type: Blount 411 S W/ Fibers

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.95	10.46	10.29	9.89	9.56	- N/A -				
Aft Front	11.87	11.13	10.87	10.69	10.13	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.06	10.34	10.08	9.72	9.34
Fwd Front	- N/A -					11.52	10.53	10.35	9.90	9.67

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	9.00	8.18	7.97	7.59	7.16	9.71	9.28	9.21	9.13	8.95
Aft Front	10.02	9.15	9.08	8.44	8.17	9.99	9.33	9.20	8.99	8.85
Middle	10.53	9.76	9.66	9.25	9.14	10.42	9.90	9.80	9.62	9.49
Fwd Rear	10.63	9.76	9.54	9.18	8.95	10.49	9.93	9.83	9.60	9.36
Fwd Front	10.43	9.59	9.49	9.17	8.89	10.11	9.50	9.15	8.85	8.81

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.49	0.66	1.06	1.39
Aft Front	0.74	1.00	1.18	1.74
Average	0.61	0.83	1.12	1.57

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.72	0.98	1.34	1.72
Fwd Front	0.99	1.17	1.62	1.85
Average	0.86	1.08	1.48	1.79

Cycles	500	1000	4000	8000
Average	0.73	0.95	1.30	1.68
Both Pills				

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.82	1.03	1.41	1.84	0.43	0.50	0.58	0.76
Aft Front	0.87	0.94	1.58	1.85	0.66	0.79	1.00	1.14
Middle	0.77	0.87	1.28	1.39	0.52	0.62	0.80	0.93
Fwd Rear	0.87	1.09	1.45	1.68	0.56	0.66	0.89	1.13
Fwd Front	0.84	0.94	1.26	1.54	0.61	0.96	1.26	1.30
Averages								
All 5	0.83	0.97	1.40	1.66	0.56	0.71	0.91	1.05
Middle 3	0.84	0.97	1.44	1.64	0.58	0.69	0.90	1.07
Middle Excluded	0.85	1.00	1.43	1.73	0.57	0.73	0.93	1.08

Appendix A – 7

County & Mix Type: Blount – Loudon 307 BM/2

Project Number: 4858

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

MIX DESIGN NO:	D-1(98)15	SERIAL NO: 97-1(98)23	DATE: 01/29/98
REGION:	ONE	ARTICLE NO:	307-03.16
PROJECT REF. NO:	DS-NH 33(12)	COUNTY:	BLOUNT & LOUDON
PROJECT NO:	[0S001-3264-14]	CONTRACT NO:	48S8
TYPE:	BCHM-BM/2	SEC. NO:	307-BM/2
CONTRACTOR:	APAC-TN:HARRISON	SUBCONTRACTOR:	
STATE RT. NO:	411-SOUTH	DATE OF LETTING:	6/97

Material	Total Percent Passing	Producer and Address				Percer Used
#S6,LIMESTONE	12.5mm-7Sum	VULCAN MATERIALS,MARYVILLE				35.3
#8,LIMESTONE	9.5mm-7Sum	VULCAN MATERIALS,MARYVILLE				15.2
NATURAL SAND	9.5mm-7Sum	HIGHLAND SAND,CRABORCHARD				25.7
RAP	12.5mm-7Sum	HARRISON,STOCKPILE				19.1
Asphalt Cement	PG 64-22	SOUTHERN STATES,KNOXVILL	3.6%	0.9%		4.5
Anti-Strip	PAVE BOND	Dossage Rate:	0.5%	VIRGIN AC	RECLAIM AC	10
% Fractured Faces on Plus No. 4 Material:		NA				
% Glassy Particles on Plus No. 4 Material:		NA				

100 PERCENT MINERIAL AGGREGATE	DESIGN RANGE	Requested Percent		AGGREGATE ANALYSIS TOTAL PERCENT PASSING #56 PERCENT	#8 PERCENT	SAND PERCENT	RAP PERCENT	FILLER PERCENT	Calculate Mix
MIX TEMP	1S2/1S8 C	1SS C	311 F	36.0%	15.0%	27.0%	20.0%	2.0%	100.0
COMP MIX	142/147 C	144 C	292 F						
% AC	4.2-6.2	4.S							
RAP AC	4.5%								
31.7Smm	100	100		100	100	100	100	100	100.
19.0mm/3/4	81/93	91	407-QA	7S	100	100	100	100	91.
9.Smm/3/8	S7/73	63	TEST	11	84	100	87	100	63.
4.7Smm/#4	40/S6	44	TOLERANCE	S	6	9S	64	100	44.
2.36mm/#8	28/43	36		4	S	87	44	100	36.
600um/#30	13/2S	2S		2	1	6S	23	100	2S.
300um/#S0	9/19	10		2	1	14	18	100	10.
150um/#100	6/10	6.6		1	1	S	13.9	100	6.
7Sum/#200	2.S/6.S	4.8		0.S	0.2	1.6	10.6	100	4.
				THEO. GRAVITY 2.602	kg/m3 2602.0	PCF 162.4	D.A.R. 1.1	TSR 84%	

Requested {APAC-TN}HARRISON DIV. Bobby Everett
Contractor

Approved
Region Materials Engineer

Approved
Region Const. Engineer

Approved
Engineer of Materials and Test

MARSHALL WORK SHEET 307-BM/2

DATE:	01/28/98	MATERIALS	
PROJ REF	DS-NH 33(12)	#56	VULCAN
PROJ. NO.	05001-3264-14	LIMESTONE	MARYVILLE
	53005-3212-14		
CONTRACT #	4858	#8	VULCAN
COUNTY:	BLOUNT	LIMESTONE	MARYVILLE
REGION:	1		
TYPE MIX:	307-BM/2	NATURAL	HIGHLAND
CONTRACTOR:	HARRISON CONST.	SAND	CRABORCHARD
AC GRADE	PG 64-22		
SP.GR.AC	1.040	RAP	HARRISON

DESIGN NO. DM-1(98)15 GRADATION OF MATERIALS USED SERIAL NO. M-1(98)23

MATERIAL	#56	#8	SAND	RAP	FILLER	BLEND	DESIGN
PERCENT	36%	15.0%	27%	20%	2%	100%	RANGE
11/4/31.75m	100%	100%	100%	100%	100%	100.0%	100
3/4/19mm	75%	100%	100%	100%	100%	91.0%	81/93
3/8/9.5mm	11%	84%	100%	87%	100%	63.0%	57/73
#4/4.75mm	5.0%	6%	98%	64%	100%	44.0%	40/56
#8/2.36mm	4.0%	5%	87%	44%	100%	36.5%	28/43
#30/600um	2.0%	1%	65%	23%	100%	25.0%	13/25
#50/300um	2.0%	1%	14%	18%	100%	10.3%	9/19
#100/150um	1.0%	1.0%	5.0%	13.9%	100%	6.6%	6/10
#200/75um	0.5%	0.2%	1.6%	10.6%	100%	4.8%	2.5/6.5
BULK SP.GR. AGG.							
EFF.SP.GR.A					2.800		
APP. SP.GR.							

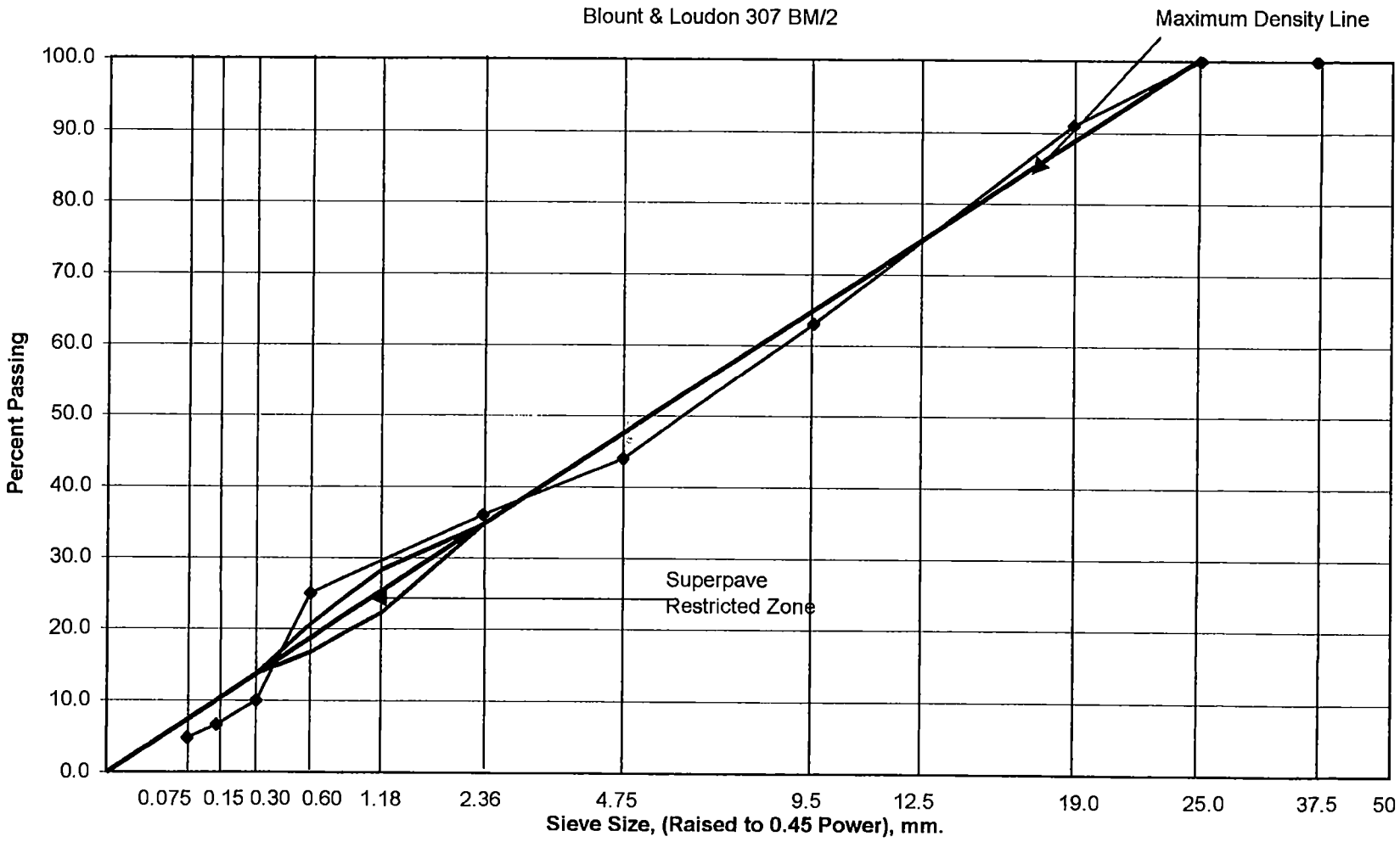
FORMULATIONS

MIX NO.	1	2	3	4	5	REG: 1/13
% ASPHALT	4.0%	4.5%	5.0%	5.5%		4.5
STABILITY L	4570	4950	3880	3500		4100
SP.GR.MAR.P	2.465	2.489	2.514	2.519		2.493
THEO.GR.MIX	2.622	2.602	2.582	2.562		2.602
LBS. CU. FT	153.8	155.3	156.9	157.2		143
FLOW	9.2	13.0	11.7	16.3		4.6
% AIR VOIDS	6.0%	4.3%	2.6%	1.7%		95.4
% THEO.GR.	94.0%	95.7%	97.4%	98.3%		153
% VMA	15.5%	15.1%	14.7%	15.0%		703
% of VFA	61.2%	71.3%	82.2%	88.8%		

11.15

%A.C. REQUE	4.50%	FRACTURED FACE:	NA
ANTI-STRIP	0.5% PAVEBOND	L.O.I.:	NA
T.S.R.	84% / REG 1834/1862 = 986	DUST/AC RATIO:	1.06
AGG. ABS.:	NA/RAP/MIX	%AC in RAP :	4.5%=0.9% RECLAIM
THEO. GR.	2.602	GRAMS 2.5" Specimen:	1250
MIXING	311F/155C	COMPACTION	292F/144C

Mix Design Gradation
19 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Blount / Loudon 307 BM/2			
Theoretical Maximum (Rice) Specific Gravity =	2.617			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3080.0	3080.1	7070.0	7070.8
(lb)	6.8	6.8	15.6	15.6
Mold Temperature, ° C	135.0	124.4	137.8	137.8
(°F)	275.0	256.0	280.0	280.0
Mix Temperature, ° C	151.1	150.6	148.3	147.8
(°F)	304.0	303.0	299.0	298.0
Number of Gyrations	11	14	N/A	N/A
Compacted Height, mm	75.0	75.2	N/A	N/A
(in.)	2.9528	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	60.0	60.0
Dry mass (A), g	3073.0	3069.0	7046.2	7027.0
(lb)	6.8	6.8	15.5	15.5
Dry mass with Parafilm (D), g	3081.4	3076.6	7057.8	7039.8
(lb)	6.8	6.8	15.6	15.5
Wet mass with Parafilm (E), g	1770.6	1770.4	4173.0	4089.3
(lb)	3.9	3.9	9.2	9.0
Wet mass w/o Parafilm (C), g	1833.1	1840.1	4257.7	4226.5
(lb)	4.0	4.1	9.4	9.3
Saturated Surface Dry mass (B), g	3093.7	3095.7	7062.7	7055.3
(lb)	6.8	6.8	15.6	15.6
Specific Gravity (Gmb), SSD	2.438	2.444	2.512	2.484
Specific Gravity (Gmb), Parafilm	2.370	2.373	2.459	2.399
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	6.6%	4.0%	5.1%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.5%	9.3%	6.0%	8.3%
NCAT Asphalt Content (%)	5.7%	5.7%	5.7%	5.7%

APA Dial Gauge Readings, mm

Mix Type: Blount / Loudon 307 BM/2

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.46	10.75	10.43	9.36	8.38	- N/A -				
Aft Front	11.71	10.99	10.72	9.73	8.88	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.60	11.00	10.68	9.42	8.29
Fwd Front	- N/A -					11.07	10.45	10.21	9.45	8.79

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.71	1.03	2.10	3.08
Aft Front	0.72	0.99	1.98	2.83
Average	0.72	1.01	2.04	2.96

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.60	0.92	2.18	3.31
Fwd Front	0.62	0.86	1.62	2.28
Average	0.61	0.89	1.90	2.80

Cycles	500	1000	4000	8000
Average Both Pills	0.66	0.95	1.97	2.88

Appendix A – 8

County & Mix Type: Campbell 307 BM/2

Project Number: 5161

07-02-98 THU 15:13 FAX 423 579 2001 TN ASPHALT-KNOX

MODIFICATION # MV-1(98)30 JMF Change for Gradation

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA Date 7-2-98

Project Reference No. IME-75-3(130)129 County Campbell Region I

Project No. 07100-8104-44 Contract No. 5161

Type BPMB-HM Sec. No. 307BM2 Article No M03.16

Contractor Tennessee Asphalt Subcontractor

State RI No I-75 TOTAL MIX INCLUDING BITUMEN Date of Letting 3-20-98

MATERIAL	SCREEN Total Percent Passing	SER.M-1(98)232 PRODUCER, AND ADDRESS DES: DV-1(98)190	PERCENT USED
C.A. Sp 5	1¼"-#200	Key Limestone, LaFollette	23.95
Med C.A. 7	¾"-#200	Key Limestone, LaFollette	19.16
Screenings 10	⅜"-#200	Key Limestone LaFollette	23.95
Sand Black	⅜"-#200	Horsehead Res Dev., Rockwood	14.37
RAP I-75 New	¾"-#200	Tennessee Asphalt Co., LaFollette	14.37
Asphalt Cement	PG 64-22	Shell Oil Co., Knoxville	4.20
Anti-Strip	Type: Parebond Lite	Dosage Rate: 0.5	

% Fractured Faces on Plus No. 4 Material: — % Glassy Particles on Plus No. 4 Material — 100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Med C.A. Percent	Screenings Percent	Sand Percent	RAP Percent	Calculated Mix
Temp.	135°-160°C 275°-325°	148.9°C 300°	280°-320°	25	20	27	10	18	100
% A.C.	4.2-6.2	4.2			Theo Dens = 2.601				
					DAR = 1.2				
2 "									
1-1/2"									
1¼" 31.5mm	100	100		100	100	100	100	100	100
¾" 19mm	81-93	93		72	100	100	100	100	93
⅝"									
½"									
⅜" 9.5mm	57-73	68 69.1		2	68	100	100	93	68
No. 4 4.75mm	40-56	46		1	1	88	92	71	46
No. 8 2.36mm	28-43	33		1	1	60	67	52	33
No. 30 600 µm	13-25	15		1	1	27	21	31	15
No. 50 300 µm	9-19	10		1	1	19	9	21	10
No. 100 150 µm	6-10	7.11		1	1	14.11	2.8	14.27	7.11
No. 200 75 µm	2.5-6.5	5.03		—	1	10.51	1.0	10.49	5.0

Requested Tennessee Asphalt Co. Approved [signature] Region Materials Engineer

Approved [signature] Project Construction Engineer Approved Engineer of Tests and Field

Date 6-12-98
Type of Mix 307 BM2
Project Reference No. IME-75-3(130)129

Contract No. 5161
County Campbell
Region I

Contractor TAC
No. Hammer Blows 75
Sp. Gr. AC 1.029

Sample No.	% AC	% Agg.	Weight - Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp. Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (0.1")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D–E	C / F	See* below	See* below	100 –G / H X 100	100 – B x G / I	(A x G / SP. GR AC) x 100 / K	62.4 x G		
	3.7	96.3	1191.4	1195.2	716.7	478.5	2.490	2.650		5.9	14.9	60.2	155.426	3050	12
			1197.2	1201.1	722.4	478.7	2.501							3175	13
			1193.4	1197.3	718.2	479.1	2.491							3225	13
						Avg.	2.494						Avg.	3150	13
	4.2	95.8	1193.6	1197.9	720.2	477.7	2.499	2.629	2.821	4.8	15.0	68.1	156.125	3750	13
			1200.6	1203.0	723.5	479.5	2.504							3650	14
			1194.2	1197.5	720.4	477.1	2.503							3425	14
						Avg.	2.502						Avg.	3608	14
	4.7	95.3	1201.3	1205.2	727.2	478.0	2.513	2.608		3.7	15.1	76.0	156.749	3400	14
			1194.7	1199.6	723.6	476.0	2.510							3275	15
			1199.2	1204.3	727.1	477.2	2513							3575	16
						Avg.	2.512						Avg.	3417	15
	5.2	94.8	1199.3	1209.6	726.0	478.6	2.506	2.587		3.0	15.7	80.8	156.562	3325	16
			1191.4	1195.7	721.4	474.3	2.512							3150	16
			1201.1	1205.8	727.1	478.7	2.509							3050	16
						Avg.	2.509						Avg.	3175	16

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*EFF. GRAV. AGGS. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{\text{Sp. Gr. AC}}}$

*Theo. Grav. (H) (At any AC content) = $\frac{100}{\frac{A}{\text{Sp. Gr. AC}} + \frac{B}{I}}$

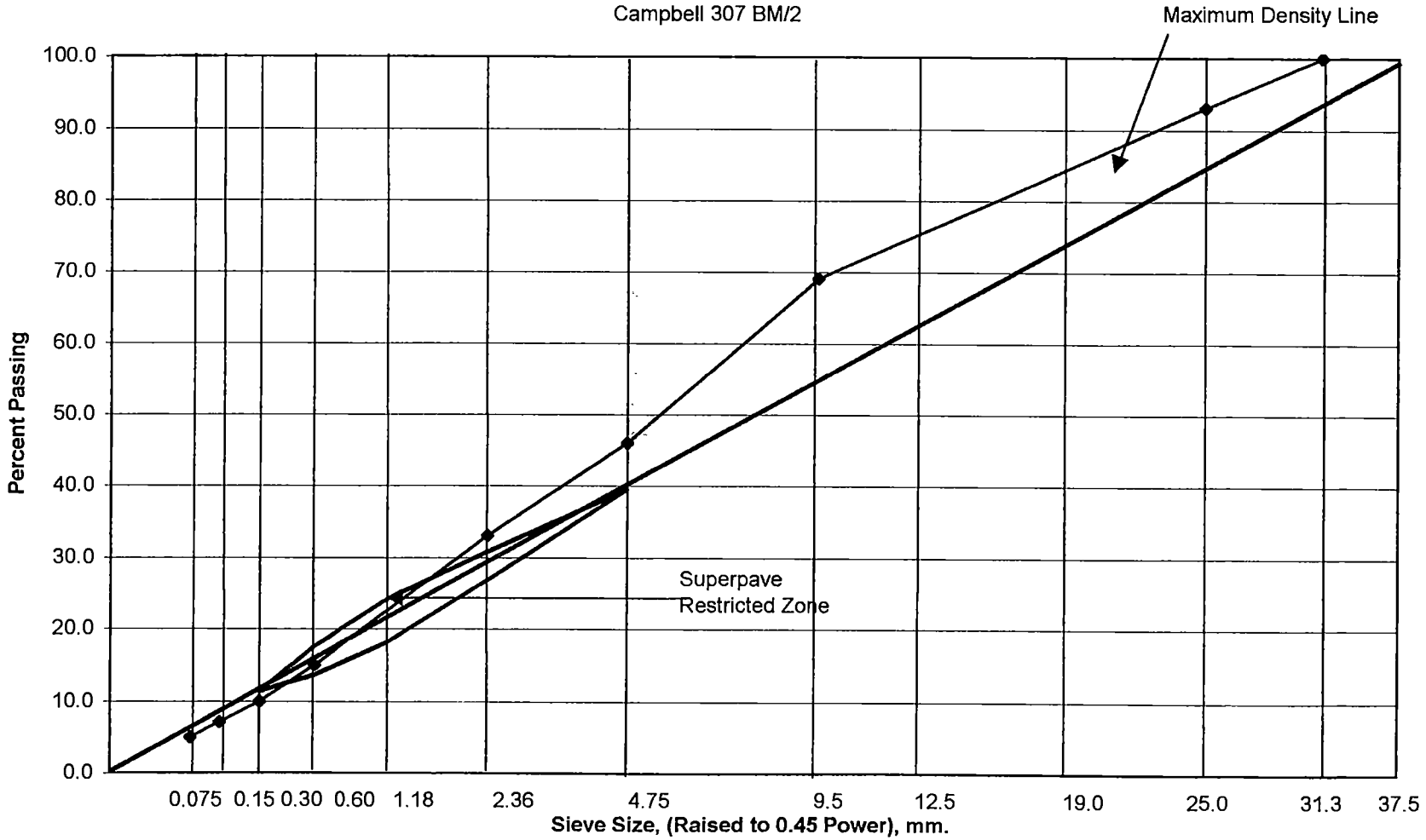
Agg. Loss on Ignition (LOI) NA
Agg. Fractured Face Count NA
Agg. Glassy Particles NA
Agg. Absorption .9
Agg. Bulk Sp. Gr. 2.752
Agg. Apparent Sp. Gr. 2.840
Grams for 2.5" Specimen 1203

Recommended AC Content 4.2
Theoretical Gravity 2.629
Dust to AC Ration (DAR) 1.1
Amount & Type Additive 0.5 Payebond L
Mix Tensile Strength Ratio (TSR) 80.8

Approved TPC/6-25-98

Mix Design Gradation
25 mm Nominal

Campbell 307 BM/2



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Campbell 307 BM/2			
Theoretical Maximum (Rice) Specific Gravity =	2.615			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3125.5	3125.2	7080.4	7080.1
(lb)	6.9	6.9	15.6	15.6
Mold Temperature, ° C	162.8	154.4	132.2	132.2
(° F)	325.0	309.9	270.0	270.0
Mix Temperature, ° C	148.9	148.3	148.9	148.3
(° F)	300.0	298.9	300.0	299.0
Number of Gyrations	52	66	N/A	N/A
Compacted Height, mm	75.1	75.2	N/A	N/A
(in.)	2.9567	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	60.0	70.0
Dry mass (A), g	3099.4	3101.4	7044.8	7050.3
(lb)	6.8	6.8	15.5	15.5
Dry mass with Parafilm (D), g	3110.2	3108.8	7057.1	7062.5
(lb)	6.9	6.9	15.6	15.6
Wet mass with Parafilm (E), g	1783.6	1795.1	4116.2	4091.9
(lb)	3.9	4.0	9.1	9.0
Wet mass w/o Parafilm (C), g	1848.0	1870.5	4204.0	4202.2
(lb)	4.1	4.1	9.3	9.3
Saturated Surface Dry mass (B), g	3107.7	3111.7	7067.5	7058.6
(lb)	6.9	6.9	15.6	15.6
Specific Gravity (Gmb), SSD	2.460	2.499	2.460	2.468
Specific Gravity (Gmb), Parafilm	2.368	2.383	2.412	2.390
VTM =[1-(Gmb/Gmm)], SSD (%)	5.9%	4.5%	5.9%	5.6%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.4%	8.9%	7.8%	8.6%
NCAT Asphalt Content (%)	4.0%	4.0%	4.0%	4.0%

APA Dial Gauge Readings, mm

Mix Type: Campbell 307 BM/2

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.64	10.55	10.46	10.39	10.22	- N/A -				
Aft Front	9.87	9.44	9.32	9.06	8.82	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.88	10.33	10.24	9.70	9.39
Fwd Front	- N/A -					10.73	9.97	9.68	8.98	8.48

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	8.32	7.68	7.45	7.04	6.41	9.23	8.48	8.35	7.91	8.35
Aft Front	8.25	7.60	7.36	7.03	6.54	9.75	9.19	9.15	8.81	7.05
Middle	8.82	7.95	7.79	7.49	7.18	9.40	8.98	8.90	8.51	7.64
Fwd Rear	8.79	7.96	7.69	7.38	7.16	9.48	8.92	8.86	8.59	7.87
Fwd Front	8.36	7.91	7.57	7.37	7.10	9.34	8.58	8.40	7.93	6.38

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.09	0.18	0.25	0.42
Aft Front	0.43	0.55	0.81	1.05
Average	**0.26**	**0.36**	**0.53**	**0.73**

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.55	0.64	1.18	1.49
Fwd Front	0.76	1.05	1.75	2.25
Average	**0.66**	**0.85**	**1.47**	**1.87**

Cycles	500	1000	4000	8000
Average Both Pills	0.46	0.61	1.00	1.30

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.64	0.87	1.28	1.91	0.75	0.88	1.32	0.88
Aft Front	0.65	0.89	1.22	1.71	0.56	0.60	0.94	2.70
Middle	0.87	1.03	1.33	1.64	0.42	0.50	0.89	1.76
Fwd Rear	0.83	1.10	1.41	1.63	0.56	0.62	0.89	1.61
Fwd Front	0.45	0.79	0.99	1.26	0.76	0.94	1.41	2.96
Averages								
All 5	**0.69**	**0.94**	**1.25**	**1.63**	**0.61**	**0.71**	**1.09**	**1.98**
Middle 3	**0.78**	**1.01**	**1.32**	**1.66**	**0.51**	**0.57**	**0.91**	**2.02**
Middle Excluded	**0.64**	**0.91**	**1.23**	**1.63**	**0.66**	**0.76**	**1.14**	**2.04**

Appendix A – 9

County & Mix Type: Campbell 411 D

Project Number: 5161

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA Date 7-17-98

Project Reference No. IME-75-3(130)129 County Campbell Region I

Project No. 07100-8104-44 Contract No. 5161

Type ACSC-HM Sec. No. 411-D Article No. M.01.01-08.01

Contractor Tennessee Asphalt Co Subcontractor

State Rt. No. I-75 TOTAL MIX INCLUDING BITUMEN Date of Letting 3-20-98

MATERIAL	SCREEN Total Percent Passing	SER. No. M-1(98)233-A PRODUCER, AND ADDRESS DES. No. DU-1(58)191-A	PERCENT USED
C.A.			
Med. C.A.	5/8"-#200	Vulcan Mtls Co., Enaka, NC	46.90
Screenings	3/8"-#200	Key Limestone Co., LaFollette, Tn	23.45
Sand Slag	3/8"-#200	Horsehead Res Dev., Rockwood, Tn	9.38
~~RAP~~ Nat. Sand	3/8"-#200	Nolichucky Sond & Gravel, Greeneville, Tn.	14.07
Asphalt Cement	PG 76-22	Shell Oil Co., Knoxville, Tn.	6.20
Anti-Strip	Type: Pavebond Lite	Dosage Rate: 0.5	

% Fractured Faces on Plus No. 4 Material: 80 % Glassy Particles on Plus No. 4 Material: NA 100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C. A. Percent	Med. C. A. Percent	Screenings Percent	Sand Slag Percent	~~RAP~~ Nat. Sand Percent	Calculated Mix
Temp.	163.9-171.3°C 327-344°F	168.6°C 335.5°F			50	25	10	15	100
% A.C.	5.3-7.0	6.2							
							2489 KN/m3		
2 "		REVISED FOR M.C. & THEO.		GRAV	Theo	Dens = 2.489/155.314 pc			
1-1/2"					DAR = 0.6				
1 "					LOI = 9.9				
3/4 "									
5/8 "16mm	100	100			100	100	100	100	100
1/2 "12.5mm	95-100	98			95	100	100	100	98
3/8 "9.5mm	80-93	87			73	100	100	100	87
No. 4 4.75mm	54-76	60			28	88	97	96	60
No. 8 2.36mm	35-57	38			7	60	76	78	38
No. 30 600 µm	17-29	17			3	27	26	38	17
No. 50 300 µm	10-18	10			2	20	11	17	10
No. 100 150 µm	3-10	6.03			2	14.11	3.78	7.47	6.03
No. 200 75 µm	0-6.5	3.85			1	10.51	1.38	3.90	3.85

Requested Tennessee Asphalt Co. Approved

Approved Jeana Norris Approved

Region Construction Engineer Region Materials Engineer

Engineer of Materials and Tests

PENNCO 573-3301 - BEEPER 622-4512

HOT MIX ASPHALT VERIFICATION

Project Ref. No. IME-75-3(130)129 Date 7/17/98
Project No. 47100-8104-44
Contract No. 3161 County Campbell
Engineer Bobby Parks Region E
Contractor Tennessee Asphalt Type Mix [redacted] 411-D
Verification No. MH(98)32 Plant Location LaFollette

EXTRACTION TEST <<<<>>>> **ASPHALT CONTENT OVEN**

Total Weight		Filter Weight After		Sample Wt. Before Ignition	931.8
Sample Agg.Wt.		Filter and Fine Agg		Sample Wt. After Ignition	872.6
Wt. of AC		Minus 75um (#200)		Calib. Factor From JMF	0.39
Percent AC		Plus 75um (#200)		Agg. Weight Loss*	3.63
				Total Dry Weight**	876.2
				Percent AC	5.78

From JMF

Serial No.	M-1(98)231
Design No.	DH-(98)191
Percent AC	7.0
Max. Spec. Grav.	2.574
T.S.R.	9226/11118 = 83.4
L.O.I.	9.9

*Agg.Wt. Loss = (Calibration Factor/100) * Sample Weight Before Ignition

**Total Dry Weight = Sample Weight After Ignition + Agg Weight Loss

Sieve Analysis

Sieve	Weight	% Ret.	% Pass.	JMF	Dev.	Sieve	Weight	% Ret.	% Pass.	JMF	Dev.
25mm(1")						25mm(1")					
19mm(3/4)						19mm(3/4)	0	0	100	100	0
12.5mm(1/2)						12.5mm(1/2)	28.6	3.3	96.7	98	1.3
9.5mm(3/8)						9.5mm(3/8)	113.5	13.0	87.0	87	0
4.75mm(#4)						4.75mm(#4)	375.4	42.8	57.2	60	2.8
2.36mm(#8)						2.36mm(#8)	502	66.0	34.0	38	4.0
1.18mm(#16)						1.18mm(#16)	~~330.0~~	~~84.5~~	~~15.5~~		
600um(#30)						600um(#30)	737.0	84.4	15.5	17	1.6
300um(#50)						300um(#50)	788.6	90.4	9.6	10	0.4
150um(#100)						150um(#100)	821.0	94.1	5.91	6.03	0.12
75um(#200)						75um(#200)	841.2	96.4	3.60	3.85	0.25

Max. Specific Gravity (Rice)

Dry Wt.	1098.5	Effective Gravity	2.796
Wet Wt.	3161.6	Maximum Gravity	2.489
Bowl Dry	647.0	Spec.Grav. of AC	1.031
Bowl Wet	2534.3		

Tensile Strength

Dry Strength	
Wet Strength	
Strength Ratio(TSR)	

Marshall Test

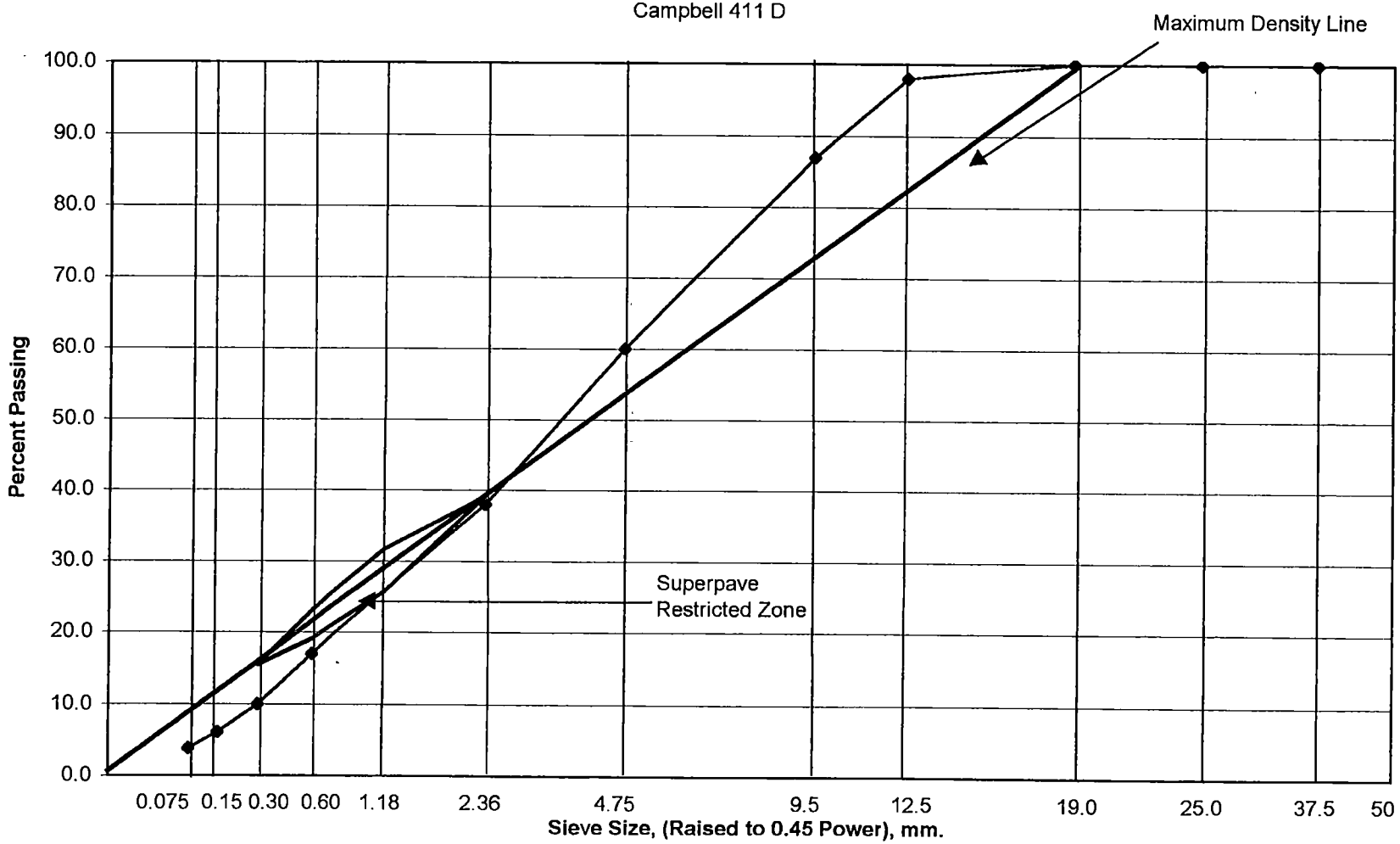
Sample	Dry Wt.	Wt. In Water	S.S.D. Wt.	Bulk Gav.	Voids	VMA	VFA
1	1197.3	700.1	1199.1	2.399	3.6	18.1	79.1
2	1196.4	698.7	1200.1	2.390	4.0	18.4	78.1
3	1195.8	704.5	1197.4	2.426	2.5	17.1	85.3
			Averages>>>>>	2.405	3.4	17.8	81.3
		Avg.Stability	3117	Avg. Flow		16.0	

Loss On Ignition

Wt. Before Ing.	
Wt After Ing.	
Percent Loss	

Contractor's Plant Tech. & No. KEN FLOWERS PT-027
State Const. Plant Tech. & No. MACK PRACE
Matls. Plant Tech. & No. Ted Foster - M 892/127-275

Mix Design Gradation
12.5 mm Nominal
Campbell 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Campbell 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.504			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3010.0	3010.0	6800.2	6800.8
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	148.9	154.4	143.3	143.3
(° F)	300.0	309.9	290.0	290.0
Mix Temperature, ° C	148.9	149.4	150.6	150.0
(° F)	300.0	300.9	303.0	302.0
Number of Gyrations	16	10	N/A	N/A
Compacted Height, mm	74.9	74.5	N/A	N/A
(in.)	2.9488	2.9331	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	60.0	60.0
Dry mass (A), g	2959.3	2876.4	6766.9	6768.1
(lb)	6.5	6.3	14.9	14.9
Dry mass with Parafilm (D), g	2967.9	2883.3	6778.7	6780.0
(lb)	6.5	6.4	14.9	14.9
Wet mass with Parafilm (E), g	1649.4	1571.1	3880.7	3806.8
(lb)	3.6	3.5	8.6	8.4
Wet mass w/o Parafilm (C), g	1696.3	1646.5	3944.0	3891.6
(lb)	3.7	3.6	8.7	8.6
Saturated Surface Dry mass (B), g	2965.2	2897.8	6776.8	6781.5
(lb)	6.5	6.4	14.9	15.0
Specific Gravity (Gmb), SSD	2.332	2.299	2.389	2.342
Specific Gravity (Gmb), Parafilm	2.269	2.211	2.351	2.292
VTM =[1-(Gmb/Gmm)], SSD (%)	6.8%	8.2%	4.6%	6.5%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.4%	11.7%	6.1%	8.5%
NCAT Asphalt Content (%)	6.6%	6.6%	6.6%	6.6%

APA Dial Gauge Readings, mm

Mix Type: Campbell 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.34	10.86	10.43	9.98	9.38	- N/A -				
Aft Front	11.61	10.69	10.55	9.89	9.28	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					12.49	11.69	11.38	10.81	10.49
Fwd Front	- N/A -					12.41	11.74	11.51	10.98	10.54

Beam 1

Cycles	Initial	500	1000	4000	8000
Aft Rear	12.06	11.31	11.18	10.87	10.56
Aft Front	11.97	11.21	11.04	10.71	10.54
Middle	11.69	10.94	10.68	10.33	10.19
Fwd Rear	12.23	11.42	11.25	10.93	10.74
Fwd Front	11.99	11.44	11.36	11.02	10.86

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	0.48	0.91	1.36	1.96
Aft Front	0.92	1.06	1.72	2.33
Average	**0.70**	**0.98**	**1.54**	**2.15**

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	0.80	1.11	1.68	2.00
Fwd Front	0.67	0.90	1.43	1.87
Average	**0.74**	**1.01**	**1.56**	**1.94**

Cycles	500	1000	4000	8000
Average Both Pills	0.72	1.00	1.55	2.04

Beam 1

Cycles	500	1000	4000	8000
Aft Rear	0.75	0.88	1.19	1.50
Aft Front	0.76	0.93	1.26	1.43
Middle	0.75	1.01	1.36	1.50
Fwd Rear	0.81	0.98	1.30	1.49
Fwd Front	0.55	0.63	0.97	1.13
Averages				
All 5	**0.72**	**0.89**	**1.22**	**1.41**
Middle 3	**0.77**	**0.97**	**1.31**	**1.47**
Middle Excluded	**0.72**	**0.86**	**1.18**	**1.39**

Appendix A – 10

County & Mix Type: Clinton Hwy 411 S

Project Number: 5366

FINE Agg. ANGULARITY = 48.4%

Date 8/18/98

Project Reference No. SP County KNOX Region ONE

Project No 47013-4222-04 Contract No 5366

Type 411-S Sec No Article No

Contractor ROGERS GROUP INC Subcontractor

State Rt No 25W TOTAL MIX INCLUDING BITUMEN Date of letting

MATERIAL	SCREEN Total Percent Passing	SER.# M-1(98)317 PRODUCER AND ADDRESS DES.# DY-1(98)263	Percent Used
Med C A.	5/8" to pan	Rogers Group Inc. Oak Ridge, TN	56.70
Screenings	3/8" to pan scr.	Rogers Group Inc. Oak Ridge, TN	23.63
SAND	3/8" to pan	Rogers Group Inc. Oak Ridge, TN	14.17
Asphalt Cement	PG 76-22	Shell Oil Knoxville, TN	5.5
Anti-Strip	Type:	Dosage Rate:	

% Fractured Faces on Plus No 4 Material 100 % Glassy Particles on Plus No 4 Material 100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C A. Percent	Med. C A Percent	Screenings Percent	Sand Percent	RAP	Calculated Percent
Temp	150C-170C	160C	148C-170C		60	25	15		
	5.3-7.0	5.5			TSR	1157.80/1315.68 = 88%			
						THEO.	2.528		
1"					L.O.I.	32.3%			
3/4"	100	100			100	100	100		100
5/8"									
1/2"	90-100	98			97	100	100		98.2
3/8"	<90	83			72	100	100		83.2
No. 4		51			22	92	99		51.05
No 8	28-58	37			15	60	87		37.05
No. 30		18			5	24	58		17.7
No. 50		12			4	20	28		11.6
No 100		7			3	18	6		7.2
No. 200	2-10	5			2	12	3		4.65

BY CLELLAN TIDWELL

Requested ROGERS GROUP INC. Contractor

Approved Region Construction Engineer

Approved Region Materials Engineer

Approved Engineer of Material and Tests

MARSHALL DESIGN

Date 8/18/98 | Contract No 5366 | Contractor ROGERS GROUP INC.
Type of Mix 411-Superpave | County KNOX | No Hammer Blows 75
Project Reference No S.P.(47013-4222-04) | Region ONE | Sp Gr. AC ~~1.034~~ 1.026

Sample No	% AC		Weight - Grams Specimen In Air	SSD	Marshall In Water	Vol Mar. Spec.	Bulk Sp. Gr. Mar. Spec.	Theo. * Grav. Mix	Eff * Grav. Aggs	% Voids Total Mix	% Voids Min. Agg (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D - E	C / F	See * below	See * below	100 - G/H x 100	100 - (B x G) / I	[(A x G)/ (SP GR AC)]/ K	62.4xG		
1	5.0	95.0	1156.5	1159.5	672.3	487.2	2.374	2.547	2.760	-6.5	-18.0	63.7	148.6	3200	11
2			1151.3	1154.1	670.4	483.7	2.380							3350	11
3			1153.7	1156.6	673.7	482.9	2.389							3100	12
						Avg.	2.381						Avg.	3217	11.3
1	5.5	94.5	1157.1	1158.2	681.8	476.4	2.429	2.530	2.760	-4.0	-16.9	76.4	151.5	2950	13
2			1155.9	1157.1	681.6	475.5	2.431							3000	13
3			1156.3	1157.5	680.5	477.0	2.424							2900	13
							2.428						Avg.	2950	13
1	6.0	94.0	1150.9	1151.5	683.3	468.2	2.458	2.509	2.760	-2.0	-16.2	88.1	153.5	2500	14.0
2			1153.6	1154.1	686.1	468.0	2.465							2600	14.0
3			1160.1	1160.9	688.7	472.2	2.457							2500	14.0
							2.460						Avg.	2533	14.0

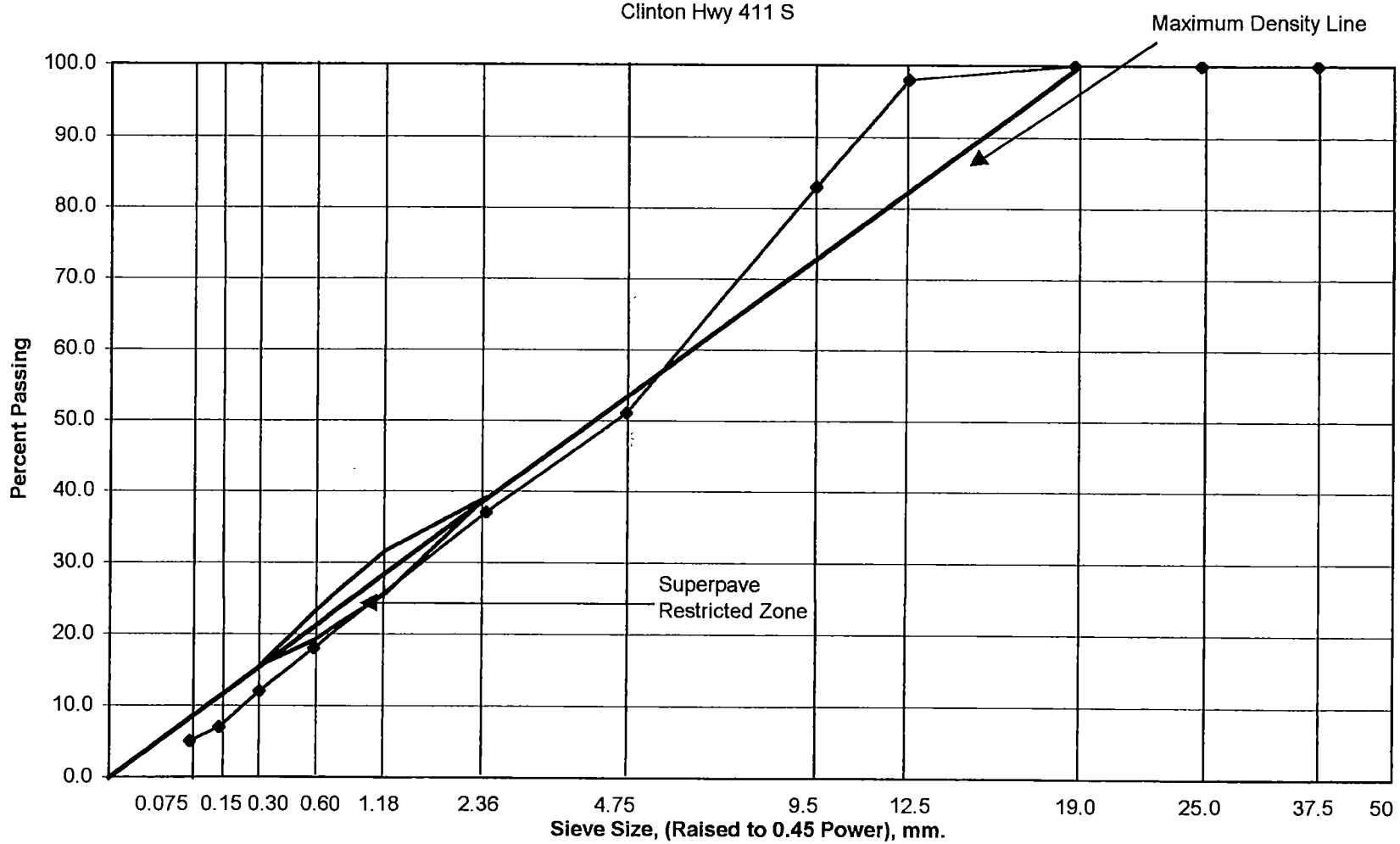
* Theo. Grav. Mix (H) as determined by AASHTO T - 208.

* Eff. Grav. Aggs (I) = $\frac{B}{[(100/H) - (A/Sp.\ Gr.\ AC)]}$

* Theo Grav. (H) (At any AC content) = $\frac{100}{[(A/Sp.\ Gr.\ AC) + (D/I)]}$

Agg. Loss on Ignition (LOI)	N/A	Recommended AC Content	5.5
Agg. Fractured Face Count	N/A	Theoretical Gravity	2.528
Agg. Glassy Particles	N/A	Dust to AC Ratio (DAR)	0.8
Agg. Absorption	0.31	Amount & Type Additive	N/A
Agg. Bulk Sp. Gr.	2.709 ~~2.700~~	Mix Tensile Strength Ratio (TSR)	100%
Agg. Apparent Sp. Gr.	2.774 ~~2.768~~		
Grams for 2.5" Specimen	1158	Approved	

Mix Design Gradation
12.5 mm Nominal
Clinton Hwy 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Clinton Hwy 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.514			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	3
Mass of Sample Before Compaction, g	3010.0	3010.0	6861.1	6860.6
(lb)	6.6	6.6	15.1	15.1
Mold Temperature, ° C	157.2	148.9	148.9	143.3
(°F)	315.0	300.0	300.0	290.0
Mix Temperature, ° C	147.2	147.2	149.4	152.2
(°F)	297.0	297.0	301.0	306.0
Number of Gyrations	29	31	N/A	N/A
Compacted Height, mm	75.3	75.2	N/A	N/A
(in.)	2.9646	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	60 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	70.0	70.0
Dry mass (A), g	2975.5	2957.4	6805.6	6790.0
(lb)	6.6	6.5	15.0	15.0
Dry mass with Parafilm (D), g	2984.9	2966.6	6820.2	6802.1
(lb)	6.6	6.5	15.0	15.0
Wet mass with Parafilm (E), g	1662.5	1646.1	3801.5	3851.7
(lb)	3.7	3.6	8.4	8.5
Wet mass w/o Parafilm (C), g	1723.4	1713.1	3907.8	3943.5
(lb)	3.8	3.8	8.6	8.7
Saturated Surface Dry mass (B), g	2984.2	2972.6	6820.5	6799.9
(lb)	6.6	6.6	15.0	15.0
Specific Gravity (Gmb), SSD	2.360	2.348	2.337	2.377
Specific Gravity (Gmb), Parafilm	2.277	2.266	2.273	2.317
VTM =[1-(Gmb/Gmm)], SSD (%)	6.1%	6.6%	7.1%	5.4%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.4%	9.9%	9.6%	7.8%
NCAT Asphalt Content (%)	6.3%	6.3%	6.3%	6.3%

APA Dial Gauge Readings, mm

Mix Type: Clinton Hwy 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.31	10.71	10.65	9.92	9.58	- N/A -				
Aft Front	11.65	11.05	10.79	10.23	9.92	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.58	10.68	10.46	9.73	9.08
Fwd Front	- N/A -					11.39	10.60	10.47	9.54	9.12

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.56	9.34	9.18	8.69	8.41	10.83	10.25	10.11	9.89	9.56
Aft Front	10.42	9.55	9.40	8.95	8.68	10.92	10.54	10.25	10.04	9.83
Middle	9.91	8.88	8.67	8.14	7.74	11.00	10.42	10.23	9.93	9.70
Fwd Rear	9.37	8.27	8.13	7.56	7.35	10.94	10.36	10.28	9.92	9.63
Fwd Front	8.90	7.94	7.80	7.42	7.14	10.19	9.85	9.70	9.45	9.16

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.60	0.66	1.39	1.73
Aft Front	0.60	0.86	1.42	1.73
Average	**0.60**	**0.76**	**1.41**	**1.73**

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.90	1.12	1.85	2.50
Fwd Front	0.79	0.92	1.85	2.27
Average	**0.85**	**1.02**	**1.85**	**2.39**

Cycles	500	1000	4000	8000
Average Both Pills	0.72	0.89	1.63	2.06

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.22	1.38	1.87	2.15	0.58	0.72	0.94	1.27
Aft Front	0.87	1.02	1.47	1.74	0.38	0.67	0.88	1.09
Middle	1.03	1.24	1.77	2.17	0.58	0.77	1.07	1.30
Fwd Rear	1.10	1.24	1.81	2.02	0.58	0.66	1.02	1.31
Fwd Front	0.96	1.10	1.48	1.76	0.34	0.49	0.74	1.03
Averages								
All 5	**1.04**	**1.20**	**1.68**	**1.97**	**0.49**	**0.66**	**0.93**	**1.20**
Middle 3	**1.00**	**1.17**	**1.68**	**1.98**	**0.51**	**0.70**	**0.99**	**1.23**
Middle Excluded	**1.04**	**1.19**	**1.66**	**1.92**	**0.47**	**0.64**	**0.90**	**1.18**

Appendix A – 11

County & Mix Type: Coffee 307 BM

Project Number: 4895

JOB MIX FORMULA

2-5-98

PROJECT REF. NO.	S.P.
PROJECT NO.	1600-4206-04
TYPE OF MIX	307BM
CONTRACTOR	ROGERS GROUP INC.
SUB CONTRACTOR	
ARTICLE NO.	

DATE	1/30/98
REGION	#2
COUNTY	COFFEE
CONT#	#4895
ST. RT.	#2
LETTING	7/16/97

Lo 1 Midley

THEORECTICAL GRAVITY	2.511
LOSS ON IGNITION	N/A
TENSIL STRENGTH RATIO	84.9
DUST TO ASPHALT RATIO	1.0
A.C. PERCENT IN RAP	
RECLAIMED A.C. FROM RAP	

Jm- 2- 11

MATERIAL	MATERIAL SIZE	PRODUCER AND ADDRESS	PERCENT USED
C.A.			
R.A.P.		Rogers Group Inc., Hillsboro Tn.	
MED C.A.	1" to pan		
MED C.A.			
SCREENINGS	3/8" to pan	Rogers Group Inc., Hillsboro Tn.	62.3
SAND	3/8" to pan	Cumb. Mtn. sand , Hillsboro Tn.	26.8
ASPHALT CEMENT	MG 20-40	Asphalt Materials Cement, Indianapolis In.	6.7
ANTI STRIP	pave bond light	Southern States Oil	4.2
FRACTURED FACES		GLASSY PARTICLES	(.5)

SCREEN SIZES	MASTER RANGE	REQUEST PERCENT	TOLER. PERCENT
TEMP.	310-340	320	
%A.C.		4.2	
50mm(2in)			
37.5mm(11/2in)			
25mm(1in)	100	100	
19mm(3/4in)	90-100	95.5	
12.5mm(1/2in)	55-80	65.7	
9.5mm(3/8in)	40-65	51.0	
4.75mm(#4)	15-35	34.7	
2.36mm(#8)	10-25	25.0	
600um(#30)	5-19	14.8	
300um(#50)	2-13	9.3	
150um(#100)	1-8	6.0	
75um(#200)	0-5	4.5	

REQUESTED Kayle Arnold RCT

APPROVED

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C.A. PERCENT	MED C.A. PERCENT	MED C.A. PERCENT	SCREEN. PERCENT	SAND PERCENT	R.A.P. PERCENT	CAL. MIX
		65	28	7		
		100	100	100		100
		93.0	100	100		95.5
		47.2	100	100		65.7
		24.6	100	100		51.0
		4.0	90.0	98.6		34.7
		2.2	61.8	90.0		25.0
		1.7	32.1	67.0		14.8
		1.5	23.1	21.4		9.3
		1.0	16.8	4.5		6.0
		0.5	12.5	2.0		4.5

APPROVED

APPROVED William T. Mounce Jr

MARSHALL MIX DESIGN

date 1/30/98
p.r. no. 16004-4206-04
type mix 307-BM

contractor ROGERS GROUP INC.
no. blows 75
sp. gr. a.c. 1.04

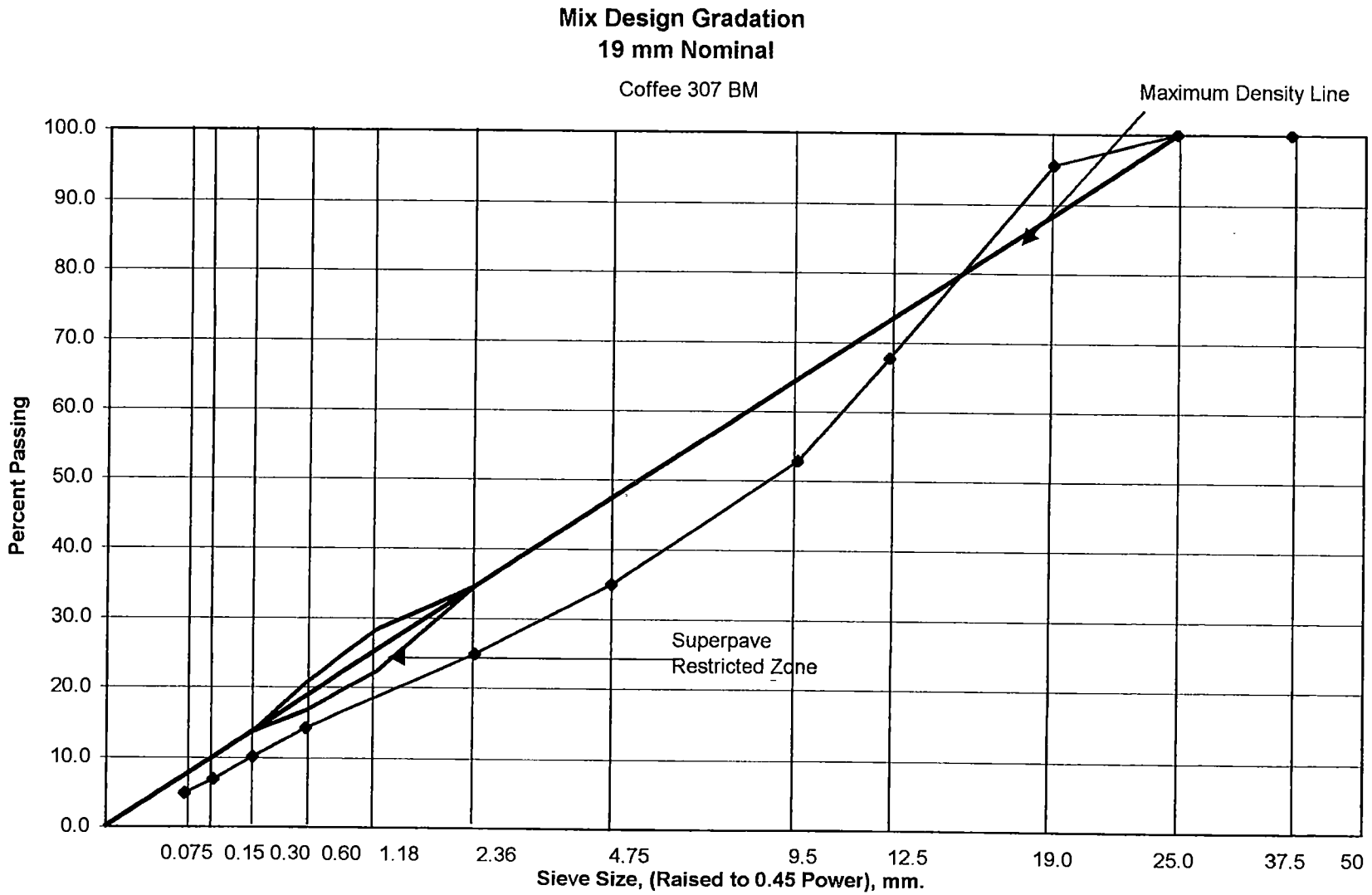
cont. no. 4895
county COFFEE CO.
region 2

sample no.	% a.c. b	% agg. c	in air d	ssd e	in water f	vol. mar. spec. g	bulk sp. gr. mar. spec. h	theo. grav. mix i	eff. grav. agg. j	voids total mix k	voids min. agg. l	voids filled a.c. m	unit weight	stability	flow
								100	c			100*			
						e-f	d/g	(b/gr.a.c)+ (c/j)	(100/i)-(b/ sp.gr.a.c.)	100- ((h/i)*100)	100- (c*h/j)	(b*h/gr.ac) /L	62.4*h		
1-1	3.85	96.15	1195.3	1201.0	702.3	498.7	2.397	2.532	2.686	5.3	14.2	62.6	149.6	3745	10
1-2			1194.9	1201.7	702.5	499.2	2.394							3622	10
1-3			1194.4	1200.4	703.0	497.4	2.401							3879	10
						avg.	2.397						avg.	3749	10
2-1	4.2	95.8	1195.3	1201.7	704.0	497.7	2.402	2.511	2.686	4.1	14.1	68.8	150.2	4004	11
2-2			1194.4	1201.4	705.5	495.9	2.409							3896	12
2-3			1197.5	1203.9	707.5	496.4	2.412							3777	13
						avg.	2.408						avg.	3892	12
3-1	4.55	95.45	1193.3	1196.2	702.3	493.9	2.416	2.506	2.686	3.5	14.1	75.3	150.9	4129	14
3-2			1195.1	1198.6	704.5	494.1	2.419							3998	14
3-3			1193.8	1195.6	702.5	493.1	2.421							3899	15
						avg.	2.419						avg.	4009	14.3
						avg.							avg.		

*Theo. Grav. Mix as determined by AASHTO T-209.

Agg. Loss on Ignition (LOI)	
Agg. Fractured Face Count	
Agg. Glossy Particles	
Agg. Absorption	1.5
Agg. Bulk Sp. Gr.	2.654
Agg. Apparent Sp. Gr.	2.721
Grams for 2.5" Specimen	1200

Recommended AC Content	4.2
Theroretical Gravity	2.511
Dust to AC Ratio (DAR)	1.0
Amount & Type Additive	0.5 pave bond lite
Mix Tensile Strength Ratio (TSR)	84.9


Mix Design Gradation
19 mm Nominal
Coffee 307 BM
Maximum Density Line
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Percent Passing
Superpave
Restricted Zone
0.075
0.15
0.30
0.60
1.18
2.36
4.75
9.5
12.5
19.0
25.0
37.5
50
Sieve Size, (Raised to 0.45 Power), mm.

Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Coffee 307 BM			
Theoretical Maximum (Rice) Specific Gravity =	2.493			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2964.7	2965.2	6745.4	6745.2
(lb)	6.5	6.5	14.9	14.9
Mold Temperature, ° C	165.6	160.0	132.2	132.2
(°F)	330.1	320.0	270.0	270.0
Mix Temperature, ° C	148.9	149.4	151.1	151.1
(°F)	300.0	300.9	304.0	304.0
Number of Gyrations	17	23	N/A	N/A
Compacted Height, mm	74.9	75.0	N/A	N/A
(in.)	2.9488	2.9528	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	448.2 / 137.9	448.2 / 137.9
(psi)	N/A	N/A	65 / 20	65 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2945.6	2949.7	6699.5	6702.3
(lb)	6.5	6.5	14.8	14.8
Dry mass with Parafilm (D), g	2959.8	2964.1	6711.3	6713.8
(lb)	6.5	6.5	14.8	14.8
Wet mass with Parafilm (E), g	1633.5	1640.3	3798.0	3800.5
(lb)	3.6	3.6	8.4	8.4
Wet mass w/o Parafilm (C), g	1714.0	1728.1	3916.6	3908.4
(lb)	3.8	3.8	8.6	8.6
Saturated Surface Dry mass (B), g	2960.9	2964.7	6716.3	6716.5
(lb)	6.5	6.5	14.8	14.8
Specific Gravity (Gmb), SSD	2.362	2.385	2.393	2.387
Specific Gravity (Gmb), Parafilm	2.261	2.269	2.315	2.316
VTM =[1-(Gmb/Gmm)], SSD (%)	5.2%	4.3%	4.0%	4.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.3%	9.0%	7.1%	7.1%
NCAT Asphalt Content (%)	4.6%	4.6%	4.6%	4.6%

APA Dial Gauge Readings, mm

Mix Type: Coffee 307 BM

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.32	10.92	10.88	10.22	9.82	- N/A -				
Aft Front	10.99	10.70	10.62	10.29	9.91	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.60	10.09	9.87	9.56	8.99
Fwd Front	- N/A -					11.10	10.56	10.37	9.82	9.17

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	0.40	0.44	1.10	1.50
Aft Front	0.29	0.37	0.70	1.08
Average	0.35	0.41	0.90	1.29

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	0.51	0.73	1.04	1.61
Fwd Front	0.54	0.73	1.28	1.93
Average	0.52	0.73	1.16	1.77

Cycles	500	1000	4000	8000
Average Both Pills	0.44	0.57	1.03	1.53

Appendix A – 12

County & Mix Type: Coffee 411 D

Project Number: 4895

JOB MIX FORMULA

PROJECT REF. NO.	S.P.	DATE	1/23/98	THEORECTICAL GRAVITY	2.512
PROJECT NO.	16004-4206-04	REGION	#2	LOSS ON IGNITION	28.0
TYPE OF MIX	411-D SURFACE	COUNTY	COFFEE	TENSIL STRENGTH RATIO	85.5
CONTRACTOR	ROGERS GROUP INC.	CONT.#	#4895	DUST TO ASPHALT RATIO	0.6
SUB CONTRACTOR		ST. RT.	#2	A.C. PERCENT IN RAP	
ARTICLE NO.		LETTING	7/18/97	RECLAIMED A.C. FROM RAP	

MATERIAL	MATERIAL SIZE	PRODUCER AND ADDRESS	PERCENT USED
C.A.			0
R.A.P.	1" to pan	Rogers Group Inc., Hillsboro Tn.	0
MED C.A.	1" to pan	Rogers Group Inc., Hillsboro Tn.	0
MED C.A.			61.75
SCREENINGS	3/8" to pan	Rogers Group Inc., Hillsboro Tn.	9.5
SAND			23.75
ASPHALT CEMENT	MG 20-40	Asphalt Materials Cement, Indianapolis In.	5.0
ANTI STRIP	pave bond light	Southern States Oil	(.5)
FRACTURED FACES		GLASSY PARTICLES	

SCREEN SIZES	MASTER RANGE	REQUEST PERCENT	TOLER. PERCENT
TEMP.	310-340	320	
%A.C.		5.0	
50mm(2in)			
37.5mm(11/2in)			
25mm(1in)			
19mm(3/4in)			
15.75(5/8in)	100	100	
12.5mm(1/2in)	90-100	94.7	
9.5mm(3/8in)	62-84	79.2	
4.75mm(#4)	35-55	44.1	
2.36mm(#8)	20-39	31.3	
600um(#30)	5-19	19.0	
300um(#50)	3-16	8.5	
150um(#100)	1-11	4.0	
75um(#200)	0-6	3.0	

REQUESTED Karl E. Arnold RCT
APPROVED

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C.A. PERCENT	MED C.A. PERCENT	MED C.A. PERCENT	SCREEN. PERCENT	SAND PERCENT	R.A.P. PERCENT	CAL. MIX
		65	10	25		
		100	100	100		100
		91.8	100	100		94.7
		68	100	100		79.2
		16	90	98.6		44.1
		3.7	61.8	91		31.3
		1	28	64		19.0
		0.9	25.3	21.4		8.5
		0.8	17.4	4.5		4.0
		0.7	12.5	2		3.0

APPROVED
APPROVED William T. Thurmond

MARSHALL MIX DESIGN

date 1/23/98
p.r. no. 16004-4206-04
type mix 411-D

contractor ROGERS GROUP INC.
no. blows 75
sp. gr. a.c. 1.04

cont. no. 4895
county COFFEE CO.
region #2

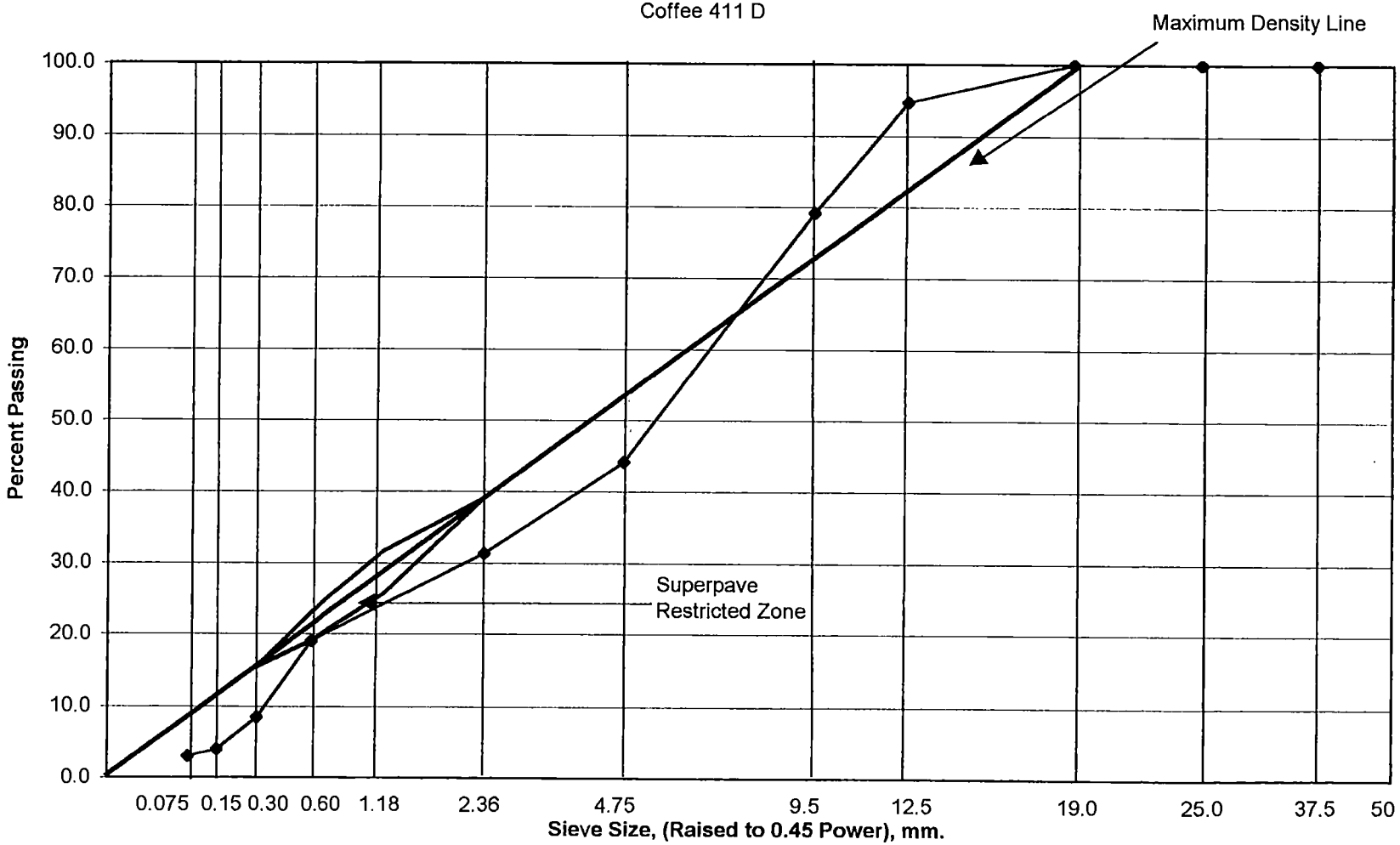
sample no.	% a c. b	% agg. c	in air d	ssd e	in water f	vol. mar. spec. g	bulk sp gr. mar. spec. h	theo. grav. mix l	eff. grav. agg. j	volds total mix k	volds min. agg. l	volds filled a.c. m	unit weight	stability	flow
								100	c			100*			
						e-f	d/g	(b/gr.a.c)+ (c/j)	(100/l)-(b/ sp.gr.a.c.)	100- ((h/l)*100)	100- (c*h/j)	(b*h/gr.ac) /L	62.4*h		
1-1	4 65	95.35	1215.5	1221 2	714.1	507.1	2.397	2.533	2.714	5.3	15.8	68.0	149.6	3253	10
1-2			1216 3	1220.8	712.3	508 5	2.392							3394	10
1-3			1211.9	1216.6	712.4	504.2	2.404							3176	10
						avg.	2.398						avg.	3274	10
2-1	5.0	95.0	1214.3	1218.9	715.0	503.9	2.410	2.512	2.714	4.1	15.6	74.1	150.4	3167	11
2-2			1214.1	1219.9	716.8	503.1	2.413							3097	12
2-3			1218.1	1221.4	715.4	506.0	2.407							3245	13
						avg.	2.410						avg.	3170	12
3-1	5.35	94.65	1215.3	1216.9	715.6	501.3	2.424	2.499	2.714	3.2	15.6	79.6	150.9	3409	14
3-2			1193.6	1195.7	704.0	491.7	2.427							3281	14
3-3			1190.3	1192.3	704.0	488.3	2.438							3155	15
						avg.	2.432						avg.	3282	14.3
						avg.							avg.		

*Theo. Grav. Mix as determined by AASHTO T-209.

Agg Loss on Ignition (LOI)	28.0
Agg Fractured Face Count	
Agg. Glossy Particles	
Agg. Absorption	1.2
Agg. Bulk Sp. Gr.	2.688
Agg. Apparent Sp. Gr.	2.728
Grams for 2.5" Specimen	1225

Recommended AC Content	5.0
Theroretical Gravity	2.512
Dust to AC Ratio (DAR)	0.6
Amount & Type Additive	0.5 pave bond lite
Mix Tensile Strength Ratio (TSR)	85.5

Mix Design Gradation
12.5 mm Nominal
Coffee 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Coffee 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.516			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.0	6820.0	6820.0
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	143.3	148.9	132.2	132.2
(°F)	289.9	300.0	270.0	270.0
Mix Temperature, ° C	148.9	147.8	151.7	148.3
(°F)	300.0	298.0	305.0	299.0
Number of Gyrations	10	9	N/A	N/A
Compacted Height, mm	74.9	74.5	N/A	N/A
(in.)	2.9488	2.9331	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	70 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	60.0
Dry mass (A), g	2980.2	2981.6	6781.3	6711.1
(lb)	6.6	6.6	15.0	14.8
Dry mass with Parafilm (D), g	2991.3	2990.8	6793.9	6723.0
(lb)	6.6	6.6	15.0	14.8
Wet mass with Parafilm (E), g	1668.9	1679.9	3925.6	3901.2
(lb)	3.7	3.7	8.7	8.6
Wet mass w/o Parafilm (C), g	1735.6	1737.6	4004.0	3986.1
(lb)	3.8	3.8	8.8	8.8
Saturated Surface Dry mass (B), g	3007.5	2995.2	6787.6	6715.7
(lb)	6.6	6.6	15.0	14.8
Specific Gravity (Gmb), SSD	2.343	2.371	2.436	2.459
Specific Gravity (Gmb), Parafilm	2.286	2.301	2.382	2.395
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	5.8%	3.2%	2.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.2%	8.5%	5.3%	4.8%
NCAT Asphalt Content (%)	6.0%	6.0%	6.0%	6.0%

APA Dial Gauge Readings, mm

Mix Type: Coffee 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.82	9.95	9.48	7.97	6.77	- N/A -				
Aft Front	9.99	9.33	9.03	7.50	6.97	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.67	9.53	9.16	7.60	6.22
Fwd Front	- N/A -					10.55	9.69	9.17	7.73	6.52

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	0.87	1.34	2.85	4.05
Aft Front	0.66	0.96	2.49	3.02
Average	0.77	1.15	2.67	3.54

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	1.14	1.51	3.07	4.45
Fwd Front	0.86	1.38	2.82	4.03
Average	1.00	1.45	2.95	4.24

Cycles	500	1000	4000	8000
Average Both Pills	0.88	1.30	2.81	3.89

Appendix A – 13

County & Mix Type: Davidson 411 D

Project Number: 5168

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT 0256
Rev Form T-118

Date 4-17-98

Project Reference No. IM-24-1(75)55 County Davidson Region III

Project No. 19003-3169-44 Contract No. 5168

Type ACS (HM) Sec. No. 411-D Article No.

Contractor Apac-Tn., Inc. Subcontractor

State Rt. No. I-24 TOTAL MIX INCLUDING BITUMEN Date of Letting

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS		Percent Used
C. A.				
Med. C. A.	5/8" - Pan	American Limestone	Springfield	42.675
Screenings	3/8" - Pan	Vulcan	Danley	23.675
Sand	3/8" - Pan	Ingram	Nashville	28.411
Asphalt Cement	PG - 76-22	Ergon	Nashville	5.3
Anti-Strip	Type: Pave Bond Lite	Dosage Rate: 0.3		[redacted]

% Fractured Faces on Plus No. 4 Material: 100% % Glassy Particles on Plus No. 4 Material: — 100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C. A. Percent	Med. C. A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
Temp.	275-325	300	280-320		45	25	30		100
% A. C.	5.3-7.0	5.3			Osisa no. 190-S				
					Theo → 2.442				
2 "					L.A.I. → 19.5				
1 1/2"									
1 "									
3/4 "									
5/8 "	100	100			100	100	100		100
½"	95-100	98			95	100	100		97.8
⅜"	80-93	87			72	100	100		87.4
No. 4	54-76	61			20	92	96		60.8
No. 8	35-57	45			5	62	91		45.1
No. 30	17-29	27			2.9	30	61		27.1
No. 50	10-18	11			2.8	22.5	12		10.5
No. 100	3-10	6.0			2.3	18.5	1.0		6.0
No. 200	0-6.5	4.9			1.9	15.8	0.4		4.9

Requested Anthony Bucknell Apac-Tn. Contractor

Approved [signature] Region Construction Engineer

Approved [signature] 11-20-98 Region Materials Engineer

Approved [signature] 5-20-98 Engineer of Materials and Tests

SA
PA

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. 416-S
TYPE OF MIX 411-D
PROJECT REFERENCE NO.
PROJECT NO. 19057-3210-04
CONTRACTOR Thomas & Assocs. : Sub. APAC

DATE 12-5-97
SERIAL NO. M-744
CONTRACT NO. 4105 5160
REGION 3
COUNTY Davidson

Sample No.	Asphalt Content	Sp. Gr. of Mar. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability	Marshall Flow	No. Blows Mar. Hammer
1	4.5	2.324	2.465	97.535	5.7	15.6	64.3	2655	9.0	75
2	5.0	2.330	2.444	97.556	4.7	15.9	70.5	2615	9.3	"
3	5.5	2.354	2.424	97.576	2.9	15.4	80.9	2188	10.2	"
4	6.0	2.372	2.406	97.594	1.4	15.3	89.5	1817	11.5	"
OPT.	5.3	2.340	2.433	97.567	3.8	15.8	75.5	2280	9.5	"

Total % Passing

Mils.	3/8	Screen	Screen		Mix	Lab
%	1/5	2.5	30		100	
5/8	100	100	100		100	
1/2	96	100	100		98.2	
3/8	92	100	100		97.4	
4	50	90	95		69.0	
8	6	60	90		44.7	
30	3.2	29	62		27.5	
50	2.7	21	13		10.5	
100	2.4	18	1		5.9	
200	2.0	13.3	0.4		4.9	

1200 Grams required to make 2.5" specimen

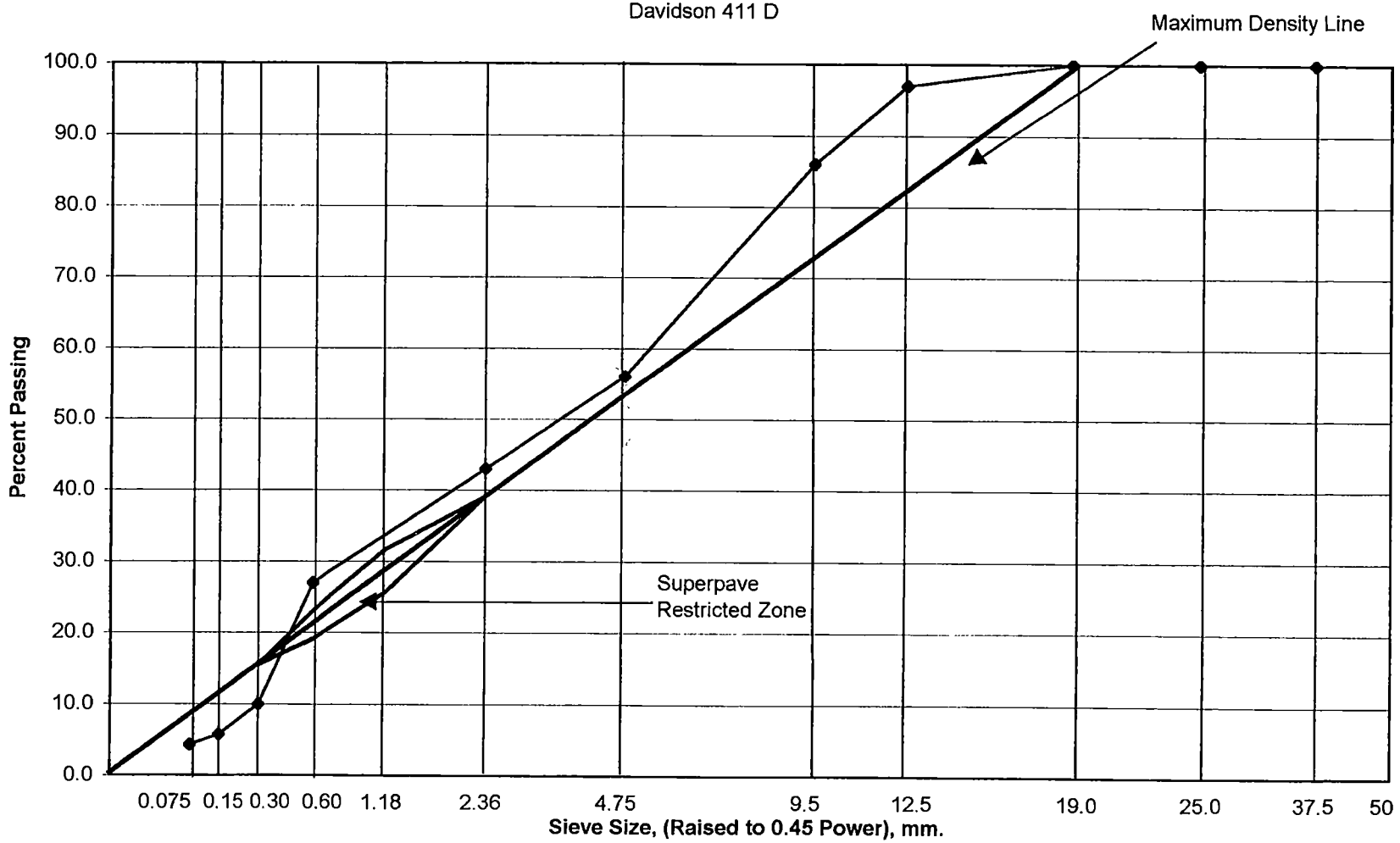
Producer

American Limestone - Springfield
Vulcan Mtls Dunlap
Tennessee Mtls Nashville
Southern Stone
Chips and Fines
.3%

Bulk Gr. 2.312
Eff. Gr. 2.631
App. Gr. 2.672
Fractured Face 100%
Glassy Particle —
LOI 19.3
RAP in AC —
DAR 0.9
TSR 78.8

Recommended 5.3 Asphalt Content
Theor. Density 2.435

Mix Design Gradation
12.5 mm Nominal
Davidson 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Davidson 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.439			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2945.0	2945.0	6490.4	6490.5
(lb)	6.5	6.5	14.3	14.3
Mold Temperature, ° C	110.0	104.4	143.3	143.3
(°F)	230.0	220.0	290.0	290.0
Mix Temperature, ° C	150.0	147.8	150.0	148.9
(°F)	302.0	298.0	302.0	300.0
Number of Gyrations	6	5	N/A	N/A
Compacted Height, mm	74.5	75.1	N/A	N/A
(in.)	2.9331	2.9567	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	18.0	18.0
Dry mass (A), g	2930.7	2920.1	6469.4	6461.1
(lb)	6.5	6.4	14.3	14.2
Dry mass with Parafilm (D), g	2938.3	2928.4	6479.8	6472.7
(lb)	6.5	6.5	14.3	14.3
Wet mass with Parafilm (E), g	1630.0	1610.5	3493.9	3649.4
(lb)	3.6	3.6	7.7	8.0
Wet mass w/o Parafilm (C), g	1657.6	1647.1	3643.2	3687.1
(lb)	3.7	3.6	8.0	8.1
Saturated Surface Dry mass (B), g	2940.0	2934.4	6477.0	6467.7
(lb)	6.5	6.5	14.3	14.3
Specific Gravity (Gmb), SSD	2.285	2.268	2.283	2.324
Specific Gravity (Gmb), Parafilm	2.262	2.239	2.179	2.304
VTM =[1-(Gmb/Gmm)], SSD (%)	6.3%	7.0%	6.4%	4.7%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	7.3%	8.2%	10.6%	5.5%
NCAT Asphalt Content (%)	6.1%	6.1%	6.1%	6.1%

APA Dial Gauge Readings, mm

Mix Type: Davidson 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.99	9.98	9.60	8.43	7.30	- N/A -				
Aft Front	11.15	10.16	9.82	8.75	7.78	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.88	9.92	9.58	8.12	7.12
Fwd Front	- N/A -					10.89	10.12	9.85	8.87	7.96

Beam 1

Cycles	Initial	500	1000	4000	8000
Aft Rear	9.00	8.41	8.25	7.39	6.56
Aft Front	9.58	8.65	8.40	7.68	6.91
Middle	9.36	8.61	8.35	7.40	6.46
Fwd Rear	9.08	8.26	8.03	7.03	6.19
Fwd Front	8.19	7.27	7.01	6.06	5.05

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	1.01	1.39	2.56	3.69
Aft Front	0.99	1.33	2.40	3.37
Average	1.00	1.36	2.48	3.53

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	0.96	1.30	2.76	3.76
Fwd Front	0.77	1.04	2.02	2.93
Average	0.87	1.17	2.39	3.35

Cycles	500	1000	4000	8000
Average Both Pills	0.93	1.27	2.44	3.44

Beam 1

Cycles	500	1000	4000	8000
Aft Rear	0.59	0.75	1.61	2.44
Aft Front	0.93	1.18	1.90	2.67
Middle	0.75	1.01	1.96	2.90
Fwd Rear	0.82	1.05	2.05	2.89
Fwd Front	0.92	1.18	2.13	3.14
Averages				
All 5	0.80	1.03	1.93	2.81
Middle 3	0.83	1.08	1.97	2.82
Middle Excluded	0.82	1.04	1.92	2.79

Appendix A – 14

County & Mix Type: Davidson 411 D With Latex

Project Number: 3556

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form RT-0256
Re: Form T-118

Date 2/12/98

Project Reference No. _____ County Davidson Region III

Project No. 19036-3215-14 Contract No. 3556

Type HCS (HM) Sec. No. 411-D Latex Article No. _____

Contractor Almaw Construction Co Subcontractor APAC TN

State Rt. No. 12 TOTAL MIX INCLUDING BITUMEN Date of Letting _____

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS		Percent Used
C. A.				
Med. C. A.	5/8" Pan	Burns Stone	Dickson	42.435
Screenings	3/8" Pan	Vulcan Mtls	River Rd	23.575
Sand	3/8" Pan	Hunter Marine	Nashville	28.29
Asphalt Cement	PG 64-22	Southern States	Nashville	5.70
	Latex	Ultra pave	Dalton Ga.	32% Solids
Anti-Strip	Type: Pave Bond Lite	Dosage Rate: .03		
% Fractured Faces on Plus No. 4 Material: ____		% Glassy Particles on Plus No. 4 Material: ____		100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
Temp.	275-325	300	280-320		45	25	30		100
% A.C.	5.3-7.0	5.7				Dalton No 38.5			
+ 5.2 % Asphalt includes 3% latex Solids						Theo= 2.416			
2 " 5.7 ÷ .7 = 8.14 total Latex						LOI= 19.5			
1 1/2"									
1 "									
3/4 "									
5/8 "	100	100			100	100	100		100
½"	95-100	97			94	100	100		97.3
⅜"	90-93	86			69	100	100		96.1
No. 4	54-76	56			11	90	95		56.0
No. 8	35-57	43			1.9	62	90		43.4
No. 30	17-29	27			1.7	30	62		26.9
No. 50	10-18	10			1.5	24.0	12		10.3
No. 100	3-10	5.7			1.2	19.6	1.0		5.7
No. 200	0-6.5	4.3			0.9	15.0	0.4		4.3

Requested Almaw Construction Co APAC TN Contractor Approved _____ Region Materials Engineer 2-26-98

Approved _____ Region Construction Engineer Approved _____ Engineer of Materials and Tests 3-9-98

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. J2-S
TYPE OF MIX 411-D
PROJECT REFERENCE NO.
PROJECT NO. 19036-3213-14
CONTRACTOR APAC

DATE 1-28-98
SERIAL NO. M-33
CONTRACT NO. 35514
REGION III
COUNTY DAVIDSON

SAMPLE NO.	ASPHALT CONTENT	SP. GR. of MAR. SAMP.	THEO. GR. OF MIX	% THEO GR	VOIDS IN TOTAL MIX	VOIDS IN MIN. AGG	VOIDS FILLED WITH ASPHALT	MARSHALL STABILITY	MARSHALL FLOW	NO. BLOWS MAR. HAM.
1	4.5	2.27-	2.459	97.541	7.4	17.3	57.2	2442	8.3	75
2	5.0	2.283	2.441	97.559	6.5	17.5	63.0	2292	9.3	"
3	5.5	2.289	2.424	97.576	5.6	17.7	68.7	2175	11.2	"
4	6.0	2.303	2.407	97.593	3.5	16.9	79.6	1875	11.8	"
OPT.	5.7	2.317	2.416	97.584	4.1	16.9	75.4	2100	11.4	"

Total % Passing

MTRLS.	5/8	Scr.	Sand		Mix	
%	45	25	30		100	
5/8	160	100	100		100	
1/2	94	100	100		97.3	
3/8	69	100	100		86.1	
#4	11	90	95		56.0	
#8	1.9	62	90		43.4	
#30	1.7	30	62		24.9	
#50	1.5	24	12		10.3	
#100	1.2	19.6	1.0		5.7	
#200	0.9	15.0	0.4		4.3	

1200 Grams required to make 2.5" speciman

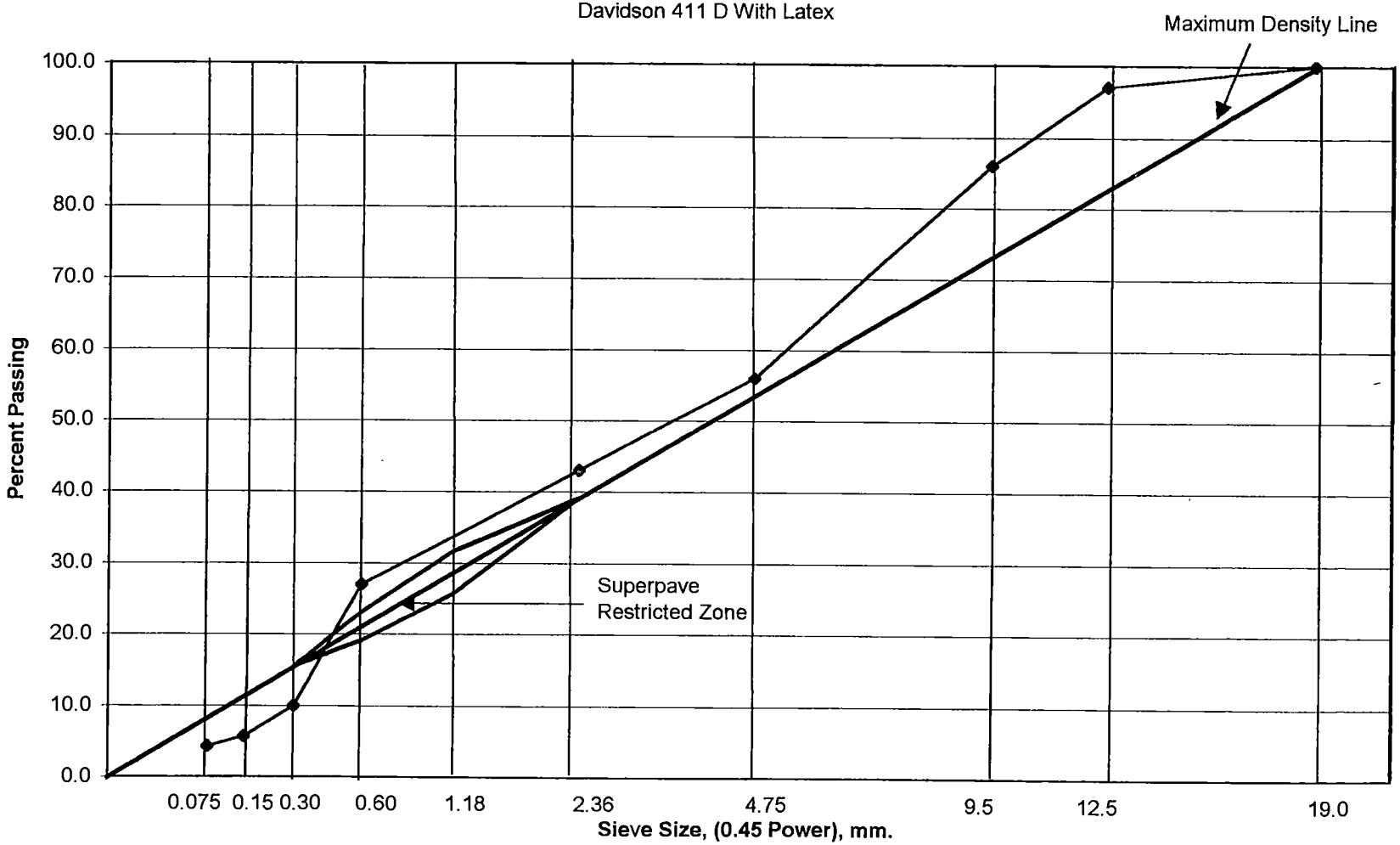
PRODUCER

Burns Stone, Dickson Tn
Vulcan Materials, River Rd.
Hunter Marine, Nashville
Southern States "
Pave Bond Lete .3%

Recommended 5.7 Asphalt Content
Theo. Density 2.416

Bulk gr. 2.306
Eff. gr. 2.628
App.gr. 2.673
Fract. face 100 %
Glassy part. —
L.O.I. 19.5
A.C. in RAP —
DAR 0.8
TSR 82.0

Mix Design Gradation
12.5 mm Nominal
Davidson 411 D With Latex



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Davidson 411 D - With Latex			
Theoretical Maximum (Rice) Specific Gravity =	2.432			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2930.0	2930.0	6470.5	6470.3
(lb)	6.5	6.5	14.3	14.3
Mold Temperature, ° C	128.3	140.6	137.8	137.8
(°F)	263.0	285.0	280.0	280.0
Mix Temperature, ° C	148.9	150.6	149.4	148.9
(°F)	300.0	303.0	301.0	300.0
Number of Gyrations	6	9	N/A	N/A
Compacted Height, mm	74.8	74.9	N/A	N/A
(in.)	2.9449	2.9488	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	12.0	15.0
Dry mass (A), g	2907.6	2908.4	6427.4	6419.6
(lb)	6.4	6.4	14.2	14.2
Dry mass with Parafilm (D), g	2915.4	2916.1	6439.0	6431.6
(lb)	6.4	6.4	14.2	14.2
Wet mass with Parafilm (E), g	1603.7	1601.4	3516.6	3507.8
(lb)	3.5	3.5	7.8	7.7
Wet mass w/o Parafilm (C), g	1654.1	1658.6	3647.3	3646.2
(lb)	3.6	3.7	8.0	8.0
Saturated Surface Dry mass (B), g	2926.1	2929.1	6472.0	6463.8
(lb)	6.5	6.5	14.3	14.3
Specific Gravity (Gmb), SSD	2.286	2.289	2.275	2.278
Specific Gravity (Gmb), Parafilm	2.239	2.234	2.214	2.211
VTM =[1-(Gmb/Gmm)], SSD (%)	6.0%	5.9%	6.4%	6.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	7.9%	8.1%	9.0%	9.1%
NCAT Asphalt Content (%)	5.7%	5.7%	5.7%	5.7%

APA Dial Gauge Readings, mm

Mix Type: Davidson 411 D (Latex)

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.18	9.23	8.22	5.44	3.55	- N/A -				
Aft Front	11.89	10.31	9.42	6.73	5.11	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					12.15	9.88	8.88	6.08	4.29
Fwd Front	- N/A -					12.18	10.21	9.17	6.45	4.38

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.26	9.35	8.47	6.08	4.82	10.17	8.04	7.34	5.50	4.14
Aft Front	11.27	9.28	8.45	5.90	4.54	10.81	8.84	8.12	6.29	4.83
Middle	11.25	9.57	8.81	6.73	5.27	11.40	9.59	8.95	7.38	6.05
Fwd Rear	11.48	9.74	8.83	6.39	4.98	11.74	10.25	9.48	7.32	5.86
Fwd Front	10.97	9.18	8.31	5.88	4.74	11.37	9.84	9.13	6.98	5.65

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.95	2.96	5.74	7.63
Aft Front	1.58	2.47	5.16	6.78
Average	1.77	2.72	5.45	7.21

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	2.27	3.27	6.07	7.86
Fwd Front	1.97	3.01	5.73	7.80
Average	2.12	3.14	5.90	7.83

Cycles	500	1000	4000	8000
Average	1.94	2.93	5.68	7.52
Both Pills				

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.91	2.79	5.18	6.44	2.13	2.83	4.67	6.03
Aft Front	1.99	2.82	5.37	6.73	1.97	2.69	4.52	5.98
Middle	1.68	2.44	4.52	5.98	1.81	2.45	4.02	5.35
Fwd Rear	1.74	2.65	5.09	6.50	1.49	2.26	4.42	5.88
Fwd Front	1.79	2.66	5.09	6.23	1.53	2.24	4.39	5.72
Averages								
All 5	1.82	2.67	5.05	6.38	1.79	2.49	4.40	5.79
Middle 3	1.80	2.64	4.99	6.40	1.76	2.47	4.32	5.74
Middle Excluded	1.86	2.73	5.18	6.48	1.78	2.51	4.50	5.90

Appendix A – 15

County & Mix Type: Davidson Wilson 307 BM

Project Number: 4352

#4751

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0256
Re: Form T-118

Date 2-5-98

Project Reference No. _____ County Davidson/Wilson Region 3

Project No. 19041-3262-04 95004-3242-04 Contract No. 4352

Type BPMB-HM Sec. No. 307 BM Article No. 307

Contractor Lotac Ent Subcontractor _____

State Rt. No. Lebanon Rd TOTAL MIX INCLUDING BITUMEN Date of Letting _____

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS		Percent Used
C. A.	1" Pan	Vulcan Mtls	Hermitage	19.16
Med. C. A.	3/4" Pan	"	"	28.74
Screenings	3/8" Pan	"	"	14.37
Sand	3/8" Pan	Ingram Mtls	Nashville	14.37
Filler RAP	3/4" Pan	Lotac Ent	Hermitage	20.96
A. C. and Pen.	AC-20 new Line Pavement	Marathon Ashland LLC	Nashville	3.30
% Fractured Faces on Plus No. 4 Material	MSH PB 1.1C	"	(.39o)	100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
Temp.	275-325	310	290-330	20	30	15	15	20	100
% A.C.	4.2-6.2	4.2				Design No.	91		
3"						Theo	2.520		
2½"						RAP AC	4.59o		
2"									
1½"									
1"	100	100	100	100	100	100	100	100	100
¾"	85-100	98	92.3-100	91	100	100	100	99	98.0
½"									
⅜"	59-79	73	67.3-72.7	19	69	100	100	90	72.5
No. 4	42-61	49	45-53	8.5	14	93	99	69	48.5
No. 8	29-47	36	32.7-39.3	5	5	63	94	50	36.1
No. 30	13-27	22	18.7-25.3	2	3	28	63	33	21.6
No. 50	7-20	10	6.7-13.3	1.2	2	20	13	22	10.3
No. 100	4-10	7.1	5.5-8.7	1	1.5	19	1.5	17	7.1
No. 200	0-6.5	5.2	4.2-7.4	.2	1.3	16	.5	14	5.8

Requested Lotac Ent Mike Ford (Contractor)

Approved _____ (Region Construction Engineer)

Approved _____ (Region Materials Engineer) 3-6-98

Approved _____ (Engineer of Materials and Tests) 3-6-98

SA
PA

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. 91
TYPE OF MIX 307 BM
PROJECT REFERENCE NO.
PROJECT NO. -1904-3262-04 / 95004-3242-04
CONTRACTOR LoTec Ent.

DATE 2-27-98
SERIAL NO. M-95
CONTRACT NO. 4352
REGION III
COUNTY Davidson/Wilson

Sample No.	Asphalt Content	Sp. Gr. of Mar. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability	Marshall Flow	No. Blows Mar. Hammer
	3.5	2.404	2.547	94.4	5.6	13.8	59.2	2891.667	10.833	75
	4.0	2.411	2.528	95.4	4.6	14.0	66.9	2800	11.333	75
	4.5	2.429	2.509	96.8	3.2	13.8	76.9	2658.333	12.0	75
	5.0	2.445	2.490	98.2	1.8	13.7	86.6	2500	13.333	75
	4.2	2.413	2.520	95.8	4.2	14.1	69.8			

20/30/15/15/20 Total % Passing

Mills.					Mix	Lab
¾						
½					98	
⅜					77	
#4					44	
8					26	
30					22	
50					10	
100					7.1	
200					5.0	

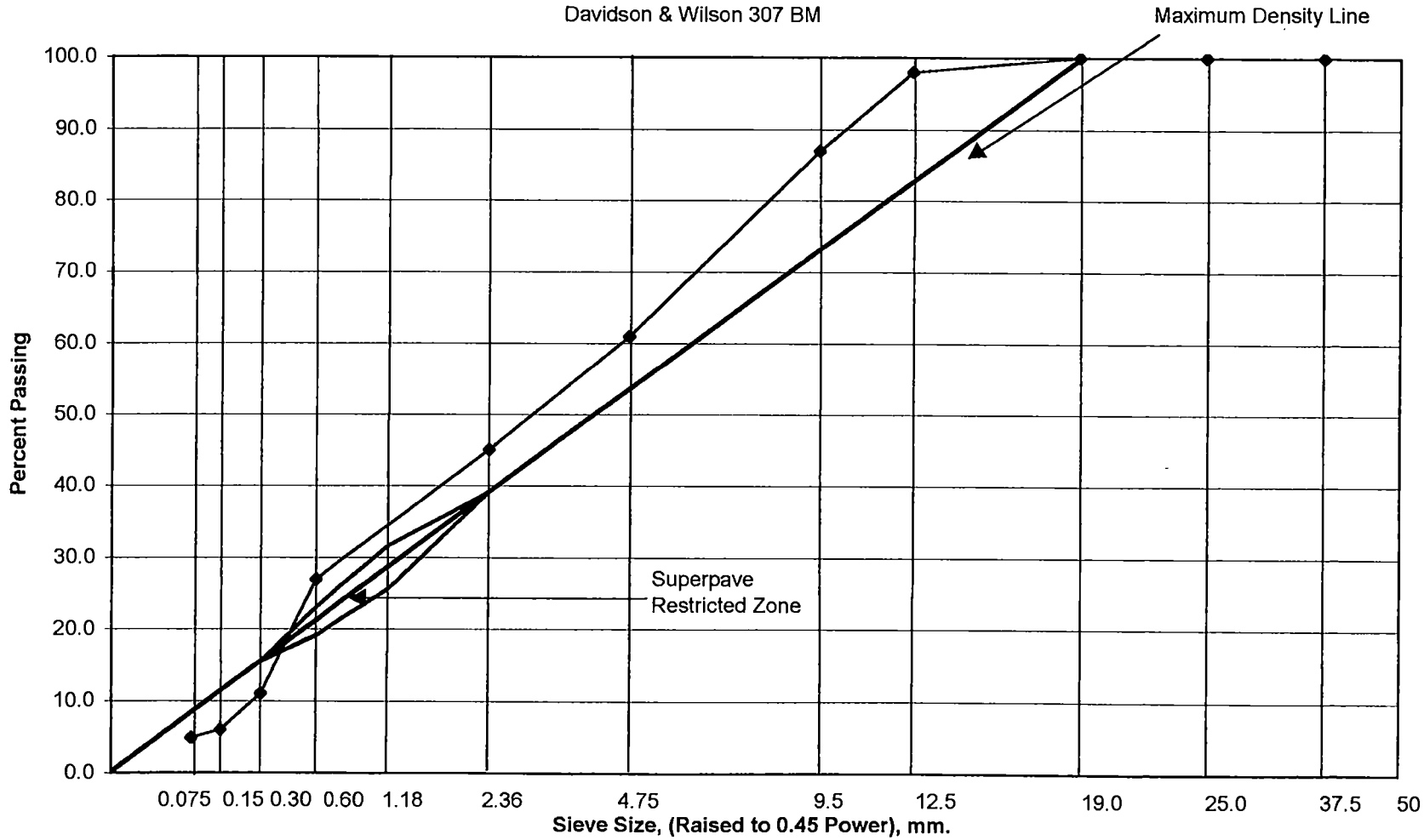
Producer
Vulcan Hsim
Ingram Nash.
LoTec Hsim.
Bou. Glass Nash. MAC
P.D. Lite .5%

Dust Gr.
Eff. Gr. 2.691
App. Gr.
Fractured Face
Glassy Particle
LOI
DAP in AC 4.5
DAH 1.58
TSR 83.3

220 Grams required to make 2.5" specimen

Recommended 4.20 Asphalt Content
Theor. Density 2.520

Mix Design Gradation
12.5 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Davidson / Wilson 307 BM			
Theoretical Maximum (Rice) Specific Gravity =	2.518			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.0	6800.0	6800.5
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	104.4	104.4	143.3	146.1
(° F)	220.0	220.0	290.0	295.0
Mix Temperature, ° C	150.0	149.4	149.4	150.6
(° F)	302.0	301.0	301.0	303.0
Number of Gyrations	6	5	N/A	N/A
Compacted Height, mm	74.7	74.8	N/A	N/A
(in.)	2.9409	2.9449	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	18.0	18.0
Dry mass (A), g	2993.3	2991.9	6787.5	6774.8
(lb)	6.6	6.6	15.0	14.9
Dry mass with Parafilm (D), g	3000.8	2999.6	6799.4	6785.6
(lb)	6.6	6.6	15.0	15.0
Wet mass with Parafilm (E), g	1693.9	1688.8	3895.2	3893.9
(lb)	3.7	3.7	8.6	8.6
Wet mass w/o Parafilm (C), g	1748.5	1740.2	3966.0	3970.5
(lb)	3.9	3.8	8.7	8.8
Saturated Surface Dry mass (B), g	3015.9	3014.2	6806.2	6793.5
(lb)	6.6	6.6	15.0	15.0
Specific Gravity (Gmb), SSD	2.362	2.348	2.390	2.400
Specific Gravity (Gmb), Parafilm	2.313	2.305	2.353	2.358
VTM =[1-(Gmb/Gmm)], SSD (%)	6.2%	6.7%	5.1%	4.7%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.2%	8.5%	6.5%	6.4%
NCAT Asphalt Content (%)	4.6%	4.6%	4.6%	4.6%

APA Dial Gauge Readings, mm

Mix Type: Davidson / Wilson 307 BM

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.24	10.35	9.90	8.83	7.53	- N/A -				
Aft Front	11.57	10.64	10.28	9.04	7.93	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.58	10.83	10.60	9.49	8.68
Fwd Front	- N/A -					11.80	11.27	10.98	10.11	9.84

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	0.89	1.34	2.41	3.71
Aft Front	0.93	1.29	2.53	3.64
Average	0.91	1.32	2.47	3.68

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	0.75	0.98	2.09	2.90
Fwd Front	0.53	0.82	1.69	1.96
Average	0.64	0.90	1.89	2.43

Cycles	500	1000	4000	8000
Average Both Pills	0.78	1.11	2.18	3.05

Appendix A – 16

County & Mix Type: Dickson 307 BM

Project Number: 5120

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0256 Rev. Form T-118

Date FEB. 12 1998

Project Reference No. SP County DICKSON Region III

Project No. 22007-4233-04 Contract No. 5120

Type BPMB-HM Sec. No. 307-BM(R) Article No. 03.16

Contractor EUBANK PAVING Subcontractor ✓

State Rt. No. HWY 48 TOTAL MIX INCLUDING BITUMEN Date of Letting FEB. 6 1998

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS		Percent Used
COARSE AGG.	1" - 1/4"	BURNS STONE	DICKSON	38.000
BLOCK MTL.	1/4" - PAN	BURNS STONE	DICKSON	19.000
SOFT SCR.	1/4" - PAN	BURNS STONE	DICKSON	9.500
SAND	3/8" - PAN	SAN-GRAVL	NEW JOHNSONVILLE	9.500
RAP	1" - PAN	EUBANK PAVING	DICKSON	20.256
ASPHALT CEMENT	PG-64-22	MARATHON/ASHLAND	NASHVILLE	3.744
Anti-Strip	Type: PAVE BOND LITE		Dosage Rate: 0.5	

% Fractured Faces on Plus No. 4 Material: ____ % Glassy Particles on Plus No. 4 Material: ____ 100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Blocks Med. C.A. Percent	Soft Screenings Percent	Sand Percent	RAP Percent	Calculated Mix
Temp. °F	275°-325°	300°	280°-320°	40	20	10	10	20	
% A.C.	4.2-6.2	5.0	4.65-5.35		Map Ac. 6.2%				
					Design No. 72				
2 "					Theor. Density -			2.446	
1 1/2"									
1 "	100	100	100	100	100	100	100	100	100
3/4 "	85-100	94	88.3-99.7	86	100	100	100	100	94.4
5/8 "									
1/2"									
3/8"	59-79	73	67.3-78.7	37	100	100	100	90	72.8
No. 4	42-61	54	50.0-58.0	8	88	96	97	68	53.7
No. 8	29-47	31	27.7-34.3	4	21	68	83	52	31.3
No. 30	13-27	17	13.7-20.3	3	6	33	59	29	17.4
No. 50	7-20	11	7.7-14.3	2	5	24	21	22	10.7
No. 100	4-10	6.70	5.10-8.30	1	5	19	4	15	6.70
o. 200	0-6.5	5.38	3.78-6.98	.7	4	16	1	13	5.38
		BY:							

Requested EUBANK PAVING / CRUM Contractor Approved [signature] 2-27-98 Region Materials Engineer

Approved [signature] Approved [signature] 3-4-98

Date 2-12-98
Type of Mix 307-BM(R) SP
Project Reference No. _____

Contract No. 5120
County DICKSON
Region III

Contractor EUBANK PAVING
No. Hammer Blows 75 each side
Sp.Gr. AC 1.02

Sample No.	% AC	% Aggs.	Weight – Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxG/I	AxG/(SP.GR. AC x100)/K	62.4xG		
1	4.0	96.0	1186.2	1197.7	676.4	521.3	2.275	2.483	2.640	7.57	16.55	54.38	145.21	4000	
2			1184.5	1192.7	682.9	509.8	2.323								
3			1190.3	1200.3	680.1	520.2	2.288							4150	
						Avg.	2.295						Avg.	4075	
1	4.5	95.5	1181.6	1185.0	681.4	503.6	2.346	2.464	2.640	4.99	15.32	67.41	146.08	4200	
2			1190.1	1193.7	683.6	509.5	2.336							4250	
3			1185.8	1189.2	682.9	506.3	2.342							3525	
						Avg.	2.341						Avg.	3992	
1	5.0	95.0	1185.3	1187.0	681.1	505.9	2.343	2.446	2.640	4.05	15.54	74.03	146.15	3500	
2			1182.9	1184.5	681.6	501.9	2.359							3225	
3			1187.4	1189.2	683.9	505.3	2.359							3975	
						Avg.	2.347						Avg.	3567	
1	5.5	94.5	1184.5	1185.8	685.4	500.4	2.367	2.428	2.640	2.64	15.38	82.88	147.51	3750	
2			1091.0	1092.6	633.0	459.6	2.374							3500	
3			1183.9	1184.5	681.3	503.2	2.352							3775	
						Avg.	2.364						Avg.	3675	

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.Gr.\ AC}}$

*Theo. Grav. (H) (At any AC content) = $\frac{100}{\frac{A}{Sp.Gr.\ AC} + \frac{B}{I}}$

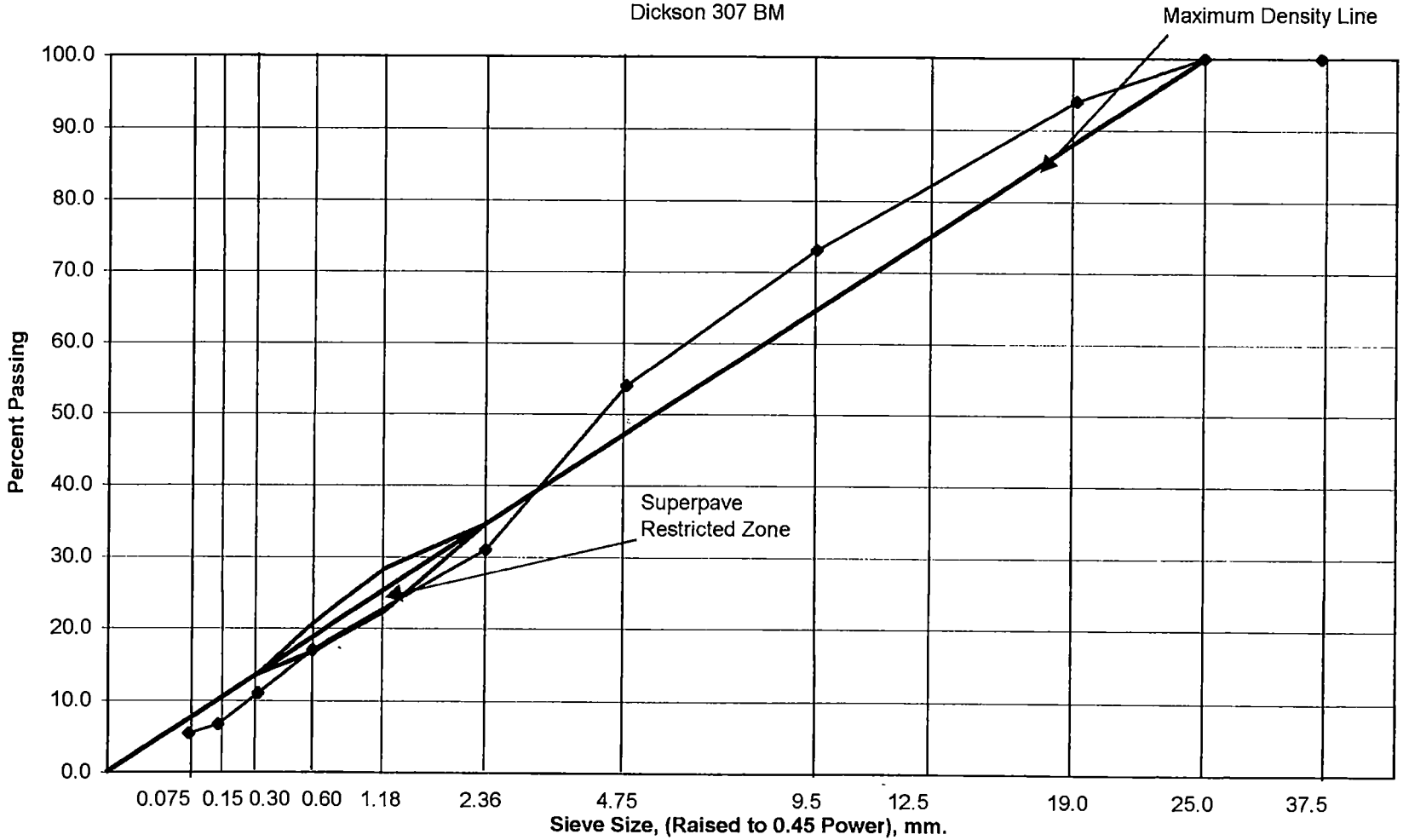
Agg. Loss on Ignition (LOI) NA
Agg. Fractured Face Count 100
Agg. Glassy Particles NA
Agg. Absorption 1.7
Agg. Bulk Sp. Gr. 2.550
Agg. Apparent Sp. Gr. 2.640
Grams for 2.5" Specimen 1175.0

Recommended AC Content 5.0
Theoretical Gravity 2.446
Dust to AC Ratio (DAR) 1.08
Amount & Type Additive 0.5 PAVE BOND LATEX
Mix Tensile Strength Ratio (TSR) 83.24

Approved

Mix Design Gradation
19 mm Nominal

Dickson 307 BM



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Dickson 307 BM			
Theoretical Maximum (Rice) Specific Gravity =	2.431			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2910.0	2910.0	6570.0	6570.4
(lb)	6.4	6.4	14.5	14.5
Mold Temperature, ° C	113.9	112.8	132.2	137.8
(° F)	237.0	235.0	270.0	280.0
Mix Temperature, ° C	150.6	150.6	149.4	150.0
(° F)	303.0	303.0	301.0	302.0
Number of Gyrations	20	22	N/A	N/A
Compacted Height, mm	75.2	75.2	N/A	N/A
(in.)	2.9606	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	60.0	60.0
Dry mass (A), g	2900.7	2902.4	6529.3	6533.4
(lb)	6.4	6.4	14.4	14.4
Dry mass with Parafilm (D), g	2908.1	2910.0	6540.5	6544.2
(lb)	6.4	6.4	14.4	14.4
Wet mass with Parafilm (E), g	1591.9	1592.9	3620.9	3616.9
(lb)	3.5	3.5	8.0	8.0
Wet mass w/o Parafilm (C), g	1643.0	1639.2	3714.0	3708.9
(lb)	3.6	3.6	8.2	8.2
Saturated Surface Dry mass (B), g	2919.0	2921.4	6543.4	6547.4
(lb)	6.4	6.4	14.4	14.4
Specific Gravity (Gmb), SSD	2.273	2.264	2.308	2.302
Specific Gravity (Gmb), Parafilm	2.225	2.225	2.251	2.246
VTM =[1-(Gmb/Gmm)], SSD (%)	6.5%	6.9%	5.1%	5.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.5%	8.5%	7.4%	7.6%
NCAT Asphalt Content (%)	5.5%	5.5%	5.5%	5.5%

APA Dial Gauge Readings, mm

Mix Type: Dickson 307 BM

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	7.24	6.63	6.27	5.03	3.59	- N/A -				
Aft Front	7.76	6.97	6.75	5.46	4.21	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					7.83	6.96	6.66	5.43	4.24
Fwd Front	- N/A -					8.17	7.19	6.88	5.51	4.06

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	0.61	0.97	2.21	3.65
Aft Front	0.79	1.01	2.30	3.55
Average	0.70	0.99	2.26	3.60

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	0.87	1.17	2.40	3.59
Fwd Front	0.98	1.29	2.66	4.11
Average	0.93	1.23	2.53	3.85

Cycles	500	1000	4000	8000
Average Both Pills	0.81	1.11	2.39	3.73

Appendix A – 17

County & Mix Type: Dickson 411 D

Project Number: 5120

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0256
Re: Form T-118

Date MARCH 4 1998

Project Reference No. SP County DICKSON Region III

Project No. 22007-4233-04 Contract No. 5120

Type ACS-HM E Sec. No. 411-D Article No. 01.01-01.02

Contractor EUBANK PAVING Subcontractor

State Rt. No. 48 TOTAL MIX INCLUDING BITUMEN Date of Letting Feb. 6, 1998

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	Percent Used
C. A.	5/8" - #4	BURNS STONE DICKSON	37.640
Med. C. A.	1/4" - PAN	BURNS STONE DICKSON	15.997
Screenings	1/4" - PAN	BURNS STONE DICKSON	16.938
Sand	3/8" - PAN	SANGRAUL NEW JOHNSONVILLE	23.525
Asphalt Cement	PG-64-22	MARATHON/ASHLAND NASHVILLE	5.900
Anti-Strip	Type: [illegible]	Dosage Rate: .5	[redacted]
% Fractured Faces on Plus No. 4 Material: ____	% Glassy Particles on Plus No. 4 Material: ____		100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
Temp.	275-325	300	280-320	40	17	18	25		
% A.C.	5.3-7.0	5.9	5.55-6.25		Design No.		98-5		
					Theor. Density -			2.399	
2 "					L.O.I. 17.8				
1 1/2"									
1 "									
3/4 "									
5/8 "	100	100	100	100	100	100	100		100
½"	95-100	98	92.3-100	95	100	100	100		98.0
⅜"	80-93	89	83.3-94.7	73	100	100	100		89.2
No. 4	54-76	63	59-67	13	96	96	97		63.1
No. 8	35-57	46	42.7-49.3	4	65	68	83		45.6
No. 30	17-29	26	22.7-29.3	3	25	33	59		26.1
No. 50	10-18	13	11.7-16.3	2	17	24	21		13.3
No. 100	3-10	7.1	5.51-8.71	1.2	13	19	4		7.1
No. 200	0-6.5	5.15	3.55-6.75	0.8	10	16	1		5.15
		By:							

Requested EUBANK PAVING [illegible] Contractor

Approved [illegible] Region Construction Engineer

Approved [illegible] Region Materials Engineer 3-9-98

Approved [illegible] 3-10-98

SA
PA

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. 310-S
TYPE OF MIX 411-D
PROJECT REFERENCE NO. STP-F-1(58)
PROJECT NO. 43003-3271-14
CONTRACTOR Kubank Paving

DATE 8-7-98
SERIAL NO. M-623
CONTRACT NO. 4552 5120
REGION III
COUNTY Humphreys Dickson

Sample No.	Asphalt Content	Sp. Gr. of Mar. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability	Marshall Flow	No. Blows Mar. Hammer
1	5.0	2.275	2.430	93.62	6.38	17.54	63.58	4158	13.2	75 each side
2	5.5	2.295	2.413	95.11	4.89	17.25	71.74	3842	13.0	75 each side
3	6.0	2.303	2.395	96.16	3.84	17.40	77.86	3558	13.3	75 each side
4	6.5	2.329	2.378	97.94	2.06	16.92	87.72	3333	15.8	75 each side
OPT	5.9	2.302	2.399	95.96	4.04	17.35	76.75	3067	10.7	75 each side

Total % Passing

Mtls.	5/8	H.Scr.	S.Scr.	Sand	Mix	Lab
%	40	17	18	25	100	100
5/8	100	100	100	100	100	100
1/2	95	100	100	100	96.2	98
3/8	73	100	100	100	89.8	89
4	13	96	96	97	63.8	63
8	4	63	68	85	46.5	46
30	3	25	33	59	26.9	26
50	2	17	24	21	14.6	13
100	1.2	13	19	4	7.00	7.11
200	.8	10	16	1	5.36	5.15

1180 Grams required to make 2.5" specimen

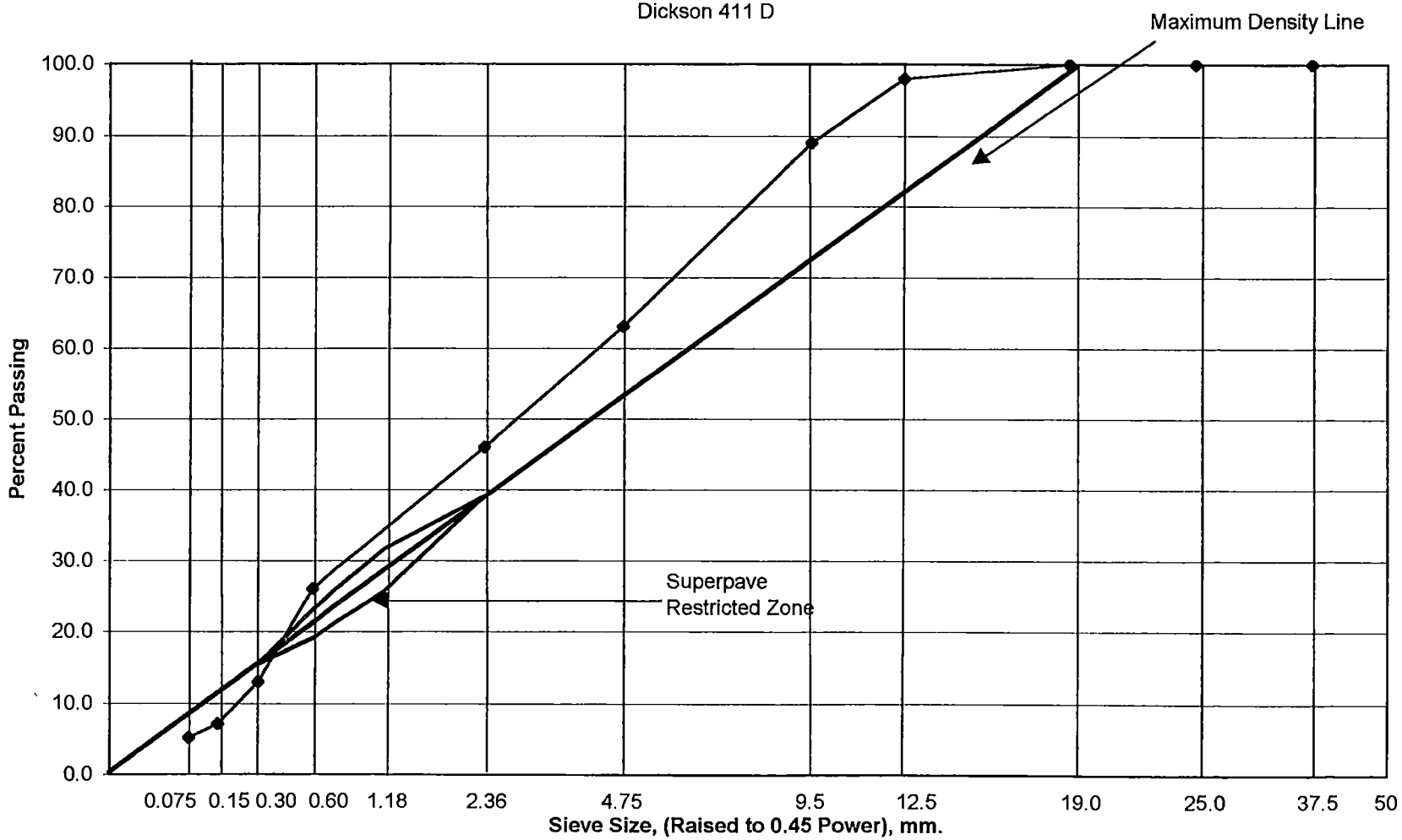
Producer

5/8 BURNS STONE
H.Scr BURNS STONE
S.Scr BURNS STONE
SAND SANGRAUL
AC-20 MARATHON/ASHLAND 5%
ANTIDOUPLITE MARATHON/ASHLAND

Bulk Gr. 2.534
Eff. Gr. 2.621
App. Gr. 2.667
Fractured Face 100%
Glassy Particle NA
LOI 17.79
RAP in AC NA
DAR 0.91
TSR 96.09%

Recommended 5.9 Asphalt Content
Theor. Density 2.399

Mix Design Gradation
12.5 mm Nominal
Dickson 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Dickson 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.430			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2925.0	2925.0	6525.0	6525.0
(lb)	6.4	6.4	14.4	14.4
Mold Temperature, ° C	115.6	112.8	132.2	132.2
(° F)	240.0	235.0	270.0	270.0
Mix Temperature, ° C	148.3	148.9	150.6	150.0
(° F)	299.0	300.0	303.0	302.0
Number of Gyrations	26	26	N/A	N/A
Compacted Height, mm	75.3	75.2	N/A	N/A
(in.)	2.9646	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	45.0	30.0
Dry mass (A), g	2917.2	2912.3	6493.7	6493.2
(lb)	6.4	6.4	14.3	14.3
Dry mass with Parafilm (D), g	2924.5	2920.0	6503.6	6504.7
(lb)	6.4	6.4	14.3	14.3
Wet mass with Parafilm (E), g	1602.0	1600.9	3628.9	3549.2
(lb)	3.5	3.5	8.0	7.8
Wet mass w/o Parafilm (C), g	1644.2	1641.6	3680.4	3643.9
(lb)	3.6	3.6	8.1	8.0
Saturated Surface Dry mass (B), g	2933.5	2928.5	6503.2	6535.7
(lb)	6.5	6.5	14.3	14.4
Specific Gravity (Gmb), SSD	2.263	2.263	2.300	2.245
Specific Gravity (Gmb), Parafilm	2.226	2.229	2.272	2.211
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	6.9%	5.3%	7.6%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.4%	8.3%	6.5%	9.0%
NCAT Asphalt Content (%)	5.7%	5.7%	5.7%	5.7%

APA Dial Gauge Readings, mm

Mix Type: Dickson 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	7.34	6.21	5.53	3.70	2.63	- N/A -				
Aft Front	7.12	5.96	5.42	3.71	2.69	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					7.26	5.88	5.21	3.41	2.59
Fwd Front	- N/A -					6.78	5.84	5.22	3.36	2.41

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear						11.83	10.13	9.23	6.84	5.60
Aft Front						11.94	10.91	10.44	8.59	7.55
Middle						11.92	10.90	10.41	8.30	6.99
Fwd Rear						11.76	10.82	10.47	8.72	7.63
Fwd Front						10.34	9.07	8.42	6.69	5.50

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.13	1.81	3.64	4.71
Aft Front	1.16	1.70	3.41	4.43
Average	1.15	1.76	3.53	4.57

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.38	2.05	3.85	4.67
Fwd Front	0.94	1.56	3.42	4.37
Average	1.16	1.81	3.64	4.52

Cycles	500	1000	4000	8000
Average Both Pills	1.15	1.78	3.58	4.55

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.00	0.00	0.00	0.00	1.70	2.60	4.99	6.23
Aft Front	0.00	0.00	0.00	0.00	1.03	1.50	3.35	4.39
Middle	0.00	0.00	0.00	0.00	1.02	1.51	3.62	4.93
Fwd Rear	0.00	0.00	0.00	0.00	0.94	1.29	3.04	4.13
Fwd Front	0.00	0.00	0.00	0.00	1.27	1.92	3.65	4.84
Averages								
All 5	0.00	0.00	0.00	0.00	1.19	1.76	3.73	4.90
Middle 3	0.00	0.00	0.00	0.00	1.00	1.43	3.34	4.48
Middle Excluded	0.00	0.00	0.00	0.00	1.24	1.83	3.76	4.90

Appendix A – 18

County & Mix Type: Giles 307 BM/2

Project Number: 5122

ASPHALT JOB MIX FORMULA

PROJECT REFERENCE NO.	IME-65-1(58)0	DATE 5/1/98	Form DT-0256 Re: Form T-118
PROJECT NO.	28001-8162-44	COUNTY GILES	REGION 3
TYPE	(BPMB-BM)	SEC. NO. 307-BM2	CONTRACT NO. 5122
CONTRACTOR	DEMENT CONSTRUCTION CO.	SUBCONTRACTOR N/A	ARTICLE NO. .03.16
STATE RT. NO.	TOTAL MIX INCLUDING BITUMEN	DATE OF LETTING	2/6/98

MATERIAL		SCREEN TOTAL PASSING	PRODUCER AND ADDRESS	PERCENT USED
C.A.	#56	30mm-PAN	ROGERS GROUP PULASKI,TN.	18.960
MED.C.A.	#7	19mm-PAN	ROGERS GROUP PULASKI,TN.	33.180
SCRNS.	#10	9.5mm-PAN	ROGERS GROUP PULASKI,TN.	17.064
SAND	SAND	9.5mm-PAN	ADAMSVILLE SAND & GRAVEL ADAMSVILLE,TN	7.584
FILLER	RAP	19mm-PAN	DEMENT CONSTRUCTION COMPANY PULASKI,TN.	19.081
A.C.	ERG	PG64-22	ERGON INC. NASHVILLE TN. RAP HAS 5.6%AC	4.131

% FRACTURED FACES ON PLUS 4 MATERIAL N/A
BRAND OF ANT-STRIP: Perma Tac Plus % ANTI-STRIP 0.30% — 100

SCREEN	100 PERCENT MINERAL AGGREGATE TOTAL PASSING MASTER RANGE	Requested %	Tolerance %	AGGREGATE ANALYSIS TOTAL C.A. %	Med.C.A. %	SCRNS. %	Sand %	FILLER %	PERCENT PASSING CALC. MIX
TEMP.	0	149	138 - 16	#56-RGP	#7-RGP	#10-RGP	SAND-AS	RAP-DC	
A.C.	4.2-6.2	5.2	Test Results @ Recommended A.C. Content	20	35	18	8	19	100.0
13mm			DESIGN NO. CONTRACTORS						
10mm			Blk Grv. 2.382	MAX. SP. GRV. 2.481					
7.5mm			Eff. Grv 2.689			Design No. 2			
5mm	100	100	Stab. 3157.8	100	100	100	100	100	100.0
3mm			Flow						
2mm	81-93	85	Voids 3.9903	25	100	100	100	100	85.0
1mm			VMA 16						
1.5mm			V.Filled 75.1						
.5mm	57-73	67	Dust-AC 0.9	5	66	100	100	89	67.0
.75mm	40-56	41	Unit WT. 148.63	4	6	92	94	73	40.9
.36mm	28-43	28		3	3	60	77	51	28.3
300um	13-25	16	Moisture Damage Information	2.5	2.5	25	57	29	15.9
150um	9-19	10	Avg.Dry 220.3	2	2	19	19	21	10.0
75um	6-10	6	Avg.Cnd. 188.9	1.5	1.5	15	3	14	6.4
1m	2.5-6.5	4.9	TSR 85.7	1	1	13	1	10	4.9

REQUESTED Josh Clement LT-303 APPROVED John Abbott 5-7-98
Dement Construction Company — Region Materials Engineer

APPROVED Joe Ellis — Region Construction Engineer
APPROVED — Engineer of Materials and Test

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. 214 DATE 5-1-98

TYPE OF MIX 307-BM2 SERIAL NO. M-263

Project Reference No. IME-65-1(58)0 Contract No. 5122

Project No. 28001-8162-44 Region 3

Contractor Dement Construction Company County Giles

Sample No.	Asphalt Content	Sp. Gr. of Mar. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability	Marshall Flow	No. Blows Mar. Hammer
1	4.5	2.363	2.507	94.2	5.8	16.1	64.1	3713	-	75
2	5.0	2.378	2.489	95.5	4.5	16.0	72.1	3263	-	75
3	5.5	2.389	2.470	96.7	3.3	16.0	79.7	3000	-	75
4	6.0	2.398	2.452	97.8	2.2	16.2	86.2	2763	-	75
5	5.2	2.382	2.481	96.0	4.0	16.0	75.1	3158	-	75

Total % Passing

Mtls.	#56	#7	#10	RAP	Sand	Mix	Lab
%	20	35	18	19	9	100	
3/4	100	100	100	100	100	100	
1/2	25	100	100	100	100	85	
3/8	5	66	100	89	100	67	
4	4	6	92	73	94	41	
8	3	3	60	51	72	29	
30	2.5	2.5	25	21	57	16	
50	2	2	19	21	19	10	
100	1.5	1.5	15	14	3	6	
200	1	1	13	10	1	4.9	

200 Grams required to make 2.5" specimen

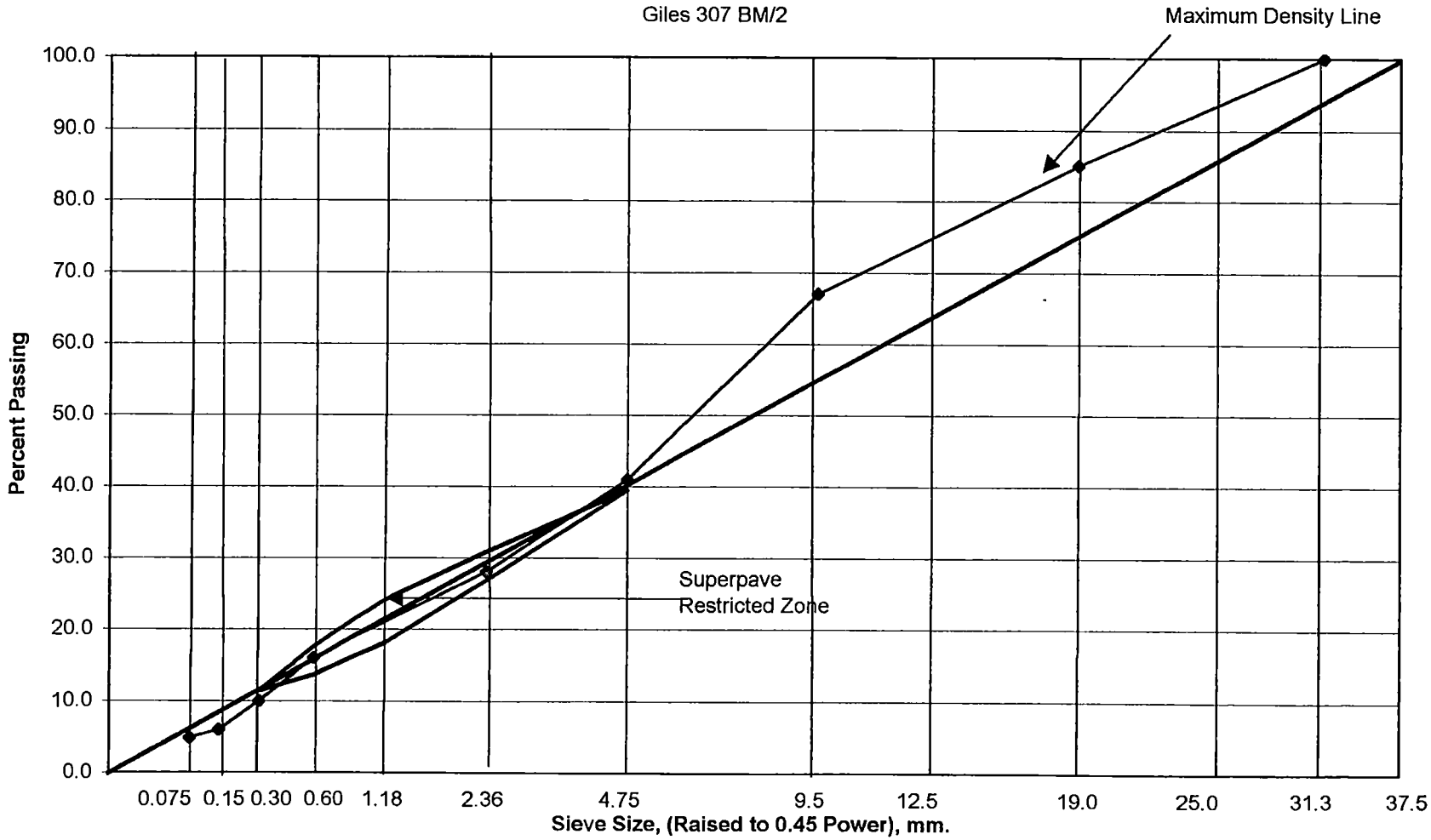
Producer

#56's, #7's, & #10's
Bogard Group Pulaski, Tenn.
Sand - Adamsville Sand & Gravel
Adamsville, TN
#5-64-22 - Logan Inc. Nashville, TN
A.S.A. - Hamilton Plus .3%
Scan Sand Waco, Texas
Rap. Dement Const. Pulaski, TN

Bulk Gr. 2673
Eff. Gr. 2689
App. Gr. 2710
Fractured Face -
Glossy Particle -
LOI -
RAP in AC Laphas 5.6% A.C.
DAR 0.9
TSR 25.7

Recommended 5.2 Asphalt Content
Theor. Density 2.491

Mix Design Gradation
25 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Giles 307 BM/2			
Theoretical Maximum (Rice) Specific Gravity =	2.486			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2950.0	2950.0	6730.8	6730.3
(lb)	6.5	6.5	14.8	14.8
Mold Temperature, ° C	121.1	112.8	137.8	137.8
(° F)	250.0	235.0	280.0	280.0
Mix Temperature, ° C	148.9	148.9	149.4	148.9
(° F)	300.0	300.0	301.0	300.0
Number of Gyrations	6	6	N/A	N/A
Compacted Height, mm	74.7	74.8	N/A	N/A
(in.)	2.9409	2.9449	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	18.0	20.0
Dry mass (A), g	2925.9	2923.8	6688.3	6668.3
(lb)	6.5	6.4	14.7	14.7
Dry mass with Parafilm (D), g	2933.1	2931.3	6699.9	6679.2
(lb)	6.5	6.5	14.8	14.7
Wet mass with Parafilm (E), g	1620.6	1618.5	3826.8	3781.8
(lb)	3.6	3.6	8.4	8.3
Wet mass w/o Parafilm (C), g	1680.9	1679.3	3865.4	3907.1
(lb)	3.7	3.7	8.5	8.6
Saturated Surface Dry mass (B), g	2939.5	2939.7	6699.9	6676.6
(lb)	6.5	6.5	14.8	14.7
Specific Gravity (Gmb), SSD	2.325	2.320	2.360	2.408
Specific Gravity (Gmb), Parafilm	2.250	2.249	2.344	2.316
VTM =[1-(Gmb/Gmm)], SSD (%)	5.8%	6.0%	5.1%	3.1%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.8%	8.9%	5.7%	6.8%
NCAT Asphalt Content (%)	5.6%	5.6%	5.6%	5.6%

APA Dial Gauge Readings, mm

Mix Type: Giles 307 BM/2

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.61	9.40	8.90	7.48	6.31	- N/A -				
Aft Front	10.98	9.98	9.52	8.34	7.41	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.49	9.41	9.03	7.27	6.16
Fwd Front	- N/A -					10.40	9.17	8.60	7.03	6.00

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	1.21	1.71	3.13	4.30
Aft Front	1.00	1.46	2.64	3.57
Average	1.11	1.59	2.89	3.94

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	1.08	1.46	3.22	4.33
Fwd Front	1.23	1.80	3.37	4.40
Average	1.16	1.63	3.30	4.37

Cycles	500	1000	4000	8000
Average Both Pills	1.13	1.61	3.09	4.15

Appendix A – 19

County & Mix Type: Grundy 307 BM

Project Number: 5295

7-30-98
K.S

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA 101

RE: Form T-116

Date: 7-14-98

Project Ref. No. _____ County Grundy Region II

Proj. No. 31006-4227-04 Contract No. 5295

Type _____ Sec. No. 307m03.15 3078m Article _____

Contractor: Thomas Bros Const. Subcontractor: _____

State Rt. 127 TOTAL MIX INCLUDING BITUMEN Date of Letting 6-12-98

MATERIAL	Screen % Passing	PRODUCER AND ADDRESS	% USED
C.A.	3/4" — #8	Dunlap Stone Inc. Dunlap TN.	23.94
Med. C.A.	1/2" — #8	" " "	23.94
Screenings	1/4" — #200	" " "	28.72
Sand	1/4" — #200	Dunlap Stone & SAND Plant. Dunlap TN.	19.15
Asphalt Cement	PG 64-22	Shell oil. Co. Chattanooga TN.	4.25
Anti-Strip yes	TYPE: LP Pavebond Lite DOSAGE RATE: 0.5%		
% Fractured Faces on +4.75 Matl: N/A	% Glassy Particles on +4.75 Matl. N/A		100 %

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Tol. Passing Design Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Percent	Calculated Mix
Temp		300		25	25	30	20		
% A.C.	4.2-6.2	4.25			(Washed Gradations)				
	Compaction Temp: 280 - 290				Jan-3-196				
	Mixing Temp:				Theo: 2.508				
50mm (2")									
37.5mm (1 1/2")									
25mm (1")	100			100	100	100	100		100
19mm (3/4")	95-100			100	100	100	100		100
16mm (5/8")									
12.5mm (1/2")									
9.5mm (3/8")	59-79			4.3	75.0	100	100		69.8
4.75mm (#4)	42.61			2.0	8.0	95	94		49.8
2.36mm (#8)	29-47			1.7	3	66	84		37.8
600um (#30)	13-27			1.5	2	30	68		23.5
300um (#50)	7-20			1.0	1.5	22	28.4		12.9
150um (#100)	4-10			1.0	1.0	15.0	4.1		5.82
75um (#200)	5.-6.5			.8	.7	11.5	1.1		4.05

Requested Paul L. Carey Jr. Approved Tom Miller
Region Materials Engineer

Approved William T. Thomas
Region Construction Engineer

Approved _____
Engineer of Materials and Tests

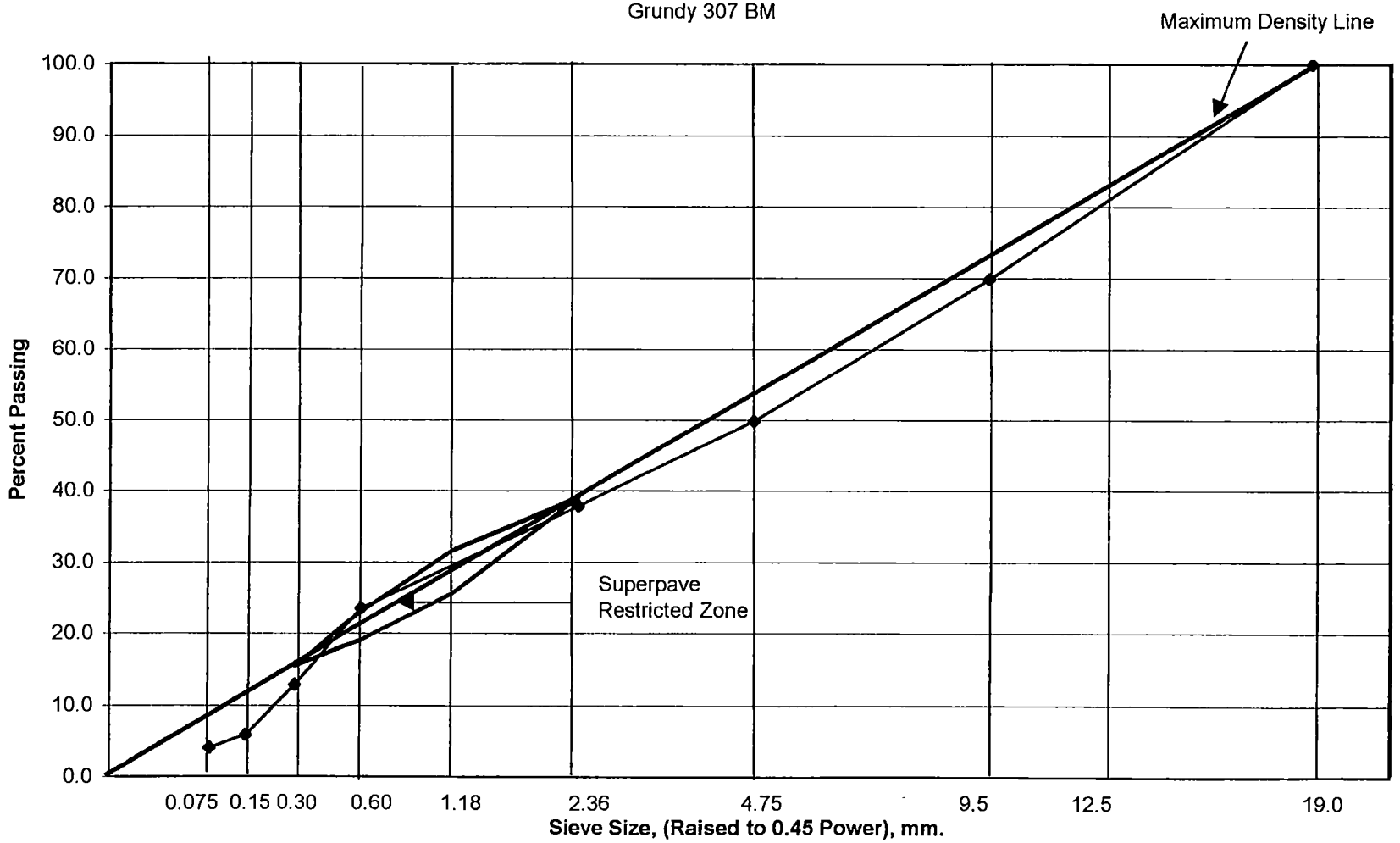
Date 7-14-98
Type of Mix 307BM
Project Reference No. _____

Contract No. 5255
County Grundy
Region III

Contractor Thomas Bros Const. Co.
No. Hammer Blows 75 Blows each side
Sp.Gr. AC 1.030

Sample No.	% AC	% Agg.	Weight – Grams Marshall Specimen In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxG I	(AxG / SP.GR. AC) x100 K	62.4xG		
1	3.50	96.10	1197.2	1201.4	698.4	502.5	2.382	2.522	2.679	5.4	14.4	62.7	148.8	4546	15
2			1193.0	1196.0	695.6	500.4	2.384							3992	15
3			1193.6	1197.1	697.7	499.4	2.390							4756	17
						Avg.	2.395						Avg.	4431.3	15.7
1	4.25	95.75	1192.1	1193.7	693.6	495.8	2.404	2.508	2.679	4.3	14.2	69.7	149.8	4737	16
2			1198.4	1201.6	701.7	500.4	2.395							4242	14
3			1196.6	1198.6	700.4	498.2	2.402							4273	14
						Avg.	2.400						Avg.	4417.3	14.7
1	4.60	95.40	1198.3	1201.1	702.9	498.2	2.338	2.495	2.679	3.0	13.6	78.3	151.1	4509	14
2			1193.3	1194.5	702.8	491.6	2.427							4876	14
3			1194.2	1195.0	698.5	496.5	2.405							4228	15
						Avg.	2.421						Avg.	4537.7	14.3
						Avg.							Avg.		

Mix Design Gradation
12.5 mm Nominal
Grundy 307 BM



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Grundy 307 BM			
Theoretical Maximum (Rice) Specific Gravity =	2.518			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3002.0	3002.0	6800.0	6800.1
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	126.7	115.6	126.7	132.2
(°F)	260.0	240.0	260.0	270.0
Mix Temperature, ° C	147.2	148.9	147.2	147.2
(°F)	297.0	300.0	297.0	297.0
Number of Gyrations	19	15	N/A	N/A
Compacted Height, mm	75.2	75.2	N/A	N/A
(in.)	2.9606	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	50.0	50.0
Dry mass (A), g	2996.6	2987.9	6770.3	6763.5
(lb)	6.6	6.6	14.9	14.9
Dry mass with Parafilm (D), g	3004.6	2995.9	6781.2	6775.4
(lb)	6.6	6.6	14.9	14.9
Wet mass with Parafilm (E), g	1685.3	1675.6	3879.9	3854.2
(lb)	3.7	3.7	8.6	8.5
Wet mass w/o Parafilm (C), g	1744.9	1731.7	3959.7	3941.8
(lb)	3.8	3.8	8.7	8.7
Saturated Surface Dry mass (B), g	3015.4	3007.1	6788.7	6780.1
(lb)	6.6	6.6	15.0	14.9
Specific Gravity (Gmb), SSD	2.359	2.343	2.393	2.383
Specific Gravity (Gmb), Parafilm	2.295	2.286	2.348	2.331
VTM =[1-(Gmb/Gmm)], SSD (%)	6.3%	7.0%	5.0%	5.4%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.9%	9.2%	6.7%	7.4%
NCAT Asphalt Content (%)	4.9%	4.9%	4.9%	4.9%

APA Dial Gauge Readings, mm

Mix Type: Grundy 307 BM

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.14	9.56	8.91	7.29	6.36	- N/A -				
Aft Front	11.36	10.24	9.67	8.17	7.38	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.41	10.47	10.13	8.94	8.06
Fwd Front	- N/A -					11.14	9.89	9.45	8.22	7.55

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.58	2.23	3.85	4.78
Aft Front	1.12	1.69	3.19	3.98
Average	1.35	1.96	3.52	4.38

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.94	1.28	2.47	3.35
Fwd Front	1.25	1.69	2.92	3.59
Average	1.10	1.49	2.70	3.47

Cycles	500	1000	4000	8000
Average Both Pills	1.22	1.72	3.11	3.93

Appendix A – 20

County & Mix Type: Grundy 411 D

Project Number: 5295

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

RE: Form T-118

* Same AS contract 4837

411D

Date: 7-16-98

Project Ref. No. _____ County Grundy Region II

Proj. No. 31006-4227-04 Contract No. 5295

Type _____ Sec. No. 411M01.01 Article _____

Contractor: Thomas Bros. const. co. Subcontractor: _____

State Rt. TOTAL MIX INCLUDING BITUMEN Date of Letting 6-12-98

MATERIAL	Screen % Passing	PRODUCER AND ADDRESS	% USED
C.A.	5/8" — #200	Vulcan Sand & Gravel Chattanooga TN	51.37
Med. C.A.			
Screenings	1/8" — #200	Dunlap Stone Inc Dunlap TN.	18.68
Sand	1/4" — #200	Dunlap Stone Sand Plant Dunlap TN.	18.68
Lime	#4 — 200	Dunlap Stone Inc Dunlap TN.	4.67
Asphalt Cement	PG-64-22	Shell oil Co. Chattanooga TN.	6.6
Anti-Strip yes	TYPE: LP Paveland Lite	DOSAGE RATE: 0.5%	
% Fractured Faces on +4.75 Matl: 88		% Glassy Particles on +4.75 Matl.	100 %

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Tol. Passing Design Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Percent	Calculated Mix
Temp		150°		55		20	20	5	
% A.C.	5.3 - 7.0	6.6			(Washed Gradations) L.O.I. 10.0				
	Compaction Temp:				Theo: 2.292				
	Mixing Temp:				Jm-2- 115				
50mm (2")									
37.5mm (1 1/2")					Jm-2- 197				
25mm (1")									
19mm (3/4")									
16mm (5/8")	100			100		100	100	100	100
12.5mm (1/2")	95-100			96		100	100	100	97.8
9.5mm (3/8")	80-93			79		100	100	100	88.5
4.75mm (#4)	54-76			47		96	94	100	68.9
2.36mm (#8)	35-57			29		64	84	95	50.7
600mm (#30)	17-29			11		29	68	62	28.6
300mm (#50)	10-18			8		20	28	46	16.3
150mm (#100)	3-10			5.2		15.5	4.1	32.8	8.42
75mm (#200)	0-6.5			3.1		11.5	1.1	23.5	5.42

Requested Paul L. Carey Jr. Contractor

Approved William T. Clausen Jr. Region Construction Engineer

Approved Tom Miller Region Materials Engineer

Approved _____ Engineer of Materials and Tests

Date _____
Type of Mix 411 M01.01
Project Reference No. 33036-3274-14

Contract No. 4837
County Hamilton
Region II

Contractor Thomas Bros
No. Hammer Blows 75 Each Side
Sp.Gr. AC 1.030

Sample No.	% AC	% Agg.	Weight – Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxG / I	(AxG / SP.GR. AC) x100 / K	62.4xG		
1	6.25	93.75	1144.9	1147.2	622.5	524.7	2.169	2.302	2.505	5.2	18.4	71.9	136.2	3930	12.0
2			1147.2	1149.3	622.6	526.7	2.178							3350	10.0
3			1141.2	1142.3	620.6	521.7	2.187							3408	12.0
						Avg.	2.182						Avg.	3563	11.3
1	6.60	93.40	1140.8	1142.3	619.9	522.4	2.184	2.292	2.505	4.6	18.6	75.3	136.4	2681	16.0
2			1138.4	1140.4	619.3	521.1	2.185							3914	14.0
3			1138.0	1142.0	622.4	519.6	2.190							4113	14.0
						Avg.	2.186						Avg.	3572	14.7
1	6.95	93.05	1148.9	1150.2	629.0	521.2	2.204	2.261	2.509	3.3	18.2	81.8	137.7	3193	14.0
2			1140.8	1141.7	625.3	516.4	2.209							3885	14.0
3			1142.5	1143.9	625.8	518.1	2.205							3902	13.0
						Avg.	2.206						Avg.	3660	13.7
						Avg.				-			Avg.		

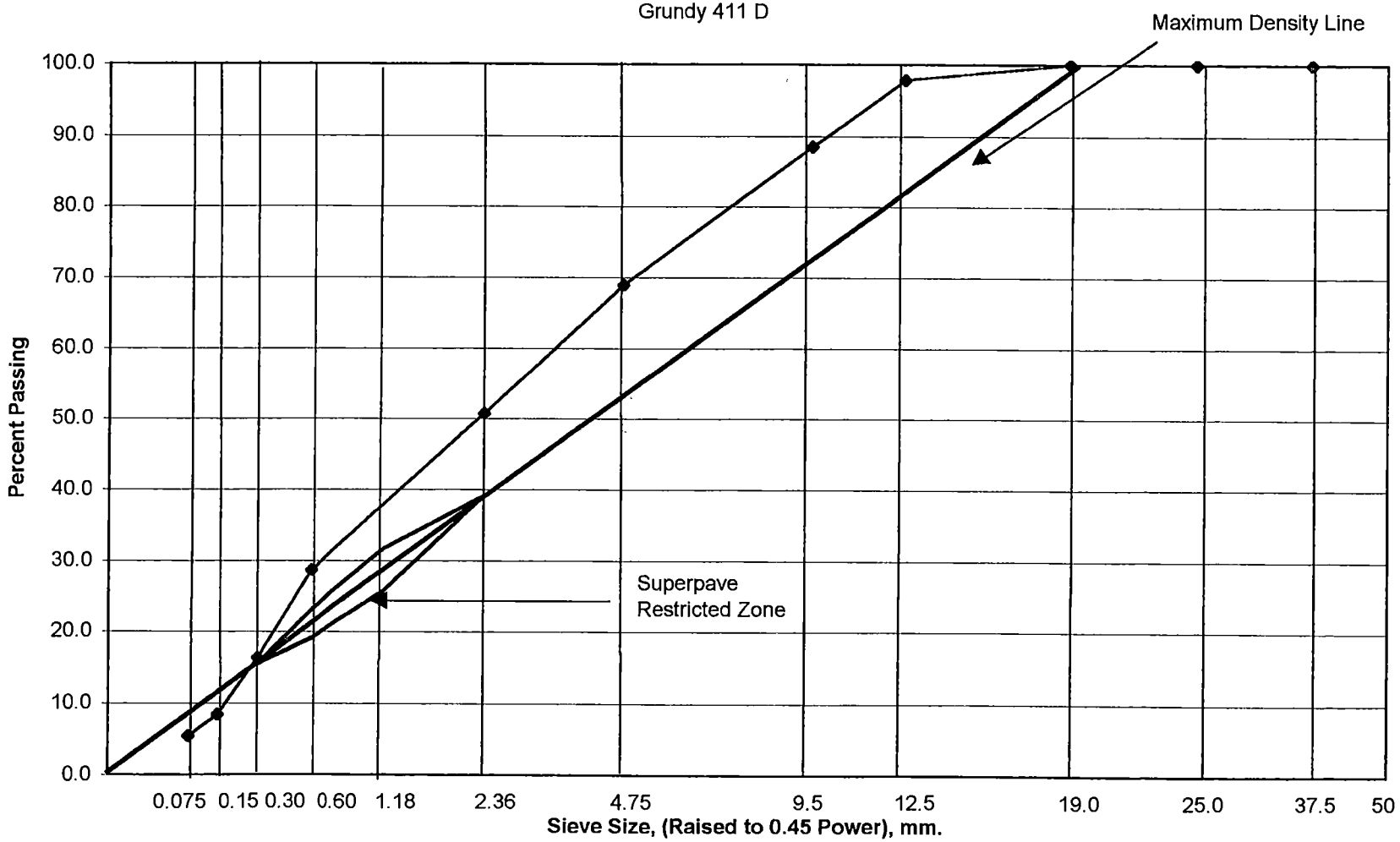
*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.Gr.\ AC}}$

Agg. Loss on Ignition (LOI) 10.55
Agg. Fractured Face Count 88
Agg. Glassy Particles NA

Recommended AC Content 6.6
Theoretical Gravity 2.392
Dust to AC Ratio (DAR) 0.8

Mix Design Gradation
12.5 mm Nominal
Grundy 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Grundy 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.297			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	4
Mass of Sample Before Compaction, g	2765.0	2765.0	6085.0	6110.2
(lb)	6.1	6.1	13.4	13.5
Mold Temperature, ° C	146.7	145.0	135.0	137.8
(°F)	296.0	293.0	275.0	280.0
Mix Temperature, ° C	146.7	147.2	147.8	152.8
(°F)	296.0	297.0	298.0	307.0
Number of Gyrations	20	22	N/A	N/A
Compacted Height, mm	75.1	75.1	N/A	N/A
(in.)	2.9567	2.9567	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	60.0	60.0
Dry mass (A), g	2746.3	2745.8	6045.8	6110.2
(lb)	6.1	6.1	13.3	13.5
Dry mass with Parafilm (D), g	2754.2	2753.9	N/A	6120.8
(lb)	6.1	6.1	N/A	13.5
Wet mass with Parafilm (E), g	1432.9	1432.3	N/A	3221.9
(lb)	3.2	3.2	N/A	7.1
Wet mass w/o Parafilm (C), g	1475.7	1476.2	3212.3	3299.3
(lb)	3.3	3.3	7.1	7.3
Saturated Surface Dry mass (B), g	2766.6	2761.2	6076.2	6122.0
(lb)	6.1	6.1	13.4	13.5
Specific Gravity (Gmb), SSD	2.127	2.137	2.111	2.165
Specific Gravity (Gmb), Parafilm	2.099	2.099	N/A	2.121
VTM =[1-(Gmb/Gmm)], SSD (%)	7.4%	7.0%	8.1%	5.8%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.6%	8.6%	N/A	7.7%
NCAT Asphalt Content (%)	7.3%	7.3%	7.3%	7.3%

APA Dial Gauge Readings, mm

Mix Type: Grundy 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.46	9.48	8.67	6.30	5.12	- N/A -				
Aft Front	11.61	9.63	8.76	7.01	6.00	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.36	9.51	8.61	6.58	5.44
Fwd Front	- N/A -					11.26	9.80	8.96	7.33	5.59

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.30	9.24	8.53	6.48	5.35	11.62	10.60	10.35	9.40	8.48
Aft Front	10.57	9.45	8.78	6.79	5.70	11.97	11.06	10.82	9.88	8.67
Middle	11.12	10.06	9.30	7.34	6.01	12.14	11.05	10.73	9.69	8.84
Fwd Rear	11.17	9.93	9.06	7.52	6.03	12.21	11.46	11.13	10.14	9.34
Fwd Front	11.01	9.74	9.18	8.05	6.41	12.42	11.38	11.02	9.93	9.24

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.98	2.79	5.16	6.34
Aft Front	1.98	2.85	4.60	5.61
Average	1.98	2.82	4.88	5.98

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.85	2.75	4.78	5.92
Fwd Front	1.46	2.30	3.93	5.67
Average	1.66	2.53	4.36	5.80

Cycles	500	1000	4000	8000
Average Both Pills	1.82	2.67	4.62	5.89

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.06	1.77	3.82	4.95	1.02	1.27	2.22	3.14
Aft Front	1.12	1.79	3.78	4.87	0.91	1.15	2.09	3.30
Middle	1.06	1.82	3.78	5.11	1.09	1.41	2.45	3.30
Fwd Rear	1.24	2.11	3.65	5.14	0.75	1.08	2.07	2.87
Fwd Front	1.27	1.83	2.96	4.60	1.04	1.40	2.49	3.18
Averages								
All 5	1.15	1.86	3.60	4.93	0.96	1.26	2.26	3.16
Middle 3	1.14	1.91	3.74	5.04	0.92	1.21	2.20	3.16
Middle Excluded	1.17	1.88	3.55	4.89	0.93	1.23	2.22	3.12

Appendix A – 21

County & Mix Type: Hamilton 411 D

Project Number: 4759

FORM DT-0256
RE Form T-118

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Date: Feb. 06, 1998

Proj. Ref. Jenkins Road Connector County Hamilton Region II
Proj. No. 33005-3160-44 Contract No. 4759
Type ACSC (HM) Sec. No. 411"D"R.Snd/Slag Article
Contractor Mayse Construction Co. Subcontractor: Vulcan Construction Co.
State Rt. **TOTAL MIX INCLUDING BITUMEN** Date of Letting

MATERIAL	Screen % Passing	PRODUCER AND ADDRESS	% USED
C.A.			
Med. C.A. Slag	16mm -4 75mm	Vulcan Wheland Slag, Chattanooga, TN	13.98
Med. C.A. 5/8's	16mm - 75um	Vulcan Sand & Gravel, Chattanooga, TN	32.62
Screenings	9.5mm - 75um	Vulcan Matenals Company, Chattanooga, TN	23.30
Sand River	4.75mm - 75um	Vulcan Sand & Gravel, Chattanooga, TN	23.30
Asphalt Cement	AC-20	Amoco Oil Co., Chatt., TN	6.80
Anti-Strip	TYPE: Pavebond Lite	DOSAGE RATE: 0.3 %	

% Fractured Faces on +4 Material: 99.0 % Glassy Particles on +4 Material 0.10% 100 %

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	TU. Passing Design Range	Requested Percent	Tolerance Percent	C. A. Percent	Med. C. A. Percent	Med. C. A. Percent	Screenings Percent	River Sand Percent	Calculated Mix
Temp		310 F			15	35	25	25	
% A.C.	5.3-7.0	6.8			(Washed Gradations)				
	Compaction Temp:		285-293		LOI : 11.1 %				
	Mixing Temp:		304-314		Theo: 2.314				
					Jm-2-13				
50mm (2")									
37.5mm(11/2")									
25mm (1")									
19mm (3/4")									
16mm (5/8")	100	100.0			100.0	100.0	100.0	100.0	100.0
12.5mm (1/2")	95-100	98.0			96.0	96.0	100.0	100.0	98.0
9.5mm (3/8")	80-93	89.2			70.0	82.0	100.0	100.0	89.2
4.75mm (#4)	54-76	66.1			20.0	46.0	91.0	97.0	66.1
2.36mm (#8)	35-57	46.4			10.0	24.0	59.0	87.0	46.4
600um (#30)	17-29	26.4			3.0	9.0	28.0	63.0	26.4
300um (#50)	10-18	13.9			2.0	8.0	21.0	22.0	13.9
150um (#100)	3-10	6.8			1.0	6.0	17.0	1.0	6.8
75um (#200)	0-6.5	5.2			1.0	5.0	13.0	0.3	5.2

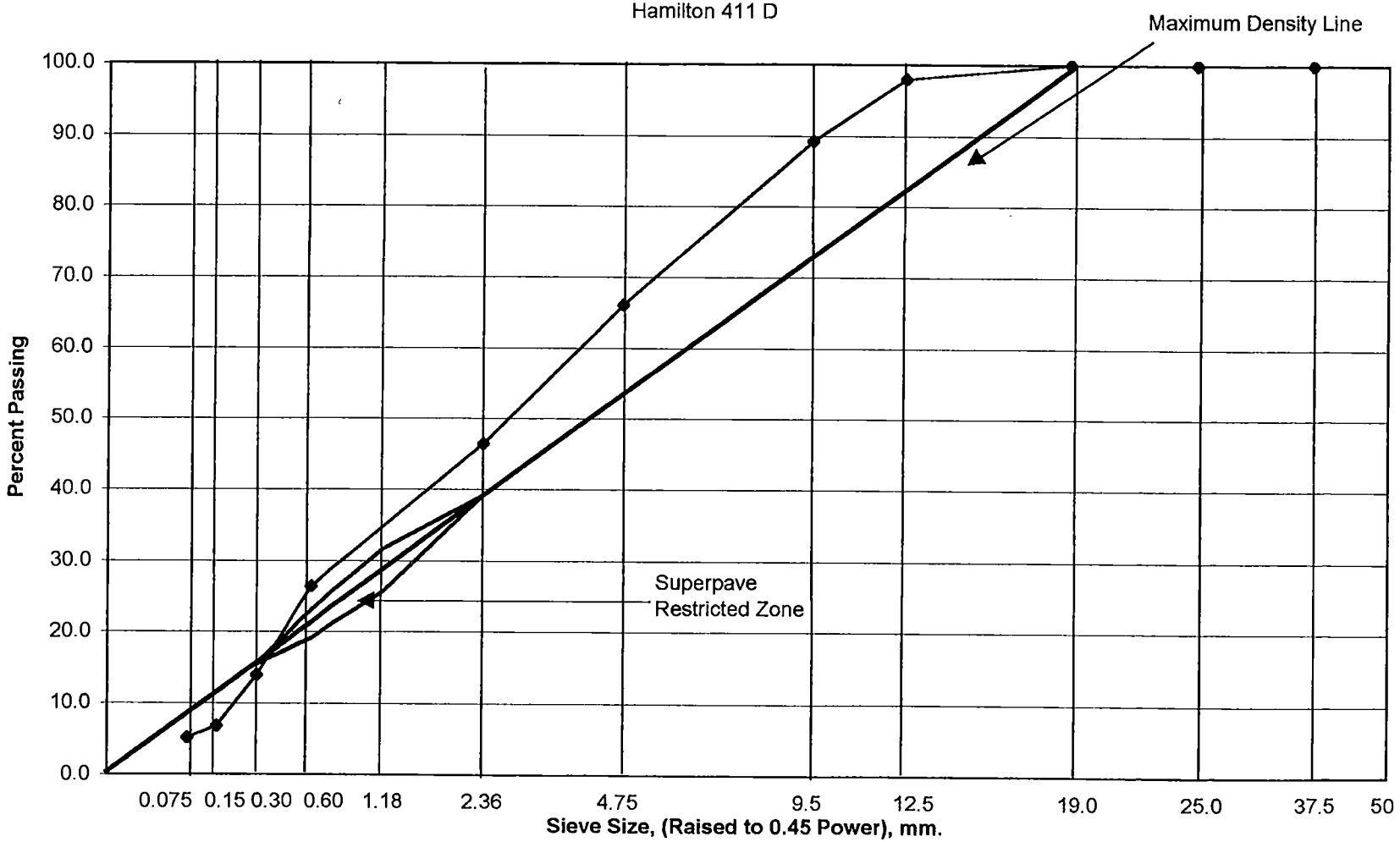
Requested Linda Jenkins (VHC) Approved W. P. Brown
Region Materials Engineer
Approved William T. Williams Jr. Approved
Contractor
Region Construction Engineer
Engineer of Materials and Tests

DATE:	Feb. 03, 1998										REGION: II					
TYPE OF MIX.	411 "D" Slag / R. Snd.										CONTRACTOR:	Vulcan Const. Co				
PROJ. #:	33005-3160-44										SP. GR. AC:	1.0320				
CONT. #	4759										EFF S.G. MIX:	2.545				
COUNTY:	Hamilton															
						WEIGHT - GRAMS MARSHALL SPECIMEN							Test Performed By:	Beda V. Gubaten		
SAMPLE NO	% AC A	% AGG B	IN AIR C	SSD D	IN H2O E	BULK VOL F	BULK SP GR G	THEO GRAV H	EFF S G I	% AIR VOIDS J	VMA K	VOIDS FILLED L	UNIT WT M	STABILITY lbs	FLOW (0.1") O	
1	6.0	94.0	1120.1	1128.4	615.4	513.0	2.183	2.339	2.545	6.7	19.4		136.2	2650	13.0	
2	6.0	94.0	1122.9	1126.7	612.5	516.2	2.175	2.339	2.545	7.0	19.7		135.7	2300	12.0	
3	6.0	94.0	1125.4	1129.8	616.3	513.5	2.192	2.339	2.545	6.3	19.0		136.8	2775	12.5	
						AVG:	2.183			6.7	19.4	65.6	136.2	2642	12.8	
4	6.5	93.5	1124.3	1125.4	617.9	507.5	2.215	2.324	2.545	4.7	18.6		136.2	2510	12.5	
5	6.5	93.5	1119.4	1120.6	613.5	507.1	2.207	2.324	2.545	5.0	18.9		137.7	2460	13.0	
6	6.5	93.5	1124.8	1127.8	618.9	508.9	2.210	2.324	2.545	4.9	18.8		137.9	2700	13.5	
						AVG:	2.211			4.9	18.8	74.1	137.9	2557	13.0	
7	7.0	93.0	1119.0	1120.0	620.4	499.6	2.240	2.308	2.545	2.9	18.1		139.8	2200	14.0	
8	7.0	93.0	1122.1	1123.0	618.7	504.3	2.225	2.308	2.545	3.6	18.7		138.8	2400	13.0	
9	7.0	93.0	1114.8	1117.9	622.1	495.6	2.248	2.308	2.545	2.6	17.9		140.3	2450	13.5	
						AVG:	2.238			3.0	18.2	83.3	139.6	2350	13.6	
10	7.5	92.5	1124.2	1125.6	623.4	502.2	2.239	2.293	2.545	2.4	18.6		139.7	2150	13.5	
11	7.5	92.5	1120.1	1121.7	625.1	496.6	2.256	2.293	2.545	1.6	18.0		140.8	2000	14.0	
12	7.5	92.5	1119.8	1122.4	626.7	495.7	2.259	2.293	2.545	1.5	17.9		141.0	2375	12.5	
	Optimum A.C. Content					AVG:	2.261			1.8	18.2	90.0	140.8	2176	13.3	
13	6.8	93.2	1114.7	1116.1	615.3	500.8	2.226	2.314	2.545	3.8	18.5		138.9	2350	12.5	
14	6.8	93.2	1125.5	1127.1	620.4	506.7	2.221	2.314	2.545	4.0	18.7		138.6	2500	13.5	
15	6.8	93.2	1122.1	1123.3	617.7	505.6	2.219	2.314	2.545	4.1	18.7		138.5	2450	12.0	
						AVG:	2.222			4.0	18.6	78.6	138.7	2433	12.7	

AGG LOSS ON IGNITION (LOI)	11.1 %	THEORETICAL GRAVITY,	2.314 %	AMOUNT & TYPE ADDITIVE	0.3 %
RECOMMENDED A.C CONTENT	6.8 %	DUST TO A.C RATIO (DAR)	0.778 %	GRMS FOR 2.5" SPECIMEN	1205 Grams
AGGREGATE ABSORPTION	2.261 %	AGG BULK SP GR	2.514 %	AGG APPARENT SP GR	2.668 %
				TSR	78.9 %

*EFF GRAV AGGS (I) = $\frac{100 - A}{\frac{100}{II} - \frac{A}{SG\ A.C}}$ *THEO GRAV (II) = $\frac{100}{\frac{A}{SG\ A.C.} + \frac{B}{I}}$

Mix Design Gradation
12.5 mm Nominal
Hamilton 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Hamilton 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.323			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2795.2	2975.1	6185.1	6185.0
(lb)	6.2	6.6	13.6	13.6
Mold Temperature, ° C	156.7	151.7	143.3	143.3
(° F)	314.0	305.0	290.0	290.0
Mix Temperature, ° C	148.3	149.4	148.9	148.3
(° F)	299.0	301.0	300.0	299.0
Number of Gyrations	10	9	N/A	N/A
Compacted Height, mm	74.9	74.6	N/A	N/A
(in.)	2.9488	2.9370	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2768.5	2776.2	6146.2	6153.9
(lb)	6.1	6.1	13.6	13.6
Dry mass with Parafilm (D), g	2778.6	2786.7	6157.6	6164.5
(lb)	6.1	6.1	13.6	13.6
Wet mass with Parafilm (E), g	1462.1	1472.9	3324.6	3356.9
(lb)	3.2	3.2	7.3	7.4
Wet mass w/o Parafilm (C), g	1496.0	1503.5	3388.5	3405.0
(lb)	3.3	3.3	7.5	7.5
Saturated Surface Dry mass (B), g	2775.6	2780.7	6150.6	6159.0
(lb)	6.1	6.1	13.6	13.6
Specific Gravity (Gmb), SSD	2.164	2.174	2.225	2.235
Specific Gravity (Gmb), Parafilm	2.130	2.142	2.184	2.206
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	6.4%	4.2%	3.8%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.3%	7.8%	6.0%	5.0%
NCAT Asphalt Content (%)	7.6%	7.6%	7.6%	7.6%

APA Dial Gauge Readings, mm

Mix Type: Hamilton 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.27	6.90	5.67	2.72	0.50	- N/A -				
Aft Front	10.36	7.71	6.65	3.94	1.62	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.06	7.72	6.50	3.78	1.59
Fwd Front	- N/A -					11.00	8.34	7.29	5.03	3.27

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	3.37	4.60	7.55	9.77
Aft Front	2.65	3.71	6.42	8.74
Average	3.01	4.16	6.99	9.26

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	3.34	4.56	7.28	9.47
Fwd Front	2.66	3.71	5.97	7.73
Average	3.00	4.14	6.63	8.60

Cycles	500	1000	4000	8000
Average Both Pills	3.01	4.15	6.81	8.93

Appendix A – 22

County & Mix Type: Jackson 307 BM

Project Number: 5185

STATE OF TENNESSEE ASPHALT JOB MIX FORMU

Rev. Form T-110

5-4-98
BJ

Date: 4/16/98

Project Ref. No. _____ County Jackson Region II

Proj. No. 44004-4235-04 Contract No. 5185

Type · BPMB-HM Sec. No. 307-BM/RAP Article 307m-03.15

Contractor Highway Materials Subcontractor: N/A

State Rt. 56 | TOTAL MIX INCLUDING BITUMEN | Date of Letting 3/20/98

MATERIAL	Screen Total % Passing	PRODUCER AND ADDRESS	% USED
C.A. #57	25mm-pan	Rogers Group Algood, TN	38.16
Med. C.A 1/2"	12.7mm-pan	Rogers Group Algood, TN	14.31
Screenin B.D.	4.75-pan	" " " "	9.54
Sand	4.75-pan	Highways, Inc. Monterey, TN	19.08
RAP	25mm-pan	Highways, Inc. Algood, TN	14.31
Asphalt Cement	PG64-22	Ergon -Nashville,Tn.	4.50
Anti-Strip	TYPE: Pavebond-Lite	DOSAGE RATE:	0
% Fractured Faces on +4 Material:		% Glassy Particles on +4 Material 0	100 %

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Ttl Passing Design Range	Requested Percent		C. A. Percent	Med. C. A. Percent	Screenings Percent	Sand Percent	RAP Percent	Calculated Mix
Temp	275-325	300° F		40	15	10	20	15	100.0
% A.C.	4.2-6.2	4.6	4.25-4.95		(Washed Gradations)				
	Compaction Temp:		280-290		A.C. In RAP: 5.1				
	Mixing Temp:		295-305		Theo 2.501				
50mm					JM 2-97				
37.5mm									
31.5mm									
25mm	100	100.0	100	100.0	100.0	100.0	100.0	100.0	100.0
19mm	85-100	93.0	87.3-98.7	85.0	100.0	100.0	100.0	95.0	93.0
16mm									
12.7mm									
9.5mm	59-79	63.0	57.3-68.7	24.0	63.0	100.0	100.0	90.0	63.0
4.75mm	42-61	43.0	39-47	7.0	10.0	94.0	98.0	66.0	43.0
2.36mm	29-47	35.0	31.7-38.3	5.0	5.0	58.0	93.0	53.0	35.0
600um	13-27	24.0	20.7-27.3	4.0	5.0	24.0	~~23.0~~ 25	31.0	24.0
300um	7-20	11.0	7.7-14.3	4.0	4.0	18.0	~~20.0~~ 25	20.0	11.0
150um	4-10	6.0	4.4-7.6	3.0	4.0	14.0	3.0	15.0	6.0
75um	0-6.5	3.9	2.3-5.5	2.0	2.0	10.0	1.0	10.0	3.9

Requested _____ Approved _____
Region Materials Engineer

Approved _____ Approved _____
J.C. Spicer I.C.T. 199
Region Construction Engineer

Engineer of Materials and Tests

MARSHALL MIX DESIGN

Date 4-16-98
Type of Mix 307m-BM/BAP
Project Reference No.

Contract No. 5185
County Jackson
Region II

Contractor Highway Materials
No. Hammer Blows 75/Side
Sp.Gr. AC 1.031

Sample No.	% AC	% Agg.	Weight - Grams Marshall Specimen In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxG / I	(AxG / SP.GR. AC) x100 K	62.4xG		
1	3.5	96.5	1189.6	1192.5	689.9	502.6	2.367	2.543	2.686	6.8	14.8	54.4	67.1	15900	2.4
2			1198.3	1201.8	696.5	505.3	2.371							13000	3.4
3			1195.1	1199.2	695.2	503.5	2.374							16000	2.5
						Avg.	2.371						Avg.	15000	2.8
1	4.0	96.0	1198.3	1202.2	695.8	506.3	2.367	2.524	2.686	5.6	14.8	62.5	67.4	15800	2.5
2			1198.7	1203.0	700.2	502.8	2.384							15200	2.5
3			1196.3	1200.4	701.6	498.8	2.398							14500	2.4
						Avg.	2.383						Avg.	15800	2.5
1	4.5	95.5	1197.0	1199.3	698.9	502.4	2.383	2.505	2.686	4.7	15.1	69.0	67.6	15200	2.6
2			1197.1	1198.5	696.7	501.8	2.386							17400	2.8
3			1196.2	1197.6	697.5	500.1	2.392							15000	2.3
						Avg.	2.387						Avg.	15900	2.6
1	5.0	95.0	1196.5	1199.6	699.5	1197.1	2.397	2.486	2.696	3.4	15.0	77.7	68.0	13800	2.8
2			1197.4	1198.4	700.9	497.5	2.406							15400	2.7
3			1197.3	1198.7	700.5	498.2	2.403							14900	3.0
						Avg.	2.402						Avg.	14700	2.8

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.Gr.\ AC}}$

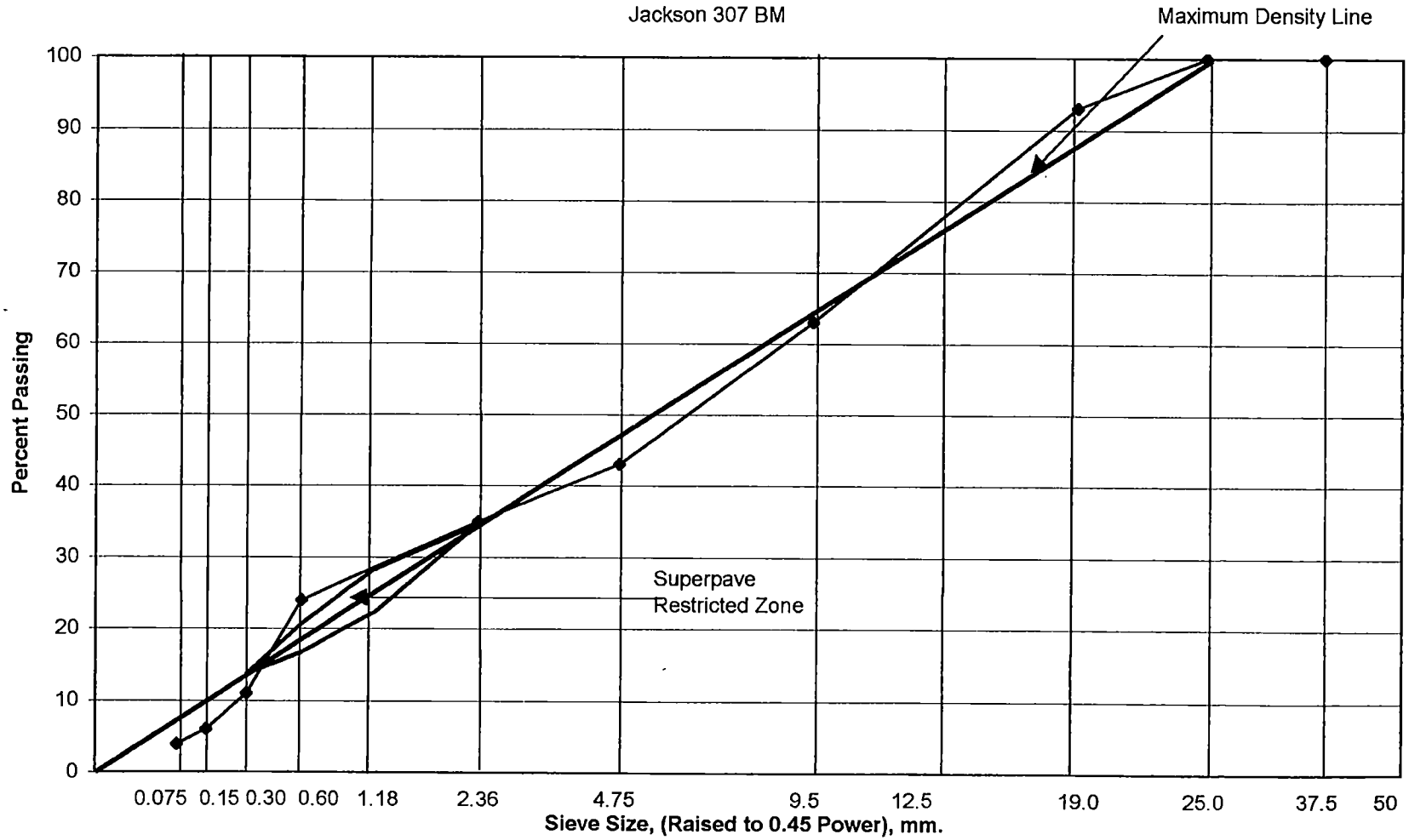
*Theo. Grav. (H) (At any AC content) = $\frac{100}{\frac{A}{Sp.Gr.\ AC} + \frac{B}{I}}$

Agg. Loss on Ignition (LOI) N/A
Agg. Fractured Face Count N/A
Agg. Glassy Particles N/A
Agg. Absorption N/A
Agg. Bulk Sp. Gr. N/A
Agg. Apparent Sp. Gr. N/A
Grams for 2.5" Specimen 1200

Recommended AC Content 4.4
Theoretical Gravity 2.501
Dust to AC Ratio (DAR) .8
Amount & Type Additive 0.0
Mix Tensile Strength Ratio (TSR) 77.9

Approved

Mix Design Gradation
19 mm Nominal



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Jackson 307 BM			
Theoretical Maximum (Rice) Specific Gravity =	2.496			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.0	6740.5	6740.0
(lb)	6.6	6.6	14.9	14.9
Mold Temperature, ° C	104.4	119.4	143.3	143.3
(°F)	220.0	247.0	290.0	290.0
Mix Temperature, ° C	146.7	147.2	149.4	148.9
(°F)	296.0	297.0	301.0	300.0
Number of Gyrations	16	16	N/A	N/A
Compacted Height, mm	75.2	75.2	N/A	N/A
(in.)	2.9606	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2987.6	2992.9	6695.2	6675.8
(lb)	6.6	6.6	14.8	14.7
Dry mass with Parafilm (D), g	2995.0	3000.4	6705.6	6685.6
(lb)	6.6	6.6	14.8	14.7
Wet mass with Parafilm (E), g	1681.1	1685.0	3780.9	3755.9
(lb)	3.7	3.7	8.3	8.3
Wet mass w/o Parafilm (C), g	1730.6	1732.6	3883.5	3878.5
(lb)	3.8	3.8	8.6	8.6
Saturated Surface Dry mass (B), g	3007.1	3011.6	6722.8	6709.8
(lb)	6.6	6.6	14.8	14.8
Specific Gravity (Gmb), SSD	2.340	2.340	2.358	2.358
Specific Gravity (Gmb), Parafilm	2.295	2.297	2.303	2.291
VTM =[1-(Gmb/Gmm)], SSD (%)	6.2%	6.2%	5.5%	5.5%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.0%	8.0%	7.7%	8.2%
NCAT Asphalt Content (%)	4.5%	4.5%	4.5%	4.5%

APA Dial Gauge Readings, mm

Mix Type: Jackson 307 BM

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.52	10.46	9.92	7.75	6.57	- N/A -				
Aft Front	11.50	10.33	10.02	8.42	6.92	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.34	9.89	9.11	7.00	5.90
Fwd Front	- N/A -					11.06	9.84	9.09	7.08	6.02

APA Measured Rut Depth Values, mm

SGC Pill # 2				
Cycles	500	1000	4000	8000
Aft Rear	1.06	1.60	3.77	4.95
Aft Front	1.17	1.48	3.08	4.58
Average	1.12	1.54	3.43	4.77

SGC Pill # 1				
Cycles	500	1000	4000	8000
Fwd Rear	1.45	2.23	4.34	5.44
Fwd Front	1.22	1.97	3.98	5.04
Average	1.34	2.10	4.16	5.24

Cycles	500	1000	4000	8000
Average Both Pills	1.23	1.82	3.79	5.00

Appendix A – 23

County & Mix Type: Jackson 411 D

Project Number: 5185

5-4-98 BS

STATE OF TENNESSEE ASPHALT JOB MIX FORMU

Same as C/N 4871

Date: 4/20/98

Project Ref. No. _____ County Jackson Region II

Proj. No. 44004 4235 04 Contract No. 5185

Type · ACS-HM Sec. No. 411m-D Article 411m-01.01..02

Contractc Highway Materials Subcontractor: N/A

State Rt TOTAL MIX INCLUDING BITUMEN Date of Letting 3/20/98

MATERIAL	Screen	Total % Passing	PRODUCER AND ADDRESS	% USED
C.A.				0.00
Med. C.A.	16mm-pan		Rogers Group-Gorrdsville,Tn.	47.30
Screenir B.D.	4.75-pan		Rogers Group-Algood,Tn.	20.81
Sand	4.75-pan		Highway Materials-Monterey,Tn.	26.49
RAP				0.00
Asphalt Cement	PG64-22		Ergon Nashville,TN	5.40
Anti-Strip	TYPE: Pavebond LP		DOSAGE RATE:	0.3
% Fractured Faces on +4 Material:			% Glassy Particles on +4 Material 0	100 %

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Tol. Passing Design Band	Requested Percent		C.A. Percent	Med. C.A. Percent	B.D Percent	Sand Percent	RAP Percent	Calculated Mix
Temp	275-325	300.0			50	22	28		
% A.C.	5.3-7.0	5.4	5.05-5.75		(Washed Gradations)				
	Compaction Temp.: 280-290				LOI: 27.5				
	Mixing Temp: 295-305				Theo: 2.484				
					Jan -2-		98		
50mm-2"									
37.5mm-1.5									
31.5mm-1.25									
25mm-1"									
19mm-3/4									
16mm-5/8	100	100.0	100		100.0	100.0	100.0		100.0
12.5mm-1/2	95-100	98.5	92.8-100		97.0	100.0	100.0		98.5
9.5mm-3/8	80-93	86.0	80.3-91.7		72.0	100.0	100.0		86.0
4.75mm-#4	54-76	55.9	51.9-59.9		16.0	93.0	98.0		55.9
2.36mm-#8	35-57	41.3	38.0-44.6		5.0	58.0	93.0		41.3
600um-30	17-29	27.2	23.9-30.5		4.0	24.0 21.5	71.0 75.0		27.2
300um-50	10-18	11.1	7.8-14.4		3.0	18.0 12.5	20.0 25.0		11.1
150um-100	3-10	4.7	3.1-6.3		2.0	13.0	3.0		4.7
75um-200	0-6.5	3.7	2.1-5.3		2.0	11.0	1.0		3.7

Requested J. C. Spicer 4-2-98 Approved _____

J.C. SPICER, Contractor

Approved _____ Approved _____

Region Construction Engineer

Region Materials Engineer

Engineer of Materials and Tests

MARSHALL MIX DESIGN

Date 2-17-98
Type of Mix 411M-D
Project Reference No. MA-IE-40-6(119)227

Contract No. 4871
County Putnam
Region II

Contractor Highway Materials
No. Hammer Blows 75/side
Sp.Gr. AC 1.026

Sample No.	% AC	% Agg.	Weight - Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxQ I	(AxG / SP.GR. AC) x100 K	62.4xG		
1	4.5	95.5	1198.0	1200.2	693.2	507.0	2.317	2.519	2.704	7.5	17.7	57.8	66.0	12800	2.8
2			1196.3	1200.7	689.8	510.9	2.342							13400	2.7
3			1198.2	1202.5	689.3	513.2	2.335							15200	2.8
						Avg.	2.331						Avg.	13800	2.8
1	5.0	95.0	1197.8	1199.5	693.6	505.9	2.368	2.500	2.704	5.6	17.1	67.3	66.8	14000	2.7
2			1196.8	1198.5	691.4	507.1	2.356							14600	3.0
3			1197.3	1199.8	691.8	508.0	2.357							14000	2.7
						Avg.	2.360						Avg.	14200	2.7
1	5.5	94.5	1193.4	1196.1	698.3	497.8	2.401	2.481	2.704	3.4	16.3	78.9	67.8	16000	2.9
2			1156.7	1197.3	698.3	499.0	2.399							15600	2.8
3			1197.0	1157.6	696.6	501.0	2.385							16200	2.6
						Avg.	2.392						Avg.	15900	2.8
1	6.0	94.0	1196.0	1196.1	699.0	497.1	2.406	2.462	2.704	2.4	16.5	85.1	68.4	14800	3.0
2			1196.2	1156.8	697.4	499.4	2.395							14800	3.1
3			1196.0	1196.7	699.3		2.405							15200	2.9
						Avg.	2.402						Avg.	14900	3.0

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = B / (100/H - A/Sp.Gr. AC)

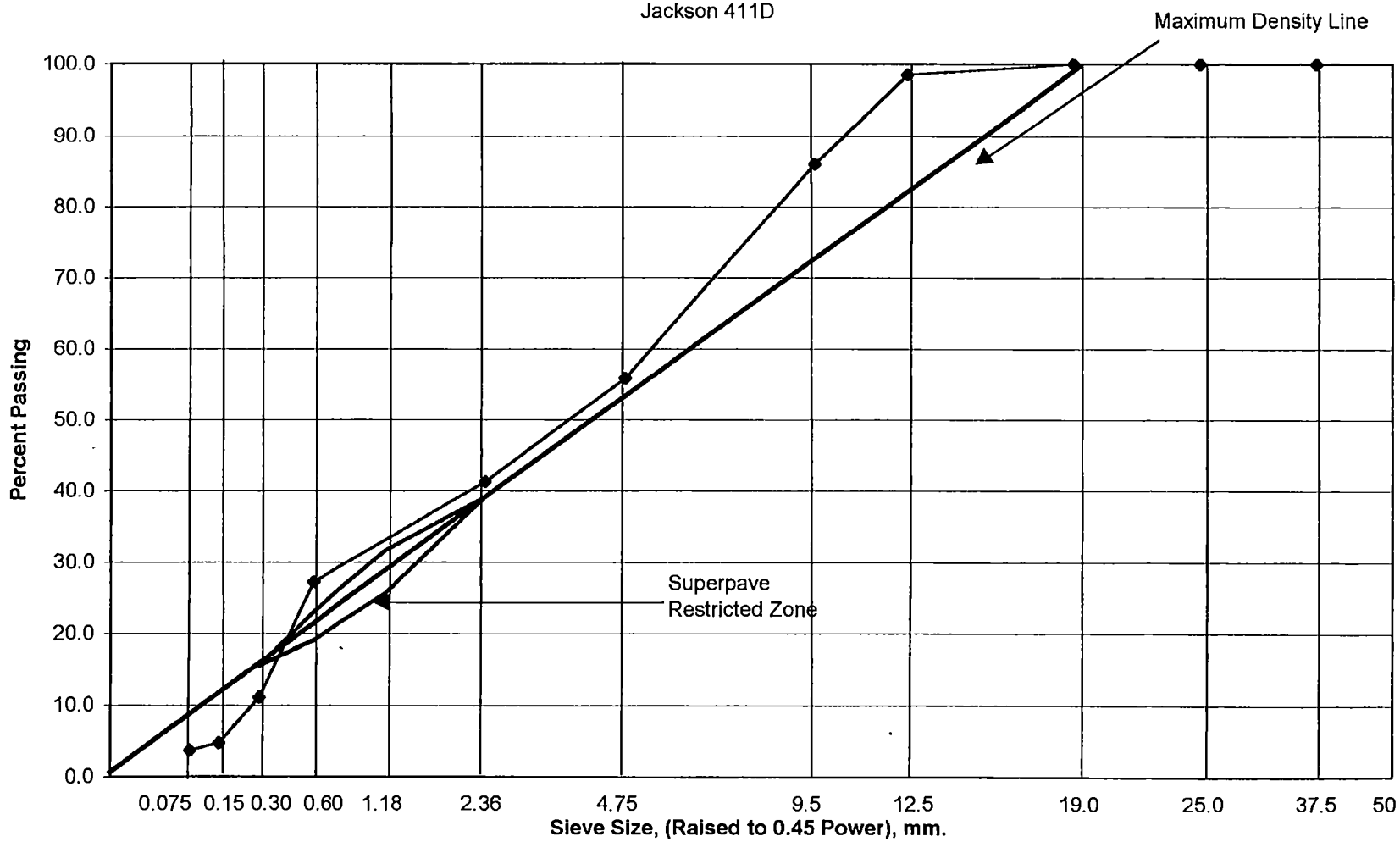
*Theo. Grav. (H) (At any AC content) = 100 / (A/Sp.Gr. AC + B/I)

Agg. Loss on Ignition (LOI) ____
Agg. Fractured Face Count N/A
Agg. Glassy Particles N/A
Agg. Absorption .8
Agg. Bulk Sp. Gr. 2.656
Agg. Apparent Sp. Gr. 2.724
Grams for 2.5" Specimen 1200

Recommended AC Content 5.4
Theoretical Gravity 2.484
Dust to AC Ratio (DAR) ____
Amount & Type Additive 0.3 Pavebond-Lit
Mix Tensile Strength Ratio (TSR) 76.4

Approved

Mix Design Gradation
12.5 mm Nominal
Jackson 411D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Jackson 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.489			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2970.0	2970.0	6620.3	6620.3
(lb)	6.5	6.5	14.6	14.6
Mold Temperature, ° C	129.4	118.3	143.3	143.3
(°F)	265.0	245.0	290.0	290.0
Mix Temperature, ° C	148.3	148.3	149.4	148.9
(°F)	299.0	299.0	301.0	300.0
Number of Gyrations	5	6	N/A	N/A
Compacted Height, mm	74.8	74.6	N/A	N/A
(in.)	2.9449	2.9370	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2953.3	2952.5	6585.3	6585.7
(lb)	6.5	6.5	14.5	14.5
Dry mass with Parafilm (D), g	2962.1	2960.9	6596.4	6597.2
(lb)	6.5	6.5	14.5	14.5
Wet mass with Parafilm (E), g	1647.9	1651.5	3746.4	3777.2
(lb)	3.6	3.6	8.3	8.3
Wet mass w/o Parafilm (C), g	1693.2	1692.3	3816.9	3838.0
(lb)	3.7	3.7	8.4	8.5
Saturated Surface Dry mass (B), g	2971.4	2970.4	6597.1	6595.0
(lb)	6.6	6.5	14.5	14.5
Specific Gravity (Gmb), SSD	2.311	2.310	2.369	2.389
Specific Gravity (Gmb), Parafilm	2.273	2.279	2.326	2.351
VTM =[1-(Gmb/Gmm)], SSD (%)	7.2%	7.2%	4.8%	4.0%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.7%	8.4%	6.6%	5.5%
NCAT Asphalt Content (%)	5.9%	5.9%	5.9%	5.9%

APA Dial Gauge Readings, mm

Mix Type: Jackson 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.13	6.60	5.41	2.58	0.98	- N/A -				
Aft Front	10.29	7.12	5.75	2.79	0.45	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.96	6.55	5.15	2.31	0.24
Fwd Front	- N/A -					10.92	6.75	5.57	3.06	0.96

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	3.53	4.72	7.55	9.15
Aft Front	3.17	4.54	7.50	9.84
Average	3.35	4.63	7.53	9.50

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	4.41	5.81	8.65	10.72
Fwd Front	4.17	5.35	7.86	9.96
Average	4.29	5.58	8.26	10.34

Cycles	500	1000	4000	8000
Average Both Pills	3.82	5.11	7.89	9.92

Appendix A – 24

County & Mix Type: Marion 411 D

Project Number: 5239

FINAL

Form RT-0216
Rev: Form T-116

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA (01)

5-20-98
BS

Date 5/25/98

Project Reference No. _____ County Marion Region 2

Project No. 58062-4271-04 Contract No. 5239

Type BPMB-HM Sec. No. 411D Article No. 411-01.02.C

Contractor Tinsley Bros. Paving Subcontractor N/A

State Rt. No. _____ TOTAL MIX INCLUDING BITUMEN Date of Letting 5/1/98

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	Percent Used
C. A.			
Med. C. A.	5/8- Pan	Vulcan Mat'l, Chattanooga Dn	46.6
Screenings	3/8- Pan	Vulcan Mat'l, Southwest Virg. Dn	23.3
Sand	1/4- Pan	Sand Switch, Swanee, Dn	23.3
Asphalt Cement	PG64-22	Gulf Oil, Chattanooga Dn	6.85
Anti-Strip	Type: Hydrona Lite	Dosage Rate: .5%	
% Fractured Faces on Plus No. 4 Material: ____		% Glassy Particles on Plus No. 4 Material: ____	100%

100 PERCENT MINERAL AGGREGATE

SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent
Temp.	275-325	310	
% A.C.	5.3-7.0	6.85	
2 "			
1 1/2"			
1 "			
3/4 "			
5/8 "	100	100	
½"	95-100	99.2	
⅜"	80-93	90.5	
No. 4	54-76	68.3	
No. 8	35-57	45.8	
No. 30	17-29	26	
No. 50	10-18	14.7	
No. 100	3-10	6.5	
No. 200	0-6.5	4.2	

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
	50	25	25		
	Lod	11.1			
	Fino	2.288			
	100	100	100		100
	98.3	100	100		99.2
	81	100	100		90.5
	41	96	95		68.3
	22	58	81		45.8
	7.0	28	62		26
	6.2	20.2	26		14.7
	4.3	14	3.5		6.5
	2.1	11	1.5		4.2

Requested Wade Crabtree Contractor

Approved Jeffrey M. Blevins Region Construction Engineer

Approved W. P. Bryan Region Materials Engineer

Approved _____ Engineer of Materials and Tests

Date 5/25/98
Type of Mix 411D
Project Reference No.

Contract No. 5239
County Marion
Region 2

Contractor Lindley Bros.
No. Hammer Blows 75
Sp.Gr. AC 1.03

Sample No.	% AC	% Agg.	Weight – Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Agge.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D–E	C/F	See* below	See* below	100 –G/H x100	100– (AxG / BxG) x100 I	(AxG / SP.GR. AC) x100 K	62.4xG		
1	6.5	94.5	1171.1	1178.7	637.2	536.5	2.183	2.278	2.514	4.2	18.0	76.5	136.2	4200	13
2			1159.3	1166.3	634.4	530.9	2.182							4100	12
3			1171.3	1174.0	636.7	537.3	2.180							4300	14
						Avg.	2.182						Avg.	4200	13
1	6.85	93.15	1167.8	1170.3	639.2	531.1	2.199	2.288	2.514	3.9	18.6	78.6	137.2	4300	14
2			1170.3	1172.4	639.1	532.7	2.197							4200	14
3			1169.6	1171.3	639.2	532.1	2.198							4000	14
						Avg.	2.198						Avg.	4166.7	14
1	7.20	92.80	1170.5	1178.7	644.2	532.5	2.198	2.278	2.514	3.3	18.7	84.8	137.4	4400	15
2			1172.5	1176.4	643.8	532.6	2.201							4600	17
3			1181.6	1185.1	644.2	535.9	2.205							4500	13
						Avg.	2.202						Avg.	4500	15.7
						Avg.							Avg.		

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.Gr.\ AC}}$

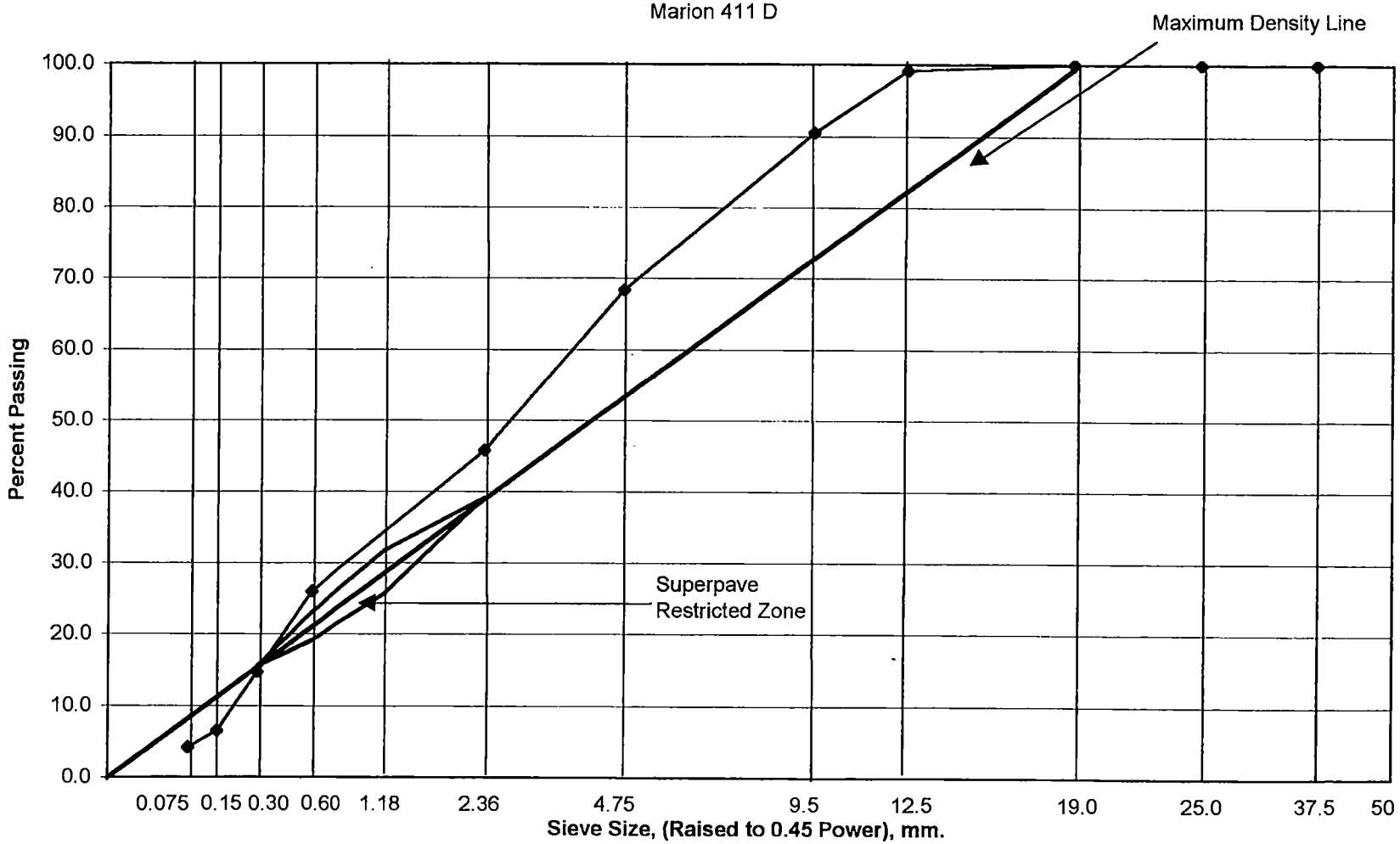
*Theo. Grav. (H) (At any AC content) = $\frac{100}{\frac{A}{Sp.Gr.\ AC} + \frac{B}{I}}$

Agg. Loss on Ignition (LOI) 11.1
Agg. Fractured Face Count
Agg. Glassy Particles
Agg. Absorption
Agg. Bulk Sp. Gr. 2.272
Agg. Apparent Sp. Gr. 2.566
Grams for 2.5" Specimen 1200

Recommended AC Content 6.85
Theoretical Gravity 2.288
Dust to AC Ratio (DAR) 1.61
Amount & Type Additive Pavebond Liquid
*Mix Tensile Strength Ratio (TSR)

Approved

Mix Design Gradation
12.5 mm Nominal
Marion 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Marion 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.305			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2740.4	2740.3	N/A	N/A
(lb)	6.0	6.0	N/A	N/A
Mold Temperature, ° C	147.8	148.9	N/A	N/A
(° F)	298.0	300.0	N/A	N/A
Mix Temperature, ° C	146.7	147.8	N/A	N/A
(° F)	296.0	298.0	N/A	N/A
Number of Gyrations	10	9	N/A	N/A
Compacted Height, mm	74.9	75.0	N/A	N/A
(in.)	2.9488	2.9528	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	N/A	N/A
(psi)	N/A	N/A	N/A	N/A
Compaction Time, sec.	N/A	N/A	N/A	N/A
Dry mass (A), g	2725.0	2720.7	N/A	N/A
(lb)	6.0	6.0	N/A	N/A
Dry mass with Parafilm (D), g	2734.7	2729.3	N/A	N/A
(lb)	6.0	6.0	N/A	N/A
Wet mass with Parafilm (E), g	1411.0	1410.9	N/A	N/A
(lb)	3.1	3.1	N/A	N/A
Wet mass w/o Parafilm (C), g	1455.9	1451.2	N/A	N/A
(lb)	3.2	3.2	N/A	N/A
Saturated Surface Dry mass (B), g	2743.7	2737.1	N/A	N/A
(lb)	6.0	6.0	N/A	N/A
Specific Gravity (Gmb), SSD	2.116	2.116	N/A	N/A
Specific Gravity (Gmb), Parafilm	2.084	2.086	N/A	N/A
VTM =[1-(Gmb/Gmm)], SSD (%)	8.2%	8.2%	N/A	N/A
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.6%	9.5%	N/A	N/A
NCAT Asphalt Content (%)	7.2%	7.2%	N/A	N/A

APA Dial Gauge Readings, mm

Mix Type: Marion 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.13	8.66	7.67	4.54	2.74	- N/A -				
Aft Front	11.48	9.03	8.13	5.29	3.31	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.59	8.67	7.70	5.36	3.53
Fwd Front	- N/A -					11.54	8.62	7.57	5.19	3.61

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	2.47	3.46	6.59	8.39
Aft Front	2.45	3.35	6.19	8.17
Average	2.46	3.41	6.39	8.28

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	2.92	3.89	6.23	8.06
Fwd Front	2.92	3.97	6.35	7.93
Average	2.92	3.93	6.29	8.00

Cycles	500	1000	4000	8000
Average Both Pills	2.69	3.67	6.34	8.14

Appendix A – 25

County & Mix Type: Maury 411 S

Project Number: 5308

Corrected Copy

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Date: 6/18/98

Project Ref. No. SP | County Maury | Region III
Proj. No. 60002-4270-04 | Layer Surface | Contract No. 5308
Type ACS-HM | Sec No. 411-S | Article 01.01-01.02
Contractor Lojac Ent. | Subcontractor
St. Route | Total Mix including Bitumen | Date of Letting

Material	Size Range or Type	Producer and Address	% Used
"D" Rock	5/8"-Pan	Burns Stone, Burns, TN	~~51.82~~ 51.81
Hard #10's	3/8"-Pan	Burns Stone, Burns, TN	~~18.88~~ 18.84
Soft #10's	3/8"-Pan	Vulcan, Franklin, TN	~~14.16~~ 14.18
Washed Scr.	1/4"-Pan	Columbia Rock, Columbia, TN	~~9.44~~ 9.42
RAP/Filler			0.00
Asphalt Cement	PG 64-22	Ergon, Nashville, TN	~~5.60~~ 5.80
Anti-Strip	Pave Bond Lite	Dosage Rate: 0.3%	
% Fractured Faces on +4 Material:	N/A	% Glassy Particles on +4 Material	N/A	100.0

100 PERCENT MINERAL AGGREGATE Screen	Tol. Passing Design Range	Requested Percent	AGGREGATE ANALYSIS TOTAL PERCENT PASSING "D" Rock Percent	Hard #10's Percent	Soft #10's Percent	Washed Scr. Percent	RAP/Filler Percent	Calculated Mix
Temp		300° F	55.0	20.0	15.0	10.0	0.0	100.0
% AC		~~5.8~~ 5.6						
Compaction Temp:		295-305						
Mixing Temp:		305-315						
2"		100	100.0	100.0	100.0	100.0	100.0	100.0
1 1/2"		100	100.0	100.0	100.0	100.0	100.0	100.0
1"		100	100.0	100.0	100.0	100.0	100.0	100.0
3/4"		100	100.0	100.0	100.0	100.0	100.0	100.0
1/2"		98	97.0	100.0	100.0	100.0	100.0	98.4
3/8"		84	70.0	100.0	100.0	100.0	100.0	83.5
#4		49	11.0	97.0	91.0	99.0	98.0	49.0
#8		33	4.0	68.0	61.0	76.0	93.0	32.6
#16		22	3.0	48.0	40.0	48.0	75.0	22.1
#30		14	2.5	28.0	30.0	29.0	62.0	14.4
#50		10	2.0	20.0	25.0	12.0	12.0	10.1
#100		7.8	1.8	15.0	20.0	8.0	2.0	7.8
#200	2-8	6.1	1.7	12.0	15.0	5.0	1.0	6.1

NCAT Furnace Corr. Factor: N/A
Loss On Ignition: 26.0
Theoretical Maximum Density: ~~2.433~~ 2.425
AC in RAP: 0.0

(Washed Gradations)

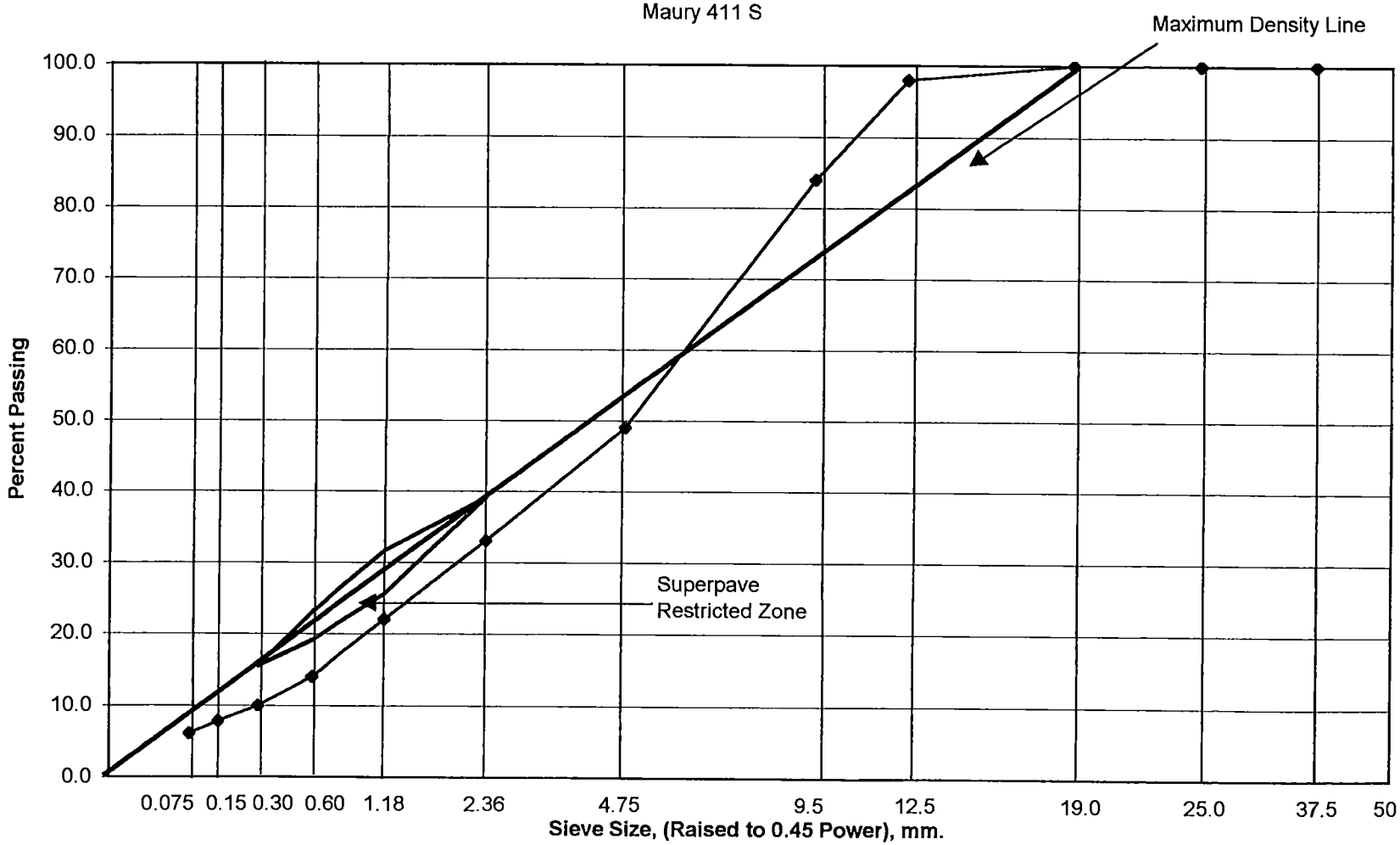
Requested Lo-Jac
Contractor

Approved [signature] 8-10-98
Region Materials Engineer

Approved [signature]
Region Construction Engineer

Approved
Engineer of Materials and Tests

Mix Design Gradation
12.5 mm Nominal
Maury 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Maury 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.437			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	4
Mass of Sample Before Compaction, g	2930.1	2930.0	6400.0	6700.0
(lb)	6.5	6.5	14.1	14.8
Mold Temperature, ° C	104.4	104.4	137.8	137.8
(°F)	220.0	220.0	280.0	280.0
Mix Temperature, ° C	149.4	147.2	147.2	149.4
(°F)	301.0	297.0	297.0	301.0
Number of Gyrations	82	75	N/A	N/A
Compacted Height, mm	75.4	75.4	N/A	N/A
(in.)	2.9685	2.9685	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	551.6 / 137.9
(psi)	N/A	N/A	60 / 20	80 / 20
Compaction Time, sec.	N/A	N/A	60.0	95.0
Dry mass (A), g	2887.9	2883.7	6361.5	6653.7
(lb)	6.4	6.4	14.0	14.7
Dry mass with Parafilm (D), g	2896.8	2892.5	N/A	N/A
(lb)	6.4	6.4	N/A	N/A
Wet mass with Parafilm (E), g	1572.2	1569.8	N/A	N/A
(lb)	3.5	3.5	N/A	N/A
Wet mass w/o Parafilm (C), g	1631.9	1628.8	3539.1	3734.8
(lb)	3.6	3.6	7.8	8.2
Saturated Surface Dry mass (B), g	2906.4	2902.4	6378.2	6665.8
(lb)	6.4	6.4	14.1	14.7
Specific Gravity (Gmb), SSD	2.266	2.264	2.241	2.270
Specific Gravity (Gmb), Parafilm	2.205	2.205	N/A	N/A
VTM =[1-(Gmb/Gmm)], SSD (%)	7.0%	7.1%	8.1%	6.8%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.5%	9.5%	N/A	N/A
NCAT Asphalt Content (%)	6.2%	6.2%	6.2%	6.2%

APA Dial Gauge Readings, mm

Mix Type: Maury 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.93	10.69	10.14	9.05	8.21	- N/A -				
Aft Front	12.13	11.29	10.87	9.46	8.36	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					12.74	11.59	11.20	10.11	9.39
Fwd Front	- N/A -					12.76	11.68	11.22	10.25	8.58

	Beam 1					Beam 4				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.33	9.98	9.52	8.23	7.33	12.03	11.11	10.77	9.64	8.63
Aft Front	11.88	10.87	10.52	9.60	8.91	12.35	11.06	10.80	9.80	9.03
Middle	11.65	10.99	10.66	9.92	9.64	12.27	11.04	10.82	9.87	9.09
Fwd Rear	11.75	11.11	10.89	9.96	9.09	12.02	10.97	10.74	10.21	9.79
Fwd Front	11.83	11.12	10.85	9.83	9.21	12.00	11.05	10.67	9.67	8.86

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.24	1.79	2.88	3.72
Aft Front	0.84	1.26	2.67	3.77
Average	**1.04**	**1.53**	**2.78**	**3.75**

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.15	1.54	2.63	3.35
Fwd Front	1.08	1.54	2.51	4.18
Average	**1.12**	**1.54**	**2.57**	**3.77**

Cycles	500	1000	4000	8000
Average	1.08	1.53	2.67	3.76
Both Pills				

	Beam 1				Beam 4			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.35	1.81	3.10	4.00	0.92	1.26	2.39	3.40
Aft Front	1.01	1.36	2.28	2.97	1.29	1.55	2.55	3.32
Middle	0.66	0.99	1.73	2.01	1.23	1.45	2.40	3.18
Fwd Rear	0.64	0.86	1.79	2.66	1.05	1.28	1.81	2.23
Fwd Front	0.71	0.98	2.00	2.62	0.95	1.33	2.33	3.14
Averages								
All 5	**0.87**	**1.20**	**2.18**	**2.85**	**1.09**	**1.37**	**2.30**	**3.05**
Middle 3	**0.77**	**1.07**	**1.93**	**2.55**	**1.19**	**1.43**	**2.25**	**2.91**
Middle Excluded	**0.93**	**1.25**	**2.29**	**3.06**	**1.05**	**1.36**	**2.27**	**3.02**

Appendix A – 26

County & Mix Type: Montgomery 307 S

Project Number: 5382

98M417

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Date 09 - 21 - 98

Project Reference No. 63 - 011 - 4235 - 04 County MONTGOMERY Region 3

Project No. Contract No 5382

Type BPMB - HM Sec. No. 307 - S Article No.

Contractor McINTOSH CONSTRUCTION Subcontractor

State Rt. N 48 / 13 TOTAL MIX INCLUDING BITUMEN Date of Letting 7 - 24 - 98

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	PERCENT USED
# 57 Stone	25.4 mm - PAN	VULCAN MATERIALS CLARKSVILLE, TN	33 320
5/8" D - Rock	19.0 mm - PAN	VULCAN MATERIALS CLARKSVILLE, TN	19.040
# 10 Screenings	9.5 mm - PAN	VULCAN MATERIALS CLARKSVILLE, TN	19.040
Mfg. Sand	9.5 mm - PAN	VULCAN MATERIALS CLARKSVILLE, TN	23 800
Asphalt Cement	PG 64 - 22	MARATHON - ASHLAND NASHVILLE, TN	4.8
Anti-Strip	Type: KLING BETA LQ	Dosage Rate: 0.5 %	
% Fractured Face on Plus No.4 Material		% Glassy Particles on Plus No.4 Material	100%

100 PERCENT MINERAL AGGREGATE — AGGREGATE ANALYSIS TOTAL PERCENT PASSING

SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	# 57 Stone	5/8" D - Rock	# 10 Screenings	Mfg. Sand	Filler Percent	Calculate Mix
Temp.	159 - 166 °C	166		35	20	20	25		
% A.C.	4.2 - 6.2	4.8							
25.4 mm	100	100		100.0	100.0	100.0	100.0		100.0
19.0 mm	90 - 100	96		88.5	100.0	100.0	100.0		96.0
12.5 mm				32.6	87.1	100.0	100.0		73.8
9.5 mm				13.4	53.0	100.0	100.0		60.3
4.75 mm				1.5	2.5	74.1	95.9		39.8
2.36 mm	23 - 49	30		0.9	1.8	42.7	81.7		29.6
1.18 mm				0.7	1.6	34.2	47.8		19.4
600 um				0.7	1.5	20.6	27.2		11.5
300 um				0.7	1.5	18.4	13.2		7.5
150 um				0.57	1.31	17.70	3.92		4.98
75 um	2 - 8	3		0.50	1.15	10.20	2.04		2.96

Requested [signature] McIntosh Contractor Approved [signature] 9-29-98 Region Materials Engineer

Approved [signature] Region Construction Engineer Approved [signature] 10-5-98 Engineer of Materials and tests

MARSHALL DESIGN

Date

Type of Mix 307 - S

Project Reference No. 63 - 011 - 4235 - 04

Contract No. 5382

County MONTGOMERY

Region III

Contractor McINTOSH

No. Hammer Blows 75

Sp Gr. AC 1.032

Sample No.	% AC	% Agg.	Weight - Grams In Air	SSD	In Water	Vol. Mar. Spec.	Sp. Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled AC	Unit Wt. kg/m^3	Stability KN	Flow mm
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D - E	C / F	See* below	See* below	100 - G/H x 100	100 - B x G / I	(A x G x 100/Sp Gr AC)/K			
1-1	4.3	95.7	1194.5	1198.6	683.8	514.8	2.320	2.471	2.636	6.5	16.1	59.8	2304	15.00	4.50
1-2			1195.2	1205.0	685.6	519.4	2.301							14.20	3.60
1-3															
						Avg.	2.311						Avg.	14.60	4.05
2-1	4.8	95.2	1193.4	1198.2	682.7	515.5	2.315	2.453	2.636	5.4	16.2	66.8	2314	14.30	4.90
2-2			1189.5	1193.0	682.0	511.0	2.328							14.20	4.70
2-3															
						Avg.	2.321						Avg.	14.25	4.80
3-1	5.3	94.7	1194.3	1198.8	688.8	508.0	2.351	2.435	2.636	3.5	15.5	77.6	2344	13.70	5.60
3-2			1195.6	1198.3	691.4	506.9	2.359							12.40	5.00
3-3			1194.0	1199.2	689.5	509.7	2.343								
						Avg.	2.351						Avg.	13.05	5.30
4-1		100.0				0.0	ERR			ERR	ERR	ERR	ERR		
4-2						0.0	ERR								
4-3						0.0	ERR								
						Avg.	ERR						Avg.	0.00	0.00

*Theo. Grav. Mix (H) as determined by AASHTO T - 209

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.\ Gr.\ AC}}$

*Theo. Grav. (H) = $\frac{100}{\frac{A}{Sp.Gr.AC} + \frac{B}{I}}$

Agg. Loss on Ignition (LOI)

Agg. Fractured Face Count

Agg. Glassy Particles

Agg. Absorption

Agg. Bulk Sp. Gr.

Agg. Apparent Sp. Gr.

Grams for 2.5" Specimen

Recommended AC Content 4.8

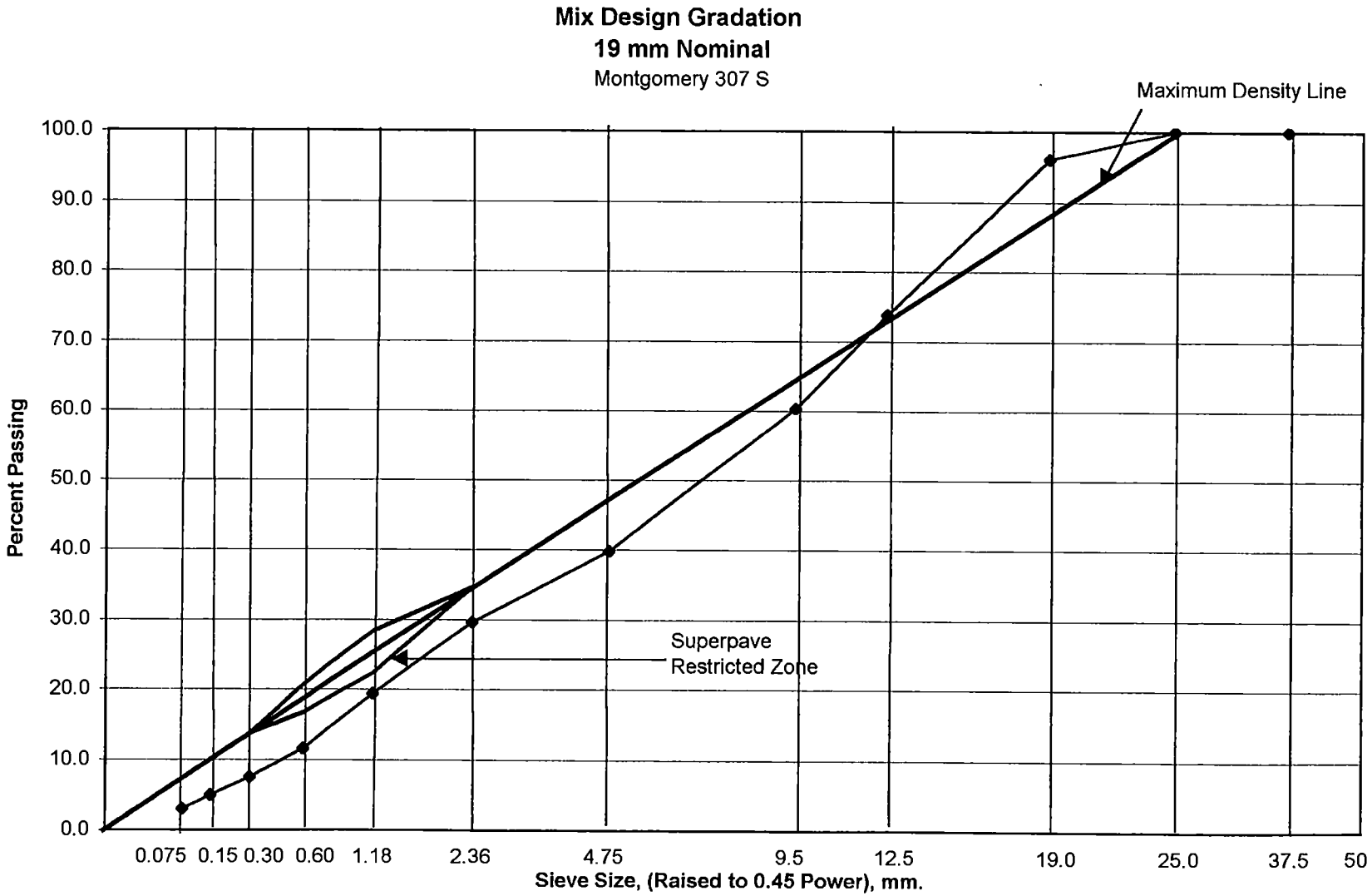
Theoretical Gravity 2.453

Dust to AC Ratio (DAR)

Amount & Type Additive 0.5% KLING BETA LO

Mix Tensile Strength Ratio (TSR)

Approved


Mix Design Gradation
19 mm Nominal
Montgomery 307 S
Maximum Density Line
Superpave
Restricted Zone
Percent Passing
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.075
0.15
0.30
0.60
1.18
2.36
4.75
9.5
12.5
19.0
25.0
37.5
50
Sieve Size, (Raised to 0.45 Power), mm.

199

Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Montgomery 307 S			
Theoretical Maximum (Rice) Specific Gravity =	2.486			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2970.0	2970.0	6735.1	6735.2
(lb)	6.5	6.5	14.8	14.8
Mold Temperature, ° C	128.3	133.9	126.7	126.7
(° F)	263.0	273.0	260.0	260.0
Mix Temperature, ° C	147.2	147.8	147.2	148.3
(° F)	297.0	298.0	297.0	299.0
Number of Gyrations	69	97	N/A	N/A
Compacted Height, mm	75.3	75.4	N/A	N/A
(in.)	2.9646	2.9685	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	60.0	70.0
Dry mass (A), g	2944.6	2947.6	6642.9	6686.0
(lb)	6.5	6.5	14.6	14.7
Dry mass with Parafilm (D), g	2952.1	2955.4	6654.7	6697.6
(lb)	6.5	6.5	14.7	14.8
Wet mass with Parafilm (E), g	1632.5	1633.6	3584.1	3682.7
(lb)	3.6	3.6	7.9	8.1
Wet mass w/o Parafilm (C), g	1694.0	1693.6	3759.3	3806.0
(lb)	3.7	3.7	8.3	8.4
Saturated Surface Dry mass (B), g	2962.8	2964.3	6703.5	6715.7
(lb)	6.5	6.5	14.8	14.8
Specific Gravity (Gmb), SSD	2.321	2.320	2.256	2.298
Specific Gravity (Gmb), Parafilm	2.253	2.252	2.177	2.232
VTM =[1-(Gmb/Gmm)], SSD (%)	6.6%	6.7%	9.2%	7.6%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.4%	9.4%	12.4%	10.2%
NCAT Asphalt Content (%)	5.3%	5.3%	5.3%	5.3%

APA Dial Gauge Readings, mm

Mix Type: Montgomery 307 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	12.06	11.32	10.99	10.11	9.57	- N/A -				
Aft Front	12.05	10.95	10.55	9.74	9.16	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.93	10.18	9.85	9.04	8.50
Fwd Front	- N/A -					10.81	9.94	9.78	9.11	8.53

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.40	9.55	9.40	8.98	7.94	11.22	10.54	10.31	9.23	8.35
Aft Front	11.57	10.64	10.41	9.41	8.70	10.91	9.88	9.68	8.24	7.05
Middle	10.99	9.87	9.62	8.36	7.61	10.69	9.70	9.36	8.76	7.64
Fwd Rear	10.68	9.32	9.03	8.42	7.73	10.84	10.27	10.19	9.05	7.87
Fwd Front	9.35	7.62	7.24	6.34	5.73	9.51	8.92	8.65	7.55	6.38

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.74	1.07	1.95	2.49
Aft Front	1.10	1.50	2.31	2.89
Average	0.92	1.29	2.13	2.69

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.75	1.08	1.89	2.43
Fwd Front	0.87	1.03	1.70	2.28
Average	0.81	1.06	1.80	2.36

Cycles	500	1000	4000	8000
Average Both Pills	0.87	1.17	1.96	2.52

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.85	1.00	1.42	2.46	0.68	0.91	1.99	2.87
Aft Front	0.93	1.16	2.16	2.87	1.03	1.23	2.67	3.86
Middle	1.12	1.37	2.63	3.38	0.99	1.33	1.93	3.05
Fwd Rear	1.36	1.65	2.26	2.95	0.57	0.65	1.79	2.97
Fwd Front	1.73	2.11	3.01	3.62	0.59	0.86	1.96	3.13
Averages								
All 5	1.20	1.46	2.30	3.06	0.77	1.00	2.07	3.18
Middle 3	1.14	1.39	2.35	3.07	0.86	1.07	2.13	3.29
Middle Excluded	1.22	1.48	2.21	2.98	0.72	0.91	2.10	3.21

Appendix A – 27

County & Mix Type: Pickett 411 S

Project Number: 5313

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

9-14-98 B.S.

Campbell

Date: 9/4/98

Project Ref. No. _____ County Pickett Region II

Proj. No. 67950-3503-04 Layer Surface Contract No. 5313

Type A.C.S.-H.M. Sec. No. 411M-D Article 411M-01,.01,.02

Contractor Highway Materials Subcontractor N/A

St. Route Total Mix including Bitumen Date of Letting 9/11/98

Material	Size Range or Type	Producer and Address	% Used
C.A.			
Med. C.A.	16mm-pan	Livingston Limestone Livingston, Tn.	57.06
Screening	4.75mm-pan	Livingston Limestone Livingston, Tn.	9.51
Nat. Sand	4.75mm-pan	Highways Inc. Monterey, Tn.	14.27
M.S.	4.75mm-pan	Livingston Limestone Livingston, Tn.	14.25
Asphalt Cement	PG64-22	Southern States/Marathon Nashville, Tn.	4.90
Anti-Strip	Pave Bond Lite	Dosage Rate:	0.3
% Fractured Faces on +4 Material:	N/A	% Glassy Particles on +4 Material N/A	100.0

100 PERCENT MINERAL AGGREGATE			AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
Screen	Ttl. Passing Design Range	Requested Percent	C.A. Percent	Med. C.A. Percent	Screening Percent	Nat. Sand Percent	M.S. Percent	Calculated Mix
Temp	275-325	300 F		60.0	10.0	15.0	15.0	100.0
% AC		4.9						
Compaction Temp:		280-290						
Mixing Temp:		295-305						
(2") 50mm								
(11/2) 37.5								
(11/4) 31.5								
(1") 25mm								
(3/4) 19mm								
(5/8) 16mm	100	100		100.0	100.0	100.0	100.0	100.0
(1/2) 12.7	95-100	94		90.0	100.0	100.0	100.0	94.0
(3/8) 9.5	80-93	79		65.0	100.0	100.0	100.0	79.0
(#4) 4.75	54-76	52		22.0	93.0	98.0	99.0	52.1
(#8) 2.36	35-57	36		7.0	63.0	93.0	78.0	36.2
(16) 1.18		29		5.0	44.0	90.0	55.0	29.2
(#30) 600	17-29	21		4.0	31.0	75.0	30.0	21.3
(#50) 300	10-18	10		3.0	22.0	24.0	16.0	10.0
(#100) 150	3-10	~~4.8~~		2.0	16.0	3.0	8.0	4.8
(#200) 75	0-6.5	3.2		2.0	11.0	1.0	5.0	3.2

NCAT Furnace Corr. Factor:
Loss On Ignition: 27.0
Theoretical Maximum Density: 2.494
AC in RAP:

(Washed Gradations)

Jm-2-291

Requested J. C. Spicer LT. 129 Contractor

Approved Tom Miller Region Materials Engineer

Approved Region Construction Engineer

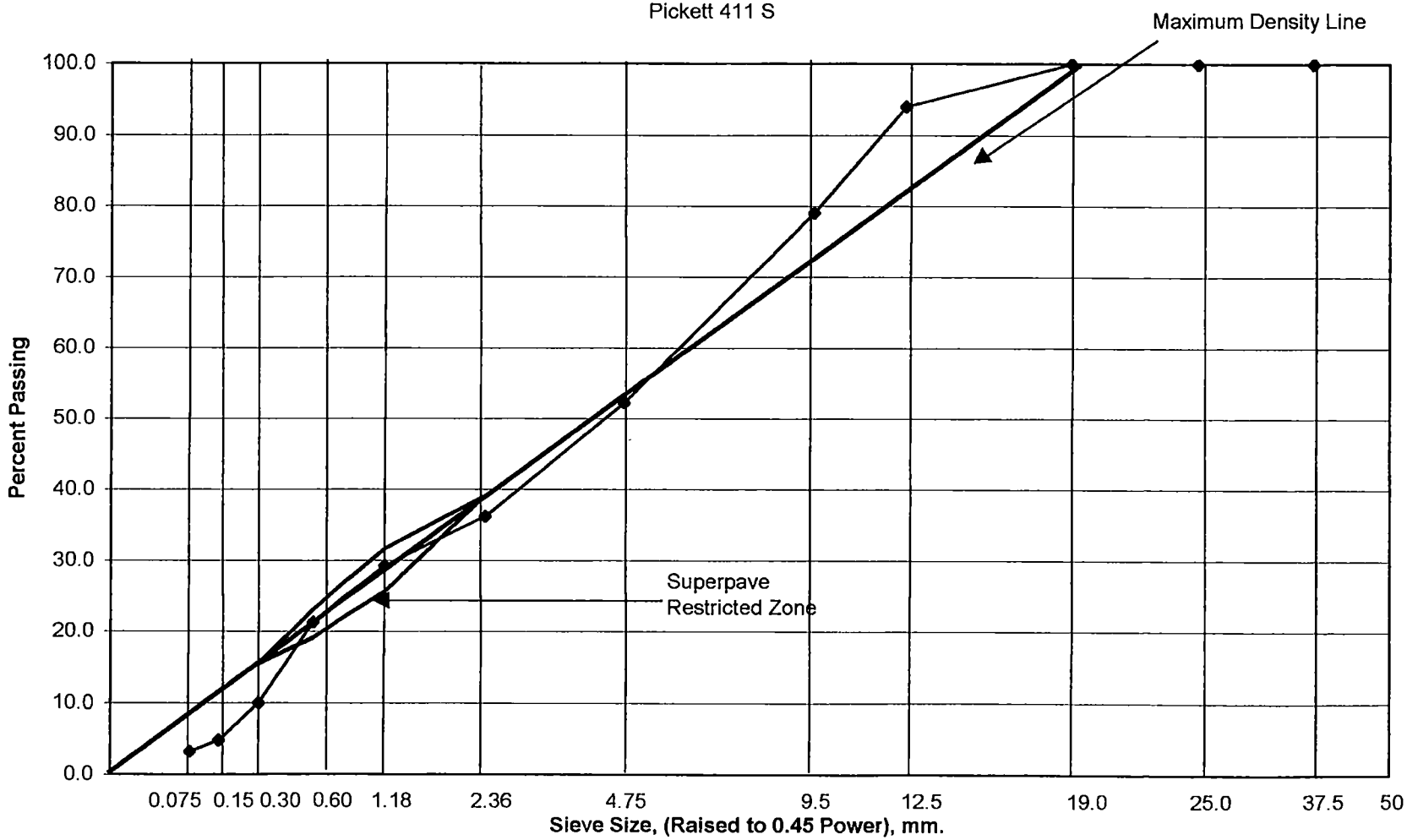
Approved Engineer of Materials and Tests

State of Tennessee Marshall Mix Design Sheet

Type of Mix	A.C.S.-H.M.	Contract No.	5313	Contractor	Highway Materials
County	Pickett	Date	9/11/98	Effective Gravity of Aggregate	2.690
Project Ref. No.	0	Region	II	SG of Asphalt	1.032

Sample No.	% AC	% Agg.	Mass (grams) In Air	SSD	In Water	Volume (ml)	Bulk SG	Rice SG or TMD	VTM (%)	VMA (%)	VFA (%)	Unit Weight (pcf)	Stability (lb)	Flow (0.01")
1-1	4.4	95.6	1197.6	1199.7	691.1	508.6	2.355	2.512	6.3	16.3	61.4	146.9	2840	10.5
1-2			1197.7	1200.7	691.8	508.9	2.354						3200	11.5
1-3			1198.3	1202.1	692.9	509.2	2.353						2900	11.5
						Avg	2.354					Avg	2980	11.2
2-1	4.9	95.1	1196.6	1198.1	693.7	504.4	2.372	2.494	4.7	16.0	70.7	148.3	3350	13.0
2-2			1194.8	1195.6	693.2	502.4	2.378						3550	11.0
2-3			1197.6	1196.1	693.1	503.0	2.381						3250	11.5
						Avg	2.377					Avg	3383	11.8
3-1	5.0	95.0	1197.7	1199.0	695.0	504.0	2.376	2.490	4.4	16.0	72.3	148.5	2700	10.0
3-2			1197.5	1199.0	695.8	503.2	2.380						2850	11.5
3-3			1197.5	1198.9	696.5	502.4	2.384						2800	13.5
						Avg	2.380					Avg	2783	11.7
4-1	5.4	94.6	1193.8	1194.4	697.6	496.8	2.403	2.475	3.2	15.7	79.8	149.5	3375	10.0
4-2			1194.4	1194.9	695.0	499.9	2.389						3400	13.0
4-3			1195.3	1196.2	697.6	498.6	2.397						3375	10.0
						Avg	2.397					Avg	3383	11.0
Opt-1						0.0	#DIV/0!		#DIV/0!	#DIV/0!	#####	#DIV/0!		
Opt-2						0.0	#DIV/0!							
Opt-3						0.0	#DIV/0!							
						Avg	#DIV/0!					Avg	#DIV/0!	#DIV/0!

Mix Design Gradation
12.5 mm Nominal
Pickett 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Pickett 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.492			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.0	6735.3	6735.4
(lb)	6.6	6.6	14.8	14.8
Mold Temperature, ° C	118.3	114.4	143.3	137.8
(° F)	245.0	238.0	290.0	280.0
Mix Temperature, ° C	146.7	148.3	148.9	149.4
(° F)	296.0	299.0	300.0	301.0
Number of Gyrations	30	27	N/A	N/A
Compacted Height, mm	75.2	75.3	N/A	N/A
(in.)	2.9606	2.9646	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	50.0	50.0
Dry mass (A), g	2983.5	2985.7	6697.1	6692.9
(lb)	6.6	6.6	14.8	14.8
Dry mass with Parafilm (D), g	2991.3	2993.2	6708.1	6704.3
(lb)	6.6	6.6	14.8	14.8
Wet mass with Parafilm (E), g	1667.7	1671.5	3784.8	3788.8
(lb)	3.7	3.7	8.3	8.4
Wet mass w/o Parafilm (C), g	1722.5	1719.8	3872.2	3865.8
(lb)	3.8	3.8	8.5	8.5
Saturated Surface Dry mass (B), g	3007.8	3007.8	6710.2	6705.1
(lb)	6.6	6.6	14.8	14.8
Specific Gravity (Gmb), SSD	2.321	2.318	2.360	2.357
Specific Gravity (Gmb), Parafilm	2.276	2.281	2.305	2.311
VTM =[1-(Gmb/Gmm)], SSD (%)	6.9%	7.0%	5.3%	5.4%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.7%	8.5%	7.5%	7.3%
NCAT Asphalt Content (%)	5.0%	5.0%	5.0%	5.0%

APA Dial Gauge Readings, mm

Mix Type: Pickett 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.89	10.84	10.21	8.88	7.98	- N/A -				
Aft Front	12.10	10.76	9.95	8.58	7.80	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.89	10.84	10.21	8.88	7.98
Fwd Front	- N/A -					12.10	10.76	9.95	8.58	7.80

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.05	1.68	3.01	3.91
Aft Front	1.34	2.15	3.52	4.30
Average	1.20	1.92	3.27	4.11

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.05	1.68	3.01	3.91
Fwd Front	1.34	2.15	3.52	4.30
Average	1.20	1.92	3.27	4.11

Cycles	500	1000	4000	8000
Average Both Pills	1.20	1.92	3.27	4.11

Appendix A – 28

County & Mix Type: Polk 411 D

Project Number: 5195

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA 61

6-18-98 13.5

Date 6-3-98

Project Reference No. _____ County Polk Region II

Project No. 70004-4575-04 Contract No. 5195

Type _____ Sec. No. 411 D Article No. _____

Contractor Hillis Group Subcontractor _____

State Rt. No. _____ TOTAL MIX INCLUDING BITUMEN Date of Letting _____

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS	Percent Used
C. A.			
Med. C. A.	5/8-Pan	Caldwell Stone Ellijay, GA	37.48
Screenings	3/8-Pan	Bradley Stone Cleveland, TN	23.42
Sand	3/8-Pan	Bradley Stone & Sand Jasper, TN	32.80
Asphalt Cement	PG64-22	Amoco Chattanooga	6.30
Anti-Strip	Type: Kling - Beta	Dosage Rate: .03	
% Fractured Faces on Plus No. 4 Material: ____		% Glassy Particles on Plus No. 4 Material: ____	100%

100 PERCENT MINERAL AGGREGATE

SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent
Temp.			
% A. C.		6.3	
2 "			
1 1/2"			
1 "			
3/4 "			
5/8 "			
½"	95-100	95.6	
⅜"	80-93	83.6	
No. 4	54-76	61.7	
No. 8	35-57	45.3	
No. 30	17-29	29	
No. 50	10-18	11.6	
No. 100	3-10	4.7	
No. 200	0-6.5	3.5	

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C. A. Percent	Med. C. A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
	40	25	35		
	Theo. 2.474				
	Root 2 33				
	L.O.T. 2 6.8				
	Jm-2-139				
	100	100	100		
	89	100	100		95.6
	59	100	100		83.
	10	95	97		61.
	2	63	82		45.
	1	26	63		29
	1	18	19		11.6
	1	13	3		4.7
	1	11	1		3.5

Requested _____ Contractor

Approved _____ Region Construction Engineer

Approved _____ Region Materials Engineer

Approved _____ Engineer of Materials

MARSHALL MIX DESIGN

Date 6/5/98
Type of Mix 411 D
Project Reference No. ____

Contract No ____
County ____
Region II

Contractor ____
No. Hammer Blows 75/side
Sp Gr. AC 1.034

Sample No	% AC	% Agg	Weight - Grams Marshall Specimen: In Air	SSD	In Water	Vol. Mat. Spec.	Bulk Sp.Gr. Mat. Spec.	Theo.* Grav. Mix	Eff.* Grav Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids filled with AC	Unit Wt. PCF	Stability lbs	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- B×D / I	(A×G / (SP.GR. AC)) x100 / K	62.4×G		
1	5.95	94.05	1187.8	1188.3	695.4	492.9	2.410	2.486	2.729	3.3	17.2	80.8	150.0	4650	15.0
2			1188.7	1189.8	694.7	495.1	2.401							4810	15.0
3			1184.5	1185.5	691.8	493.7	2.399							4670	15.0
						Avg.	2.403						Avg.	4710	15.0
1	6.30	93.70	1196.1	1196.3	690.9	505.4	2.367	2.474	2.729	4.2	18.6	77.8	147.9	4720	15.2
2			1187.3	1188.2	687.5	500.7	2.371							4630	15.0
3			1188.1	1189.3	688.2	501.1	2.371							4660	15.0
						Avg.	2.370						Avg.	4670	15.1
1	6.65	93.35	1189.3	1193.7	683.4	510.3	2.331	2.461	2.729	5.3	20.3	74.2	145.4	4390	15.5
2			1179.2	1185.9	680.7	505.1	2.335							4610	15.5
3			1187.4	1193.3	682.6	510.7	2.325							4390	15.4
						Avg.	2.330						Avg.	4430	15.5
						Avg.							Avg.		

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = B / (100 - A / Sp.Gr. AC) = H

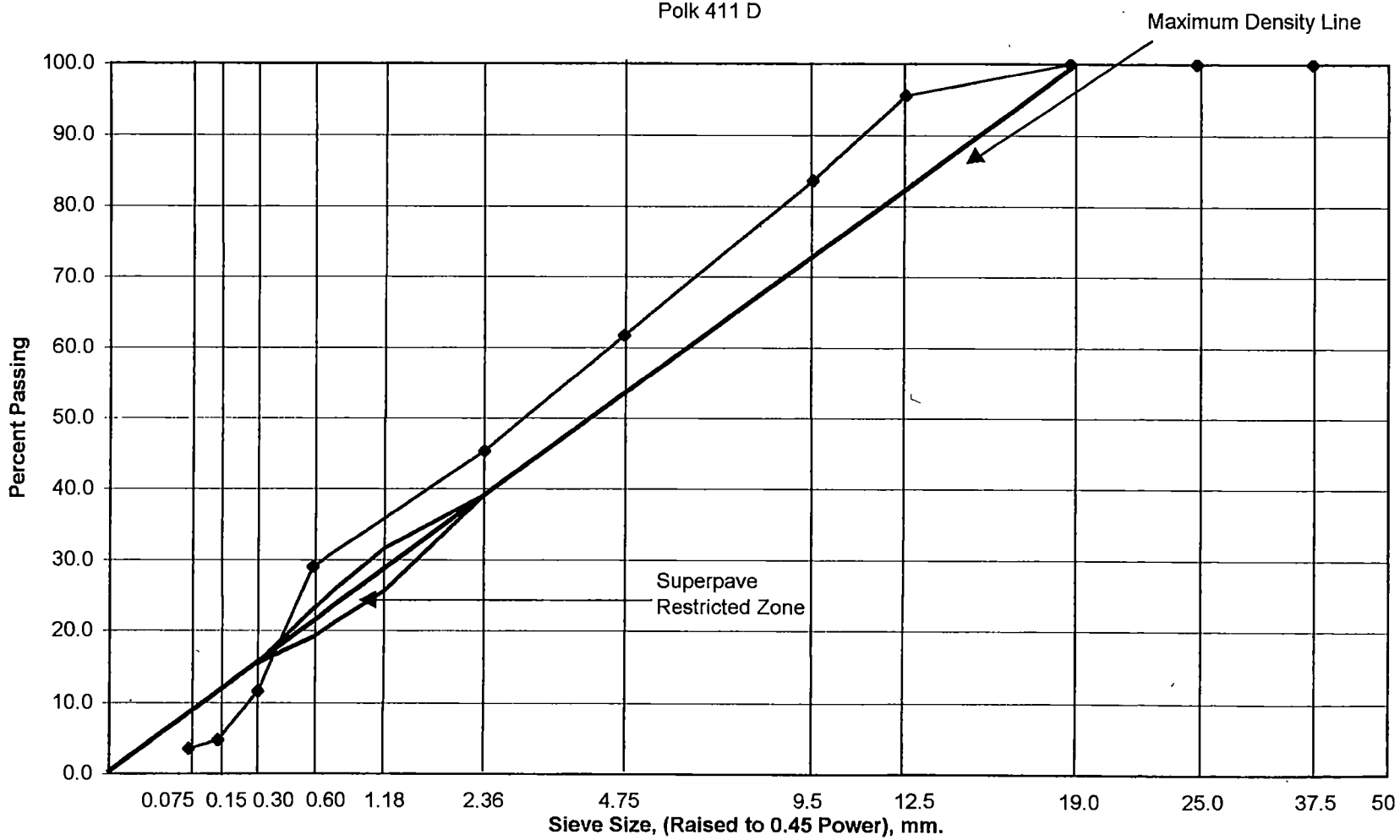
*Theo. Grav. (H) (At any AC content) = 100 / (A / Sp.Gr. AC + B / I)

Agg. Loss on Ignition (LOI) ____
Agg. Fractured Face Count ____
Agg. Glossy Particles ____
Agg. Absorption ____
Agg. Bulk Sp. Gr. ____
Agg. Apparent Sp. Gr. ____
Grams for 2.5" Specimen ____

Recommended AC Content ____
Theoretical Gravity ____
Dust to AC Ratio (DAR) ____
Amount & Type Additive ____
Mix Tensile Strength Ratio (TSR) ____

Approved

Mix Design Gradation
12.5 mm Nominal
Polk 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Polk 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.439			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	4
Mass of Sample Before Compaction, g	2930.1	2930.2	6570.0	6570.0
(lb)	6.5	6.5	14.5	14.5
Mold Temperature, ° C	115.6	132.8	148.9	140.6
(° F)	240.0	271.0	300.0	285.0
Mix Temperature, ° C	147.8	149.4	147.8	148.3
(° F)	298.0	301.0	298.0	299.0
Number of Gyrations	6	6	N/A	N/A
Compacted Height, mm	74.6	74.3	N/A	N/A
(in.)	2.9370	2.9252	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	70.0	30.0
Dry mass (A), g	2916.2	2909.7	6526.4	6524.1
(lb)	6.4	6.4	14.4	14.4
Dry mass with Parafilm (D), g	2921.7	2915.1	6536.9	6533.0
(lb)	6.4	6.4	14.4	14.4
Wet mass with Parafilm (E), g	1612.2	1610.8	3712.8	3733.9
(lb)	3.6	3.6	8.2	8.2
Wet mass w/o Parafilm (C), g	1641.9	1639.8	3764.3	3777.6
(lb)	3.6	3.6	8.3	8.3
Saturated Surface Dry mass (B), g	2922.5	2916.9	6528.5	6527.0
(lb)	6.4	6.4	14.4	14.4
Specific Gravity (Gmb), SSD	2.277	2.278	2.361	2.373
Specific Gravity (Gmb), Parafilm	2.243	2.246	2.325	2.343
VTM =[1-(Gmb/Gmm)], SSD (%)	6.6%	6.6%	3.2%	2.7%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.1%	7.9%	4.7%	3.9%
NCAT Asphalt Content (%)	6.6%	6.6%	6.6%	6.6%

APA Dial Gauge Readings, mm

Mix Type: Polk 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.27	5.59	4.08	0.73	n/a	- N/A -				
Aft Front	10.80	6.71	5.49	2.14	0.19	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.56	7.26	5.83	2.12	n/a
Fwd Front	- N/A -					11.21	7.70	6.40	3.00	0.73

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	4.68	6.19	9.54	n/a
Aft Front	4.09	5.31	8.66	10.61
Average	4.39	5.75	9.10	10.61

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	4.30	5.73	9.44	n/a
Fwd Front	3.51	4.81	8.21	10.48
Average	3.91	5.27	8.83	10.48

Cycles	500	1000	4000	8000
Average Both Pills	4.15	5.51	8.96	10.55

Appendix A – 29

County & Mix Type: Putnam 411 S

Project Number: 5386

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Date: 10/27/98

Project Ref. Nc	S.P.	County	Putnam	Region	II
Proj. No.	71005-4229-04	Layer	Surface	Contract No.	5386
Type	A.C.S.-H.M.	Sec. No.	411M-S.P.	Article	411M-01.01,.02
Contractor	Highway Materials	Subcontractor			N/A
St. Route	Total Mix including Bitumen	Date of Letting			7/24/98

Material	Size Range or Type	Producer and Address	% Used
C.A.			
Med. C.A.	16mm-pan	Rogers Group Gordonsville,Tn.	57.06
B. D.	4.75-pan	Rogers Group Algood, Tn.	23.78
Nat. Sand	4.75-pan	Highways Inc. Monterey, Tn.	14.27
M.S.			
Asphalt Cement	PG-64-22	Ergon Nashville, Tn.	4.90
Anti-Strip	Pave Bond Lite	Dosage Rate:	0.0
% Fractured Faces on +4 Material:	N/A	% Glassy Particles on +4 Material N/A	100.0

100 PERCENT MINERAL AGGREGATE			AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
Screen	Ttl. Passing Design Range	Requested Percent	C.A. Percent	Med. C.A. Percent	B. D. Percent	Nat. Sand Percent	M.S. Percent	Calculated Mix
Temp		300 F		60.0	25.0	15.0		100.0
% AC		4.9						
Compaction Temp:		295-305						
Mixing Temp:		305-315						
(2") 50mm								
(11/2) 37.5								
(11/4) 31.5								
(1") 25mm								
(3/4) 19mm								
(5/8) 16mm		100		100.0	100.0	100.0		100.0
(1/2) 12.7		98		97.0	100.0	100.0		97.5
(3/8) 9.5		83		72.0	100.0	100.0		83.2
(#4) 4.75		50		20.0	93.0	98.0		50.0
(#8) 2.36		32		5.0	58.0	93.0		31.5
(16) 1.18		25		5.0	34.0	90.0		25.0
(#30) 600		20		4.0	24.0	75.0		19.7
(#50) 300		10		3.0	18.0	25.0		10.1
(#100) 150		4.9		2.0	~~13.0~~ no	3.0		~~4.9~~ 5.9
(#200) 75		4.1		2.0	11.0	1.0		4.1

NCAT Furnace Corr. Factor:
Loss On Ignition: 32.1
Theoretical Maximum Density: 2.545
AC in RAP:
(Washed Gradations)

Jm-2-307

chm 11-17 8:

Requested J. C. Spicer L/T. 129 Contractor

Approved Region Materials Engineer

Approved Region Construction Engineer

Approved Engineer of Materials and Tests

Mixture Summary Report for Varying %AC Analysis

Project Name:	69002-4230-04	**N Initial:**	8
Workbook Name:	5386-1.xls	**N Design:**	96
Technician:	B. Smith	**N Max:**	152
Date:	7/24/98	**Nom. Sieve Size:**	12.5 mm
Asphalt Grade:	PG 64-22	**Compaction Temperature:**	149 °C
		Mixture Temperature:	154°C
Design ESAL's (millions):	4	**Depth from Surface (mm):**	0
Design Temperature:	38°C	**Mold Size:**	150 mm

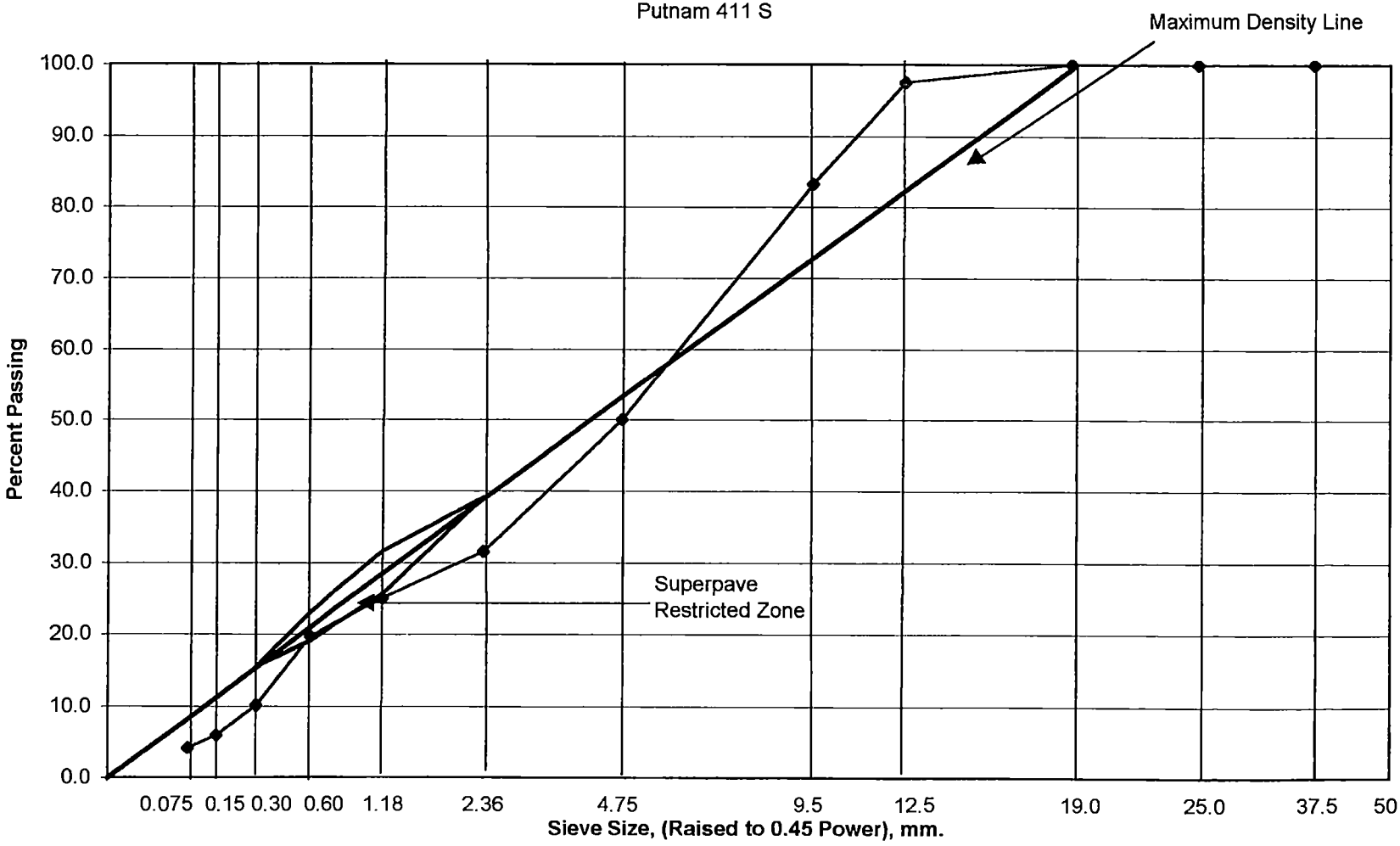
Property	Results				Criteria
	Blend 1	Blend 2	Blend 3	Blend 4	
%AC	4.5	5.0	5.5		
%Air Voids (V_a)	5.2	3.9	2.7		4.0 %
%VMA	14.0	14.0	14.1		14.0 % Min.
%VFA	62.9	72.2	80.7		65.0 % Min.
					75.0 % Max.
Dust/Asphalt Ratio	1.3	1.1	1.0		0.6-1.2 %
Max. Specific Gravity (G_{mm})	2.583	2.562	2.542	0.000	
Bulk Specific Gravity (G_{mb})	2.480	2.490	2.503		
$\%G_{mm}$ @ N_{ini}	86.2	87.3	87.8		89.0 % Max.
$\%G_{mm}$ @ N_{max}	96.0	97.2	98.4		98.0 % Max.
Effective Sp. Gravity of Blend (G_{se})	2.783	2.783	2.783		—
Sp. Gravity of Binder (G_b)	1.022	1.022	1.022		—
Sp. Gravity of Aggregate (Gs_b)	2.719	2.719	2.719		—

State of Tennessee Marshall Mix Design Sheet

Type of Mix	411-S.P.	Contract N	5386	Contractor	Highway Materials		
County	Putnam	Date	10/26/98	Effective Gravity of Aggregate	2.757		
Project Ref. No.		Region	II	SG of Asphalt	1.022		

Sample No.	% AC	% Agg.	Mass (grams) In Air	SSD	In Water	Volume (ml)	Bulk SG	Rice SG or TMD	VTM (%)	VMA (%)	VFA (%)	Unit Weight (pcf)	Stability (lb)	Flow (0.01")
1-1	4.0	96.0	1196.7	1198.6	701.7	496.9	2.408	2.582	7.0	16.4	57.4	149.9	2450	11.0
1-2			1197.0	1202.7	703.1	499.6	2.396						2300	9.5
1-3			1197.1	1201.4	702.8	498.6	2.401						2600	11.0
						Avg	2.402					Avg	2450	10.5
2-1	4.5	95.5	1195.1	1196.4	706.7	489.7	2.440	2.561	4.9	15.6	68.8	152.0	2550	14.0
2-2			1194.4	1196.7	705.0	491.7	2.429						2000	12.0
2-3			1195.7	1197.1	707.0	490.1	2.440						2350	11.0
						Avg	2.436					Avg	2300	12.3
3-1	5.0	95.0	1194.7	1195.4	709.1	492.9	2.424	2.541	3.8	15.8	75.7	152.5	2700	11.0
3-2			1195.1	1196.1	708.4	487.7	2.450						2400	11.0
3-3			1195.6	1196.5	709.8	486.7	2.457						2550	10.5
						Avg	2.444					Avg	2550	10.8
4-1	5.5	94.5	1192.7	1193.5	702.4	491.1	2.429	2.522	3.7	16.8	77.8	151.5	2125	13.5
4-2			1192.0	1193.0	703.4	489.6	2.435						2075	12.0
4-3			1192.6	1193.7	700.9	492.8	2.420						2350	11.0
						Avg	2.428					Avg	2183	12.2
Opt-1	4.9	95.1	1191.0	1192.2	707.7	484.5	2.458	2.545	3.4	15.2	77.5	153.3	2430	12.0
Opt-2			1185.0	1186.1	702.9	483.2	2.452						2125	12.0
Opt-3			1189.3	1190.0	706.9	483.1	2.462						2400	13.0
						Avg	2.457					Avg	2318	12.3

Mix Design Gradation
12.5 mm Nominal
Putnam 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Putnam 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.523			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3000.0	3000.8	6825.1	6825.1
(lb)	6.6	6.6	15.0	15.0
Mold Temperature, ° C	126.7	137.8	126.7	132.2
(°F)	260.0	280.0	260.0	270.0
Mix Temperature, ° C	147.8	148.9	149.4	148.9
(°F)	298.0	300.0	301.0	300.0
Number of Gyrations	8	6	N/A	N/A
Compacted Height, mm	75.0	74.9	N/A	N/A
(in.)	2.9528	2.9488	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	448.2 / 137.9	448.2 / 137.9
(psi)	N/A	N/A	65 / 20	65 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2979.1	2980.8	6788.9	6787.1
(lb)	6.6	6.6	15.0	15.0
Dry mass with Parafilm (D), g	2986.6	2988.4	6800.6	6798.1
(lb)	6.6	6.6	15.0	15.0
Wet mass with Parafilm (E), g	1677.7	1678.3	3916.4	3912.7
(lb)	3.7	3.7	8.6	8.6
Wet mass w/o Parafilm (C), g	1737.8	1735.9	4014.8	4000.9
(lb)	3.8	3.8	8.9	8.8
Saturated Surface Dry mass (B), g	2998.5	3002.3	6799.6	6805.1
(lb)	6.6	6.6	15.0	15.0
Specific Gravity (Gmb), SSD	2.363	2.354	2.438	2.420
Specific Gravity (Gmb), Parafilm	2.298	2.297	2.370	2.367
VTM =[1-(Gmb/Gmm)], SSD (%)	6.3%	6.7%	3.4%	4.1%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.9%	8.9%	6.1%	6.2%
NCAT Asphalt Content (%)	5.4%	5.4%	5.4%	5.4%

APA Dial Gauge Readings, mm

Mix Type: Putnam 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.02	8.80	8.13	5.85	4.38	- N/A -				
Aft Front	11.29	8.96	7.98	5.89	4.54	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					10.73	8.62	7.65	5.49	4.30
Fwd Front	- N/A -					10.60	8.64	7.61	5.68	4.52

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	2.22	2.89	5.17	6.64
Aft Front	2.33	3.31	5.40	6.75
Average	2.28	3.10	5.29	6.70

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	2.11	3.08	5.24	6.43
Fwd Front	1.96	2.99	4.92	6.08
Average	2.04	3.04	5.08	6.26

Cycles	500	1000	4000	8000
Average Both Pills	2.16	3.07	5.18	6.48

Appendix A – 30

County & Mix Type: Rutherford 307 BM/2

Project Number: 4725

TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0326
Re: Form T-114

Date 5-6-97

Reference No. TN-24-1 (77) 62 County Rutherford Region 3

Project No. 75001-3167-44 Contract No. 4725

Type BPMB-HM Sec. No. 307-BM2R Article No. 307-04.34

Contractor Lojac Ent Subcontractor

State Rt. No. I-24 TOTAL MIX INCLUDING BITUMEN Date of Letting

MATERIAL	SCREEN Total Percent Passing	PRODUCER AND ADDRESS		Percent Used
C.A. 56's	1¼ Pan	Stoneman Inc	M'Boro	26.824
Med. C.A.	¾ Pan	"	"	18.202
(Washed Screenings)	⅜ Pan	"	"	12.454
Sand	⅜ Pan	Hunter Marine	Nashville	19.16
Filler RAP	¾ Pan	Lojac Ent	M'Boro	20.17
A.C. and Pen.	AC-20 Polymer	Sou. States	Nashville	3.19
% Fractured Faces on Plus No. 4 Material	ASA PB Lite	Sou. States	(.39%)	100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent WASHED	Sand Percent	Filler Percent RAP	Calculated Mix
Temp.	275-325	315	295-335	28	19	13	20	20	100
% A.C.	4.2-6.2	4.2				Davis No.		221	
3"						Lap AC 5.0			
2½"						Theo	2.52		
2"									
1½"									
1¼"	100	100	100	100	100	100	100	100	100
¾"	91-93	91	85.3-96.7	70	100	100	100	99	91.4
½"									
⅜"	57-73	67	51.3-72.7	10	67	100	100	90	66.5
No. 4	40-56	47	43-51	4	13	83	99	67	47.4
No. 8	28-43	35	31.7-38.3	3	4	33	94	50	34.7
No. 30	13-25	21	17.7-24.3	2	3	10	63	30	21.0
No. 50	9-19	9	5.7-12.3	1.9	2.5	7	13	20	8.5
No. 100	6-10	5.2	3.6-6.8	1.7	2.2	5	15	17	5.2
No. 200	2.5-6.5	4.6	3.0-6.2	1.6	2	4.5	.8	15	4.6

Requested Lojac Warren Davis Contractor

Approved

Approved Graham Abbott 5-28-97 Region Materials Engineer

Approved Billy E. Ray for DEP 6-12-97

SA
PA

ASPHALT MIX DESIGN SUMMARY

DESIGN NO. 145
TYPE OF MIX 307 BM 2(R)/MAC
PROJECT REFERENCE NO. IM 24-1(77)62
PROJECT NO. 75001-3167-44
CONTRACTOR LeTac Ent

DATE 3-20-98
SERIAL NO. M-160
CONTRACT NO. 4725
REGION III
COUNTY Rutherford

Sample No.	Asphalt Content	Sp. Gr. of Mix. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability	Marshall Flow	No. Blows Mar. Hammer
	3.5	2.338	2.547	93.7	6.3	14.4	56.4	3577	10	75
	4.0	2.401	2.530	93.0	5.0	14.3	65.3	3111	11	75
	4.5	2.411	2.511	96.3	3.7	14.3	73.9	2667	12.7	75
4	5.0	2.425	2.492	97.5	2.5	13.4	82.9	2300	14.3	75
	4.2	2.406	2.522	95.4	4.6	14.4	68.1			

Total % Passing

Mtls.					Mix	Lab
1						
1/2						100
3/8						92.6
#10						62.9
4						42.5
8						32.8
30						20.9
50						9.2
100						6.1
200						4.6

1206 Grams required to make 2.5" specimen

Producer

CH Vulcan Mtls Hermitage
Mtls # " "
Sand " " "
Sand Source Nashville

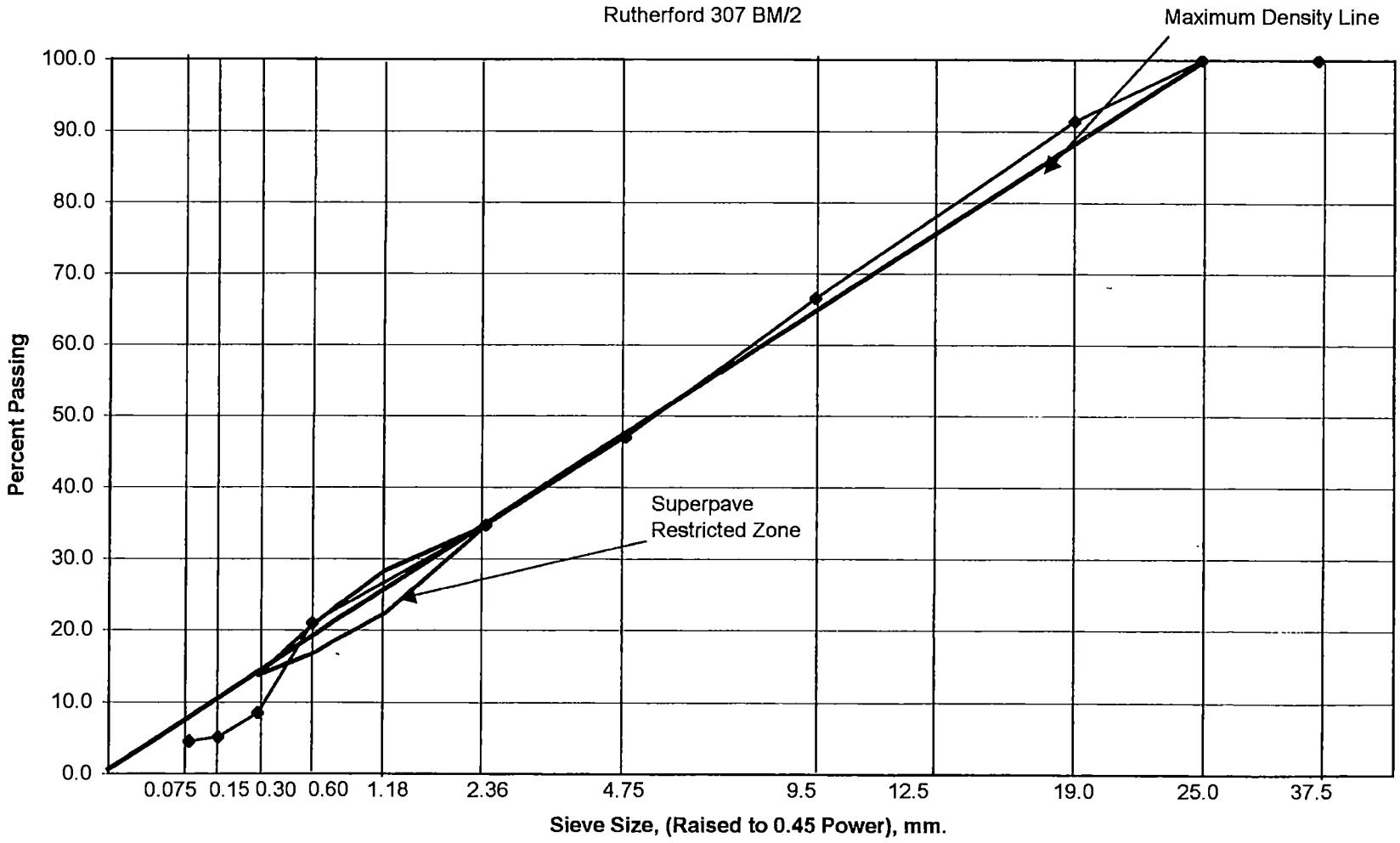
MAC Ergon
Mtls No. 1 Sand Source 34

Bulk Gr.
Eff. Gr. 2.643
App. Gr.
Fractured Face
Glossy Particle
LOI
BAP in AC 4.5
DAH 1.10
TSR 89.0

Recommended 4.2 Asphalt Content
Theor. Density 2.522

Mix Design Gradation
19 mm Nominal

Rutherford 307 BM/2



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Rutherford 307 BM/2			
Theoretical Maximum (Rice) Specific Gravity =	2.528			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	3004.0	3004.0	6835.2	6835.0
(lb)	6.6	6.6	15.1	15.1
Mold Temperature, ° C	148.3	135.0	137.8	137.8
(° F)	299.0	275.0	280.0	280.0
Mix Temperature, ° C	147.8	149.4	149.4	151.1
(° F)	298.0	301.0	301.0	304.0
Number of Gyrations	9	9	N/A	N/A
Compacted Height, mm	74.7	74.9	N/A	N/A
(in.)	2.9409	2.9488	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2987.6	2991.2	6812.5	6802.7
(lb)	6.6	6.6	15.0	15.0
Dry mass with Parafilm (D), g	2995.2	2998.7	6823.3	6813.1
(lb)	6.6	6.6	15.0	15.0
Wet mass with Parafilm (E), g	1686.4	1688.0	3935.5	3956.5
(lb)	3.7	3.7	8.7	8.7
Wet mass w/o Parafilm (C), g	1753.5	1752.7	4013.6	4026.2
(lb)	3.9	3.9	8.8	8.9
Saturated Surface Dry mass (B), g	3009.6	3016.3	6825.7	6811.2
(lb)	6.6	6.6	15.0	15.0
Specific Gravity (Gmb), SSD	2.378	2.367	2.423	2.443
Specific Gravity (Gmb), Parafilm	2.305	2.304	2.374	2.396
VTM =[1-(Gmb/Gmm)], SSD (%)	5.9%	6.4%	4.2%	3.4%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.8%	8.9%	6.1%	5.2%
NCAT Asphalt Content (%)	4.2%	4.2%	4.2%	4.2%

APA Dial Gauge Readings, mm

Mix Type: Rutherford 307 BM/2

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.98	9.80	9.31	7.88	7.01	- N/A -				
Aft Front	11.40	10.65	10.35	9.03	7.96	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.28	10.22	10.22	8.91	7.77
Fwd Front	- N/A -					11.18	10.51	10.20	8.78	7.92

APA Measured Rut Depth Values, mm

SGC Pill # 2

Cycles	500	1000	4000	8000
Aft Rear	1.18	1.67	3.10	3.97
Aft Front	0.75	1.05	2.37	3.44
Average	0.97	1.36	2.74	3.71

SGC Pill # 1

Cycles	500	1000	4000	8000
Fwd Rear	1.06	1.06	2.37	3.51
Fwd Front	0.67	0.98	2.40	3.26
Average	0.86	1.02	2.39	3.39

Cycles	500	1000	4000	8000
Average	0.92	1.19	2.56	3.55
Both Pills				

Appendix A – 31

County & Mix Type: Sequatchie 411 D

Project Number: 5318

7-10-97
SJ

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

RE: Form T-116

* Same as Cont. 4837

Date: 7-6-98

Project Ref. No. _____ County Sequatchie Region II

Proj. No. 77004 - 4207 - 04 Contract No. 5318

Type _____ Sec. No. 411 MD1. 01 Article _____

Contractor: Thomas Bros. Const. Subcontractor: _____

State Rt. _____ TOTAL MIX INCLUDING BITUMEN Date of Letting 6-12-98

MATERIAL	Screen % Passing	PRODUCER AND ADDRESS	% USED
C.A.	5/8" — #200	Vulcan Sand & Gravel Chattanooga	51.37
Med. C.A.			
Screenings	1/4" — #200	Dunlap Stone Inc. Dunlap TN.	18.68
Sand	1/4" — #200	Dunlap Stone Sand Dunlap TN	8.68
Lime	#4 — #200	Dunlap Stone Inc. Dunlap TN.	4.67
Asphalt Cement	PG. 64-22	Shell Oil Co. Chattanooga TN.	6.6
Anti-Strip	TYPE: LO Dandlard Lite	DOSAGE RATE: 0.5%	100 %

% Fractured Faces on +4.75 Matl: 88 % Glassy Particles on +4.75 Matl.

100 PERCENT MINERAL AGGREGATE SCREEN	Ttl. Passing Design Range	Requested Percent	Tolerance Percent	AGGREGATE ANALYSIS TOTAL PERCENT PASSING C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Percent	Calculated Mix
Temp		150°C		55		20	20	5	
% A.C.	5.3 - 7.0	6.6			(Washed Gradations) #05: 10.0				
	Compaction Temp:				Theo: 2.292				
	Mixing Temp:				2.4 - 2 - 16 8				
50mm (2")									
37.5mm (1 1/2")									
25mm (1")									
19mm (3/4")									
16mm (5/8")	100	100		100		100	100	100	100
12.5mm (1/2")	95-100	97.8		96		100	100	100	97.8
9.5mm (3/8")	80-93	88.5		79		100	100	100	88.5
4.75mm (#4)	56-76	68.9		47		96	97	100	68.9
2.36mm (#8)	35-57	50.7		29		66	84	95	50.7
600mm (#30)	17-35	28.6		11		29	68	62	28.6
300mm (#50)	9-18	16.3		8		20	28	46	16.3
150mm (#100)	3-10	8.42		5.2		15.5	4.1	32.8	8.42
75mm (#200)	0-6.5	5.40		3.1		11.5	1.1	23.5	5.40

Requested Paul Lowery
Contractor

Approved Jeff Blevins
Region Construction Engineer

Approved Tom Miller
Region Materials Engineer

Approved _____
Engineer of Materials and Tests

Date _____

Type of Mix 411 MOD.01

Project Reference No. 33036-3274-14

Contract No. 4837

County Hamilton

Region II

Contractor Thomas Bros

No. Hammer Blows 75 each Side

Sp.Gr. AC 1.030

Sample No.	% AC	% Agg.	Weight - Grams Marshall Specimen In Air	SSD	In Water	Vol. Mar. Spec.	Bulk Sp.Gr. Mar. Spec.	Theo.* Grav. Mix	Eff.* Grav. Aggs.	% Voids Total Mix	% Voids Min. Agg. (VMA)	% Voids Filled with AC	Unit Wt. PCF	Stability Lbs.	Flow (.01")
	A	B	C	D	E	F	G	H	I	J	K	L	M		
						D-E	C/F	See* below	See* below	100 -G/H x100	100- BxG / I	(AxG / SP.GR. AC) x100 / K	62.4xG		
1	6.25	93.75	1144.9	1147.2	623.5	523.7	2.186	2.302	2.505	5.2	18.4	71.9	136.2	3930	12.0
2			1147.2	1149.3	622.6	526.7	2.178							3350	10.0
3			1141.2	1142.3	620.6	521.7	2.187							3408	13.0
						Avg.	2.182						Avg.	3563	11.3
1	6.60	93.40	1140.8	1142.3	619.9	522.4	2.184	2.292	2.505	4.6	18.6	75.3	136.4	2689	16.0
2			1138.4	1140.0	619.3	520.7	2.185							3914	14.0
3			1138.0	1142.0	622.1	519.9	2.190							4113	14.0
						Avg.	2.186						Avg.	3572	14.7
1	6.95	93.05	1148.9	1150.7	629.0	521.7	2.204	2.261	2.505	3.3	18.2	81.8	137.7	3193	14.0
2			1149.8	1151.7	625.3	526.4	2.209							3885	14.0
3			1142.5	1143.9	625.8	518.1	2.205							3902	13.0
						Avg.	2.206						Avg.	3660	13.7
						Avg.				-			Avg.		

*Theo. Grav. Mix (H) as determined by AASHTO T-209.

*Eff. Grav. Aggs. (I) = $\frac{B}{\frac{100}{H} - \frac{A}{Sp.Gr.\ AC}}$

*Theo. Grav. (H) (At any AC content) = $\frac{100}{\frac{A}{Sp.Gr.\ AC} + \frac{B}{I}}$

Agg. Loss on Ignition (LOI) 10.55

Agg. Fractured Face Count 88

Agg. Glassy Particles NA

Agg. Absorption _____

Agg. Bulk Sp. Gr. _____

Agg. Apparent Sp. Gr. _____

Grams for 2.5" Specimen 1200

Recommended AC Content 6.6

Theoretical Gravity 2.292

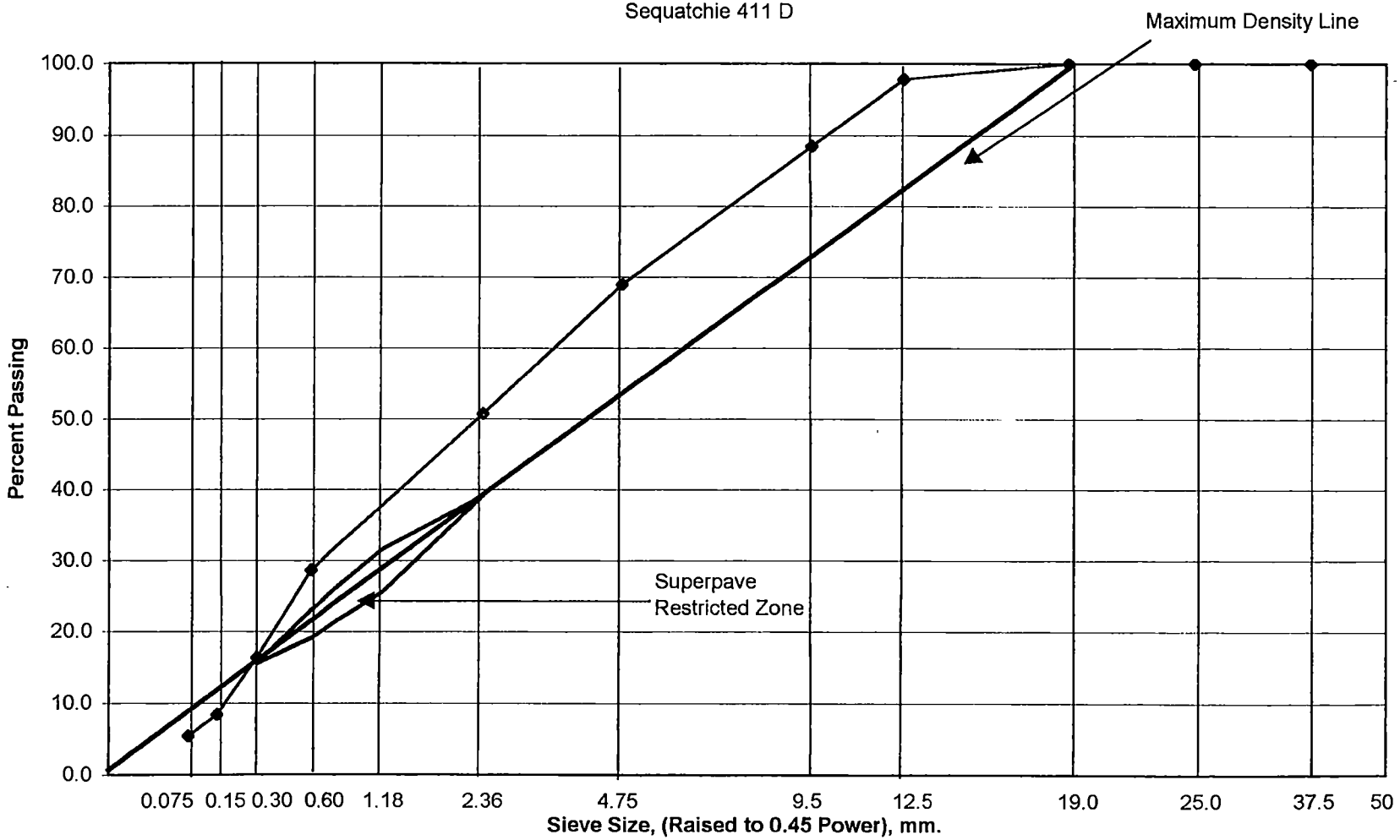
Dust to AC Ratio (DAR) 0.8

Amount & Type Additive 0.5 %

Mix Tensile Strength Ratio (TSR) 74.4

Approved _____

Mix Design Gradation
12.5 mm Nominal
Sequatchie 411 D



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Sequatchie 411 D			
Theoretical Maximum (Rice) Specific Gravity =	2.312			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2790.0	2790.0	6150.1	6150.0
(lb)	6.2	6.2	13.6	13.6
Mold Temperature, ° C	136.1	135.0	137.8	137.8
(° F)	277.0	275.0	280.0	280.0
Mix Temperature, ° C	151.1	149.4	147.2	147.8
(° F)	304.0	301.0	297.0	298.0
Number of Gyrations	21	21	N/A	N/A
Compacted Height, mm	74.9	75.0	N/A	N/A
(in.)	2.9488	2.9528	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	30.0	30.0
Dry mass (A), g	2760.6	2768.7	6115.1	6118.4
(lb)	6.1	6.1	13.5	13.5
Dry mass with Parafilm (D), g	2770.2	2778.6	6127.1	6129.9
(lb)	6.1	6.1	13.5	13.5
Wet mass with Parafilm (E), g	1451.3	1459.3	3229.5	3209.2
(lb)	3.2	3.2	7.1	7.1
Wet mass w/o Parafilm (C), g	1487.0	1493.2	3291.5	3291.5
(lb)	3.3	3.3	7.3	7.3
Saturated Surface Dry mass (B), g	2773.7	2782.0	6133.0	6141.8
(lb)	6.1	6.1	13.5	13.5
Specific Gravity (Gmb), SSD	2.145	2.148	2.152	2.147
Specific Gravity (Gmb), Parafilm	2.119	2.125	2.125	2.109
VTM =[1-(Gmb/Gmm)], SSD (%)	7.2%	7.1%	6.9%	7.2%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.4%	8.1%	8.1%	8.8%
NCAT Asphalt Content (%)	7.1%	7.1%	7.1%	7.1%

APA Dial Gauge Readings, mm

Mix Type: Sequatchie 411 D

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.82	9.81	8.99	7.32	6.20	- N/A -				
Aft Front	12.37	10.57	9.65	7.98	6.86	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.75	9.69	8.92	7.63	6.51
Fwd Front	- N/A -					12.36	10.64	9.78	8.10	6.86

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.83	9.06	8.06	5.25	3.94	10.52	9.23	8.98	6.80	5.63
Aft Front	10.69	9.47	8.44	5.77	4.73	11.01	9.70	9.02	6.81	5.69
Middle	10.77	9.64	8.63	5.37	4.40	10.83	10.00	9.47	7.25	6.18
Fwd Rear	10.65	9.54	8.71	5.70	4.52	10.90	9.89	9.26	7.15	6.10
Fwd Front	9.93	8.62	7.80	5.25	4.14	10.47	9.66	9.00	6.64	5.50

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	2.01	2.83	4.50	5.62
Aft Front	1.80	2.72	4.39	5.51
Average	1.91	2.78	4.45	5.57

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	2.06	2.83	4.12	5.24
Fwd Front	1.72	2.58	4.26	5.50
Average	1.89	2.71	4.19	5.37

Cycles	500	1000	4000	8000
Average Both Pills	1.90	2.74	4.32	5.47

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.77	2.77	5.58	6.89	1.29	1.54	3.72	4.89
Aft Front	1.22	2.25	4.92	5.96	1.31	1.99	4.20	5.32
Middle	1.13	2.14	5.40	6.37	0.83	1.36	3.58	4.65
Fwd Rear	1.11	1.94	4.95	6.13	1.01	1.64	3.75	4.80
Fwd Front	1.31	2.13	4.68	5.79	0.81	1.47	3.83	4.97
Averages								
All 5	1.31	2.25	5.11	6.23	1.05	1.60	3.82	4.93
Middle 3	1.15	2.11	5.09	6.15	1.05	1.66	3.84	4.92
Middle Excluded	1.35	2.27	5.03	6.19	1.11	1.66	3.88	5.00

Appendix A – 32

County & Mix Type: Sevier 307 S

Project Number: 5398

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0234 Rev. Form T 116

FINE ANGULARITY 47.0%

Date OCT 11, 1998

Project Reference No. SP County SEVIER Region I

Project No. 78014.4397.04 Contract No. 5398

Type TRMB Nm Grading S Sec. No. 302-5.0 Article No.

Contractor CHARLES Blalock & Sons Subcontractor

State RL No. 939 TOTAL MIX INCLUDING BITUMEN Date of Letting 7-27-98

MATERIAL	SCREEN Total Percent Passing	SER. # M-1(98)389 PRODUCER AND ADDRESS DES # DY-1(98)323	Percent Used
C.A.	19mm-75µm	VULCAN MATERIALS, SEVIERVILLE TN	28.50
Med. C.A.	19mm-75µm	VULCAN MATERIALS, SEVIERVILLE TN	23.75
Screenings	19mm-75µm	VULCAN MATERIALS, SEVIERVILLE TN	42.75
Sand			
Asphalt Cement	PG 64-22	VOLUNTEER SHELL, KNOXVILLE TN	5.0
Anti-Strip	Type: Kling Beta LV	Dosage Rate: 0.3%	
% Fractured Faces on Plus No. 4 Material: —		% Glassy Particles on Plus No. 4 Material: —	100%

100 PERCENT MINERAL AGGREGATE				AGGREGATE ANALYSIS TOTAL PERCENT PASSING					
SCREEN	Total Passing Spec. Range	Requested Percent	Tolerance ± Percent	C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
Temp.	135°-142°	138°C		30	25	45			100
% A.C.		5.0							
					Theoretical Density			2.533	
2 "						KG/m³ =		2533	
1½"					CALIBRATION FACTOR =			25	
1 "	100	100		100					100
3/4 "	90-100	98		94.3	100				98.3
1/2"	-90	88		45	96				82.5
3/8 "			N	27.4	75	100			72
No. 4			40	6	24	93			49.7
No. 8	23-49	33		3.5	10	66			33.3
No. 16				2.6	5	42			20.9
No. 30				2	3	27			13.5
No. 50				1.3	2	17			8.5
No. 100			SEE TABLE	0.6	0.7	12			5.8
No. 200	2-8	4.4		0.4	0.8	9.1			4.4

Requested Jerry Miller Blalock Contractor

Approved Jack E. Contractor Region Construction Engineer

Approved Region Materials Engineer

Approved Engineer of Materials and Tests

Tennessee Department of Transportation
SHRP Mix Design Worksheet

Date: October 11, 1998

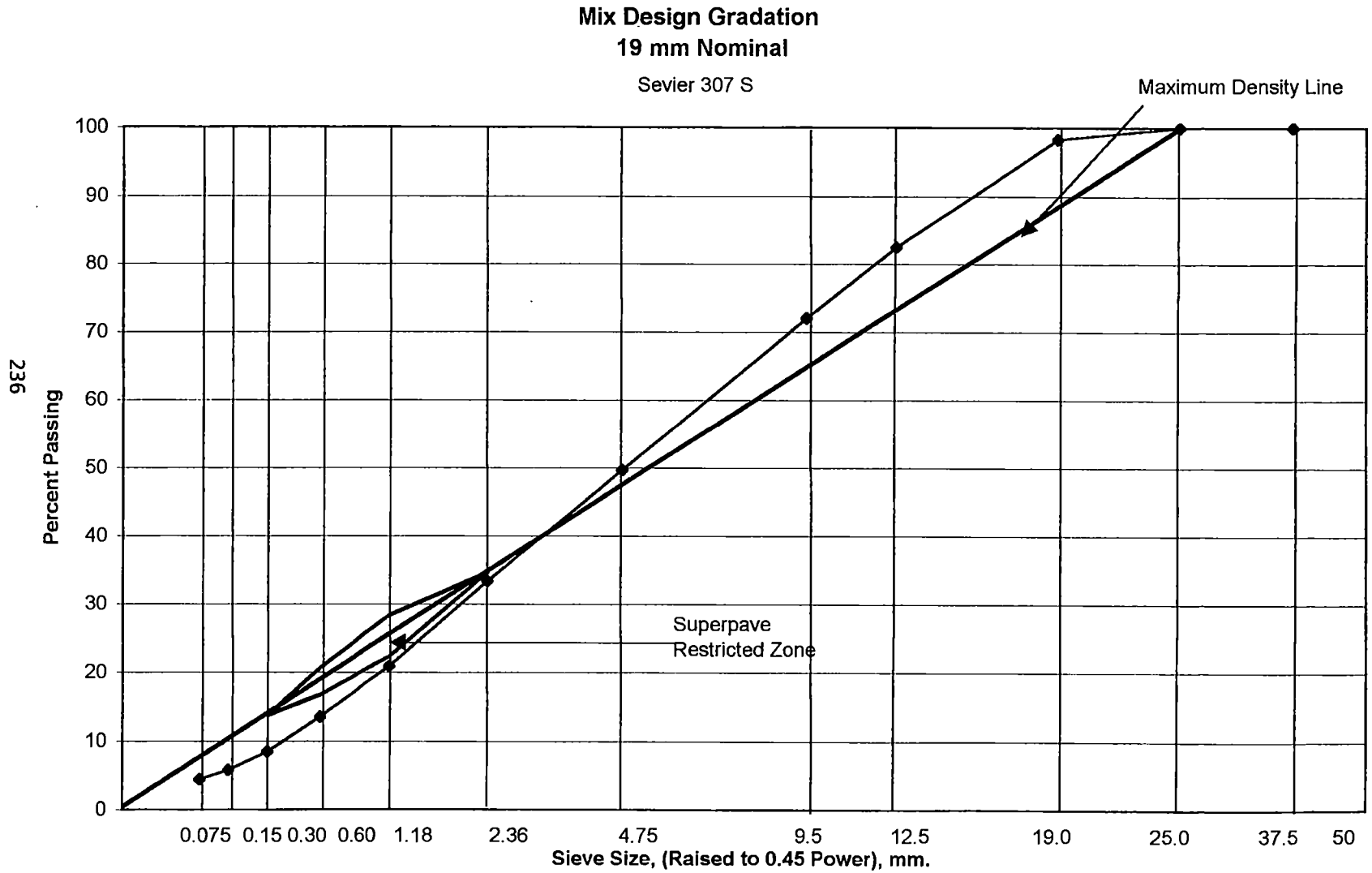
Contract Num: 5398
Contractor: BLALOCK & SONS
Plant Location: EVIERVILLE TN.
Type of Mix: 307-S
Bulk of Agg: [redacted] 2.715
Eff. of Agg: 2.748
Angularity Agg: 0.0

Type Asphalt: PG 64-22
Source: SHELL OIL KNOXVILLE TN.
Calib.Factor of Oven: 0

Specific Gravity of AC: 1.025

Specimen	%AC	Weight (g)	Height (mm) Ndes=96	Height (mm) Nmax=152	Bulk SG det.	C	Bulk SG est. @ Ndes	TMD	VTM (%)	VMA blk (%)	VMA eff (%)	VFA blk (%)	VFA eff (%)
1	4.5	4902.3	116.9	114.3	2.452	1.010	2.397	2.555	6.2	15.9	16.7	61.4	63.1
2	4.5	4895.3	117.1	115.3	2.439	1.015	2.402	2.555	6.0	15.8	16.5	62.0	63.7
3	4.5	4900.9	117.8	114.8	2.455	1.016	2.397	2.555	6.2	16.0	16.7	61.2	63.0
Avg.			117.3	114.6	2.449		2.399		6.1	15.9	16.6	61.5	63.3
1	5.0	4843.2	115.4	113.5	2.466	1.022	2.427	2.535	4.2	15.3	16.1	72.3	73.6
2	5.0	4853.1	114.6	112.7	2.469	1.022	2.449	2.535	3.4	14.6	15.3	76.7	77.8
3	5.0	4864.9	116.2	114.2	2.466	1.023	2.424	2.535	4.4	15.5	16.2	71.6	72.9
Avg.			116.8	113.9	2.475		2.433		4.0	15.1	15.9	73.5	74.8
1	5.5	4885.3	117.0	115.3	2.466	1.037	2.450	2.515	2.6	15.0	15.8	82.6	83.5
2	5.5	4883.4	116.2	114.7	2.469	1.033	2.457	2.515	2.3	14.8	15.5	84.2	85.0
3	5.5	4889.1	115.6	114.5	2.475	1.024	2.451	2.515	2.5	14.9	15.7	83.0	83.8
Avg.			116.3	114.9	2.483		2.453		2.5	14.9	15.7	83.3	84.1
1	5.0	4899.6	117.6	115.6	2.471	1.030	2.429	2.535	4.2	15.3	16.0	72.6	73.9
2	5.0	4901.3	115.8	113.9	2.483	1.020	2.442	2.535	3.7	14.8	15.6	75.3	76.5
3	5.0	4898.8	117.1	114.6	2.486	1.028	2.433	2.535	4.0	15.1	15.9	73.4	74.7
Avg.			117.4	115.1	2.480		2.435		4.0	15.1	15.8	73.8	75.0

N des 96
N Max 152


Mix Design Gradation
19 mm Nominal
Sevier 307 S
Maximum Density Line
Superpave
Restricted Zone
Percent Passing
100
90
80
70
60
50
40
30
20
10
0
0.075
0.15
0.30
0.60
1.18
2.36
4.75
9.5
12.5
19.0
25.0
37.5
50
Sieve Size, (Raised to 0.45 Power), mm.

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Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Sevier 307 S			
Theoretical Maximum (Rice) Specific Gravity =	2.553			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	2	3
Mass of Sample Before Compaction, g	3032.0	3032.0	6950.2	6950.4
(lb)	6.7	6.7	15.3	15.3
Mold Temperature, ° C	126.1	112.8	137.8	137.8
(°F)	259.0	235.0	280.0	280.0
Mix Temperature, ° C	149.4	148.9	149.4	151.1
(°F)	301.0	300.0	301.0	304.0
Number of Gyrations	29	26	N/A	N/A
Compacted Height, mm	75.2	75.3	N/A	N/A
(in.)	2.9606	2.9646	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	70.0	60.0
Dry mass (A), g	3007.4	3010.8	6906.0	6911.8
(lb)	6.6	6.6	15.2	15.2
Dry mass with Parafilm (D), g	3014.9	3018.3	6917.2	6922.2
(lb)	6.6	6.7	15.2	15.3
Wet mass with Parafilm (E), g	1694.9	1695.7	3953.7	3941.0
(lb)	3.7	3.7	8.7	8.7
Wet mass w/o Parafilm (C), g	1752.5	1752.3	4032.5	4019.7
(lb)	3.9	3.9	8.9	8.9
Saturated Surface Dry mass (B), g	3020.3	3024.6	6913.1	6924.6
(lb)	6.7	6.7	15.2	15.3
Specific Gravity (Gmb), SSD	2.372	2.366	2.397	2.379
Specific Gravity (Gmb), Parafilm	2.300	2.298	2.345	2.332
VTM =[1-(Gmb/Gmm)], SSD (%)	7.1%	7.3%	6.1%	6.8%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.9%	10.0%	8.1%	8.7%
NCAT Asphalt Content (%)	5.7%	5.7%	5.7%	5.7%

APA Dial Gauge Readings, mm

Mix Type: Sevier 307 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.85	9.45	9.07	7.86	6.97	- N/A -				
Aft Front	11.84	10.33	9.71	8.10	7.31	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.94	10.31	9.71	8.03	7.24
Fwd Front	- N/A -					12.03	10.94	10.36	8.94	8.17

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	12.15	11.14	10.33	8.85	8.34	10.50	9.81	9.35	8.34	7.36
Aft Front	12.34	11.30	10.64	9.19	8.44	10.57	9.28	8.96	8.18	7.51
Middle	12.06	10.82	10.53	9.77	8.72	10.48	9.07	8.84	8.02	7.14
Fwd Rear	11.92	10.59	10.51	9.50	8.85	10.49	9.53	9.27	8.25	7.36
Fwd Front	11.60	10.48	9.92	8.55	7.87	9.75	8.23	7.98	7.30	6.69

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	1.40	1.78	2.99	3.88
Aft Front	1.51	2.13	3.74	4.53
Average	1.46	1.96	3.37	4.21

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.63	2.23	3.91	4.70
Fwd Front	1.09	1.67	3.09	3.86
Average	1.36	1.95	3.50	4.28

Cycles	500	1000	4000	8000
Average Both Pills	1.41	1.95	3.43	4.24

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.01	1.82	3.30	3.81	0.69	1.15	2.16	3.14
Aft Front	1.04	1.70	3.15	3.90	1.29	1.61	2.39	3.06
Middle	1.24	1.53	2.29	3.34	1.41	1.64	2.46	3.34
Fwd Rear	1.33	1.41	2.42	3.07	0.96	1.22	2.24	3.13
Fwd Front	1.12	1.68	3.05	3.73	1.52	1.77	2.45	3.06
Averages								
All 5	1.15	1.63	2.84	3.57	1.17	1.48	2.34	3.15
Middle 3	1.20	1.55	2.62	3.44	1.22	1.49	2.36	3.18
Middle Excluded	1.13	1.65	2.98	3.63	1.12	1.44	2.31	3.10

Appendix A – 33

County & Mix Type: Sevier 411 S

Project Number: 5398

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Form DT-0258
Re: Form T-116

Date OCT 19, 1998

Project Reference No. SP County Sevier Region I

Project No. 78016-4207-04 Contract No. 5398

Type ACS Grading 411-S Sec. No. 411-S Article No. ____

Contractor CHARLES Blalock & Sons Subcontractor ____

State Rt. No. 339 TOTAL MIX INCLUDING BITUMEN Date of Letting 7-27-98

MATERIAL	SCREEN Total Percent Passing	M-(98)397 PRODUCER AND ADDRESS OV-(98)331	Percent Used
C.A.			
Med. C.A.	19mm - 75um	Newport Sand & Gravel, Newport TN	56.76
Screenings	9.5mm - 75um	Vulcan Materials, Sevierville TN	23.65
Sand	9.5mm - 75um	Newport Sand & Gravel, Newport TN	14.19
Asphalt Cement	PG 64-22	Volunteer Shell, Knoxville TN	5.40
Anti-Strip	Type: Kling Beta LV	Dosage Rate: 0.3%	[redacted]
% Fractured Faces on Plus No. 4 Material: 96+	% Glassy Particles on Plus No. 4 Material: —		100%

100 PERCENT MINERAL AGGREGATE

SCREEN	Total Passing Master Range	Requested Percent	Tolerance Percent
Temp.	135°-162.8°	148.9°	
% A.C.		5.4	
2 "			
1 1/2"			
1 "			
3/4 "19mm	100		
1/2 "12.5mm	90-100	97	±7.2
3/8 9.5mm	—90	82.8	
No. 4 4.75mm		55.3	
No. 8 2.36mm	28-58	37.6	±6
No. 16 1.18mm		26.5	
No. 30 600µm		18.2	±5
No. 50 300µm		11.4	
No. 100 150µm		6.5	
No. 200 75µm	2-10	4.6	

AGGREGATE ANALYSIS TOTAL PERCENT PASSING

C.A. Percent	Med. C.A. Percent	Screenings Percent	Sand Percent	Filler Percent	Calculated Mix
	60	25	15		100
	Theoretical Density = [redacted]				
Adj. = 45.5		KG-M³ = [redacted]			
	LOI = 11.0	Calibration Factor = .04			
	100				100
	95				97
	71.3	100	100		82.8
	29	93	97.8		55.3
	17	66	72.5		37.6
	12.4	42	56.9		26.5
	9.8	27	37.2		18.2
	7.5	17	17.4		11.4
	4.6	12	5		6.5
	3.3	9.1	2.4		4.6

Requested Jerry Miller Blalock
Contractor

Approved [signature]
Region Construction Engineer

Approved [signature]
Region Materials Engineer

Approved ____
Engineer of Materials and Tests

DESIGN NO. _____

ASPHALT MIX DESIGN SUMMARY

DATE 10-23-98

TYPE OF MIX 411-S

SERIAL NO. _____

Project Reference No. SP

Contract No. 5398

Project No. 78016-4207-04

Region I

Contractor CHARLES BLOCK & SONS

County SEVIER

Sample No.	Asphalt Content	Sp. Gr. of Mar. Samp.	Theor. Gr. of Mix	% Theor. Gr.	Voids in Total Mix	Voids in Min. Agg.	Voids Filled with Asp.	Marshall Stability /	Marshall Flow	No. Blows Mar. Hammer
1	4.9	2.355	2.458	95.8	4.2	15.5	72.6	3870	14.2	75
2	5.4	2.369	2.440	97.1	2.9	15.4	81.0	3895	14.3	75
3	5.9	2.383	2.422	98.4	1.6	15.3	89.7	3990	14.3	75

Total % Passing

Mils.	P.G	#40	#5		Mix	Lab
%	60	25	15			
3/4	100					
1/2	95					
3/8	71.3	100	100			
4	29	93	97.8			
8	17	64	72.5			
30	12.9	43	56.9			
50	9.5	27	32.2			
100	7.5	17	17.4			
200	4.6	12	5			
	3.3	9.1	2.4			

1220 Grams required to make 2.5" specimen

Produner

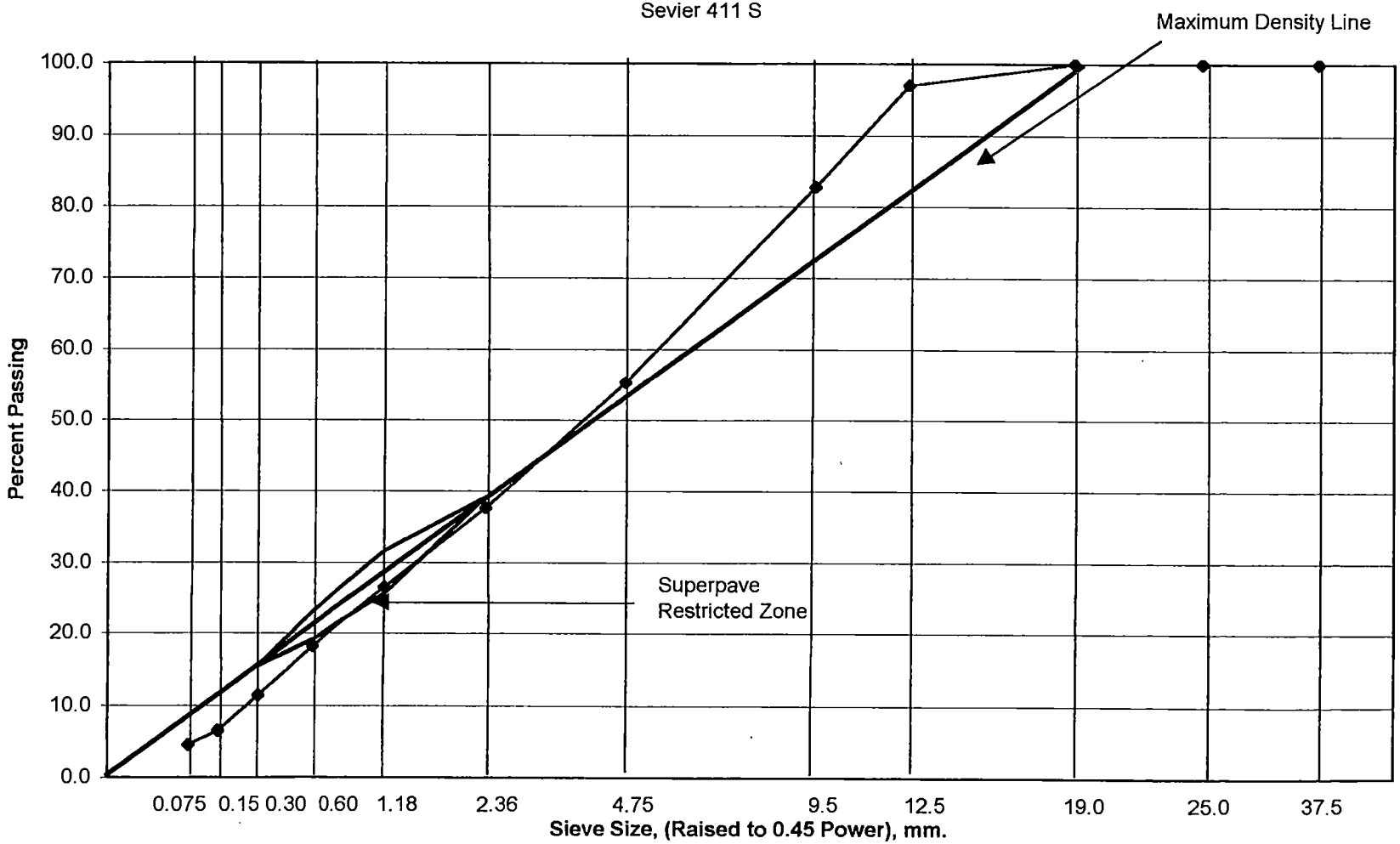
Vanpoor Sand Grav Vanpoor
Vulcan Materials Sevierville
Valentine Sand Knoxville
Klug Rock LV 0.3 %

Recommended 5.4 Asphalt Content

Theor. Density 2.440

Bulk Gr. 2.624
Eff. Gr. 2.649
App. Gr. 2.670
Fractured Face 96.4
Glassy Particle N/A
LOI 11.0
RAP in AC N/A
DAR 85
TSR 80.1
Abs. .87

Mix Design Gradation
12.5 mm Nominal
Sevier 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Sevier 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.458			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	3	4
Mass of Sample Before Compaction, g	2950.5	2954.2	6610.0	6610.5
(lb)	6.5	6.5	14.6	14.6
Mold Temperature, ° C	101.7	126.7	126.7	126.7
(° F)	215.0	260.0	260.0	260.0
Mix Temperature, ° C	146.1	147.8	152.2	149.4
(° F)	295.0	298.0	306.0	301.0
Number of Gyrations	70	66	N/A	N/A
Compacted Height, mm	75.4	75.3	N/A	N/A
(in.)	2.9685	2.9646	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	482.6 / 137.9	482.6 / 137.9
(psi)	N/A	N/A	70 / 20	70 / 20
Compaction Time, sec.	N/A	N/A	70.0	70.0
Dry mass (A), g	2921.3	2928.4	6556.5	6558.3
(lb)	6.4	6.5	14.5	14.5
Dry mass with Parafilm (D), g	2929.3	2936.0	6568.6	6569.2
(lb)	6.5	6.5	14.5	14.5
Wet mass with Parafilm (E), g	1606.5	1612.8	3607.1	3610.6
(lb)	3.5	3.6	8.0	8.0
Wet mass w/o Parafilm (C), g	1661.2	1664.9	3714.0	3710.0
(lb)	3.7	3.7	8.2	8.2
Saturated Surface Dry mass (B), g	2936.3	2941.2	6576.6	6577.5
(lb)	6.5	6.5	14.5	14.5
Specific Gravity (Gmb), SSD	2.291	2.294	2.290	2.287
Specific Gravity (Gmb), Parafilm	2.231	2.235	2.229	2.230
VTM =[1-(Gmb/Gmm)], SSD (%)	6.8%	6.7%	6.8%	7.0%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	9.2%	9.1%	9.3%	9.3%
NCAT Asphalt Content (%)	5.3%	5.3%	5.3%	5.3%

APA Dial Gauge Readings, mm

Mix Type: Sevier 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.43	10.73	10.24	8.92	8.47	- N/A -				
Aft Front	11.84	10.96	10.62	9.48	8.89	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.54	10.45	10.04	8.91	8.08
Fwd Front	- N/A -					11.61	10.77	10.33	9.27	8.62

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.96	10.85	10.33	8.85	8.34	12.09	9.69	8.84	8.27	7.72
Aft Front	11.99	11.03	10.64	9.19	8.44	12.35	10.94	10.64	9.67	9.21
Middle	11.76	10.83	10.53	9.77	8.72	11.88	11.00	10.74	10.12	9.79
Fwd Rear	11.87	10.99	10.51	9.50	8.85	12.26	11.15	10.76	9.97	9.36
Fwd Front	12.15	10.55	9.92	8.55	7.87	12.23	11.15	10.86	9.93	9.32

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.70	1.19	2.51	2.96
Aft Front	0.88	1.22	2.36	2.95
Average	0.79	1.21	2.44	2.96

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	1.09	1.50	2.63	3.46
Fwd Front	0.84	1.28	2.34	2.99
Average	0.97	1.39	2.49	3.23

Cycles	500	1000	4000	8000
Average Both Pills	0.88	1.30	2.46	3.09

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	1.11	1.63	3.11	3.62	2.40	3.25	3.82	4.37
Aft Front	0.96	1.35	2.80	3.55	1.41	1.71	2.68	3.14
Middle	0.93	1.23	1.99	3.04	0.88	1.14	1.76	2.09
Fwd Rear	0.88	1.36	2.37	3.02	1.11	1.50	2.29	2.90
Fwd Front	1.60	2.23	3.60	4.28	1.08	1.37	2.30	2.91
Averages								
All 5	1.10	1.56	2.77	3.50	1.38	1.79	2.57	3.08
Middle 3	0.92	1.31	2.39	3.20	1.13	1.45	2.24	2.71
Middle Excluded	1.14	1.64	2.97	3.62	1.50	1.96	2.77	3.33

Appendix A – 34

County & Mix Type: Shelby 411 S

Project Number: 5149

STATE OF TENNESSEE ASPHALT JOB MIX FORMULA

Plant # 5 Date: 7/13/98
L-R Job # 98-095
Project Ref. No. County Shelby Region IV
Proj. No. 79020-4242-04 Layer Surface Contract No 5149
Type ASCS-HM Sec. No. 411-S Article 01 01-01.02
Contractor Lehman-Roberts Co. Subcontractor Lehman-Roberts Co.
St. Route Lamar **Total Mix including Bitumen** Date of Letting 1/26/98

Material	Size Range or Type	Producer and Address	% Used
			0.00
5/8" Cr Gravel	5/8" - #200	Memphis Stone & Gravel pit# 534	56.34
#10 Limestone	3/8" - #200	Vulcan Materials Pit# 457	15.96
Mfg Sand	3/8" - #200	Memphis Stone & Gravel pit# 534	15.96
Ag Lime	3/8" - #200	Vulcan Materials Pit# 457	5.63
Asphalt Cement	PG76-22	Ergon Petroleum Poly Blend	6 10
Anti-Strip	Morelife	Dosage Rate 0.3%	
% Fractured Faces on +4 Material:	88.9	% Glassy Particles on +4 Material N/A	100.0

100 PERCENT MINERAL AGGREGATE			AGGREGATE ANALYSIS TOTAL PERCENT PASSING				
Screen	Tot Passing Design Range	Requested Percent		5/8" Cr Gravel Percent	#10 Limestone Percent	Mfg Sand Percent	Ag Lime Percent	Calculated Mix
Temp	320-360		0.0	60.0	17.0	17.0	6 0	100.0
% AC		6.1				Latex Brand:	None	
Compaction Temp:		345				% Latex Used:	N/A	
Mixing Temp:		355				Theoretical Maximum Density:	2.341	
						L.O.I.:	9.2	
				(Washed Gradations)				
50								0.0
37.5								0.0
25.0		100		100.0	100.0	100.0	100.0	100.0
19.0		100		100.0	100.0	100.0	100.0	100.0
12.5	90-100	95		92.0	100.0	100.0	100.0	95.2
9.5		86		77.0	100.0	99.0	100.0	86.0
4.75		60		42.0	91.0	81.0	99.0	60.4
2.36	28-58	36		23.0	60.0	37.0	97.0	36.1
1.18		26		18.0	36.0	21.0	85.0	25.6
0.600		18		13.0	22.0	9.5	73.0	17.5
0.300		13		9.0	16.0	7.4	56.0	12.7
0.425		8.9		6.0	11.5	5.8	40.0	8.9
0.075	2-10	6.3		4.0	9.7	3.1	28.0	6.3

Requested Larry D Brewer
Contractor

Approved Allen A. Gutthrie
Region Materials Engineer

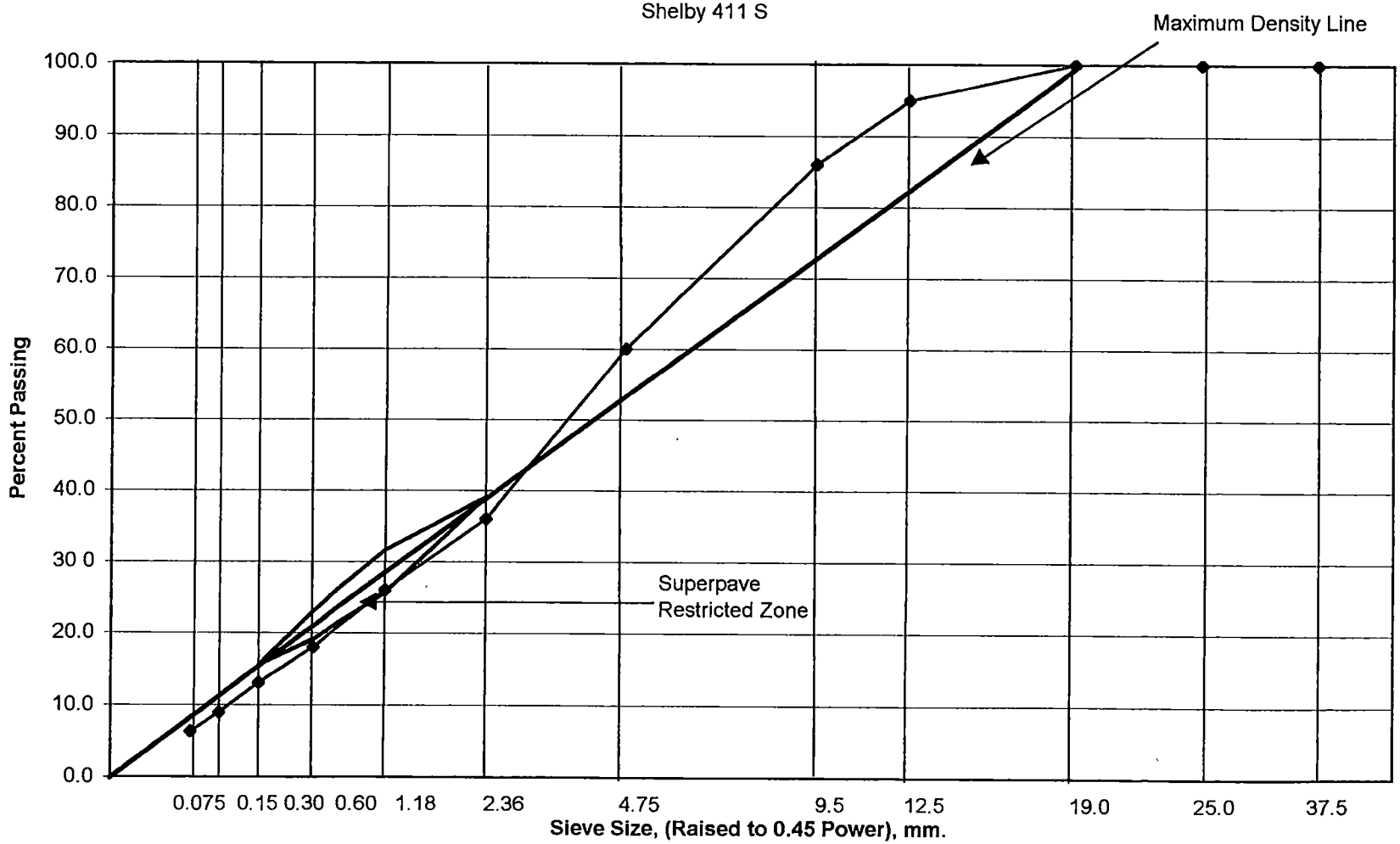
Approved Wesley T. Hutto for
Region Construction Engineer

Approved _____
Engineer of Materials and Tests

Design Aggregate Structure

Design AC	6.1							
Effective AC	5.41		Dust to Asphalt	1.17				
Effective Specific Gravity	2.551		Specific Gravity AC	1.032				
Asphalt Content	6	6	6.5	6.5	7	7	7.5	7.5
Agg Bulk Sp. Gr.	2.491	2.491	2.491	2.491	2.491	2.491	2.491	2.491
Specimen	1	2	1	2	1	2	1	2
Height @Nini	127.9	128.4	125.9	125.8	127	128.1	127	126.4
Height @Ndes	116.1	116.5	114.4	113.8	116	117.3	116.1	115.7
Height @Nmax	114.6	114.9	112.9	112.4	114.7	115.9	115	114.5
Mass in Air	4539.3	4537.4	4452.7	4440.5	4594.8	4602.7	4614.2	4610.3
Mass in Water	2549.7	2546.9	2508.7	2496.3	2600.3	2604.3	2613.6	2609.5
Mass @ SSD	4542.8	4539.2	4454.3	4441.9	4595.4	4603.4	4614.6	4610.7
Bulk Sp. Grav.	2.278	2.277	2.289	2.282	2.303	2.302	2.306	2.304
% of Gmm @Nini	87.1	86.9	88.2	87.6	90.0	90.1	91.0	90.9
% of Gmm @Ndes	95.9	95.8	97.0	96.8	98.5	98.4	99.5	99.3
% of Gmm @Nmax	97.2	97.2	98.3	98.0	99.6	99.6	100.5	100.4
Corrected Bulk								
Gmb @ Nini	2.041	2.038	2.052	2.039	2.080	2.083	2.088	2.087
Gmb @Ndes	2.248	2.246	2.259	2.254	2.277	2.275	2.284	2.280
Gmb @Nmax	2.278	2.277	2.289	2.282	2.303	2.302	2.306	2.304
Thero. Gravity	2.344	2.344	2.328	2.328	2.312	2.312	2.295	2.295
% Air Voids @Ndes	4.1	4.2	3.0	3.2	1.5	1.6	0.5	0.7
% VMA @Ndes	15.2	15.2	15.2	15.4	15.0	15.1	15.2	15.3
Avg Air Voids	**4.1**		**3.1**		**1.6**		**0.6**	
Avg VMA	**15.2**		**15.3**		**15.0**		**15.3**	

Mix Design Gradation
12.5 mm Nominal
Shelby 411 S



Compaction Data Sheet
SGC Pills and AVC Beams

County and Mix Type:	Shelby 411 S			
Theoretical Maximum (Rice) Specific Gravity =	2.360			
	SGC Pills 75 mm x 150mm		AVC Beams 75 x 125 x 300 mm	
	1	2	1	2
Mass of Sample Before Compaction, g	2825.0	2825.1	6375.4	6375.0
(lb)	6.2	6.2	14.1	14.1
Mold Temperature, ° C	154.4	154.4	148.9	148.9
(°F)	310.0	310.0	300.0	300.0
Mix Temperature, ° C	150.0	151.7	148.9	149.4
(°F)	302.0	305.0	300.0	301.0
Number of Gyrations	19	20	N/A	N/A
Compacted Height, mm	75.1	75.2	N/A	N/A
(in.)	2.9567	2.9606	N/A	N/A
Vertical / Back Pressure (kPa)	N/A	N/A	413.7 / 137.9	413.7 / 137.9
(psi)	N/A	N/A	60 / 20	60 / 20
Compaction Time, sec.	N/A	N/A	60.0	60.0
Dry mass (A), g	2815.1	2812.3	6348.7	6350.4
(lb)	6.2	6.2	14.0	14.0
Dry mass with Parafilm (D), g	2824.2	2821.4	6364.3	6357.7
(lb)	6.2	6.2	14.0	14.0
Wet mass with Parafilm (E), g	1504.3	1498.9	3394.5	3429.7
(lb)	3.3	3.3	7.5	7.6
Wet mass w/o Parafilm (C), g	1541.6	1536.6	3473.6	3485.5
(lb)	3.4	3.4	7.7	7.7
Saturated Surface Dry mass (B), g	2826.2	2820.7	6362.6	6356.4
(lb)	6.2	6.2	14.0	14.0
Specific Gravity (Gmb), SSD	2.191	2.190	2.198	2.212
Specific Gravity (Gmb), Parafilm	2.158	2.151	2.157	2.178
VTM =[1-(Gmb/Gmm)], SSD (%)	7.1%	7.2%	6.9%	6.3%
VTM = [1-(Gmb/Gmm)], Parafilm (%)	8.6%	8.8%	8.6%	7.7%
NCAT Asphalt Content (%)	6.2%	6.2%	6.2%	6.2%

APA Dial Gauge Readings, mm

Mix Type: Shelby 411 S

	SGC Pill # 2					SGC Pill # 1				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	11.52	10.66	10.48	9.63	8.79	- N/A -				
Aft Front	11.36	10.47	10.27	9.62	8.84	- N/A -				
Middle	- N/A -					- N/A -				
Fwd Rear	- N/A -					11.77	11.23	11.07	10.24	9.46
Fwd Front	- N/A -					11.66	11.26	11.08	10.16	9.55

	Beam 1					Beam 2				
Cycles	Initial	500	1000	4000	8000	Initial	500	1000	4000	8000
Aft Rear	10.66	10.10	9.95	9.64	9.31	9.97	9.45	9.36	9.04	8.63
Aft Front	11.71	10.79	10.76	10.04	9.60	10.15	9.77	9.71	9.53	9.22
Middle	10.88	10.32	10.13	9.71	9.44	10.02	9.64	9.55	9.44	9.01
Fwd Rear	11.99	11.45	11.20	10.79	10.45	10.16	9.88	9.76	9.64	9.37
Fwd Front	12.30	11.70	11.45	10.91	10.30	10.20	9.74	9.64	9.56	9.17

APA Measured Rut Depth Values, mm

	SGC Pill # 2			
Cycles	500	1000	4000	8000
Aft Rear	0.86	1.04	1.89	2.73
Aft Front	0.89	1.09	1.74	2.52
Average	0.87	1.07	1.82	2.63

	SGC Pill # 1			
Cycles	500	1000	4000	8000
Fwd Rear	0.54	0.70	1.53	2.31
Fwd Front	0.40	0.58	1.50	2.11
Average	0.47	0.64	1.52	2.21

Cycles	500	1000	4000	8000
Average Both Pills	0.67	0.85	1.67	2.42

	Beam 1				Beam 2			
Cycles	500	1000	4000	8000	500	1000	4000	8000
Aft Rear	0.56	0.71	1.02	1.35	0.52	0.61	0.93	1.34
Aft Front	0.92	0.95	1.67	2.11	0.38	0.44	0.62	0.93
Middle	0.56	0.75	1.17	1.44	0.38	0.47	0.58	1.01
Fwd Rear	0.54	0.79	1.20	1.54	0.28	0.40	0.52	0.79
Fwd Front	0.60	0.85	1.39	2.00	0.46	0.56	0.64	1.03
Averages								
All 5	0.64	0.81	1.29	1.69	0.40	0.50	0.66	1.02
Middle 3	0.67	0.83	1.35	1.70	0.35	0.44	0.57	0.91
Middle Excluded	0.66	0.83	1.32	1.75	0.41	0.50	0.68	1.02

APPENDIX B

TESTING PROTOCOL:

ASPHALT VIBRATORY COMPACTOR (AVC)

Vibratory Compaction Protocol Using the Asphalt Vibratory Compactor (AVC)

1. Perform Theoretical Maximum Specific Gravity (Rice Gravity) in accordance with ASTM D2041.
2. Establish the desired percent air voids to remain in mix after compaction.
3. Determine the amount of asphaltic concrete to be compacted based on the Rice gravity and percent air voids using the following equation:

$W = (\text{Vol. } cm^3) \times (1 - \%V) \times (Gmm)$,

where,

W = Optimum weight of the beam
V = % air voids
Gmm = Maximum Theoretical Specific Gravity
Vol. = Volume of the beam, calibrated with the standard calibration block provided with the vibratory compactor by Pavement Technologies, Inc.

Block Dimensions = 75mm x 125mm x 300mm

4. Heat a sufficient amount of mix at 240° F, for one hour or until the mix becomes alive. The mix must be quartered to obtain a representative sample, so be sure to heat more mix than was calculated above.

* Note: Heat all utensils, bowls, mold, and base plates in the oven to 300 ^{0} F to prevent the asphalt from sticking to them.

5. Prepare a workstation by placing paper on a tabletop.
6. Remove the workable mix from the oven and pour into a uniform pile on the workstation.
7. Split the sample into four equal quarters. Scoop sufficient mix from opposite quarters into a bowl until the calculated weight is achieved.
8. Place the weighed sample into the oven at 300° F for no more than two hours or until the internal temperature of the sample reaches the desired compaction temperature.

*Note:
Avoid: 1) Heating the mix above the desired compaction temperature
2) Leaving the mix in the oven for more than three hours total time

9. Depress the E-STOP button for safety.

10. Set the vertical pressure on the vibratory compactor to 60 psi and the back pressure to 20 psi.
11. On the control panel, set the compaction time for 60seconds. Set MODE and VIBRATE switches to AUTO position.
12. Retrieve the heated mold and spoon from the oven and place them on a table near the vibratory compactor.
13. Remove the mix from the oven and obtain the temperature.
14. If compaction temperature is achieved, place one plate into the bottom of the mold.
15. Pour the mix into the mold, stirring 5 times with the spoon after the mold is half full. Smooth out the mix in the mold and build the edges up slightly.
16. Cap the beam with the other plate.
17. Align the mold into the vibratory compactor with the alignment guides.

*Note: Due to the high decibel levels achieved during compaction, ear protection should be provided before running the compactor.

18. Release the E-STOP.
19. Depress both green RUN buttons simultaneously to begin compaction. Observe the compaction head as it lowers into the mold to assure proper seating. The vibratory compactor will run for the prescribed time and then will automatically disengage the vibrator and raise the compaction head.
20. Place the mold in the extraction device on the vibratory compactor and set the MODE switch to EJECT.
21. Depress the two green RUN buttons simultaneously to initiate the ejection ram.
22. Stop ejecting just as the top plate clears the mold. Use a screwdriver to remove the top plate.
23. Once the plate is removed, continue to eject the beam.
24. Once the beam is ejected from the mold, it must be handled with extreme care.
25. The bottom plate must be removed immediately. To remove the bottom plate, the beam must be flipped over. The best way to do this is to load the beam into the beam mold provided by Pavement Technologies, Inc., for the Asphalt Pavement Analyzer. If no mold is available, simply obtain a piece of ½" minimum thickness plywood or similarly stiff material that is at least 1" wider than the beam. Place the mold (wood) on the top of the beam and flip them over with care. Remove the former bottom, now top plate.
26. Allow the beam to cool to room temperature.
27. Perform bulk specific gravity, ASTM D2726, and calculate actual % air voids using:
    % Voids = (1 – Gmb/Gmm) x 100%
    Where;
    Gmb = Bulk specific gravity
    Gmm = Maximum (Rice) specific gravity

APPENDIX C

TESTING PROTOCOL:

ASPHALT PAVEMENT ANALYZER (APA)

Asphalt Pavement Analyzer (APA) Rut Testing Protocol

Procedure

1) Preset chamber temperature to 50 ^{0} C +/- 1 ^{0} C (120 ^{0} F +/- 3 ^{0} F).

2) Open the front doors, unlock the toggle clamps and pull out the sample tray.

3) Loosen and remove the bolts and the restraining brackets at the front ends of the three PVC molds that have been secured on the sample tray. Remove the molds from the sample tray and place them on a firm counter top for installing asphalt samples in the sample mold.

4) After installing the samples into the molds, transfer the sample molds to the sample tray, one at a time, making sure to fit the recessed area of the sample mold to the front end restraining bracket. Do the same for all three molds.

5) After placing the asphalt samples in the APA, allow the samples 4 hours to come up to the testing temperature.

6) Set the MODE switch to RUT. Reset the TOTALIZING counters to zero, turn the cylinder operation mode control switch to AUTO, and check the pressure gauge readings to be corresponding to the wheel load. Do this for all three (3) cylinders.

7) Set the Counter for 10 Cycles. Press the green rectangular STROKE TEST START button to start the rut testing. Allow the machine to stroke through the 10 cycles to assure that the specimens are seated well in the molds or between the restraint brackets and that there is no build-up asphalt binder film thickness on the sample surface.

8) Open the doors and place the measuring template on the first sample. Measure and record the initial gauge readings on the data sheet for each sample by taking indicator readings at all five slots for beam samples, or by taking indicator readings using the two end slots on each end of the template for cylindrical samples. After closing the front door, allow the test samples to be stabilized at the test temperature for ten (10) minutes before starting the rutting test. The STROKE ON DELAY timer can be used to set the delay start time.

9) Repeat testing procedures for 490, 500, 3000, and 4000 cycles, taking dial gauge readings at each interval. This will give rut measurements at 500, 1000, 4000, and 8000 cycles respectively.

** Note: If the APA is equipped with the automatic data collection system, the dial gauge recording is moot.

Calculations:

1. Calculation of Specimen Mass:

   a. Volume of Specimen [cm^3]:
      1) Beam:
         $V = L \times w \times h$

      2) Cylindrical Specimen:
         $V = \frac{\pi D^2}{4} \times 0.001\ cm^3/mm^3 \times h$

   b. Target Mass of Specimen [g]:
      1) Beam:
         $W_{mb} = \rho_{opt} \times V$

      2) Cylindrical Specimen:
         $W_{mb} = G_{mm}\ (1 g/cm^3) \times \%\ G_{mm} \times V$

      Where,

L = Length of beam specimen, cm
w = Width of beam specimen, cm
h = Height of specimen, cm (7.5 cm)
D = Diameter of cylindrical mold, mm (15.0 cm)
V = Volume of specimen, cm^3
(30.0 cm x 12.5 cm x 7.5 cm = 2812.5 cm^3 for laboratory beam specimen,
22.5 cm x 12.5 cm x 7.5 cm = 2109.4 cm^3 for field beam specimen,
$[\pi\ (15.0\ cm)^2]/4 \times 7.5\ cm = 1325.4\ cm^3$ for cylindrical specimen)
ρ_{opt} = Density @ optimum asphalt content, g/cm^3
G_{mm} = Theoretical maximum specific gravity @ optimum asphalt content
$\%\ G_{mm}$ = $1.0 - \frac{\text{Target \% air voids}}{100}$
$(1\ g/\ cm^3)$ = Density of water
W_{mb} = Target mass of specimen, g.

2. Calculation of Rut Depth:

   a. The rut depth at each location is determined by subtracting the final measurement from the initial measurement.

   b. Determine the average rut depth for each specimen.

Calibration

Calibration should be performed every 5 to 10 tests, depending on the machine.

1) Place the calibration load cell provided with the APA under the middle of one wheel. Plug the load cell into the signal conditioner. Plug the signal conditioner into one of the outlets located in the front, top right of the APA.

2) Set the cylinder to CALIBRATE. The wheel will automatically depress the load cell and display the load on the signal conditioner. Adjust the pressure on the dial of the cylinder to get the desired load. Repeat for all wheels.

3) For Rut testing, the cylinders should be set at 445 +/- 4 N (100 +/- 1 lbs).

APPENDIX D

TROUBLESHOOTING:

ASPHALT VIBRATORY COMPACTOR (AVC)

Trouble Shooting The Asphalt Vibratory Compactor (AVC)

The AVC exhibited extreme variability in reproducing 7 +/- 1 percent air voids during compaction of AVC beam specimens. This variability, as mentioned earlier, can be attributed to various mix properties, but no specific properties were recognizable. The extreme vibrations of the machine led to several mechanical flaws that resulted in several lost-work hours. Some problems encountered include:

1. The electrical circuitry is attached directly to the frame of the compaction equipment. Screws have rattled loose during compaction, causing the machine to shut down.
2. The power switch located on the stand alone control box has shorted, causing a thirty-minute delay at crucial compaction temperature.
3. The ejection ram cylinder has leaked hydraulic fluid from one of the hose connections.
4. The vibration from the compaction head sheared the four spot welded bolts that held the ejection ram onto the machine. This happened during crucial compaction temperature of several mixes.
5. Some air connections have leaked. Tracing the problem may result in severe electrical shock.
6. The decibel level is very high.
7. Trying to move the AVC without a forklift is difficult at best. This machine is not designed for use in small spaces.

8. The combined weight of adequate asphalt sample plus beam mold is approximately 20.4 kg (45 lbs.). Making several beams at a time results in user fatigue and restricts production.
9. The beams require adequate time to cool to maintain their proper dimensions before removal from the mold. Extracting the beam molds without an unlimited supply of top plates or APA rutting molds to flip the beams causes delays.
10. The unpredictable behavior of the HMA under the vibrations of the compaction head requires that multiple samples of the same mix must be compacted in order to achieve a specific air-void range.
11. The location of the pressure dial gages and regulators in the back of the machine away from the user causes many problems when adjusting pressures during compaction.
12. Changing the compaction head is also difficult at best. When calibrating the specimen height with the calibration mold, the wrench required is too large to fit in the space available. In addition, the machine often vibrates the nuts loose during compaction.

Several basic design flaws have contributed to the difficult use of the AVC. All the controls for the entire machine should be located in one central area. The electrical components should be separate from the actual compaction head and vibrator. The decibel level achieved must be lowered in order for this machine to be useful in a production laboratory. All air and hydraulic connections, as well as, bolts

and nuts should be improved to withstand the shear forces generated by the vibrations. Beams are necessary for fatigue testing of the asphalt and this compactor will make beams. With a few minor alterations, the AVC could be a very useful tool in an asphalt laboratory. The manufacturer is currently addressing most of the design concerns with this apparatus. They are in the process of updating the equipment in the University of Tennessee Asphalt Laboratory.

APPENDIX E

TROUBLESHOOTING:

ASPHALT PAVEMENT ANALYZER (APA)

Trouble Shooting The Asphalt Pavement Analyzer (APA).

The APA is a mechanical engineers dream. The machine must heat to 76 ° C (170 °F) and it must cool to 4 ° C (40 ° F). Samples are run under a water bath that must maintain adequate temperature. The electrical components must remain below 40.5 ° C (105 ° F), while the maximum testing temperature is 76 ° C (170 °F). The loading is pneumatically controlled. The samples are tested under a pressurized hose with wheels loaded to 445 to 1112 N (100 to 250 lbs.). They must cycle back and forth across the sample. All of the working mechanical, electrical, and pneumatic parts result in wear and tear to the machine. Examples of such fatigue follow:

1. Fans were installed in the upper cabinet of the machine to prevent electrical circuits from getting to hot.
2. The batteries in the counters are unreliable. They are difficult to locate when replacement is required, and they do not last long in the heated environment.
3. The temperature controls are inaccurate. Temperatures measured by an ASTM thermometer in the chamber differ from the APA Chamber Temperature Control output by as much as 6 ° C (20 °F).
4. After completing one fatigue test of 300,000 cycles, the motor that operates the carriage burned out and required replacing.
5. One of the bearings that the carriage rides on broke. It appears now that the carriage alignment is off.

6. The regulators that maintained the hose and cylinder pressure had some problems maintaining 690 kPa (100 psi). Several of the regulators required replacement.
7. The electric fan that circulates heat from the heater coils throughout the chamber burned out.
8. Taking rut depth measurements to the 0.01 mm is difficult at best.
9. The method of calibrating the wheel loads needs to be re-examined. It is very difficult to center the wheels onto the load cell because there is no guide provided.
10. The hoses are extremely difficult to replace, sometimes leading to injury.
11. After approximately 100 tests, one of the loading cylinders began to consistently leak air. This was not a major problem, but the air compressor was required to run longer and more often.

Many malfunctions and minor setbacks were encountered during the two years spent testing asphalt samples. The APA is a good tool for use in proof testing asphalt mix designs to determine their propensity for rutting. This study proves that the APA can distinguish between mixes that have a rutting susceptibility under controlled laboratory conditions. It has proven to be sensitive to certain asphalt mix properties and not apparently sensitive to others.

The important issue with the APA is determining its ability to reproduce results between various laboratories. This variability is currently too high to make accurate claims about various mixes. More research is needed to determine if the

APA accurately distinguishes between good and poor performing HMA. The next step of this study is to develop a correlation with actual field performance data of the same asphalt mixes studied during this research. The APA appears to show some sort of difference between HMA mixes, but continuos improvement shall continue to perfect the Asphalt Pavement Analyzer. The manufacturer is currently addressing the design concerns and is making the necessary adjustments to the apparatus for the University of Tennessee Asphalt Laboratory.

VITA

Chris Baldwin was born in Montgomery, Alabama on March 13, 1972. He moved to Virginia Beach when he was two years old, where he attended grammar and middle school in the Virginia Beach Public School System. He moved to Tennessee halfway through his seventh grade year and attended the rest of middle and high school in the Sevier County Public School System. He graduated Valedictorian from Gatlinburg-Pittman High School in June 1990. He attended the University of Tennessee, Knoxville, and received the Bachelor of Science in Industrial Engineering in May 1995. After working in the Industrial Engineering field for two years, he decided to return to the University of Tennessee to pursue the Master of Science in Civil Engineering. He officially entered the program in August 1997 and completed the degree in May 1999. He, his wife, and their seven animals currently live in Sevierville, Tennessee.