Construction, Testing and Performance Report

State Study No. 137

Resin Modified Pavement Demonstration Project

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16. Abstract

Resin Modified Pavement (RMP) is a composite paving material consisting of a thin layer (2 inches) of open graded hot mix asphalt (HMA) whose internal air voids (approximately 30% voids) are filled with a latex rubber-modified portland cement grout. The objective of this project was to construct test sections composed of three different types of pavement; RMP, 3 inch thick ultra-thin whitetopping and Superpave performance graded 82-22 polymer modified HMA pavement. This project was constructed at two signalized intersections on US 72 in Corinth, Mississippi in April of 2001 and will be monitored for a period of five years. Using the information gained from these test sections, the Mississippi DOT will be able to develop a "paving strategy" for heavily trafficked intersections within our highway network based on both economics and performance.

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Resin Modified Pavement, Ultra-Thin Whitetopping, Polymer Modified Hot Mix Asphalt, rutting	Unclassified

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NOTICE

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The author wishes to express his appreciation to the many people whose efforts contributed to the success of this study. Acknowledgment is made to Messrs. John W. Avent, Johnny L. Hart, Alan D. Hatch, Chester M. Drake and Sammie D. Evans who assisted with the construction documentation and data collection. Appreciation is expressed to the personnel of MDOT District One, including but not limited to, Messrs. Paul Swindoll, Neal Peach, Keith Swain, Barry Boyd, Johnnie Bennett, Robert Parks and Leon Burns who were most supportive and instrumental in the construction of this project. Additional acknowledgment is made to the personnel of APAC Corinth operations, including but not limited to Messrs. Mike Tucker, Mike Bogue, Donnie Dees, Keith Kelly and to Mr. Mark Ishee of Ergon Inc. The contributions of Dr. Randy Ahlrich, Gary Anderton and Ibrahim Murr should be recognized, for without their experience and assistance this project would not have been possible.

During the period of this study, the Executive Director of MDOT was Mr. Hugh Long followed by Mr. Larry “Butch” Brown. The Deputy Executive Director / Chief Engineer was Mr. James Kopf.

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

LIST OF FIGURES AND TABLES(Continued)

LIST OF FIGURES AND TABLES (Continued)

Chapter 1 – Project Introduction

US 72 in Corinth, Mississippi is a moderately trafficked route located in the extreme north-east corner of Mississippi and utilized by traffic traveling between Memphis, Tennessee and Huntsville, Alabama. Within the limits of the research project location, US 72 is a 5-lane facility, with 2- 12' wide thru lanes in both the eastern and western directions and a 12' wide turning lane between the thru lanes.

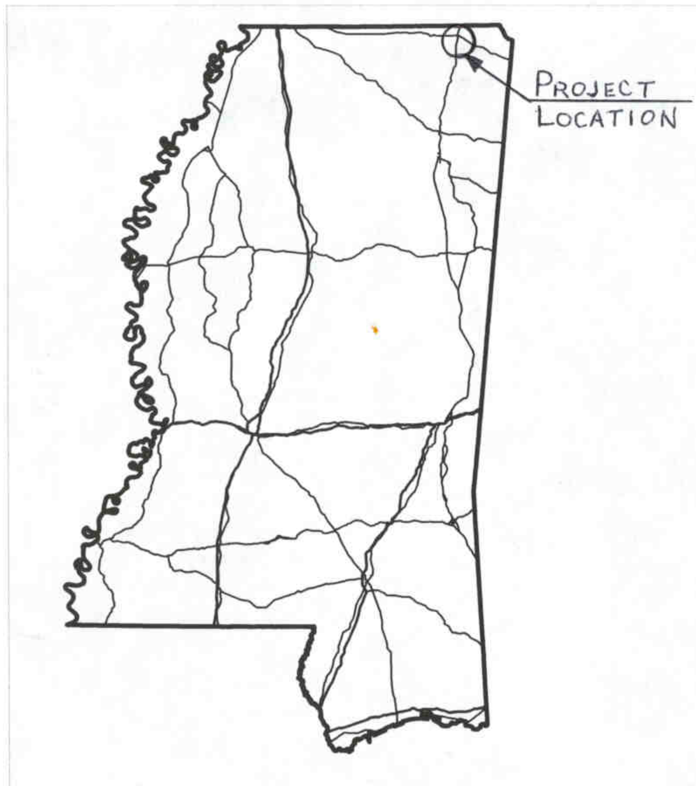


Figure 1 – Project location

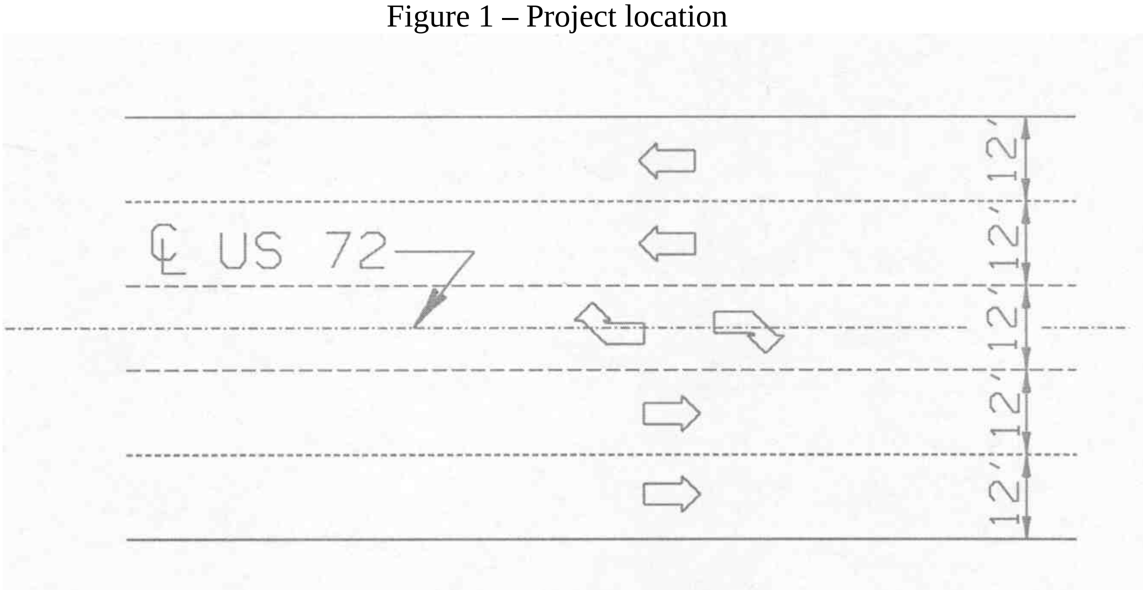


Figure 2 – Typical plan view of US 72

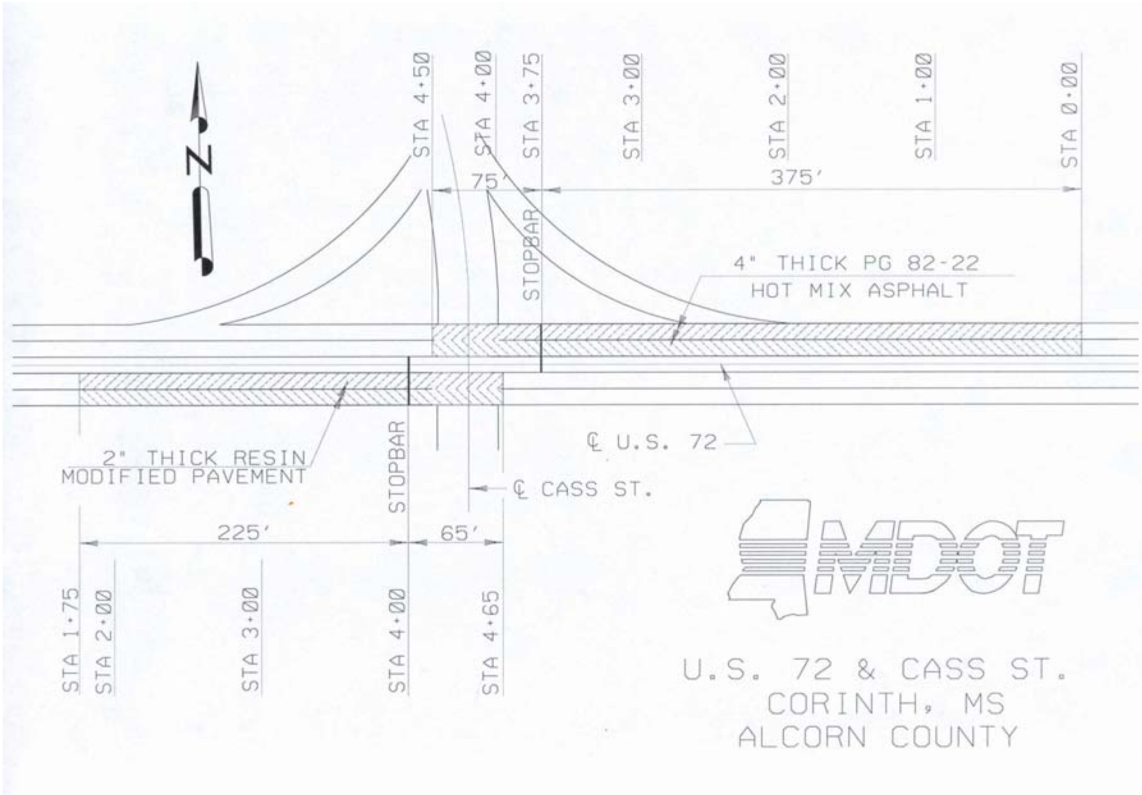


Figure 3 – Plan view intersection of US 72 & Cass Street

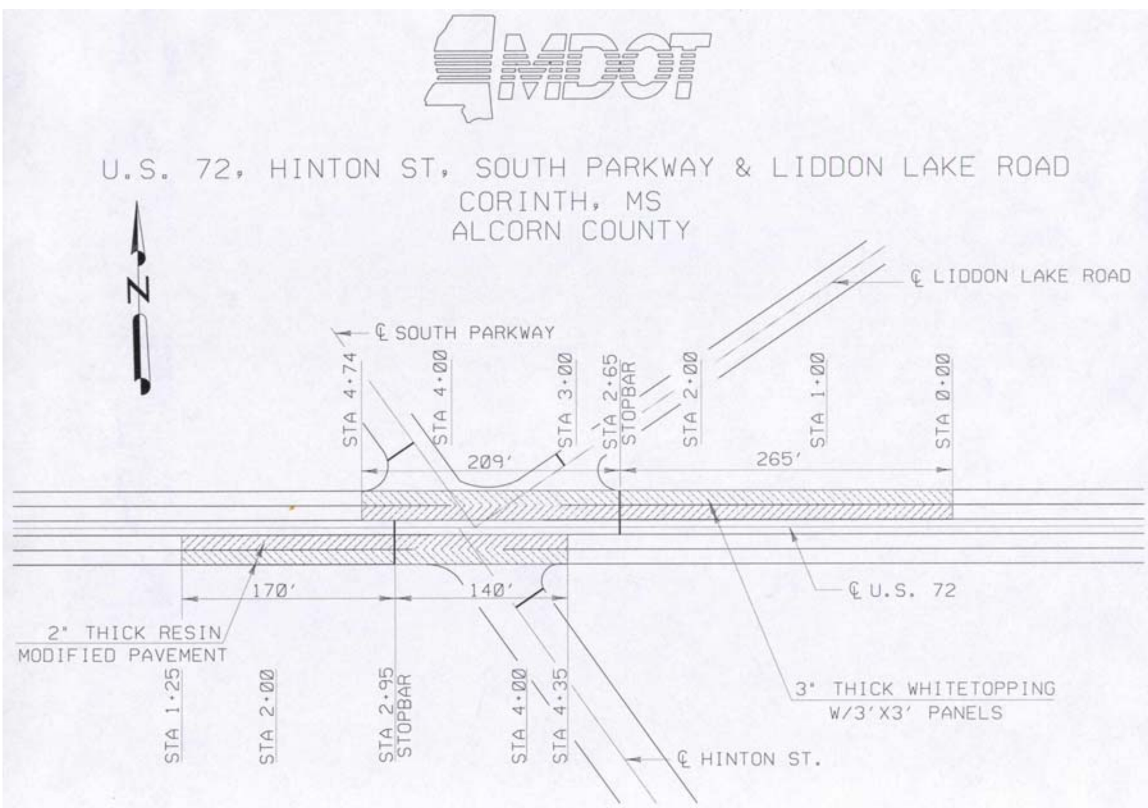


Figure 4 – Plan view intersection of US 72 & Hinton Street

The existing pavement is 12.5” of full depth hot mix asphalt. The 1.5” thick surface course was placed during a 1992 overlay and the remainder of the pavement was constructed in 1976.

Both current and projected traffic data are shown in Appendix A.

Preconstruction measurements were taken to quantify the condition of the existing pavement at each section in the outside thru lane and can be found in Appendix B. These measurements include existing rut measurements, friction data, “California style” profilograph Profile Index (PI) and International Roughness Index (IRI).

Rut measurements were taken manually by placing a metal straight edge on the pavement and measuring the depth from the straight edge to the pavement surface in the wheel paths. Measurements were taken to the nearest 1/16” and were taken on 25’ intervals.

All friction data was gathered using the department’s high speed friction testing system designed to meet all of the requirements of ASTM E274-90 “Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire” and utilized a ribbed tire for friction data collection.

All PI data was gathered utilizing a computerized “California Type” profilograph with a 2’ low pass third order butterworth filter. PI data is presented with a 0.2” Blanking Band and with a “Zero” Blanking Band.

Preconstruction IRI data was collected using the department’s ARRB Transport Research Walking Profiler.

Figure 5 – Intersection of US 72 and Cass Street (looking east)

Figure 6 – Intersection of US 72 and Hinton Street (looking east)

Figure 7 – Intersection of US 72 and Hinton Street (looking east)

Figure 8 – Trenches taken from the two intersections

Chapter 2 - Construction of Ultra-Thin Whitetopping

US 72 Westbound at the intersection with Hinton Street was selected for the location of the Ultra-Thin Whitetopping (UTW) test section. Construction of the section took place in both the right and left thru lanes in phases and extended 265' behind the stopbar and 209' ahead of the stopbar for a total length of 474' in each thru lane. A 3" concrete thickness was constructed with the ends of each section being thickened to 6" in depth. Sawcut panels were cut on 3'x3' centers.

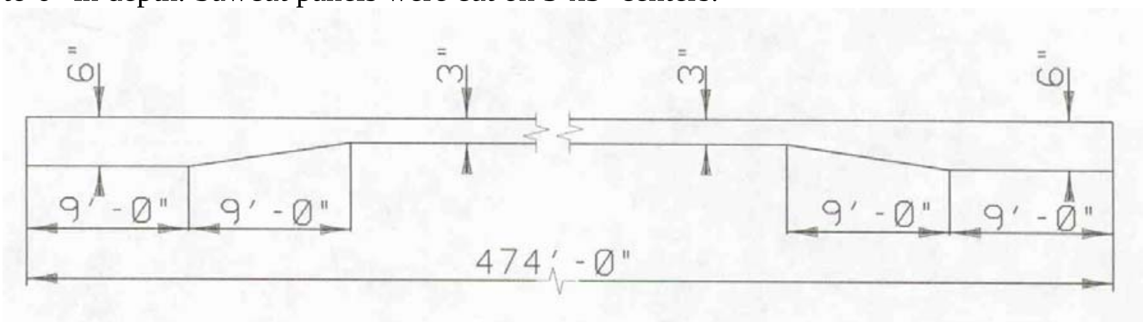


Figure 9 – Elevation view of UTW section

Preconstruction pavement condition measurements for the proposed UTW section yielded an average rut depth of 1.43", an average skid friction number (SN) of 34.5, an average $PI_{(0.2\text{" Blanking Band})}$ of 167 inches/mile, an average $PI_{(\text{Zero Blanking Band})}$ of 215 inches/mile and an average IRI of 584 inches/mile.

APAC – Northern Division using their Corinth, Mississippi operations were selected to perform the milling and construct the UTW. B & B Concrete of Tupelo, Mississippi, batched the concrete to the site from their plant in Corinth, Mississippi.

On April 3, 2001, the inside thru lane of the UTW section was milled with a target depth of 3", and an additional 3" depth for 6" total milled at either end. Due to the nature of the milling procedure, achieving an exact depth of 3" throughout our section was impossibility.

On April 4, 2001, the construction of the inside thru lane with UTW began. The contractor chose to employ a vibratory manual screed for the construction of the pavement. A 5000 psi air-entrained concrete mix containing fibrillated polypropylene fibers was utilized for the project. See Appendix C for the complete concrete mix design and Appendix D for MDOT Special Provisions related to the construction of the UTW section.

The first concrete truck arrived at the project site at approximately 10:30am on a sunny but cool day with temperatures ranging in from 55 degrees Fahrenheit at the beginning of the pour, to 60 degrees at completion. A total of 66 cubic yards of concrete was utilized in phase I of the 474' long section and paving was completed in 5 ½ hours.

During the pouring of concrete, random samples were taken and the slump and air content were measured. The average slump was 4.5" and the average air content was 5.5%. A complete listing of the slump and air content measurements appears in

Appendix C. Cylinders were constructed from 2 trucks during the course of construction. These cylinders were broken at 24 hours, 48 hours, 7 days and 28 days. A listing of the cylinder break results is also included in Appendix E.

Once the concrete had achieved its initial “set”, a metal broom was used to achieve the transverse tined finish. This was performed on a section approximately 2 hours behind the paving screed.

After the pavement had been transverse tined, the contractor applied a water based white pigmented concrete curing compound.

For a 3” thick UTW, it is common practice to saw cut 3’ x 3’ panels in the “green” concrete. This project adhered to that practice. Two “Soff-cut” concrete saws were utilized and began sawing the panels at approximately 3:00 pm about 4½ hours behind the paving operation.

The concrete industry has recommended that plastic spacers be utilized at locations where sawcuts cross. The first cut is made and at the location where the second cut will cross the first, a plastic spacer is inserted in the fresh cut. This prevents the joint from closing up when the second cut is made. The UTW section employed these spacers at every cross cut.

Construction of the inside thru lane was completed at 11:00 pm.

The newly constructed UTW was allowed to cure for approximately 48 hours and was opened to traffic at 12 pm on April 6, 2001.

On April 9, 2001, the outside thru lane of the UTW section was milled with a target depth of 3”, and an additional 3” depth for 6” total milled at either end.

On April 10, 2001, construction of the outside thru lane with UTW began. The contractor utilized the same construction methods as had been employed on the inside lane one week previous. The same concrete mix was used for both lanes.

The first concrete truck arrived at the project at 9:00am on a sunny and warm day with temperatures ranging from 70 degrees F at the beginning of the pour, to 86 degrees F at completion of the pour. A total of 63 cubic yards of concrete was utilized in phase II of the 474’ long section and paving was completed in 5½ hours.

Samples were taken and the slump and air content measured. The average slump was 5.25” and the average air content was measured to be 4.9% in the concrete utilized in phase II. A complete listing of all slump and air content measurements appears in Appendix C. A list of all cylinder break results from phase II of construction is also available in Appendix E.

Once again a metal broom was used to achieve the transverse tined finish approximately 2 hours behind the paving screed.

After the white pigmented concrete curing compound had been applied to the freshly tined concrete surface, sawing of the 3’ x 3’ panels began. The two “Soff-cut” concrete saws began sawing panels at 1:30 pm which was approximately 4½ hours behind the paving screed.

The cross cut spacers were utilized for sawing in phase II of the UTW section.

Construction of the outside thru lane was completed at 7:30 pm.

The newly constructed UTW in the outside thru lane was allowed to cure for approximately 48 hours and was opened to traffic at 12 pm on April 12, 2001.

A complete listing of the California type profilograph, high speed profiler and surface friction data for the UTW section appears in Appendix C.

Cost data for the construction of the UTW section appears in Appendix I.

Figure 10 – Milling of the existing asphalt prior to construction of each test section

Figure 11 – Pouring concrete at the Ultra-Thin Whitetopping test section

Figure 12 – Whitetopping is given a transverse tined finish with a metal broom

Figure 13 – White pigmented curing compound is applied to fresh concrete

Figure 14 – 3'x3' panels are sawcut into the "green" concrete


Figure 15 – Plastic spacers are used at the cross cuts to achieve a clean cut

Chapter 3 - Construction of Resin Modified Pavement

Resin Modified Pavement (RMP) is a composite paving material that combines the rut resistance of a concrete pavement with the lower initial cost of an asphalt pavement.

An open graded 2" thick lift of hot-mix asphalt is constructed with approximately 30% air voids. After the mat has been allowed to cool to ambient temperature, a highly fluid cement grout is poured onto the mat. The grout must penetrate the entire 2" depth of the open graded asphalt and fill all of the internal voids in the mat.

This paving technique was developed in France in the 1960's and has been widely utilized throughout Europe. To date most of the UTW in the United States have been pavements constructed for military applications.

The United States Army Center for Public Works published a "User's Guide: Resin Modified Pavement" in 1996 which is included in Appendix G. This document was utilized as a guide during the construction of Mississippi's RMP test sections.

In addition, the Mississippi DOT contracted the services of Dr. Randy Ahlrich. Dr. Ahlrich is an employee of Burns, Cooley and Dennis, a Jackson Mississippi Geotechnical engineering firm. Dr. Ahlrich gained extensive experience with RMP during his former employment with the United States Army Engineer Waterways Experiment Station.

Since the Mississippi DOT has no previous experience with the RMP pavement, it was decided that a 100' x 12' test strip should be constructed off site in a "mill and fill" application as would be utilized on site. A location at the APAC – Corinth asphalt plant was utilized for the test section.

On April 2, 2001 construction of the RMP test strip began. The strip was milled to the approximate 2" depth at 8:00 am. At approximately 2:00 pm on a sunny 78 degree F afternoon, the open graded mix was laid into the freshly milled section. It required approximately 15 tons of asphalt to construct the strip. The mat temperature was approximately 290 degrees F at laydown. After approximately 1 hour, when the mat temperature had reached 140 degrees F, a small 2-ton steel wheel roller in static mode made one roller pass on the mat to smooth any imperfections in the mat.

After examining the gradations from the truck samples that were taken from the test strip material, it was determined not to accept the first test strip. For unexplained reasons the mix gradation had "fined" during production with too much material passing the #4 sieve, hence our air voids in the mat were at the 25% minimum limit. Rather than risk attempting to add the grout to the strip, APAC was told they must remove the mat, make adjustments to the gradation to "coarsen" the mix and place the mat again.

On April 5, 2001, construction of RMP test strip 2 began. At 9:20 am on an overcast 63-degree F morning, the open graded mix was laid into the milled section. Once again 15 tons of asphalt was required to construct the test strip. For test strip 2 the mat temperature was approximately 240 degrees F at laydown. After approximately 20 minutes, when the mat temperature had reached 140 degrees F, the small 2-ton steel wheel roller was utilized in static mode to smooth any imperfections in the mat.

The gradations were examined from the truck samples that were taken from the test strip material and they were well within the Job Mix Formula tolerances. The mat was deemed acceptable and was covered with a tarp to prevent any excessive moisture infiltration until the grout could be added.

On April 9, 2001 after a three day delay due to mechanical difficulties with the fly ash silo auger at B & B Concrete's Corinth plant, the cement grout was batched at 11:00 am. It is important to note that prior to batching grout into cement trucks, care should be taken to ensure that the drum of the truck is clean. Contamination of the grout with other material can be detrimental to the grout. During the plant batching process for a 4 cubic yard load of grout, initially half of the water or 1550 gallons was added to the cement truck. Next, the Silica Sand, 2280 lbs dry weight is added to the truck. After the sand has been added, 4556 lbs of Type 1 Cement is added to the truck. Next, the Type F Fly Ash, 2280 lbs, is added. And finally the remaining water with the exception of ten gallons was added. It is important to note that during loading and transport of the mixture the drum of the cement truck must be agitating. For this project, the resin additive PL7, was added to the truck at the project site. The concrete truck arrived at the project site at 11:30 am on a sunny 76-degree F morning. A small pump was used to pump the PL7 from its 55-gallon drum into the concrete truck. After all of the additive had been pumped out of the drum, the remaining 10 gallons of water was used to rinse out the drum and pumped into the concrete truck. The grout mixture should undergo the maximum rotations of the concrete truck for no less than 10 minutes to insure that the PL7 is thoroughly mixed. For construction of the RMP test strip 2 at APAC-Corinth's plant, only 3 cubic yards of the grout was batched. Therefore, all of the mixture quantities detailed in the previous paragraph were reduced by 25%.

At 11:50 am after adding the PL7 and mixing for 10 minutes, the grout was ready to be poured into our mat of open graded asphalt. Before pouring the viscosity of the grout must be checked using a Marsh flow cone. The Marsh cone is used to measure the length of time it takes for 1 liter of grout to flow through the cone. Too high of a flow time would mean that the grout is too viscous and might not penetrate the open graded asphalt layer completely. If the flow time was too low, the grout may not gain the strength required. For this project an acceptable flow time is between 7 and 10 seconds. The flow of the grout that was used in RMP test strip 2 was checked and timed out to 8.72 seconds which was acceptable.

Using 2” grout cube molds, six grout cubes were made to verify the strength of the grout. The compressive strength of these cubes would be checked at 48 hours. The grout should have a compressive strength of at least 2000 psi. after 48 hours.

The grout was poured into the RMP test strip 2 mat. Hand held squeegees are used to “push and pull” excess grout material to under-saturated areas. Due to the low viscosity of the grout, care must be taken at the edges of the mat to insure that significant amount of grout is not lost due to grout overflowing the mat. During the distribution of grout material, a three-ton roller in vibratory mode is driven over the grouted mat. The vibration of the roller helps the grout to penetrate the entire 2” depth of the open graded asphalt mat. Air bubbles should be visible behind the roller wheels indicating that the air voids in the asphalt are being saturated with the grout. After the mat has been fully saturated with grout, a push broom is used to get the final surface texture of the grouted mat.

Two days later on April 11, 2001, 4” diameter cores were taken in the RMP test strip 2 mat. A visual inspection of the cores was made to determine if the grout had penetrated the entire depth of the open graded asphalt mat. If more than 95% of the voids appear to be saturated with grout, then the grout has sufficiently penetrated the mat. All of our cores appeared to have over 95% penetration and the RMP test strip 2 was considered a success. With the test strip constructed and approved, plans were made to begin construction of our two RMP test sections on US 72 the following week.

Also on April 11, our 2” grout cubes were broken in the laboratory to determine their compressive strength. The cubes met the 2000 psi compressive strength after 48 hours requirement. A complete listing of cube breaks appears in Appendix F.

On April 16, 2001, with an air temperature of 70 degrees F, the 2” thick open graded HMA mat was laid in the inside thru lane at each of our RMP test locations on US 72 Eastbound. The hot-mix asphalt arrived at the site with a temperature of approximately 220 degrees F and paving began at approximately 5:20 pm at US 72 and Cass Street and took 20 minutes to pave the 365’ x 12’ area. Once the paver had moved the 3000’ to the test location at US 72 and Hinton Street, paving resumed at 6:10 pm and took approximately 25 minutes to pave the 435’ x 12’ area at the intersection with Hinton Street. A complete listing of mat temperatures and paving times are provided in Appendix F. Samples were taken from two trucks of hot-mix asphalt at the plant and gradations and asphalt cement content of the mix was verified. A listing of those results appears in Appendix F.

During the night a cold front moved through the area and on a cold morning on April 17, 2001 with temperatures near 40 degrees F, the cement grout was poured into the 2” thick open graded mix at both of the RMP test locations on US 72 Eastbound.

On the morning of April 17, 2001, prior to the arrival of grout, nuclear density gauge readings were performed both test sections to verify the target 30% air voids. A complete listing of the nuclear density gauge results appears in Appendix F.

Batches of cement grout arrived on site in 4 cubic yard quantities per truck. The identical mixing technique that was detailed during the construction of the test strip 2 at APAC's plant was utilized during construction of the test sections. Once again, the PL7 additive was pumped into the trucks on site and mixed vigorously for 10 minutes before being poured into the open graded mat.

Grout began to be poured at the intersection with Hinton St. at approximately 9:20 am. Prior to utilizing any truck load of grout, the flow time was checked using the Marsh funnel as detailed during the construction of the test strip. A complete listing of production rates and Marsh funnel flow times appears in Appendix F. As with the test strip, 2" grout cube molds were utilized to construct six grout cubes with which to check the 48 hour compressive strength of the grout. Once the flow time was checked, the grout was poured onto the open graded asphalt mat. As with the construction of the test strip, hand held squeegees were used to "push and pull" excess grout material to under-saturated areas. Due to the low viscosity of the grout, care must be taken at the edges of the mat to insure that a significant amount of grout is not lost due to the grout overflowing the mat. Since the grout is being added to a 2" thick mat which has been inlayed into the existing asphalt, the only grout that could be lost due to overflow is on the surface of the mat and at the ends of the section. To prevent seepage at the ends of the section, a temporary wedge of cold mix asphalt was constructed at each end of the section. During the distribution of grout material, a three-ton roller in vibratory mode is driven over the grouted mat. The vibration of the roller helps the grout to penetrate the entire 2" depth of the open graded asphalt mat. Air bubbles should be visible behind the roller wheels indicating that the air voids in the asphalt are being saturated with the grout. After the mat has been fully saturated with grout, a push broom is used to get the final surface texture of the grouted mat.

Each 4 cubic yard truck of grout would yield enough grout to fill approximately 125 linear feet of the 12' wide x 2" thick open graded asphalt mat. Each 55 gallon drum of the PL-7 additive would produce 4 cubic yards of grout and only 12 drums of the PL-7 were available for this experiment. During construction of the test strip three quarters of one drum of PL-7 was utilized to produce the 3 cubic yards of grout required for the test strip. This left 11.25 drums available for construction of the two test sections on US 72. Since the additive is very expensive and the quantity that was available for this experiment was limited, attention to production was very high to determine if enough additive was available to complete the sections.

During construction of the US 72 inside thru lane at Hinton Street, it was decided to terminate construction of the section 125' short of the 435' design length. This would provide more of a "safety factor" since the amount of PL-7 available was limited. Thus the section at Hinton Street was now 310' in length.

Construction of the 310' x 12' RMP section (inside thru lane) at Hinton Street was completed at approximately 11:45 am. Since the construction of the inside thru lane at the intersection with Hinton Street had required approximately 10 cubic yards of grout and the grout was being batched in 4 cubic yard loads, there was approximately 2 cubic yards remaining in the last truck upon completion of the section. This grout needed to be utilized to begin construction of the inside thru lane at the intersection with Cass Street. It is important to point out that during construction, the concrete truck must be continually agitating the grout mixture to prevent it from prematurely thickening. Should thickening of the grout occur, it would be detrimental to achieving full penetration of the grout into the 2" thick open graded mat of asphalt. Therefore, it was important to utilize this grout as quickly as possible before the grout could "set up".

Approximately 30 minutes later with the remaining 2 cubic yards of grout undergoing the maximum revolutions that the concrete truck was capable of, the second test section at Cass Street was ready for grouting. The Marsh funnel was used to check the flow of the 2 cubic yards and it timed out at 9.66 seconds which was acceptable and grouting of the intersection at Cass Street began at approximately 12:15pm.

After a long cold day with wind chills near the freezing mark, construction of the 365' x 12' section at the intersection of Cass Street was completed at approximately 2:15pm. Each section received a dusting of a water based white pigmented concrete curing compound.

It is important to point out that throughout the day, each 4 cubic yard load of grout yielded approximately 125' of production. However, the final truck of the day at the intersection of Cass Street yielded 175' of RMP pavement. This will be a critical piece of information as time progresses.

During the night, the temperature in Corinth dropped to 32 degrees F. The next morning (4/18) when we collected our grout cubes, we were disturbed by what was discovered. Apparently the severe cold had caused excessive shrinkage of the grout and each cube had imploded on itself leaving them impossible to perform a compressive strength test on and basically useless to the study. An inspection of the pavement sections troubled us as well. The grout appeared to be "powdering up" on the surface as you could lightly scrape the surface and produce a powdery residue. This condition had not appeared at the test strip and apparently the severe cold had slowed down the curing of the grout tremendously. After consulting with Dr. Ahlrich, it was decided that a "wait and see" approach should be taken to determine if as the pavement warmed whether the grout would begin undergoing it's cementitious reaction once again. During the day on April 18 the temperature warmed to approximately 55 degrees F.

On April 19, 2001, the pavement surface was inspected once again and the powdering condition that had been observed on the previous morning was not evident and the grout appeared to be gaining strength. Our entire research team gave a collective sigh of relief. Original plans called for coring the sections on Thursday April 20, 2001 and should we achieve the required visual grout penetration in the cores, opening the lane to traffic on Friday April 21. However, based on the slow curing and the lack of grout cubes to verify strength, it was decide to continue to keep the lane closed over the weekend and core the sections on the morning of Monday April 23. Assuming coring showed no problems, open the lane to traffic on the afternoon of April 23rd, which would allow the grout 6 days for curing.

On April 23, 2001, the two sections were cored. In the section at the intersection with Cass Street the mystery as to why one concrete truck had yielded 175' of production as opposed to 125' everywhere else was solved. When we cored this area, the cores revealed that the grout had "capped off" and not sufficiently penetrated the entire 2" thickness of the mat. Therefore we were able to get more linear production in this area than anywhere else. After coring to verify the extent of the "capping", it was determined that the last 75' of the section must be milled and removed. Thus the section at Cass Street arrived at it present dimension of 290' x 12'. All other coring in both sections yielded satisfactory grout penetration. After the failed 75' section had been removed, the sections were opened to traffic on the afternoon of April 23, 2001.

On April 24, 2001, construction of the RMP in the right thru lane at each test section began. Throughout the construction of the right lane the weather was much warmer and low temperatures failed to drop below 50 degrees F. Identical construction techniques used during the construction of the left thru lane portion of the sections were employed throughout the construction of the right thru lane sections. Data taken at the lab from the two truck asphalt samples appears in Appendix F. Nuclear density readings taken on the mat prior to incorporation of the grout appears in Appendix F.

Grout was incorporated into the open graded asphalt on the morning of April 25, 2001. The temperature when work began was 52 degrees F and warmed to 67 degrees F by the time construction had completed. Once again flow times were checked and grout cubes prepared. A full listing of production rates and Marsh flow times appears in Appendix F.

Since the temperatures during construction of the right thru lanes were much higher than during the construction of the left thru lanes successful grout cubes were prepared and broken in the lab. A listing of the cube compressive strengths appears in Appendix F.

Due to the warmer weather, the "powdering" effect that appeared during the curing of the left thru lane sections failed to materialize during curing of the right thru lanes. It was still decided to be conservative and wait to open the lanes to traffic until April 30, allowing the grout 5 days to cure.

On April 30, the right thru lanes were cored to verify grout penetration. This time no capping of the material was discovered and both test sections were opened to traffic as built.

A complete listing of the California type profilograph, high speed profiler and surface friction data for the RMP section appears in Appendix F. Cost data for the construction of the RMP sections appears in Appendix I.

Figure 16 – APAC Corinth "drum" plant which produced both the PG 67-22 open graded mix for the Resin Modified Pavement and the PG 82-22 dense graded mix

Figure 17 – Paving the PG 67-22 open graded mix for the RMP test section

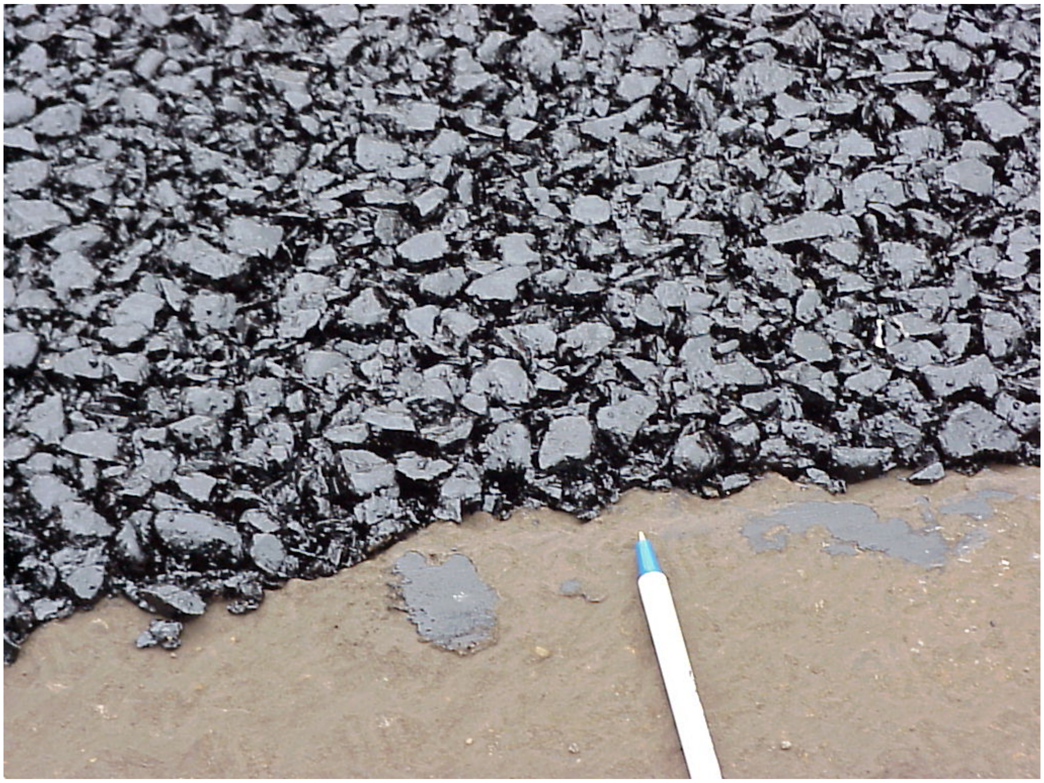


Figure 18 – Close up of the surface of the 2” thick open graded mat

Figure 19 – Open graded mix is subjected to one pass with a 1½ ton roller in static mode @ approximately 150 degrees F to “seat” the aggregate

Figure 20 – B & B Concrete Corinth plant which supplied the grout for the RMP

Figure 21 – PL7 latex additive is added to the grout at the site

Figure 22 – Close up of PL7 latex additive

Figure 23 – Flow time of the grout is checked with a Marsh cone

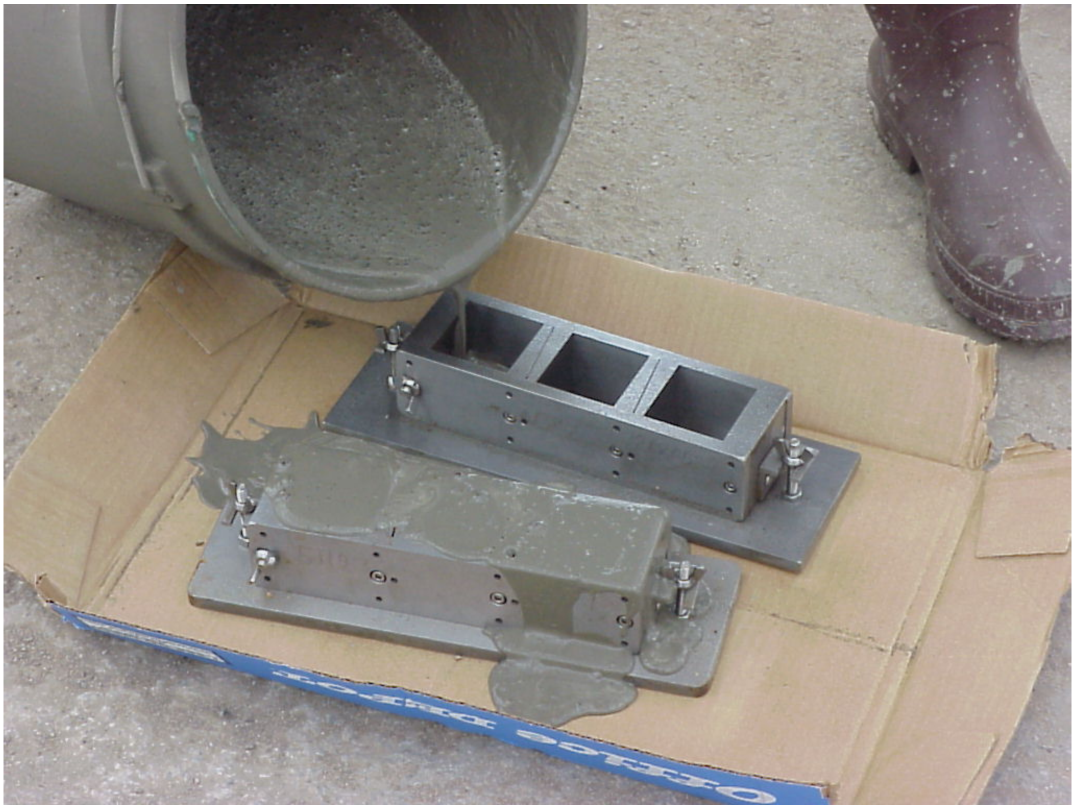


Figure 24 – 2” mortar cubes are made to test the grout strength

Figure 25 – Grout is poured onto the open graded asphalt mat

Figure 26 – Using a 3 ton roller in vibratory mode, the grout is forced to penetrate the entire thickness of the 2” open graded asphalt mat

Figure 27 – Excess grout is worked to under grouted areas using squeegees

Figure 28 – “Working the grout”

Figure 29 – Excess grout is pulled forward

Figure 30 – Finished product the next morning (US 72 & Hinton St. looking east)

Figure 31 – Cores are taken to insure 95% saturation of grout

Figure 32 – Entire mat did not get saturated in some areas (1” capping of grout)

Figure 33 – Milling up of 75’ x 12’ area that failed to achieve full grout penetration

Chapter 4 - Construction of Performance Graded 82-22 Polymer Modified Hot Mix Asphalt

Once MDOT granted approval to the contractor's proposed mix design (see Appendix H) for the PG 82-22 HMA, a 450'x 24' test strip was constructed on June 12, 2001 to establish rolling patterns and density gauge biases. The paving train consisted of a Craftco Accupave Windrow propelled by a Cat 966C, a Lincoln Shuttle Buggy, a Blaw Knox paver and 2 Cat CB634C 15 ton steel wheel rollers.

The liquid AC used in the hot-mix was modified with a Styrene Butydene Styrene (SBS) polymer to achieve the PG 82-22 grade and was supplied by Ergon Asphalt & Emulsions, Inc., Memphis, Tennessee terminal. It should also be noted, that MDOT standard practice is to include 1% hydrated lime in all our asphalt mixes to serve as an anti-strip agent. The PG 82-22 mix involved in our research did not deviate from that policy.

For construction of the test strip, hot-mix asphalt left the plant at approximately 345 degrees F. Temperatures behind the paver averaged 340 degrees F. A rolling pattern was established using six passes with a 15 ton roller in vibratory mode and one finishing pass in static mode. Attached in Appendix H is a complete listing of all densities both gauge and core verified gradations, SGC air voids and AC contents.

Three gyratory pills were compacted to approximately 7 % air voids using mix material and run in the department's Asphalt Pavement Analyzer (APA) dry and subjected to 8000 cycles of 100 psi hose pressure at 147 degrees F. The pills average depth of rut following the test was 0.10 inches (2.55 mm). The complete results of the APA testing can be found in Appendix H.

Our Research section would consist of 2 – 2" thick lifts of 12.5mm Nominal Maximum Aggregate Size (NMAS) PG 82-22 hot mix asphalt. A chert gravel & limestone blend was utilized for the mix. MDOT policy currently prohibits the use of more than 30% limestone in surface course asphalt mixes due to concerns about polishing of some limestone mixes and the subsequent lack of friction resulting from that polishing. This mix adhered to that limitation and utilized only 30% limestone aggregate. The test strip would serve as the lower lift of our research section located on U.S. 72 Westbound at the intersection on Cass Street.

On June 15, 2001 the surface lift of the left thru lane of our 450' research section was paved. Temperatures of the mat directly behind the paver averaged approximately 305 degrees F. See Appendix H for the surface mat temperatures. Attached in Appendix H is a complete listing of all densities both gauge and core verified, gradations, SGC air voids and AC contents from the surface of the left thru lane of the research section.

On June 18, 2001 the surface lift of the right thru lane of our 450' research section was paved. Temperatures of the mat directly behind the paver averaged approximately 305 degrees F. See Appendix H for the surface mat temperatures.

Attached in Appendix H is a complete listing of all densities both gauge and core verified gradations, SGC air voids and AC contents from the surface of the left thru lane of the research section.

Unfortunately during construction of the right lane of our research section, the breakdown roller experienced mechanical difficulties. Due to the high amount of traffic in the area, approximately 10 vehicles drove on the fresh mat of asphalt before the breakdown roller could begin compacting the section. The traffic “scarred’ the mat and the rollers were unable to remove all of the initial rutting due to the early traffic. After construction of the right lane, manual rut measurements were taken and the rutting due to the early traffic averaged 0.09” in the left wheelpath and 0.04” in the right wheelpath. The entire list of manual rut measurements that were collected upon completion of the research section are available in Appendix H.

A complete listing of the California type profilograph, high speed profiler and surface friction data for the PG 82-22 hot mix asphalt section appears in Appendix H.

Cost data for the construction of the PG 82-22 section appears in Appendix I.

Figure 34 – PG 82-22 dense graded HMA being dumped ahead of Windrow device

Figure 35 – Paver equipped with “shuttlebuggy” for PG 82-22 paving

Figure 36 – Breakdown rolling (note scarring from traffic getting on the fresh mat)

Figure 37 – Finish rolling

Chapter 5 – Conclusions from Construction and Early Performance

Ultra-Thin Whitetopping

As the data in Table C7 of Appendix C indicates, the smoothness of the Ultra-Thin Whitetopping test section is less than satisfactory. Undoubtedly this amount of roughness will impact the service life of the pavement. For future projects utilizing Ultra-Thin Whitetopping, adequate smoothness incentive/disincentive specifications should be utilized to insure proper care and construction techniques are employed by the contractor. One step in the right direction would be to disallow the use of small "bull" floats for the finishing of the concrete surface.

Resin Modified Pavement

It cannot be stressed enough that care must be taken to insure proper quality control is in place to successfully construct the Resin Modified Pavement. The gradations of the open graded asphalt mix must be carefully controlled to insure the target 30% air void level is obtained. Should the mat have less than the target 30%, the ability of the grout to penetrate the entire 2" thickness is compromised.

The grout must be agitated continuously once the PL7 latex additive has been introduced into the mix. If proper agitation is not provided, the grout will become too viscous, which will hamper its ability to penetrate the entire 2" thickness of the mat.

Planning quantities of grout that will be needed are difficult to calculate. Due to the nature of the pavement system, there are many variables which influence the amount of grout that will be required for a project. If air voids vary from the target 30%, the amount of grout required to fill the open graded mat will increase or decrease. On inlay situations, if the milling depth varies and the thickness of the open graded asphalt mat varies, the quantity of grout required will also change.

Since the PL7 latex additive is so expensive (approximately $1000 per 55 gallon drum) and it is imported, a limited amount of PL7 was available for this project. Attention to grout usage must be monitored during construction. Measures should be taken to insure that too much grout is not wasted by overflowing the mat. During this project when it appeared that grout usage was higher than planned, 225' of the Resin Modified Pavement test section was eliminated to insure that the quantity of available PL7 would not be exhausted prior to the completion of the test sections.

The difficulty of constructing this pavement system is best exemplified by this project. Even with all of the above listed "attentions to detail" provided during construction, there still was a 75' section of the pavement that had to be removed due to a lack of grout penetration of the mat. For an unexplained reason, a 75' section of one of the Resin Modified Pavement test sections "capped off", with only approximately the top 1" of the 2" thick mat receiving the proper amount of grout. A review of the air voids in the mat of this area and the grout flow times don't indicate any problems. The same construction techniques that were employed in the successfully constructed portions of the test section were also utilized in the 75’ failed area. The answer as to why this happened remains a mystery.

Should temperatures during construction and curing of the Resin Modified Pavement drop below 50 degrees F, additional curing time will be required for the grout to obtain its design compressive strength. A rule of thumb is that no less than 72 hours of above 50 degree F temperatures should be provided for the grout to cure. Even then, grout cubes should be constructed to verify the compressive strength of the grout before opening the Resin Modified Pavement to traffic.

Precipitation can also be a factor in the construction of the Resin Modified Pavement. It is critical that moisture does not enter the open graded asphalt mix prior to the addition of the grout. If it does rain before the addition of grout, the voids in the mat must be free of moisture before the grout can be added.

One additional point of note concerning the Resin Modified Pavement is early skid performance. A review of tables F28 & F29 in Appendix F indicates that initial skid performance (values in the low to mid 20’s) is less than satisfactory. However, as traffic begins to wear the top film of grout off the section and aggregate from the open graded asphalt mat is exposed, the skid numbers begin to improve to adequate levels. This early lack of surface friction could be a safety issue, especially in high speed traffic applications.

Performance Graded 82-22 Asphalt

Normal quality HMA construction techniques should be utilized when performing PG 82-22 paving. When utilizing highly modified asphalt, the mix must arrive at the project with a high enough temperature to insure proper densification during rolling operations. For this project, APAC’s Corinth plant was only located approximately one mile from the test section, therefore temperature was not a problem.

Chapter 6 – Long Term Performance

Each test section was monitored over a five year period (April 2001- April 2006). Data collected included skid resistance, rut depth, IRI, and pavement distress surveys. Pavement distresses were identified using the LTPP distress identification manual and the following distresses were identified during this project:

- Transverse Cracking
- Longitudinal Cracking
- Patching
- Rutting

Once identified and measured, total deduct points were calculated using curves previously developed for MDOT. It should be noted that distresses for each of the test sections were normalized to a 500 foot section length for analysis due to the fact that MDOT's deduct curves are based on a 500 foot section length.

A pavement condition rating (PCR) was calculated using both IRI and distress ratings.

All long term roughness and rutting data was collected using an International Cybernetics Corporation full size profiler model MDR 4086L3.

The following is a summary of the long term data for each test section.

Ultra-Thin Whitetopping

Long term data for the Ultra-Thin Whitetopping test section is given in Table C10 of Appendix C.

Skid resistance performance was good for the Ultra-Thin Whitetopping test section, with no average values falling below 40. A value of 35 or better is desired on all MDOT maintained roads.

Collection of the rut values for the Ultra-Thin Whitetopping produced some minimal average rut values. It was determined however that these values were due to the lasers of the profiler reading the joints cut into the pavement and not due to actual rutting of the pavement.

Test sections for the Ultra-Thin Whitetopping, as noted in the previous chapter, began in less than satisfactory condition with initial IRI values above 4. Those values were significantly higher than those of the other test sections. IRI values this high are normally associated with older pavements in need of repair, not new construction. A review of the data shows that the condition of the pavement continued to deteriorate over the life of the project.

The substantially high IRI values were most likely what produced the low pavement condition rating (PCR) values. Initial PCR values for the inside and outside lane were 65.9 and 54.6 respectively. MDOT suggests that four lane pavements with a PCR value of 72 or lower should be considered for rehabilitation. This means the Ultra-Thin Whitetopping test section was inadequate from the time of construction.

Approximately two years into the project (2003), several Ultra- Thin Whitetopping panels began to crack and break apart. Broken panels were removed and replaced with concrete containing a product called STRUX 90/40 fibers provided by Grace Construction. STRUX 90/40 is a high performance synthetic structural fiber specifically engineered to impart tight crack control as well as plastic shrinkage control. In 2007, MDOT maintenance crews informed us of their intentions to remove and replace the entire Ultra-Thin Whitetopping test section due to excessive failures. An example of these failures is shown in Figure C11 of Appendix C. It should be noted that some of the panels replaced in 2003 experienced failure as well, meaning the added STRUX 90/40 fibers did not make a significant difference. This can be seen in Figure C12 of Appendix C.

Resin Modified Pavement

Long term data for the Resin Modified Pavement test sections is provided in Tables F30 and F31 of Appendix F.

Early skid resistance was noted as a problem for the Resin Modified Pavement test sections. This problem improved within a few months, however by the fourth year (2005) skid values again fell near 30, a value well below MDOT's recommended acceptable value of 35.

A review of the long term Resin Modified Pavement data provided one significant result. There was no rutting observed in either test section throughout the duration of the project.

Overall, the PCR values for the Resin Modified Pavement sections were acceptable. The lone exception was the inside lane of Cass Street. This is most likely attributed to the IRI values for that lane being substantially higher than the other lanes in the test sections. The higher IRI values can most likely be attributed to improper care during construction to insure smoothness of the pavement.

It should be noted that Resin Modified Pavement is not a specific pavement category for use in the deduct curves used by MDOT in PCR calculations. After consideration, it was decided that a Resin Modified Pavement behaved most like a continuously reinforced concrete pavement and therefore CRCP deduct curves were used for the PCR calculations of the Resin Modified Pavement sections.

Performance Graded 82-22 Asphalt

Long term data for the PG 82-22 test section can be found in Table H17 of Appendix H.

Skid resistance values for the PG 82-22 test section were adequate for the first few years of the study, but deteriorated by the fourth year (2005). At 28.1 and 28.5 for the inside and outside lane respectively, the values are well below the recommended value of 35.

These values are of greater concern due to the test section being located at an intersection where frequent braking occurs.

Rut values for the PG 82-22 performed much the same as the skid resistance over time. Initially the values were good, however in year four (2005), the higher trafficked outside lane showed an average rut value of 0.25 inches. It should be noted that those are average rut measurements over the entire section. Visual observations showed that the ruts were minimal at the beginning of the section and significantly worse closer to the intersection.

The PG 82-22 mix provided a smooth surface as noted in the IRI values. This smooth surface combined with few distresses allowed for a satisfactory PCR value throughout the duration of the project.

Chapter 7 – Conclusions

Using construction, performance, and cost data from these test sections; a head to head comparison of each paving method can be made in order to assist the Mississippi Department of Transportation in developing a paving strategy for highly trafficked intersections. For the comparison, each paving method will be ranked in several categories. The best paving option for each category will be given a value of 1, the next best will be given a 2, and the least desirable option will be given a 3. Once all categories are ranked, the pavement options will be totaled with the lowest total being ranked the best option. These comparisons and results can be seen below in Table 1.

Table 1- Comparison of paving methods

Category	Ultra-Thin Whitetopping	Resin Modified Pavement	PG 82-22
Ease of Construction	2	3	1
Skid Resistance	1	3	2
Rutting	2	1	3
IRI	3	2	1
PCR	3	2	1
Cost	2	3	1
Total	**13**	**14**	**9**

The comparison above shows the PG 82-22 to be the best option. That result is supported by the information gathered throughout this study.

One issue affecting the PG 82-22 was rutting near the end of the study. This is an issue with all asphalt pavements; however improvements continue to be made in Superpave mix designs to alleviate rutting. Also, the PG 82-22 section was constructed at about one third of the cost of the other test sections, meaning the Ultra-Thin Whitetopping and the Resin Modified test sections would need to have three times the service life to account for the difference in cost. That was certainly not the case with the Ultra-Thin Whitetopping as it was removed and replaced in 2007 due to excessive failures.

The Resin Modified pavement sections held up throughout the study, however the complexity and attention to detail in construction needed for this pavement to perform successfully makes it a less appealing option. This was evident because even in the controlled environment provided by this study, construction problems occurred with the capping of grout before it fully penetrated the mat.

After reviewing all available data for this study, the cost, performance, and ease of construction makes the PG 82-22 the most reasonable choice for paving of MDOT's highly trafficked intersections.

APPENDIX A
TRAFFIC DATA

Figure A1 – Design Traffic Data

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Inter-Departmental Memorandum

TO: Research Division
Randy Battey

DATE: September 19, 2000

FROM: Planning Division
Nelson Sellers

SUBJECT OR PROJECT NO: Design Traffic Data

FMS NO:

INFORMATION COPY TO:
District 1
Mr. Billy Grantham - Materials
Construction Division
Federal Highway Administration
Research Division

COUNTY: Alcorn

In accordance with your request of August 23, 2000, the estimate of design traffic data for the desired location is as follows:

Termini: US 72 - From Harper to Cass					
Year	**Projected ADT**	**Average 18 KIP Axle Loads Per 1,000 Vehicles**		**Cumulative Thousands Of 18K ESALS From Base Year**	
		Rigid	**Flex**	**Rigid**	**Flex**
2000	22,600	985	635	0	0
2010	30,400	985	635	4,800	3,096
2020	40,900	985	635	11,257	7,257

Year 2020 Design Data		
DHV	**D % Of DHV**	**Trucks % Of ADT**
4,100	50	10

Cumulative total ESALS represents one direction only.

Figure A2 – Yearly Itemized Projected Traffic Data

18 Kip ESAL Analysis

Project Route & Termini
US 72 - From Harper to Cass

Section 1 of 1
From Harper to Cass

Project Number **FMS Number** **County**
Alcorn

Year	ADT	FLEXIBLE PAVEMENT ESAL (1000s)	FLEXIBLE PAVEMENT ACCUM (1000s)	FLEXIBLE PAVEMENT ESAL FACTOR	RIGID PAVEMENT ESAL (1000s)	RIGID PAVEMENT ACCUM (1000s)	RIGID PAVEMENT ESAL FACTOR	DIR SPLIT	% TRUCKS
2000	22,600	262	0	635	406	0	985	.50	.10
2001	23,300	270	270	635	419	419	985	.50	.10
2002	24,000	278	548	635	431	850	985	.50	.10
2003	24,700	286	834	635	444	1294	985	.50	.10
2004	25,500	296	1130	635	458	1752	985	.50	.10
2005	26,200	304	1434	635	471	2223	985	.50	.10
2006	27,000	313	1747	635	485	2708	985	.50	.10
2007	27,800	322	2069	635	500	3208	985	.50	.10
2008	28,700	333	2402	635	516	3724	985	.50	.10
2009	29,500	342	2744	635	530	4254	985	.50	.10
2010	30,400	352	3096	635	546	4800	985	.50	.10
2011	31,300	363	3459	635	563	5363	985	.50	.10
2012	32,300	374	3833	635	581	5944	985	.50	.10
2013	33,200	385	4218	635	597	6541	985	.50	.10
2014	34,200	396	4614	635	615	7156	985	.50	.10
2015	35,300	409	5023	635	635	7791	985	.50	.10
2016	36,300	421	5444	635	653	8444	985	.50	.10
2017	37,400	433	5877	635	672	9116	985	.50	.10
2018	38,500	446	6323	635	692	9808	985	.50	.10
2019	39,700	460	6783	635	714	10522	985	.50	.10
2020	40,900	474	7257	635	735	11257	985	.50	.10

Figure A3 – Year 2000 Projected 24 hour turning movements for US 72 @ Cass Street

MDOT

Planning Division
09/19/2000

Intersection Turning Movements

Intersection of: Cass Street and US 72
City: Corinth
County: Alcorn
Date: 2000
Estimated 24 Hour Count

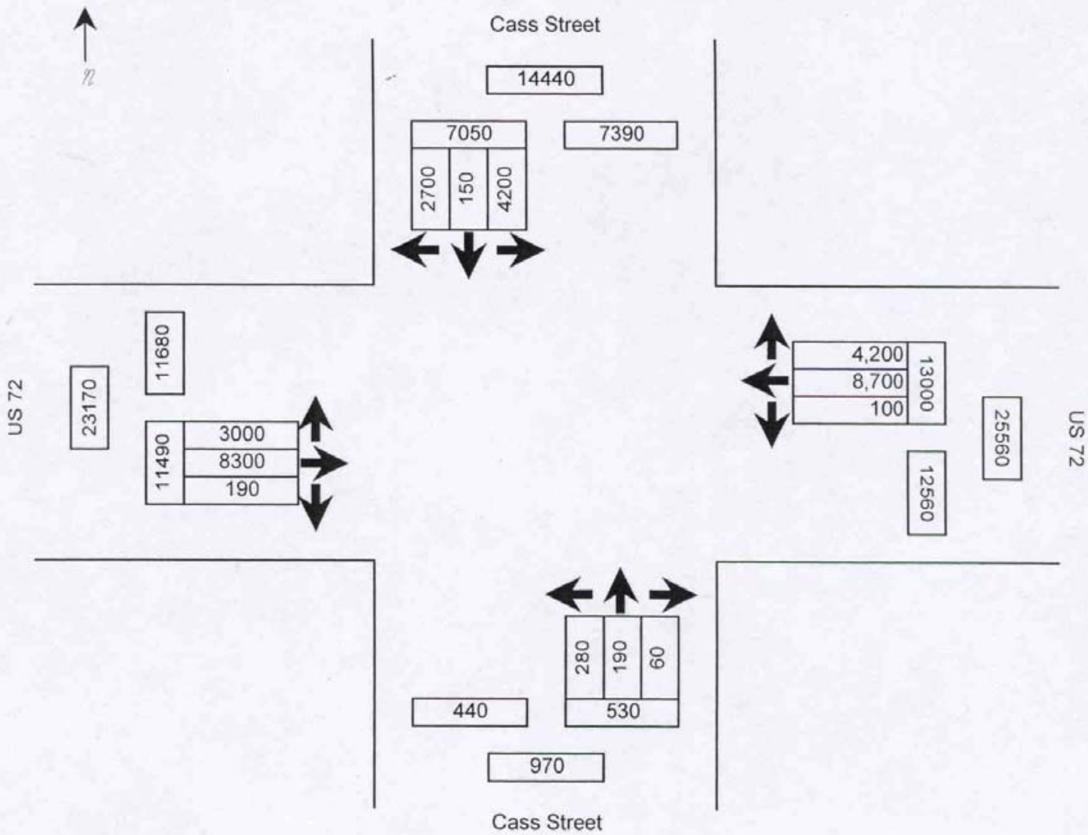


Figure A4 – Year 2020 Projected 24 hour turning movements for US 72 @ Cass Street

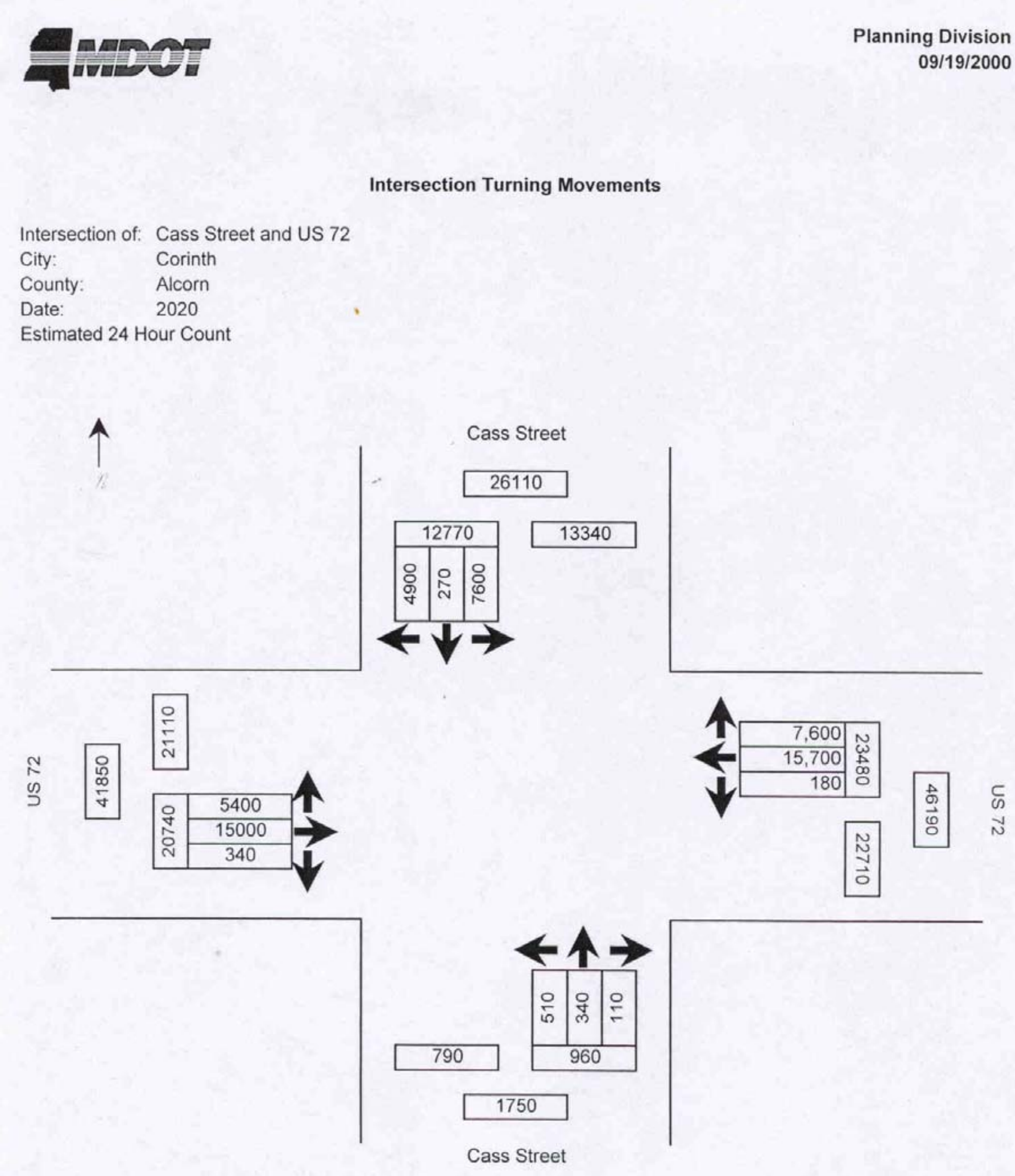


Figure A5 – Year 2000 Projected 24 hour turning movements for US 72 @ Hinton Street

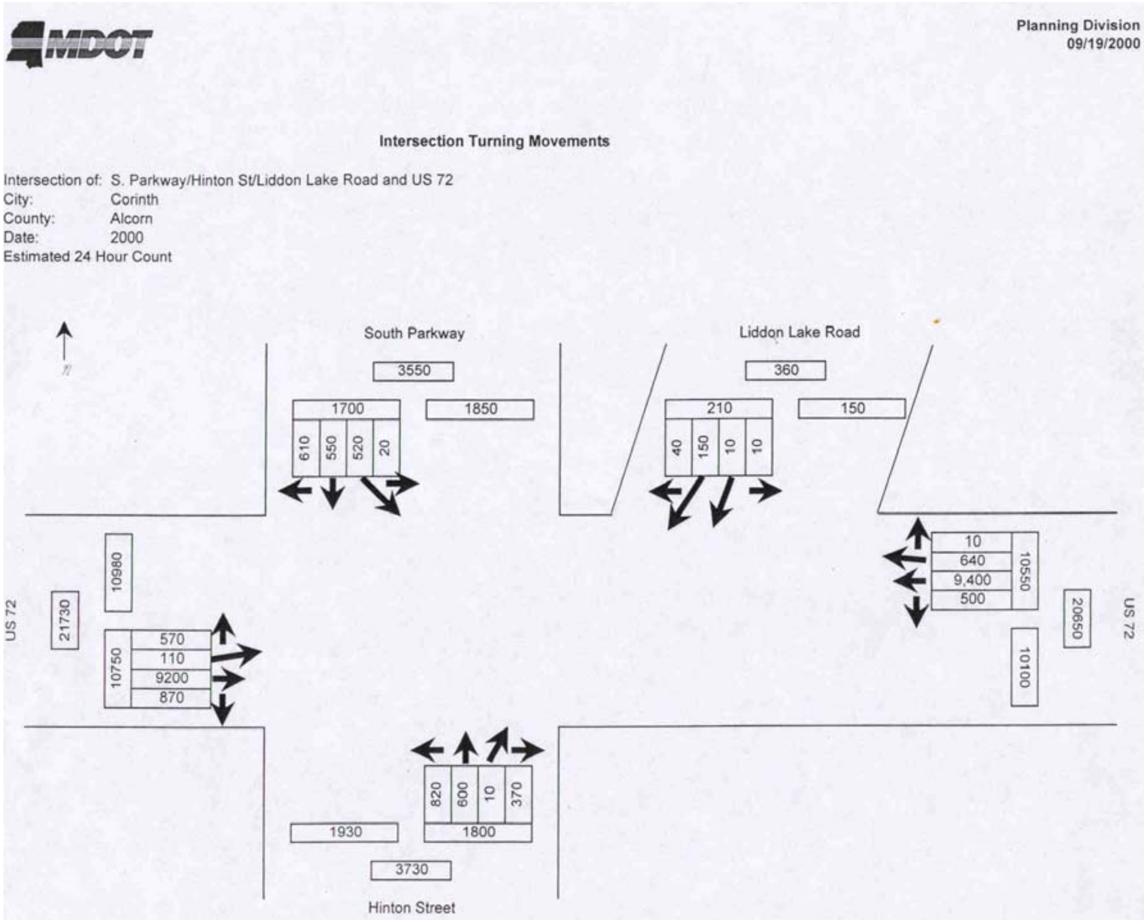
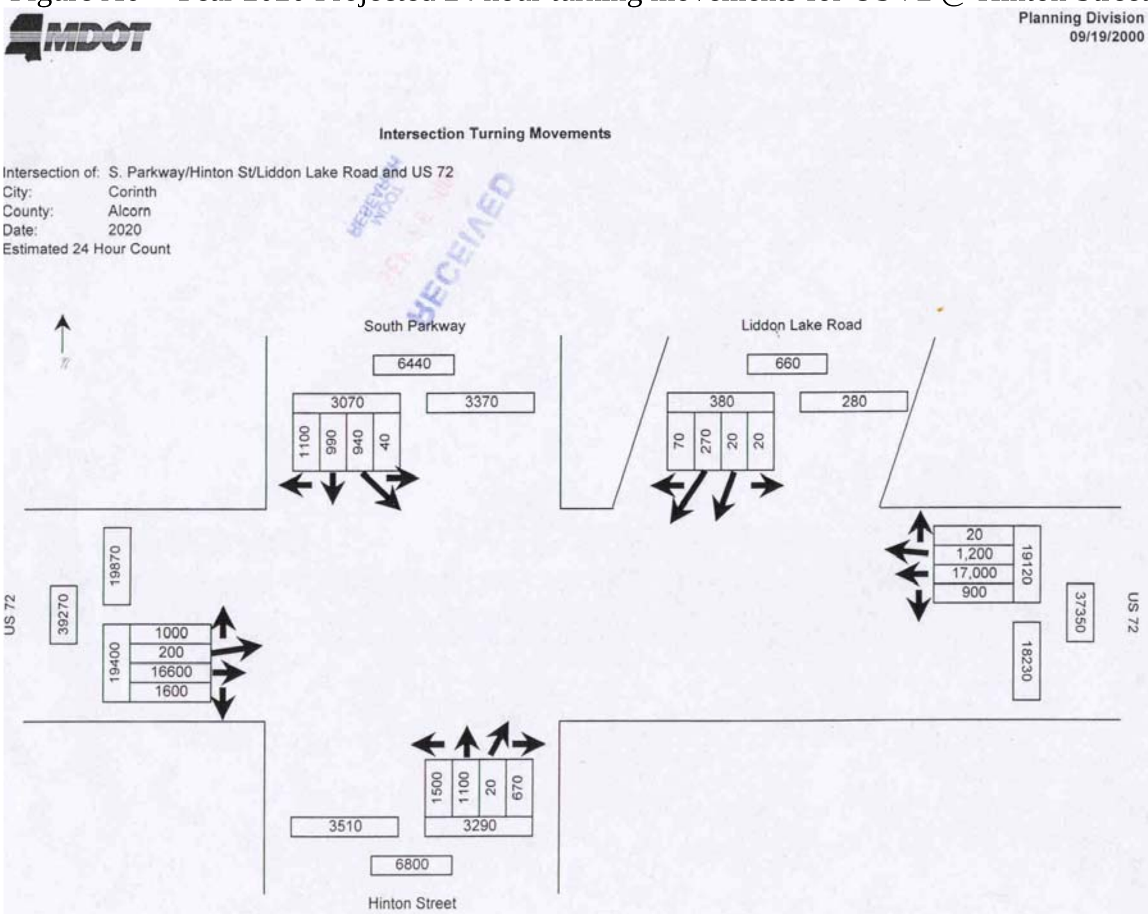


Figure A6 – Year 2020 Projected 24 hour turning movements for US 72 @ Hinton Street



APPENDIX B
PRECONSTRUCTION DATA

Table B1 – Preconstruction Rut Data for US 72 Eastbound

US72 Eastbound @ Cass St.				US72 Eastbound @ Hinton St.		
(Future Resin Modified Location)				(Future Resin Modified Location)		
	Ruts (1/16 th inch)				Ruts (1/16 th inch)	
Station	LWP	RWP		Station	LWP	RWP
0+00	4	3		0+00	12	12
0+25	6	5		0+20	10	13
0+50	8	6		0+45	15	15
0+75	7	6		0+70	17	18
1+00	7	7		0+95	23	16
1+25	11	10		1+20	21	18
1+50	16	18		1+45	21	20
1+75	11	12		1+70	23	26
2+00	15	18		1+95	21	26
2+25	18	18		2+20	19	29
2+50	20	24		2+45	18	16
2+75	18	24		2+70	22	24
3+00	16	23		2+75	20	23
3+25	17	24		2+80	17	18
3+50	17	25		2+85	22	25
3+75	17	24		2+90	22	25
3+80	20	24		2+95	18	13
3+85	18	26		3+00	19	16
3+90	17	26		3+05	21	16
3+95	18	24		3+10	15	13
4+00	17	16		3+15	15	12
4+05	19	19		3+20	13	10
4+10	18	14		3+25	16	13
4+15	18	19		3+30	15	15
4+20	16	19		3+35	17	12
4+25	17	18		4+35	10	8
4+30	16	18				
4+35	15	17				
4+65	14	17				

Table B2 – Preconstruction Rut Data for US 72 Westbound

US72 Westbound @ Cass St.				US72 Westbound @ Hinton St.		
(Future PG 82-22 HMA Location)				(Future Ultra-Thin Whitetopping Location)		
	Ruts (1/16 th inch)				Ruts (1/16 th inch)	
Station	LWP	RWP		Station	LWP	RWP
0+00	12	10		0+00	15	26
0+25	14	12		0+15	21	25
0+50	15	13		0+40	20	34
0+75	16	15		0+65	18	30
1+00	13	12		0+90	18	18
1+25	17	11		1+15	22	32
1+50	21	15		1+40	22	28
1+75	26	20		1+65	28	40
2+00	19	14		1+90	26	40
2+25	28	17		2+15	26	40
2+50	30	20		2+40	28	40
2+75	24	15		2+45	28	40
3+00	28	18		2+50	28	35
3+25	30	16		2+55	26	40
3+50	32	24		2+60	28	34
3+55	32	28		2+65	24	28
3+60	24	22		2+70	22	35
3+65	25	23		2+75	24	32
3+70	21	24		2+80	19	21
3+75	19	20		2+85	21	32
3+80	28	20		2+90	24	35
3+85	20	12		3+15	16	18
3+90	16	16		3+40	16	24
3+95	18	14		3+65	13	12
4+00	16	10		3+90	11	14
4+45	13	7		4+74	9	16

Table B3 - Preconstruction Friction Data Taken in Outside Lane at each location on March 30, 2001

Location	Skid No	Avg Speed (mph)	Temp (F)	Time (CST)
US 72E @ Cass St. (Future RMP)	31.5	41.3	53	5:33 AM
US 72E @ Cass St. (Future RMP)	35.5	39.2	53	5:33 AM
US 72E @ Cass St. (Future RMP)	32.5	43.2	55	5:42 AM
US 72E @ Cass St. (Future RMP)	35.8	41.1	55	5:42 AM
	33.8			
US 72E @ Hinton St. (Future RMP)	33.7	38.2	60	5:36 AM
US 72E @ Hinton St. (Future RMP)	34.8	41.7	60	5:36 AM
US 72E @ Hinton St. (Future RMP)	32.0	39.6	59	5:44 AM
US 72E @ Hinton St. (Future RMP)	35	43.7	59	5:44 AM
	33.9			
US 72W @ Hinton St. (Future UTW)	32.0	40.2	59	5:38 AM
US 72W @ Hinton St. (Future UTW)	36.9	38.3	59	5:38 AM
US 72W @ Hinton St. (Future UTW)	32.0	40.8	57	5:45 AM
US 72W @ Hinton St. (Future UTW)	37.2	38.7	57	5:45 AM
	34.5			
US 72W @ Cass St. (Future 82-22 HMA)	32.2	40.8	60	5:40 AM
US 72W @ Cass St. (Future 82-22 HMA)	33.5	41.1	60	5:40 AM
US 72W @ Cass St. (Future 82-22 HMA)	33.0	40.1	55	5:47 AM
US 72W @ Cass St. (Future 82-22 HMA)	33.9	42.6	53	5:47 AM
	33.2			

Table B4 – Preconstruction Smoothness Data

Location	IRI (mm/m)	PI (0.2" Blanking Band) (in/mi)	PI (Zero Blanking Band) (in/mi)
US 72E @ Cass St. (Future RMP)	3.00	31.27	71.88
US 72E @ Hinton St. (Future RMP)	n/a	n/a	n/a
US 72W @ Hinton St. (Future UTW)	9.22	166.87	215.40
US 72W @ Cass St. (Future 82-22 HMA)	3.99	56.20	93.79

APPENDIX C
ULTRA-THIN WHITETOPPING DATA

Figure C1 – Ultra-Thin Whitetopping Concrete Mix Design

B & B CONCRETE CO., INC.

P. O. BOX 407
ADMIN. PHONE 662-842-6312

130 N. INDUSTRIAL ROAD
DISPATCH 662-842-6313

TUPELO, MS 38802-0407
FAX 662-842-6327

CONCRETE MIX DESIGN

5010LS8.00YS57F [00]   5000 PSI   03/23/01

CONTRACTOR: B & B CONCRETE CO., INC. - CORINTH DIVISION
PROJECT: MDOT PROJECT: 61-0137-02-143-00 RESIN MODIFIED PAVEMENT
SOURCE OF CONCRETE: B & B CONCRETE CO., INC. - CORINTH PLANT
MIX DESCRIPTION: 5000 PSI AIR-ENTRAINED CONCRETE

WEIGHTS PER CUBIC YARD (SATURATED, SURFACE-DRY)

			YIELD, CU FT
TYPE I CEMENT (8.00 SK INC. FA), LB	677		3.44
TYPE C FLY ASH (10%), LB	75		0.48
CONCRETE SAND, LB	1205		7.34
#57 LIMESTONE, LB	1723		10.91
WATER, LB (GAL-US)	225	(27.0)	3.61
AIR TOTAL, %	4.5%	+/- 1.5%	1.22
		TOTAL	27.00

GRACE WRDA-35 WATER REDUCER, OZ-US	15.0
GRACE DARAVAIR AIR-ENTRAINING ADMIXTURE, OZ-US	2.0
GRACE WRDA-19 SUPERPLASTICIZER, OZ-US	90.2
FIBRILLATED POLYPROPYLENE FIBERS (3 LB/CY), LB	3.0

WATER/CEMENT RATIO, LBS/LB	0.30	
SLUMP, IN	3.00	+/- 1.00
CONCRETE UNIT WEIGHT, PCF	144.6	

NOTE: MOISTURE CORRECTIONS FOR FREE MOISTURE IN AGGREGATE TO BE DAILY. AVERAGE CORRECTIONS: 1% ON COARSE AGGREGATE AND 5% ON FINE AGGREGATE. AIR-ENTRAINING AGENT DOSAGE TO BE ADJUSTED AS REQUIRED. SLUMP MAY BE INCREASED UP TO 8" WITH SUPERPLASTICIZER.

PREPARED BY:

Bill Waters

BILL WATERS, PE

Table C2 – UTW Properties for Inside Lane Construction (April 4, 2001)

Truck No	Cubic Yds	Sta. Begin	Sta. End	Slump (in)	Air Content (%)
1	8	0+00	0+45	4 1/2	3.1
2	5	0+45	0+75	5	7.6
3	6	0+75	1+10	4	6
4	6	1+10	1+50	n/a	n/a
5	6	1+50	2+00	4	5.3
6	6	2+00	2+50	n/a	n/a
7	6	2+50	3+00	n/a	n/a
8	6	3+00	3+50	5	5.5
9	6	3+50	4+00	n/a	n/a
10	6	4+00	4+45	n/a	n/a
11	6	4+45	4+74	n/a	n/a

Table C3 – Compressive Strength Properties of Inside Lane Constructed UTW

Truck No	24 hour break (psi)	48 hour break (psi)	7 day break (psi)	28 day break (psi)
1	2933	4357	5489	6124
1	2808	4198	5599	6650
6	2727	4379	5666	6632
6	2622	4665	5673	6501
Average	2773	4400	5607	6477

Table C3 – UTW Properties for Outside Lane Construction (April 10, 2001)

Truck No	Cubic Yds	Sta. Begin	Sta. End	Slump (in)	Air Content (%)
1	6	0+00	0+30	6	5.5
2	6	0+30	0+75	5	4.3
3	6	0+75	1+15	n/a	n/a
4	6	1+15	1+60	4 1/2	4.5
5	6	1+60	2+15	5 1/2	4.2
6	6	2+15	2+60	n/a	n/a
7	6	2+60	3+25	5	5.9
8	6	3+25	3+65	n/a	n/a
9	6	3+65	4+25	n/a	n/a
10	6	4+25	4+55	5 1/2	4.9
11	3	4+55	4+74	n/a	n/a

Table C4 – Compressive Strength Properties of Outside Lane Constructed UTW

Truck No	**24 hour break (psi)**	**48 hour break (psi)**	**7 day break (psi)**	**28 day break (psi)**
1	3181	4050	5510	5590
1	3243	4347	4654	5279
5	3393	5132	5832	6735
5	3944	4944	6048	7175
Average	3440	4618	5511	6195

Table C5 – Thickness of Ultra-Thin Whitetopping Left Lane of US 72 @ Hinton Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets	→	Right	
Station	0'	3'	6'	9'	12'	Avg. Thick
0+00	0.51'	0.49'	0.52'	0.51'	0.51'	0.508'
0+09	0.48'	0.49'	0.56'	0.55'	0.53'	0.522'
0+18	0.28'	0.33'	0.33'	0.32'	0.30'	0.312'
0+25	0.26'	0.28'	0.31'	0.32'	0.32'	0.298'
0+50	0.27'	0.31'	0.31'	0.33'	0.33'	0.310'
0+75	0.24'	0.27'	0.30'	0.33'	0.34'	0.296'
1+00	0.22'	0.26'	0.29'	0.26'	0.25'	0.256'
1+25	0.26'	0.28'	0.30'	0.27'	0.25'	0.272'
1+50	0.25'	0.29'	0.31'	0.29'	0.28'	0.284'
1+75	0.23'	0.29'	0.29'	0.29'	0.29'	0.278'
2+00	0.25'	0.30'	0.33'	0.32'	0.32'	0.304'
2+25	0.26'	0.31'	0.32'	0.31'	0.32'	0.304'
2+50	0.24'	0.28'	0.30'	0.32'	0.31'	0.290'
2+75	0.29'	0.29'	0.32'	0.31'	0.30'	0.302'
3+00	0.26'	0.26'	0.28'	0.27'	0.27'	0.268'
3+25	0.27'	0.32'	0.31'	0.27'	0.27'	0.288'
3+50	0.26'	0.28'	0.29'	0.28'	0.29'	0.280'
3+75	0.27'	0.29'	0.30'	0.30'	0.31'	0.294'
4+00	0.26'	0.28'	0.28'	0.29'	0.30'	0.282'
4+25	0.26'	0.29'	0.30'	0.30'	0.31'	0.292'
4+50	0.27'	0.29'	0.31'	0.33'	0.33'	0.306'
4+56	0.31'	0.31'	0.35'	0.35'	0.36'	0.336'
4+65	0.49'	0.54'	0.55'	0.54'	0.56'	0.536'
4+74	0.49'	0.54'	0.54'	0.52'	0.51'	0.520'
		Total Concrete Used Left Lane =			63.9 cubic	yards

Table C6 – Thickness of Ultra-Thin Whitetopping in Right Lane of US 72 @ Hinton Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets		→ Right	
Station	0'	3'	6'	9'	12'	Avg. Thick
0+00	0.49'	0.52'	0.60'	0.50'	0.54'	0.530'
0+09	0.52'	0.55'	0.61'	0.57'	0.65'	0.580'
0+18	0.36'	0.40'	0.44'	0.43'	0.45'	0.416'
0+25	0.29'	0.32'	0.37'	0.35'	0.41'	0.348'
0+50	0.28'	0.30'	0.35'	0.37'	0.41'	0.342'
0+75	0.28'	0.31'	0.39'	0.37'	0.42'	0.354'
1+00	0.25'	0.26'	0.31'	0.30'	0.32'	0.288'
1+25	0.26'	0.30'	0.29'	0.26'	0.25'	0.272'
1+50	0.25'	0.26'	0.29'	0.24'	0.24'	0.256'
1+75	0.24'	0.27'	0.29'	0.25'	0.25'	0.260'
2+00	0.25'	0.26'	0.28'	0.25'	0.25'	0.258'
2+25	0.28'	0.28'	0.29'	0.27'	0.25'	0.274'
2+50	0.27'	0.28'	0.27'	0.29'	0.25'	0.272'
2+75	0.28'	0.28'	0.30'	0.28'	0.28'	0.284'
3+00	0.25'	0.27'	0.26'	0.24'	0.19'	0.242'
3+25	0.25'	0.25'	0.28'	0.26'	0.25'	0.258'
3+50	0.26'	0.26'	0.27'	0.23'	0.25'	0.254'
3+75	0.27'	0.28'	0.28'	0.31'	0.32'	0.292'
4+00	0.26'	0.26'	0.28'	0.25'	0.25'	0.260'
4+25	0.25'	0.27'	0.27'	0.25'	0.27'	0.262'
4+50	0.25'	0.30'	0.34'	0.28'	0.28'	0.290'
4+56	0.27'	0.26'	0.25'	0.28'	0.28'	0.268'
4+65	0.49'	0.34'	0.51'	0.42'	0.47'	0.446'
4+74	0.48'	0.52'	0.53'	0.48'	0.50'	0.502'
		Total Concrete Used In Right Lane =			62.7 cubic yards	

Table C7 – UTW Smoothness Data collected in the Outside Lane

Date Collected	IRI (mm/m)	PI (0.2" Blanking Band) (in/mi)	PI (Zero Blanking Band) (in/mi)
April 18, 2001	5.42*	100.03	148.28
July 6, 2001	4.75**	n/a	n/a
August 22, 2001	4.54**	n/a	n/a

Note: PI data was collected in the right wheelpath using a “California Type” Profilograph with a 2’ low pass Butterworth filter.
* - April 18 IRI was collected in the right wheelpath using MDOT’s ARRB Tranport Research Walking Profiler.
** - July 6 & August 22 IRI is the average IRI of both wheelpaths collected using MDOT’s High Speed “South Dakota Type” Profiler.

Table C8 – UTW Friction Data collected in the Outside Lane

Date Collected	Skid No	Avg Speed (mph)	Temp (F)	Time (CST)
April 19, 2001	38.2	37.5	41	4:02 AM
April 19, 2001	36.8	39.2	44	4:05 AM
April 19, 2001	36.7	40.2	44	4:08 AM
April 19, 2001	35.6	40.3	44	4:10 AM
	36.8			
May 1, 2001	31.8	39.3	66	3:19 AM
May 1, 2001	33.0	39.3	66	3:25 AM
May 1, 2001	34.7	39.3	66	3:45 AM
	33.2			
July 6, 2001	32.6	38.1	n/a	3:57 AM
July 6, 2001	33.2	38.3	73	4:02 AM
July 6, 2001	34.0	38.3	73	4:07 AM
	33.3			
August 22, 2001	40.8	39.7	n/a	11:00 PM
August 22, 2001	35.3	40.7	86	11:05 PM
August 22, 2001	37.3	40.3	84	11:09 PM
	37.8			
December 4, 2001	44.2	39.2	59	12:08 AM
December 4, 2001	43.5	40.5	60	12:13 AM
December 4, 2001	44.8	39.1	60	12:19 AM
	44.2			

Table C9 – UTW Crack Mapping in the Outside Lane performed December 19, 2001 (approximately eight months after construction)

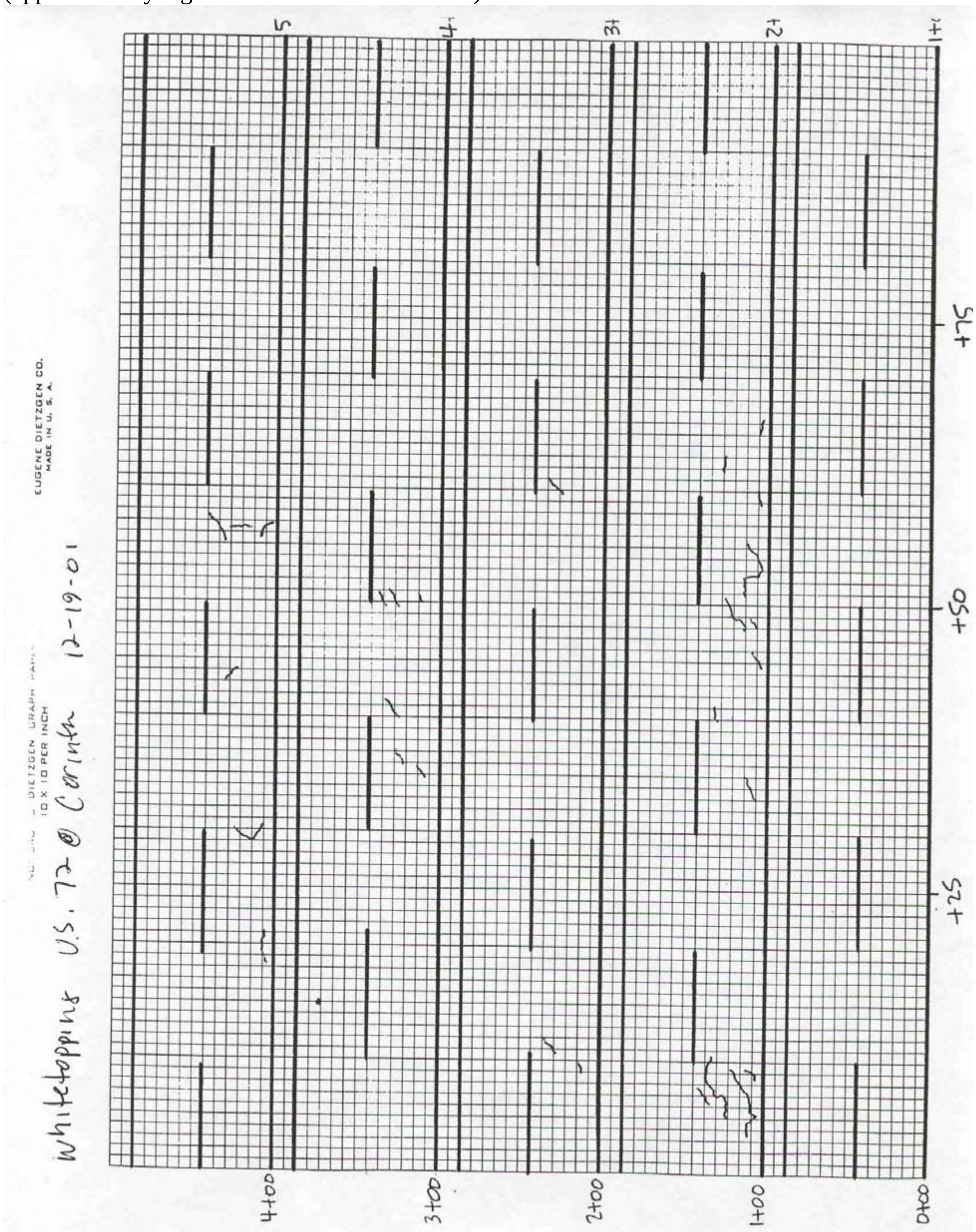


Table C10- Long Term Data for Ultra-Thin Whitetopping

Hinton Street Ultra Thin Whitetopping								
Year	Inside Lane				Outside Lane			
	SN	Rut Avg. (in)	IRI Avg. (mm/m)	PCR	SN	Rut Avg. (in)	IRI Avg. (mm/m)	PCR
2002	45	-	-	-	43.6	-	-	-
2003	47.3	0	4.24	65.9	45.2	0	5.62	54.6
2004	-	0	4.29	65.5	-	0	5.46	55.6
2005	42.4	0	4.43	64.4	40.5	0	6.23	48.8
2006	-	0	4.5	63.7	-	0	6.31	46.7

Figure C11- UTW Failure.

Figure C12- Failure of Original and Replaced Panels.

APPENDIX D
MDOT UTW STANDARD SPECIFICATIONS

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

DATE: **01/06/01**

SUBJECT: **Thin Portland Cement Concrete Pavement (Whitetopping)**

PROJECT: **Resin Modified Pavement Demonstration Project ~ Corinth, MS**

Description. This work shall consist of the construction of portland cement concrete pavement in accordance with Section 501 of the 1990 Edition of the Mississippi Standard Specifications for Road and Bridge Construction, except as modified herein.

Materials. Materials shall meet the requirements of the Division 700 and the following subsections:

Material	Standard Specification Reference
Portland Cement	701.01 and 701.02
Admixtures	713.02
Fly Ash	714.05
Water	714.01
Fine Aggregate	703.01 and 703.02
Coarse Aggregate	703.01 and 703.03
Curing Materials	713.01

Fibers used shall be Fibrillated Polypropylene fibers. Fibrillated Polypropylene fibers shall be added at a rate of 3.0 lbs/yd^3.

Concrete slump shall not exceed 4 inches. An approved type F or G admixture shall be used. Admixtures shall be incorporated into the concrete in accordance with the manufacturer's recommendations, subject to approval by the Engineer.

Fly Ash may be substituted for cement at a maximum rate of 20% by weight and shall be included with the cement when determining the water/cement ratio, i.e. the water/cementitious material ratio. Ground Granulated Blast-Furnace Slag (GGBFS) may be substituted for cement at a maximum rate of 50% by weight and shall be included with the cement when determining the water/cement ratio, i.e. the water/cementitious material ratio. Any GGBFS incorporated into the cement shall conform to the requirements of Special Provision 907-714.

Proportioning. The Ready-Mix Concrete Producer shall furnish the mix design. Concrete used in this application shall meet the following compressive strength requirement. The mix shall be designed to achieve a minimum compressive strength of 2500 psi within 24 hours (field cured) after placement. The mix shall develop a minimum compressive strength of 3500 psi 14 days (standard cured) after placement.

Verification of Mix Design. The Ready-Mix Concrete Producer shall furnish the Engineer with the required documentation indicating proper verification of the mix design. Documentation presented must indicate that the mix achieves the desired 2500 psi in 24 hours. As a minimum, the Ready-Mix Concrete Producer shall submit to the Engineer the aggregate and concrete test results performed during the verification process by technicians certified by MDOT. Minimum tests for aggregates are specific gravity, moisture, and grading. The minimum tests for concrete are slump, air content, temperature, unit weight, yield, and compressive strength. For verification of the mix design used in this application the following requirements in Table 1 shall be met.

Table 1

Criteria	Requirements
Slump	4”
Air Content	3% - 6%
Yield	± 3%
Compressive Strength	2500 psi in 24 hours(field curing); 3500 psi in 14 days (standard curing)

<u>Concrete Testing</u>. The ready-mix concrete producer shall be responsible for testing aggregates, moisture, and gradation at the batch plant. MDOT will be responsible for field testing of the concrete. A minimum of six test cylinders shall be made for each continuous placement or every 100 cubic yards of concrete placed, whichever is less. Compressive strength testing shall be performed to accommodate traffic movements and to ensure proper strength of the concrete pavement. A compressive test is the average of two cylinders. Test cylinders cast to determine when the pavement can be opened to traffic shall be field cured next to the pavement until time of test. Test cylinders cast for acceptance of the concrete, 3500 psi in 14 days, shall be standard cured as per AASHTO Designation: T 23.

Slump and air content tests shall be performed on the first load and then once every 50 cubic yards. Yield shall be verified for each mix design during the first placement and every 400 cubic yards of concrete placed on the project, with a minimum of one yield test per day. Concrete temperature shall be taken with each slump/air test, and each time cylinders are made. Due to the high early strength requirements, cooling precautions shall be implemented to prevent concrete temperatures from exceeding 100°F. A maximum concrete temperature of 95°F is required without cooling precautions implemented. No concrete shall be placed with temperatures exceeding 100°F.

Acceptance of the concrete will be based on test results meeting the requirements of Table 1 and other requirements herein specified. All concrete testing shall be performed by MDOT Certified Technicians.

Construction Requirements.

General. Concrete shall be placed and spread in an approved manner so as to distribute the concrete uniformly without segregation. The base shall be dampened just prior to placement of the concrete. Additional placement requirements are provided in Subsection 501.03.13.

Final finishing of the concrete pavement surface shall be in accordance with Subsection 501.03.17 of the Standard Specifications. The surface of the concrete pavement shall be transverse tined in accordance with Subsection 501.03.18.4 of the Standard Specifications with two exceptions: the uniform parallel grooves perpendicular to the centerline of the pavement may be up to 1 inch on centers, and the drag finish is not required.

Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to support the mass of the saw. The concrete pavement joints shall be cut utilizing an early-cut saw or Engineer-approved equal. The joints shall be spaced in accordance with the plans. The depth of the joints shall be t/6 inches (t is the pavement thickness) and the maximum width of the joint shall be 1/8th inch provided sawing is performed within two hours after final finishing. If sawing is performed more than 2 hours after final finishing, the depth shall be t/4 inches and the maximum width of the joint shall be 1/8th inch. The minimum depth of any joint shall be 1.5 inches. The joints are not to be sealed but shall be cleaned of all deleterious material after sawing. Sawing shall be accomplished by using a minimum of two saws in operation. The Joint Sawing Contractor must have one additional saw available on site within one hour in case of mechanical failure or failure to stay on schedule. Pavement thickness and other details shall be as specified in the project plans.

Curing. Curing compound shall be applied per Standard Specification Subsections 501.03.20 and 501.03.20.1 at a rate of one gallon to not more than 100 square feet. If the time period between floating and texturing of the concrete exceeds 30 minutes the concrete shall be kept damp by fogging with water or by use of an evaporative retarder to prevent rapid evaporation of the surface.

Opening to Traffic. The Engineer will determine when the pavement will be opened to traffic. No traffic will be allowed on the completed pavement until the concrete has attained a compressive strength of 2500 psi (based on field cured cylinders). Concrete that fails to develop a compressive strength of 3500 psi (based on standard cured cylinders) within 14 days shall be removed and replaced or accepted at a reduced price.

Basis of Payment.

General. The accepted quantities of concrete pavement placement, finishing and curing, concrete volume, and saw cuts will be paid for at the contract unit prices which shall be full compensation for completing the work, furnishing all labor, equipment, tools, and materials for the items identified in the plans and specifications.

Payment will be made under:

907-501-X:	Concrete Pavement Placement, Finishing and Curing (Tine Finish)	- lump sum
907-501-X1:	Fiber Reinforced Concrete	- lump sum
907-503-C	Saw Cut in Asphalt Pavement	- lump sum
907-503-C	Saw Cut in Concrete Pavement	- lump sum

APPENDIX E
UTW CYLINDER TEST REPORTS

Figure E1 – UTW 24 hour test report (Inside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7441 Accept Code ____ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ____
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1-10am Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/5/01
Remarks 24 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7441				1	82940	2933	20.23
AVG. of Breaks					82940	2933	20.23

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure: ____

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E2 – UTW 24 hour test report (Inside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7442 Accept Code ____ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ____
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1-10am Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/5/01
Remarks 24 hour break - 10 am
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7442				1	79390	2808	19.36
AVG. of Breaks					79390	2808	19.36

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure: ____

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E3 – 24 hour test report (Inside Lane/Truck 6)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7443 Accept Code Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/5/01
Remarks 24 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7443				1	77090	2727	18.80
AVG. of Breaks					77090	2727	18.80

	Section Area	Core Height		Beam	
Cylinder (in²)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E4 – UTW 24 hour test report (Inside Lane/Truck 6)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7444 Accept Code Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 2-1 pm Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/5/01
Remarks 24 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7444				1	74130	2622	18.08
AVG. of Breaks					74130	2622	18.08

	Section Area	Core Height		Beam	
Cylinder (in²)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E5 – UTW 48 hour test report (Inside Lane/Truck 1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7445 Accept Code Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1 - 10am Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/6/01
Remarks 48 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7445				2	123200	4357	30.04
AVG. of Breaks					123200	4357	30.04

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: Irregular - Shear\\\ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E6 – UTW 48 hour test report (Inside Lane/Truck 1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7446 Accept Code Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1-48 hr Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/6/01
Remarks 48 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7446				2	118700	4198	28.95
AVG. of Breaks					118700	4198	28.95

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: \\ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E7 – UTW 7 day test report (Inside Lane/Truck 1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7450 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1-14 day Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/11/01
Remarks 7 day break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7450				7	155200	5489	37.85
AVG. of Breaks					155200	5489	37.85

Section Area		Core Height		Beam		
Cylinder (in²)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: Irregular - Shear\ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E8 – UTW 7 day test report (Inside Lane/Truck 1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7451 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 2-14 day Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/11/01
Remarks 7 day break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7451				7	158300	5599	38.60
AVG. of Breaks					158300	5599	38.60

Section Area		Core Height		Beam		
Cylinder (in²)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: Irregular - Shear\ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E9 – UTW 7 day test report (Inside Lane/Truck 6)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7449 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 1-14day Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/11/01
Remarks 7 day
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7449				7	160200	5666	39.07
AVG. of Breaks					160200	5666	39.07

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
		H/D	Sec. Area		
		Factor			

T-22
Pad Cap
T-231

Initialed NM

Fracture: Irregular - Shear\ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E10 – UTW 7 day test report (Inside Lane/Truck 6)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7452 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 2-14 day Class
Reported To Johnnie Bennet Date Cast 4/4/01 Date Tested 4/11/01
Remarks 7 day break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7452				7	160400	5673	39.11
AVG. of Breaks					160400	5673	39.11

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
		H/D	Sec. Area		
		Factor			

T-22
Pad Cap
T-231

Initialed NM

Fracture: Irregular - Shear\ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E11 –UTW 28 day test report (Inside Lane/Truck 1)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750042 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 1 Date: 04/04/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/02/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 7 BREAK 05/02/2001

Date Cast 04/04/2001 Time Cast ______ Age Days 28
Station No ______ Type Cure ______

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
173,138.0	6124.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ____
H/D Ratio ____
Corr Factor ____

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E12 – UTW 28 day test report (Inside Lane/Truck 1)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750041 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 1 Date: 04/04/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/02/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 6 BREAK 05/02/2001

Date Cast 04/04/2001 Time Cast ______ Age Days 28
Station No ______ Type Cure ______

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
188,028.0	6650.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ______
H/D Ratio ______
Corr Factor ______

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E13 – UTW 28 day test report (Inside Lane/Truck 6)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg — CYLINDER TEST REPORT — MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750039 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 2 Date: 04/04/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/02/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 4 BREAK 05/02/2001

Date Cast 04/04/2001 Time Cast ____ Age Days 28
Station No ____ Type Cure ____

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
187,516.0	6632.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ____
H/D Ratio ____
Corr Factor ____

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231).
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02
on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E14 – UTW 28 day test report (Inside Lane/Truck 6)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750036 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 2 Date: 04/04/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/02/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 1 BREAK 05/02/2001

Date Cast 04/04/2001 Time Cast ______ Age Days 28
Station No ________________ Type Cure ________________

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
183,801.0	6501.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) _____
H/D Ratio _____
Corr Factor _____

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02
on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E15 – UTW 24 hour test report (Outside Lane/Truck 1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7458 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number	75-9999-99-137-10	County	Alcorn	Quantity Repr.	
Received From	Johnnie Bennet	Producer	1-24 B & B Concrete Corinth		
Identification	0.375	Class			
Reported To	Johnnie Bennet	Date Cast	4/10/01	Date Tested	4/11/01
Remarks	24 hour break				
Units		QMP (Yes/No)?			

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7458				1	89930	3181	21.93
AVG. of Breaks					89930	3181	21.93

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E16 – UTW 24 hour test report (Outside Lane/Truck1)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7459 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number	75-9999-99-137-10	County	Alcorn	Quantity Repr.	
Received From	Johnnie Bennet	Producer	1-24 B & B Concrete Corinth		
Identification	9am	Class			
Reported To	Johnnie Bennet	Date Cast	4/10/01	Date Tested	4/11/01
Remarks	24 hour break				
Units		QMP (Yes/No)?			

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7459				1	91700	3243	22.36
AVG. of Breaks					91700	3243	22.36

	Section Area	Core Height		Beam	
Cylinder (in^2)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
T-22		H/D	Sec. Area		
Pad Cap		Factor			
T-231					

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E17 – UTW 24 hour test report (Outside Lane/Truck 5)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7461 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 0.4583 Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/11/01
Remarks 11a.m. 24 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7461				1	95920	3393	23.39
AVG. of Breaks					95920	3393	23.39

	Section Area	Core Height		Beam	No. 1	No. 2
Cylinder (in^2)	28.274	Setting				
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E18 – UTW 24 hour test report (Outside Lane/Truck 5)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7460 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 11am Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/11/01
Remarks 11 am 24 hour break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7460				1	111500	3944	27.19
AVG. of Breaks					111500	3944	27.19

	Section Area	Core Height		Beam	No. 1	No. 2
Cylinder (in^2)	28.274	Setting				
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
		H/D		Sec. Area		
		Factor				

T-22
Pad Cap
T-231

Initialed NM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E19 – UTW 48 hour test report (Outside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7463 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 9am Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/12/01
Remarks 48 hour break 9 am
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7463				2	114500	4050	27.92
AVG. of Breaks					114500	4050	27.92

	Section Area	Core Height		Beam	No. 1	No. 2
Cylinder (in^2)	28.274	Setting				
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: \ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E20 – UTW 48 hour test report (Outside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7462 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 9am Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/12/01
Remarks 48 hour break - 9 am
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7462				2	122900	4347	29.97
AVG. of Breaks					122900	4347	29.97

	Section Area	Core Height		Beam	No. 1	No. 2
Cylinder (in^2)	28.274	Setting				
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: \ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E21 – UTW 48 hour test report (Outside Lane/Truck 5)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7464 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 11am Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/12/01
Remarks 48 hour 11am break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7464				2	145100	5132	35.38
AVG. of Breaks					145100	5132	35.38

	Section Area	Core Height		Beam	
Cylinder (in²)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
		H/D	Sec. Area		
		Factor			

T-22
Pad Cap
T-231

Initialed NJM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E22 – UTW 48 hour test report (Outside Lane/Truck 5)

Test Code	Fund	A/C No.	Func.	Obj.	Detail Code	Par.	Quantity
042			154	846	75-9999-99-137-10		1

MDOT Lab No. 7465 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr.
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 11am Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/12/01
Remarks 48 hour break - 11 am
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7465				2	139800	4944	34.09
AVG. of Breaks					139800	4944	34.09

	Section Area	Core Height		Beam	
Cylinder (in²)	28.274	Setting		No. 1	No. 2
Core		Reading	Depth		
Soil Cement		H	Width		
		D	Load		
		H/D	Sec. Area		
		Factor			

T-22
Pad Cap
T-231

Initialed NJM

Fracture: \ Failure:

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E23 – UTW 7 day test report (Outside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7466 Accept Code ____ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number	75-9999-99-137-10	County	Alcorn	Quantity Repr.	
Received From	Johnnie Bennet	Producer	1-24 B & B Concrete Corinth		
Identification	1	Class			
Reported To	Johnnie Bennet	Date Cast	4/10/01	Date Tested	4/17/01
Remarks	7 day break				
Units		QMP (Yes/No)?			

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7466				7	155800	5510	37.99
AVG. of Breaks					155800	5510	37.99

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: Irregular - Shear\ Failure: ____

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E24 – UTW 7 day test report (Outside Lane/Truck 1)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7467 Accept Code ____ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number	75-9999-99-137-10	County	Alcorn	Quantity Repr.	
Received From	Johnnie Bennet	Producer	1-24 B & B Concrete Corinth		
Identification	1	Class			
Reported To	Johnnie Bennet	Date Cast	4/10/01	Date Tested	4/17/01
Remarks	7 day break				
Units		QMP (Yes/No)?			

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7467				7	131600	4654	32.09
AVG. of Breaks					131600	4654	32.09

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: Irregular - Shear\ Failure: ____

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E25 – UTW 7 day test report (Outside Lane/Truck 5)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7468 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 2 Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/17/01
Remarks 7 day break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7468				7	164900	5832	40.21
AVG. of Breaks					164900	5832	40.21

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: Irregular - Shear\ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E26 – UTW 7 day test report (Outside Lane/Truck 5)

Test Code
042

Fund	A/C No.	Func.	Obj.	Detail Code	Par.
		154	846	75-9999-99-137-10	

Quantity
1

MDOT Lab No. 7469 Accept Code ______ Resp Code 11 - 30 Mat'l Concrete Cylinder

Project Number 75-9999-99-137-10 County Alcorn Quantity Repr. ______
Received From Johnnie Bennet Producer 1-24 B & B Concrete Corinth
Identification 2 Class
Reported To Johnnie Bennet Date Cast 4/10/01 Date Tested 4/17/01
Remarks 7 day break
Units QMP (Yes/No)?

Lab No.	Spec. No.	Sta. No.	Type Cure	Age Days	Total Load	PSI	mPA
7469				7	171000	6048	41.70
AVG. of Breaks					171000	6048	41.70

Section Area		Core Height		Beam		
Cylinder (in^2)	28.274	Setting			No. 1	No. 2
Core		Reading		Depth		
Soil Cement		H		Width		
		D		Load		
T-22		H/D		Sec. Area		
Pad Cap		Factor				
T-231						

Initialed NM

Fracture: Irregular - Shear\ Failure: ______

Distribution:
Materials Engineer (72-01)
Project Engineer (Johnnie Bennet)
District Lab File

Figure E27 – UTW 28 day test report (Outside Lane/Truck 1)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

(Cost Distribution: Fund, Accnt, Func, Obj, Detail Code, Par)

MDOT Lab Number: 9750040 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 2 Date: 04/10/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/08/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 5 BREAK 05/08/2001

Date Cast 04/10/2001 Time Cast ____ Age Days 28
Station No ____ Type Cure ____

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
158,044.0	5590.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ____
H/D Ratio ____
Corr Factor ____

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E28 – UTW 28 day test report (Outside Lane/Truck 1)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750037 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 1 Date: 04/10/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/08/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 2 BREAK 05/08/2001

Date Cast 04/10/2001 Time Cast ______ Age Days 28
Station No ______ Type Cure ______

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
149,254.0	5279.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ______
H/D Ratio ______
Corr Factor ______

TYPE BREAK: Cone _ Cone/Split _ Cone/Shear _ Shear X Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E29 – UTW 28 day test report (Outside Lane/Truck 5)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --

MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Cost Distribution

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9750038 Accept Code: 4 Responsibility Code: 00

Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.

Project: 103152-001000 7599999913710 County: STATEWIDE

Producer: NOT SUPPLIED Address: (?).

Manufacturer: NOT SUPPLIED Address: (?).

Sampled By: RANDY BATTEY Samp Id: 1 Date: 04/10/2001

Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001

Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/08/2001

Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH

Remarks: JOB CONTROL SAMPLE.

TEMP NO. 3 BREAK 05/08/2001

Date Cast 04/10/2001 Time Cast ______ Age Days 28

Station No ______ Type Cure ______

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
190,426.0	6735.00	3500.00	P

CYLINDER / CORE		CORE	
Diameter (in)	6.000	Height (in)	
Area (sq in)	28.27431	H/D Ratio	
		Corr Factor	

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

Figure E30 – UTW 28 day test report (Outside Lane/Truck 5)

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-084cg CYLINDER TEST REPORT MAY 8 2001

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	042			113	846	00 0000 00 262 1 0	1	1.0

(Cost Distribution: Fund through Par)

MDOT Lab Number: 9750043 Accept Code: 4 Responsibility Code: 00
Mtl: CONC CLASS PA (3500 PSI) (CYLINDER) Qty: 0.0 C.Y.
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: NOT SUPPLIED Address: (?).
Sampled By: RANDY BATTEY Samp Id: 2 Date: 04/10/2001
Submitted By: DISTRICT 1 LAB BARRY BOYD Date: 04/20/2001
Reported To: DISTRICT 1 LAB BARRY BOYD Date: 05/08/2001
Intended Use: WHITE TOPPING Test Desired: COMPRESSIVE STRENGTH
Remarks: JOB CONTROL SAMPLE.
TEMP NO. 8 BREAK 05/08/2001

Date Cast 04/10/2001 Time Cast ______ Age Days 28
Station No ______ Type Cure ______

COMPRESSIVE STRENGTH

Total Load (lbs)	Pressure (psi)	Min	P/F
202,873.0	7175.00	3500.00	P

CYLINDER / CORE
Diameter (in) 6.000
Area (sq in) 28.27431

CORE
Height (in) ______
H/D Ratio ______
Corr Factor ______

TYPE BREAK: Cone X Cone/Split _ Cone/Shear _ Shear _ Columnar _

Test Methods: Concrete Cylinder (ASTM-C39, ASTM-C1231, T22, PAD CAP or T231),
Concrete Core (T24), Soil-Cement, Lime Fly-Ash (MT-26)
Soil-Cement, Lime Fly-Ash (MT-26)

This material (DOES / DOES NOT) meet the requirements of Section 501.02 on the basis of the above tests.

Tested By PHYSICAL LAB-MICHAEL THOM

** INFORMATION ONLY **

APPENDIX F
RESIN MODIFIED PAVEMENT DATA

Table F1 – Gradations, AC Contents & Air Voids of RMP Open Graded Mix

Sieve Size	Specification Limits	JMF	2nd Test Section (4-5-01)	Cass Street (4-16-01)	Hinton Street (4-16-01)	Hinton Street (4-24-01)	Cass Street (4-24-01)
3/4 in.	100	100	100	100	100	100	100
1/2 in.	54-76	67.3	66.7	66.4	67.0	65.3	68.9
3/8 in.	38-60	41.8	37.5	40.0	42.0	36.9	39.8
No. 4	10-26	17.9	14.2	16.5	16.4	13.0	15.3
No. 8	8-16	8.2	5.6	6.7	6.3	3.9	61
No. 30	4-10	3.8	2.4	3.3	2.3	1.9	3.2
No. 200	1-3	1.4	1.1	1.1	0.7	0.4	1.2
Asphalt Content (%)	3.5-4.5	4.0	4.0	3.8	4.2	4.1	4.0
Air Voids (%)	25-35	30	32.3	33.3	33.2	33.2	34.2

Table F2 – Open Graded Mix Design Results

OPEN-GRADED ASPHALT CONCRETE MIX DESIGN RESULTS						
ASPHALT CONTENT (%)	GMM	Wtair (g)	SPECIMEN DIAMETER (cm)	SPECIMEN HEIGHT (cm)	VOLUME (cm)	VTM (%)
3.8	2.352	776.8	10.19	5.94	484.4	31.9
3.8	2.352	776.8	10.29	5.84	485.7	32.1
						32.0
4	2.345	776.5	10.16	5.94	481.6	31.3
4	2.345	777.4	10.24	5.72	471.1	29.7
						30.5
4.2	2.339	776.4	10.19	5.77	470.6	29.6
4.2	2.339	776.7	10.26	5.69	470.4	29.5
						29.6
4.4	2.333	778.1	10.13	5.87	473.1	29.6
4.4	2.333	775.6	10.16	5.94	481.6	31.1
						30.4
4.6	2.327	777.5	10.19	5.82	474.6	29.7
4.6	2.327	776	10.13	5.97	481.2	30.8
						30.3

Table F3 – Job Mix Design for Open Graded Mix

TMD-042
Rev. 10/98

MISSISSIPPI DEPARTMENT OF TRANSPORTATION

Bituminous Mix Design for Resin Modified Pavement

Project No. 99594-3 | Contractor: APAC | Date: MARCH 2001

Sub-Contr.

TEST DATA: _x_ Original Design ___Revised Design

Sample No.	1	2	3	4	5	Agg. Blend	Job Mix	Spec.
Type Material	3/4"-1/2" Crushed Gravel	5/8" Crushed Gravel	#89 Limestone	Coarse Sand				
Aggregate Source	R&S Haulers	R&S Haulers	Vulcan Cherokee	R&S Haulers		% Passing	% Passing	Design Range
Percent of Material Used in Blend	48	26	20	6				
Sieve Size	**Gradation (Percent by Weight Passing)**							
1-1/2"	100	100	100	100		100	100	100
1"	100	100	100	100		100	100	100
3/4"	100	100	100	100		100	100	100
1/2"	27.5	83.7	100	100		61.0	61	54-76
3/8"	2.3	67.2	96.1	100		43.8	44	38-60
No. 4	1.1	39.1	32.5	94.2		22.8	23	10-26
No. 8	1.1	22.8	3.2	77.2		11.7	12	8-16
No. 16	1.1	13.8	1.5	67.2		8.4	8	---
No. 30	1.1	9	1.1	58.8		6.6	7	4-10
No. 50	1	6.2	0.8	27.7		3.9	4	---
No. 100	0.9	4.3	0.7	2.4		1.8	1.8	---
No. 200	0.7	3.1	0.6	0.4		1.3	1.3	1-3
% Clay	0	0	0	0				
PI -40 Material	NP	NP	NP	NP				
% Crushed, + #4	99	98	100	0				
Apparent SG, Gsa	2.560	2.580	2.680	2.632				
Bulk SG, Gsb	2.407	2.399	2.604	2.544				
% Abs. Moisture	2.47	2.92	1.17	1.33				

Comb. Aggr. Blend Properties

0	% Total Clay
0.31	Dust/Binder Ratio
99	% Crushed, + #4
2.593	Apparent SG, Gsa
2.476	Effective SG, Gse
2.450	Bulk SG, Gsb
2.00	% Abs. Moisture
-	Thin & Elong. Pcs., %
-	Sand Ratio

Mix Properties @ Ndes

300	Mix Temp.
30	Air Voids, Pa, %
-	VMA, %
0.44	Absorbed AC by wt. of Total Mix, %
3.68	Effective AC, %
2.342	Max. SG, Gmm
0.002	(Dry Back)

Compaction Temperature

Compaction Temp. 250

Asphalt Cement

Source: Southland Oil | Grade: PG 67-22 | Spec. Grav.

AC(New) 4.1 % | Total AC 4.1%

Remarks: Designed By Burns Cooley Dennis, Inc. P.O. Box 12828/Jackson, MS 39236 551 Sunnybrook Rd./Ridgeland, MS 39157

SIGNATURE

Figure F4 – Aggregate Gradation Chart for RMP Open Graded Mix

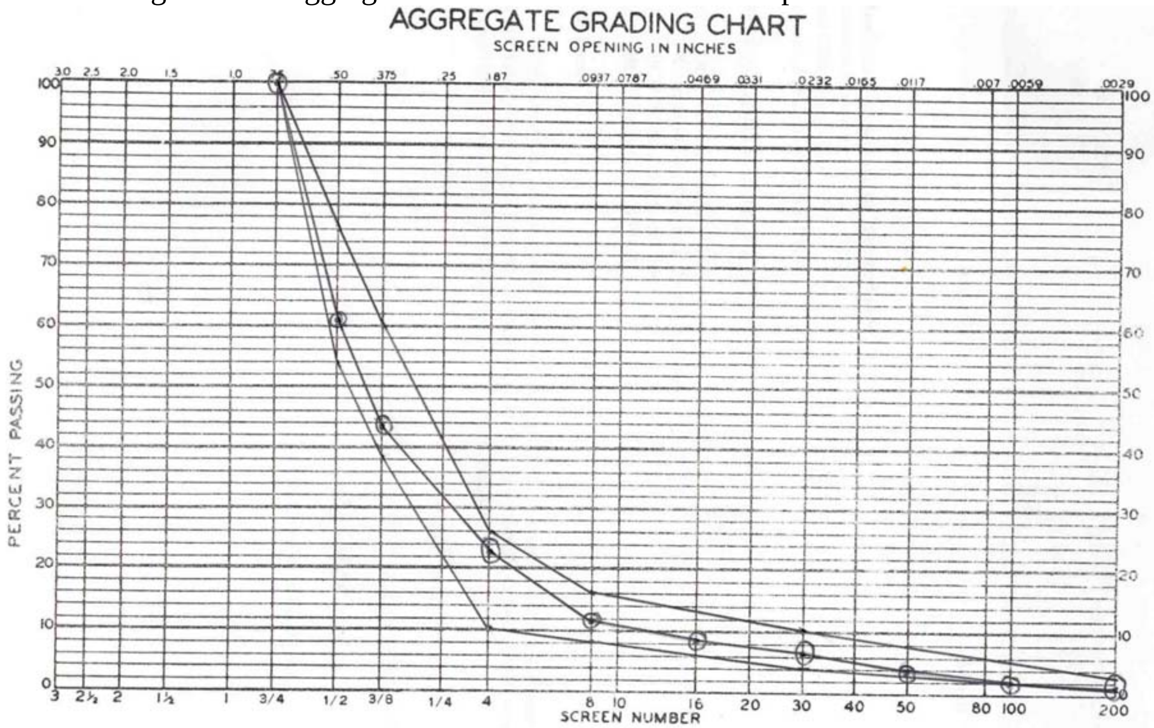


Table F5 – Test Strip 2 RMP Paving times and Mat Temperatures

04/05/2001Test Strip 2 @ APAC Corinth 63 Degrees F & Overcast			
14.95 Tons Used for 2" Thick 12' x 100' Strip			
Station	**Time**	**Mat Temperature (F)**	
0+00	9:19 AM	230	Behind paver
	9:34 AM	162	
	9:49 AM	107	
	10:04 AM	88	
	10:19 AM	81	
0+25	9:20 AM	228	Behind paver
	9:35 AM	162	
	9:50 AM	130	
	10:05 AM	102	
	10:20 AM	99	
0+50	9:21 AM	228	Behind paver
	9:36 AM	161	
	9:51 AM	133	
	10:06 AM	106	
	10:21 AM	102	
0+75	9:23 AM	232	Behind paver
	9:38 AM	161	
	9:53 AM	135	
	10:08 AM	101	
	10:23 AM	99	
1+00	9:25 AM	232	Behind paver
	9:40 AM	162	
	9:55 AM	138	
	10:10 AM	128	
	10:25 AM	107	

Table F6 – Test Strip 2 RMP mat thicknesses

	Left		Offsets		Right	
Station	0'	3'	6'	9'	12'	Avg Thick
0+00	0.18	0.11	0.13	0.15	0.15	0.14
0+25	0.19	0.14	0.17	0.17	0.15	0.16
0+50	0.13	0.10	0.13	0.15	0.17	0.14
0+75	0.14	0.08	0.12	0.13	0.14	0.12
1+00	0.13	0.13	0.12	0.06	0.06	0.10

Table F7 – RMP Open Graded Mix Mat Temperatures @ Cass Street (Inside Lane)

April 16, 2001 Open Graded Mix US 72E @ Cass Street Inside Lane		
70 Degrees F with 10-15 mph wind		
Station	**Paver Time**	**Mat Temp (F)**
1+00	5:20 PM	251
1+25	5:22 PM	252
1+50	5:24 PM	250
1+75	5:25 PM	248
2+00	5:26 PM	245
2+25	5:27 PM	239
2+50	5:28 PM	242
2+75	5:29 PM	245
3+00	5:30 PM	249
3+25	5:31 PM	246
3+50	5:33 PM	227
3+75	5:35 PM	232
4+00	5:36 PM	238
4+25	5:37 PM	241
4+50	5:38 PM	241
4+65	5:39 PM	243

Table F8 – RMP Open Graded Mix Mat Temperatures @ Hinton Street (Inside Lane)

April 16, 2001 Open Graded Mix US 72E @ Hinton Street Inside Lane		
70 Degrees F with 10-15 mph wind		
Station	**Paver Time**	**Mat Temp (F)**
0+00	6:08 PM	224
0+25	6:10 PM	228
0+50	6:11 PM	224
0+75	6:11 PM	223
1+00	6:12 PM	213
1+25	6:14 PM	191
1+50	6:15 PM	221
1+75	6:15 PM	223
2+00	6:16 PM	221
2+25	6:18 PM	212
2+50	6:19 PM	213
2+75	6:19 PM	216
3+00	6:20 PM	223
3+25	6:21 PM	223
3+50	6:22 PM	223
3+75	6:31 PM	215
4+00	6:32 PM	209
4+25	6:33 PM	234
4+35	6:34 PM	230

Table F9 – RMP Open Graded Mix Mat Temperatures @ Cass Street (Outside Lane)

<u>April 24, 2001 Open Graded Mix US 72E @ Cass Street Outside Lane</u>		
65 Degrees F with light wind		
<u>Station</u>	**<u>Paver Time</u>**	**<u>Mat Temp (F)</u>**
1+75	1:41 PM	226
2+00	1:44 PM	224
2+25	1:45 PM	220
2+50	1:46 PM	220
2+75	1:47 PM	218
3+00	1:48 PM	209
3+25	1:51 PM	202
3+50	1:52 PM	214
3+75	1:53 PM	217
4+00	1:55 PM	216
4+25	1:56 PM	220
4+50	1:57 PM	219
4+65	1:59 PM	212

Table F10 – RMP Open Graded Mix Mat Temperatures @ Hinton Street (Outside Lane)

<u>April 24, 2001 Open Graded Mix US 72E @ Hinton Street Outside Lane</u>		
65 Degrees F with light wind		
<u>Station</u>	**<u>Paver Time</u>**	**<u>Mat Temp (F)</u>**
1+25	12:34 PM	221
1+50	12:35 PM	232
1+75	12:36 PM	221
2+00	12:37 PM	213
2+25	12:39 PM	214
2+50	12:42 PM	205
2+75	12:43 PM	210
3+00	12:44 PM	207
3+25	12:45 PM	215
3+50	12:47 PM	217
3+75	12:48 PM	212
4+00	12:49 PM	204
4+25	12:51 PM	203
4+35	12:52 PM	212

Table F11 – Air Voids in Mat @ Cass Street (Inside Lane)

April 17, 2001 Open Graded Mix US 72E @ Cass Street Inside Lane		
Nuclear Density Gauge Readings @ 146.6 lbs/cubic ft		
Station	**Voids @ Left Wheelpath**	**Voids @ Right Wheelpath**
1+35	30.3	28.7
1+50	28.7	31.2
1+85	n/a	27.1
2+00	30.5	n/a
2+35	30.1	n/a
2+45	n/a	29.2
2+80	n/a	30.5
3+00	n/a	28.6
3+25	33.2	n/a
3+75	n/a	31.8
4+00	31.7	n/a
4+50	n/a	31.6

Table F12 – Air Voids in Mat @ Hinton Street (Inside Lane)

April 17, 2001 Open Graded Mix US 72E @ Hinton Street Inside Lane		
Nuclear Density Gauge Readings @ 146.6 lbs/cubic ft		
Station	**Voids @ Left Wheelpath**	**Voids @ Right Wheelpath**
0+25	33.6	30.0
0+75	32.3	29.5
1+25	32.5	30.2
1+75	33.4	32.2
2+25	32.6	30.1
2+75	31.4	31.2
3+25	32.7	29.8
3+75	30.6	30.3
4+25	31.2	31.2

Table F13 – Air Voids in Mat @ Cass Street (Outside Lane)

April 25, 2001 Open Graded Mix US 72E @ Cass Street Outside Lane		
Nuclear Density Gauge Readings @ 146.6 lbs/cubic ft		
Station	**Voids @ Left Wheelpath**	**Voids @ Right Wheelpath**
2+00	30.9	30.3
2+50	29.6	28.5
3+00	30.3	26.8
3+50	31.2	29.1
4+00	31.1	28.4
4+50	30.9	25.8

Table F14 – Air Voids in Mat @ Hinton Street (Outside Lane)

April 25, 2001 Open Graded Mix US 72E @ Hinton Street Outside Lane		
Nuclear Density Gauge Readings @ 146.6 lbs/cubic ft		
Station	**Voids @ Left Wheelpath**	**Voids @ Right Wheelpath**
1+50	30.1	30.9
2+00	31.8	30.5
2+50	29.4	32.7
3+00	29.7	29.9
3+50	30.2	30.0
4+00	31.7	31.0
4+25	31.3	29.6

Table F15 – Thickness of Resin Modified Pavement in Inside Lane of US 72 @ Cass Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets		→ Right	
Station	0'	3'	6'	9'	12'	Avg Thick
0+00	N/A	N/A	N/A	N/A	N/A	N/A
0+25	N/A	N/A	N/A	N/A	N/A	N/A
0+50	N/A	N/A	N/A	N/A	N/A	N/A
0+75	N/A	N/A	N/A	N/A	N/A	N/A
1+00	0.18'	0.17'	0.17'	0.18'	0.17'	0.174'
1+25	0.17'	0.17'	0.17'	0.18'	0.19'	0.175'
1+50	0.16'	0.15'	0.17'	0.18'	0.18'	0.168'
1+75	0.17'	0.17'	0.17'	0.18'	0.19'	0.175'
2+00	0.18'	0.19'	0.18'	0.18'	0.21'	0.186'
2+25	0.17'	0.19'	0.18'	0.18'	0.20'	0.184'
2+50	0.19'	0.18'	0.17'	0.17'	0.17'	0.175'
2+75	0.20'	0.19'	0.19'	0.19'	0.20'	0.193'
3+00	0.19'	0.20'	0.18'	0.21'	0.24'	0.201'
3+25	0.20'	0.19'	0.21'	0.23'	0.26'	0.218'
3+50	0.18'	0.22'	0.20'	0.24'	0.25'	0.219'
3+75	0.18'	0.22'	0.20'	0.24'	0.25'	0.219'
4+00	0.20'	0.22'	0.22'	0.22'	0.23'	0.218'
4+25	0.21'	0.20'	0.18'	0.18'	0.21'	0.193'
4+50	0.22'	0.19'	0.20'	0.17'	0.17'	0.189'
4+65	0.20'	0.20'	0.21'	0.20'	0.22'	0.205'

Table F16 – Thickness of Resin Modified Pavement in Outside Lane of US 72 @ Cass Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets		→ Right	
Station	0'	3'	6'	9'	12'	Avg Thick
0+00	N/A	N/A	N/A	N/A	N/A	N/A
0+25	N/A	N/A	N/A	N/A	N/A	N/A
0+50	N/A	N/A	N/A	N/A	N/A	N/A
0+75	N/A	N/A	N/A	N/A	N/A	N/A
1+00	N/A	N/A	N/A	N/A	N/A	N/A
1+25	N/A	N/A	N/A	N/A	N/A	N/A
1+50	N/A	N/A	N/A	N/A	N/A	N/A
1+75	0.21'	0.19'	0.21'	0.19'	0.19'	0.198'
2+00	0.16'	0.14'	0.16'	0.17'	0.18'	0.160'
2+25	0.16'	0.15'	0.18'	0.16'	0.17'	0.164'
2+50	0.17'	0.17'	0.20'	0.17'	0.15'	0.175'
2+75	0.17'	0.18'	0.19'	0.19'	0.18'	0.184'
3+00	0.17'	0.17'	0.20'	unknown	unknown	0.182'
3+25	0.17'	0.17'	0.19'	unknown	unknown	0.178'
3+50	0.18'	0.18'	0.20'	unknown	unknown	0.188'
3+75	0.16'	0.16'	0.18'	unknown	unknown	0.168'
4+00	0.16'	0.15'	0.16'	unknown	unknown	0.156'
4+25	0.18'	0.19'	0.20'	unknown	unknown	0.192'
4+50	0.17'	0.17'	0.17'	unknown	unknown	0.170'
4+65	0.19'	0.17'	0.20'	unknown	unknown	0.186'

Table F17 – Thickness of Resin Modified Pavement in Inside Lane of US 72 @ Hinton Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets		→ Right	
Station	0'	3'	6'	9'	12'	Avg Thick
0+00	N/A	N/A	N/A	N/A	N/A	N/A
0+25	N/A	N/A	N/A	N/A	N/A	N/A
0+50	N/A	N/A	N/A	N/A	N/A	N/A
0+75	N/A	N/A	N/A	N/A	N/A	N/A
1+00	N/A	N/A	N/A	N/A	N/A	N/A
1+25	0.21'	0.19'	0.19'	0.20'	0.22'	0.199'
1+50	0.20'	0.20'	0.23'	0.23'	0.21'	0.216'
1+75	0.17'	0.21'	0.18'	0.21'	0.17'	0.193'
2+00	0.17'	0.19'	0.17'	0.18'	0.19'	0.180'
2+25	0.16'	0.18'	0.21'	0.15'	0.20'	0.180'
2+50	0.17'	0.16'	0.18'	0.15'	0.19'	0.191'
2+75	0.17'	0.18'	0.18'	0.19'	0.19'	0.183'
3+00	0.17'	0.19'	0.21'	0.20'	0.19'	0.195'
3+25	0.18'	0.19'	0.18'	0.19'	0.20'	0.188'
3+50	0.17'	0.18'	0.19'	0.19'	0.20'	0.186'
3+75	0.19'	0.19'	0.18'	0.18'	0.21'	0.188'
4+00	0.17'	0.20'	0.20'	0.20'	0.21'	0.198'
4+25	0.18'	0.20'	0.21'	0.15'	0.17'	0.184'
4+35	0.18'	0.21'	0.21'	0.15'	0.19'	0.189'

Table F18 – Thickness of Resin Modified Pavement in Outside Lane of US 72 @ Hinton Street
(Note: thicknesses shown at each offset are in feet)

	Left ←		Offsets	→	Right	
Station	0'	3'	6'	9'	12'	Avg Thick
0+00	N/A	N/A	N/A	N/A	N/A	N/A
0+25	N/A	N/A	N/A	N/A	N/A	N/A
0+50	N/A	N/A	N/A	N/A	N/A	N/A
0+75	N/A	N/A	N/A	N/A	N/A	N/A
1+00	N/A	N/A	N/A	N/A	N/A	N/A
1+25	0.19'	0.19'	0.25'	0.18'	0.16'	0.199'
1+50	0.17'	0.17'	0.21'	0.15'	0.18'	0.176'
1+75	0.17'	0.20'	0.24'	0.16'	0.17'	0.193'
2+00	0.18'	0.17'	0.23'	0.18'	0.16'	0.188'
2+25	0.17'	0.18'	0.22'	0.20'	0.20'	0.196'
2+50	0.16'	0.16'	0.18'	0.17'	0.16'	0.168'
2+75	0.14'	0.14'	0.19'	0.16'	0.19'	0.164'
3+00	0.14'	0.14'	0.17'	0.16'	0.14'	0.153'
3+25	0.17'	0.17'	0.21'	0.20'	0.18'	0.189'
3+50	0.16'	0.15'	0.17'	0.16'	0.15'	0.159'
3+75	0.19'	0.17'	0.19'	0.17'	0.14'	0.174'
4+00	0.17'	0.17'	0.19'	0.16'	0.16'	0.171'
4+25	0.17'	0.16'	0.19'	0.15'	0.15'	0.165'
4+35	0.18'	0.16'	0.16'	0.15'	0.17'	0.161'

Table F19 – RMP grout design chart

RESIN MODIFIED PAVEMENT
MDOT PROJECT NO. 61-0137-02-143-00
HIGHWAY #72, CORINTH, MS

04/03/2001

CUBIC YARDS	TYPE 1 CEMENT LBS	TYPE F FLY ASH LBS	TOTAL CEMENT FLYASH LBS	SILICA SAND DRY LBS.	RESIN PL7 POUNDS	RESIN PL7 GALS.	WATER LBS.	WATER GALS
0.50	570	285	855	285	55	6.55	388	47
0.75	854	428	1282	428	83	9.82	582	70
1.00	1139	570	1709	570	110	13.10	776	93
1.25	1424	713	2137	713	138	16.37	970	116
1.50	1709	855	2564	855	165	19.64	1164	140
1.75	1993	998	2991	998	193	22.92	1358	163
2.00	2278	1140	3418	1140	220	26.19	1552	186
2.25	2563	1283	3846	1283	248	29.46	1746	210
2.50	2848	1425	4273	1425	275	32.74	1940	233
2.75	3132	1568	4700	1568	303	36.01	2134	256
3.00	3417	1710	5127	1710	330	39.29	2328	279
3.25	3702	1853	5555	1853	358	42.56	2522	303
3.50	3987	1995	5982	1995	385	45.83	2716	326
3.75	4271	2138	6409	2138	413	49.11	2910	349
4.00	4556	2280	6836	2280	440	52.38	3104	373
4.25	4841	2423	7264	2423	468	55.65	3298	396
4.50	5126	2565	7691	2565	495	58.93	3492	419
4.75	5410	2708	8118	2708	523	62.20	3686	442
5.00	5695	2850	8545	2850	550	65.48	3880	466
5.25	5980	2993	8973	2993	578	68.75	4074	489
5.50	6265	3135	9400	3135	605	72.02	4268	512
5.75	6549	3278	9827	3278	633	75.30	4462	536
6.00	6834	3420	10254	3420	660	78.57	4656	559

Table F20 – RMP Grout JMF

Material	Percent by Weight	Pounds Per Cubic Yard
Type I Cement	36.0	1,139
Fly Ash (Class F)	18.0	57.0
Silica Sand	18.0	570
Water	24.5	776
Resin Additive (PL7)	3.5	110

Grout Viscosity - 9.4 seconds

Table F21 – RMP Grout Material Properties

Date	Location	Grout Viscosity	Compressive Strength
March 29	Lab Mix	9.5 sec	2 day - 2410 psi 7 day - 4250 psi 28 day - 5758 psi
April 9	Test Section @ APAC Plant	8.7 sec	3 day - 2200 psi 7 day - 2225 psi 28 day - 4063 psi
April 25	Hinton Street	- - -	9 day - 3255 psi

Table F22 – RMP Grout Construction Data @ Cass Street (Inside Lane)

Grout Construction Data @ Cass Street Inside Lane					
April 17, 2001- Begin Temp 45F, End Temp 40F 15 mph wind					
Begin Time	**End Time**	**Truck Amount**	**Begin Sta**	**End Sta**	**Marsh Flow Time**
12:14 PM	12:36 PM	<4 cu. yds	4+65	3+98	9.66 sec
12:41 PM	1:19 PM	4 cu. yds	3+98	2+75	9.06 sec
1:34 PM	2:11 PM	4 cu. yds	2+75	1+00	9.41 sec

Table F23 – RMP Grout Construction Data @ Hinton Street (Inside Lane)

Grout Construction Data @ Hinton Street Inside Lane					
April 17, 2001- Begin Temp 40F, End Temp 45F 15 mph wind					
Begin Time	**End Time**	**Truck Amount**	**Begin Sta**	**End Sta**	**Marsh Flow Time**
9:19 AM	9:54 AM	4 cu. yds	4+35	3+06	10.97 sec
10:30 AM	11:04 AM	4 cu. yds	3+06	1+80	9.72 sec
11:20 AM	11:45 AM	<4 cu. yds	1+80	1+25	8.87 sec

Table F24 – RMP Grout Construction Data @ Cass Street (Outside Lane)

Grout Construction Data @ Cass Street Inside Lane					
April 25, 2001- Begin Temp 62F, End Temp 67F no wind					
Begin Time	**End Time**	**Truck Amount**	**Begin Sta**	**End Sta**	**Marsh Flow Time**
11:35 AM	12:16 PM	<4 cu. yds	4+65	3+65	9.32 sec
12:25 PM	1:34 PM	4 cu. yds	3+65	2+25	9.03 sec
1:45 PM	2:06 PM	<4 cu. yds	2+25	1+75	8.78 sec

Table F25 – RMP Grout Construction Data @ Hinton Street (Outside Lane)

Grout Construction Data @ Hinton Street Inside Lane					
April 25, 2001- Begin Temp 51F, End Temp 62F no wind					
Begin Time	**End Time**	**Truck Amount**	**Begin Sta**	**End Sta**	**Marsh Flow Time**
8:32 AM	9:35 AM	4 cu. yds	4+35	2+90	9.44 sec
9:39 AM	10:43 AM	4 cu. yds	2+90	1+75	9.18 sec
10:50 AM	11:06 AM	<4 cu. yds	1+75	1+25	8.94 sec

Table F26 – RMP Smoothness Data Collected @ Cass Street in the Outside Lane

Date Collected	IRI (mm/m)	PI (0.2" Blanking Band) (in/mi)	PI (Zero Blanking Band) (in/mi)
April 30, 2001	2.04*	11.42	27.80
July 6, 2001	1.78**	n/a	n/a
August 22, 2001	1.76**	n/a	n/a

Note: PI data was collected in the right wheelpath using a "California Type" Profilograph with a 2' low pass Butterworth filter.
* - April 30 IRI was collected in the right wheelpath using MDOT's ARRB Transport Research Walking Profiler.
** - July 6 & August 22 IRI is the average IRI of both wheelpaths collected using MDOT's High Speed "South Dakota Type" Profiler.

Table F27 – RMP Smoothness Data Collected @ Hinton Street in the Outside Lane

Date Collected	IRI (mm/m)	PI (0.2" Blanking Band) (in/mi)	PI (Zero Blanking Band) (in/mi)
April 30, 2001	2.36*	23.53	59.21
July 6, 2001	2.12**	n/a	n/a
August 22, 2001	2.01**	n/a	n/a

Note: PI data was collected in the right wheelpath using a "California Type" Profilograph with a 2' low pass Butterworth filter.
* - April 30 IRI was collected in the right wheelpath using MDOT's ARRB Transport Research Walking Profiler.
** - July 6 & August 22 IRI is the average IRI of both wheelpaths collected using MDOT's High Speed "South Dakota Type" Profiler.

Table F28 – RMP Friction Data Collected @ Cass Street in the Outside Lane

Date Collected	Skid No	Avg Speed (mph)	Temp (F)	Time (CST)
May 1, 2001	24.5	44.6	64	3:18 AM
May 1, 2001	23.4	39.4	66	3:24 AM
May 1, 2001	25.4	39.2	64	3:44 AM
	24.4			
July 6, 2001	28.4	39.2	73	4:00 AM
July 6, 2001	30.3	39.8	73	4:05 AM
July 6, 2001	30.7	39.6	73	4:10 AM
	29.8			
August 22, 2001	35.3	39.8	87	11:03 PM
August 22, 2001	36.9	38.6	84	11:07 PM
August 22, 2001	39.0	38.4	86	11:12 PM
	37.1			
December 4, 2001	40.3	39.5	60	12:06 AM
December 4, 2001	36.6	39.1	59	12:11 AM
December 4, 2001	39.2	39.2	59	12:16 AM
	38.7			

Table F29 – RMP Friction Data Collected @ Hinton Street in the Outside Lane

Date Collected	Skid No	Avg Speed (mph)	Temp (F)	Time (CST)
May 1, 2001	21.5	42.5	64	3:19 AM
May 1, 2001	23.7	41.4	64	3:25 AM
May 1, 2001	24.9	41.1	64	3:45 AM
	23.4			
July 6, 2001	30.3	40.8	73	4:01 AM
July 6, 2001	33.2	40.2	73	4:06 AM
July 6, 2001	31.9	39.9	73	4:11 AM
	31.8			
August 22, 2001	36.8	39.2	86	11:04 PM
August 22, 2001	37.5	39.4	84	11:08 PM
August 22, 2001	39.7	38.8	84	11:13 PM
	38.0			
December 4, 2001	39.8	40.3	59	12:07 PM
December 4, 2001	38.3	40.2	59	12:12 PM
December 4, 2001	40.1	40.2	59	12:17 PM
	39.4			

Table F30- Long Term Data for Resin Modified Pavement (Cass Street)

Cass Street Resin Modified Pavement								
Year	**Inside Lane**				**Outside Lane**			
	SN	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**	**SN**	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**
2002	37.7	-	-	-	36	-	-	-
2003	36.2	0	2.65	78.8	34.3	0	1.64	86.9
2004	-	0	2.68	57.6	-	0	1.79	77
2005	34.3	0	2.82	55	30.2	0	2.06	71.7
2006	-	0	2.87	52.6	-	0	2.01	67.4

Table F31- Long Term Data for Resin Modified Pavement (Hinton Street)

Hinton Street Resin Modified Pavement								
Year	**Inside Lane**				**Outside Lane**			
	SN	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**	**SN**	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**
2002	32.9	-	-	-	34.6	-	-	-
2003	37.4	0	1.95	84.4	36.7	0	1.95	84.4
2004	-	0	1.9	79.5	-	0	1.93	82.6
2005	30	0	1.94	77.1	30.1	0	1.98	78.4
2006	-	0	2.05	74.8	-	0	2.06	76.8

APPENDIX G
USER'S GUIDE: RESIN MODIFIED PAVEMENT
(AS PUBLISHED BY THE UNITED STATES ARMY ENGINEER WATERWAYS EXPERIMENT STATION – MARCH 1996)

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FACILITIES ENGINEERING APPLICATIONS PROGRAM

USER'S GUIDE

User's Guide: Resin Modified Pavement

by

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Vicksburg, MS 39180-6199

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Innovative Ideas for the Operation, Maintenance, & Repair of Army Facilities

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Resin modified pavement (RMP) is a composite pavement surfacing that uses a unique combination of asphalt concrete (AC) and portland cement concrete (PCC) materials in the same layer. The RMP material is generally described as an open-graded asphalt concrete mixture containing 25- to 35-percent voids which are filled with a resin modified portland cement grout. The RMP layer is typically 50 mm (2 in.) thick and has a surface appearance similar to a rough-textured PCC.

This report includes discussions of the description, applications, benefits, limitations, costs, and recommended uses for RMP. A fact sheet and guide specification are included in the appendices of this report.

14.SUBJECT TERMS

Asphalt concrete	Open-graded asphalt concrete	Salviacim
Cement grout	Portland cement concrete	
Composite pavement	Resin modified pavement	
Flexible pavement	Rigid pavement	

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Contents

List of Figures

List of Tables

1 Executive Summary

Description

Resin modified pavement (RMP) is a composite pavement surfacing that uses a unique combination of asphalt concrete (AC) and portland cement concrete (PCC) materials in the same layer. The RMP material is generally described as an open-graded asphalt concrete mixture containing 25- to 35-percent voids which are filled with a resin modified portland cement grout. The open-graded asphalt mixture and resin modified cement grout are produced and placed separately. The open-graded mixture is produced in a typical asphalt concrete plant and placed with standard asphalt paving equipment. After the open-graded layer has cooled, the slurry grout is poured onto the porous surfacing and vibrated into the internal voids. The RMP layer is typically 50 mm (2 in.) thick and has a surface appearance similar to a rough-textured PCC.

Applications

The RMP process is applicable to new pavement construction as well as rehabilitation of existing pavement structures. A new RMP layer may be placed as an overlay over existing flexible or rigid pavements. The RMP is suitable to carry heavy and abrasive traffic loads and it is resistant to damage from fuel and chemical spills. Successful RMP applications are documented for various low-speed traffic areas, such as airport aprons and taxiways, lowspeed roadways, industrial and warehouse floorings, fuel depots, railways stations, and port facilities.

Benefits

RMP provides a tough and durable pavement surface that resists rutting caused by heavy channelized traffic loads, surface abrasion caused by tracked vehicle traffic, and deterioration due to fuel spillage. The jointless surface is simple to construct and requires little to no maintenance effort. Performance records in the United States indicate that RMP is suitable for practically any environmental condition.

Limitations

RMP should only be used for relatively low-speed traffic applications. The surface texture can be irregular, resulting in areas of variable skid resistance. The irregular surface texture can also be unsightly when compared to a typical PCC surfacing with a relatively uniform surface texture. Construction experience is somewhat limited, which causes paving production rates to start off slowly at the beginning of most projects.

Costs

The cost of a 50-mm-thick RMP layer is currently about $9.60 to 19.20 per square meter ($8 to 16 per square yard) as compared to a typical cost of $3.60 to 6.00 per square meter ($3 to 5 per square yard) for a 50-mm-thick layer of dense-graded AC. The initial cost of a full-depth RMP design is generally 50 to 80 percent higher than a comparable AC design when considering a heavy-duty pavement. A more important cost comparison is between the RMP design and the rigid pavement design, since the RMP is usually used as a cost-saving alternative to the standard PCC pavement. In the case of a standard military heavy-duty pavement application, the RMP design is generally 30 to 60 percent less in initial cost than a comparable PCC pavement design. In many circumstances, the RMP also provides cost savings from reduced or eliminated maintenance efforts when compared to other pavement surfacing alternatives.

Recommendations for Use

RMP is recommended for any newly constructed or rehabilitated pavement carrying low-speed traffic (less than 65 kilometer/hr or 40 mile/hr). RMP can be an ideal cost-saving alternative to PCC pavements where resistance to heavy loads, tracked vehicle traffic, or fuel spillage is required. The available guide specification should be followed closely and the recommended quality control practices should be followed at all times during construction.

Point of Contact

Point of contact regarding this technology is:

Technical:

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Telephone: 601-634-2955
Facsimile: 601-634-3020

2 Preacquisition

Description of Resin Modified Pavement

RMP is a relatively new type of pavement process in the United States that uses a unique combination of AC and PCC materials in the surface layer. The RMP layer is generally described as an open-graded AC mixture containing 25- to 35-percent voids which are filled with a resin modified cement grout. The open-graded asphalt mixture and resin modified cement grout are produced and placed separately. The RMP is typically a 50-mm-thick layer placed on top of a flexible pavement substructure when newly constructed. This same thickness may be placed on existing flexible or rigid pavement structures as well. RMP provides performance benefits attributable to both its AC and PCC material properties at a cost somewhere between the typical AC and PCC ranges.

The open-graded asphalt mixture is designed to be the initial Askeleton@ of the RMP. A coarse aggregate gradation with very few fines is used along with a low asphalt cement content (typically 3.5 to 4.5 percent by total weight) to produce 25- to 35-percent voids in the mix after construction. The open-graded asphalt mixture can be produced in either a conventional batch plant or drum-mix plant and is placed with typical AC paving equipment. After placing, the open-graded asphalt material is smoothed over with a minimal number of passes from a small (3-tonne maximum) steel-wheel roller.

The resin modified cement grout is composed of fly ash, silica sand, cement, water, and a cross polymer resin additive. The resin additive is generally composed of five parts water, two parts cross polymer resin of styrene and butadiene, and one part water-reducing agent. The slurry grout water/cement ratio (w/c) is between 0.65 and 0.75, giving the grout a very fluid consistency. The cement grout material can be produced in a conventional concrete batch plant or a small portable mixer. After the asphalt mixture has cooled, the slurry grout is poured onto the open-graded asphalt material and squeegeed over the surface. The slurry grout is then vibrated into the voids with the 3-tonne vibratory steel-wheel roller to ensure full penetration of the grout. This process of grout application and vibration continues until all voids are filled with grout.

Depending upon the specific traffic needs, the freshly grouted surface may be hand broomed or mechanically textured to improve skid resistance. Spray-on curing compounds, typical to the PCC industry, are generally used for short-term curing. The new RMP surfacing usually achieves full strength in 28 days, but it may be opened to pedestrian traffic in 24 hours and light automobile traffic in 3 days.

Background

The RMP process was developed in France in the 1960's as a fuel and abrasion resistant surfacing material. The RMP process, or Salviacim process as it is known in Europe, was developed by the French construction company Jean Lefebvre Enterprises as a cost-effective alternative to PCC (Roffe 1989a). RMP has been successfully marketed throughout France as a pavement and flooring material in numerous applications. By 1990, Jean Lefebvre Enterprises had successfully placed over 8.3 million square meters (10 million square yards) of Salviacim pavement in France (Jean Lefebvre Enterprise 1990). Today, RMP is an accepted standard paving material throughout France.

Soon after the RMP process became successful in France; its use in other countries began to grow. In the 1970's and 1980's, RMP usage spread throughout Europe and into several countries in Africa, the South Pacific, the Far East, and North America (Ahlrich and Anderton 1991a). Twenty-five countries around the world had documented experience with RMP by 1990 (Jean Lefebvre Enterprise 1990).

The earliest documented experience with RMP in the United States occurred in the mid-1970's when the U.S. Army Engineer Waterways Experiment Station (WES) conducted limited evaluations of an RMP test section constructed in Vicksburg, MS (Rone 1976). The study was conducted to evaluate the effectiveness of the new surfacing material to resist damage caused by fuel and oil spillage and abrasion from tracked vehicles. The evaluation results indicated that the effectiveness of the RMP was very construction sensitive, and if all phases of design and construction were not performed correctly, the RMP process would not work.

In 1987, the U.S. Army Corps of Engineers tasked WES to reevaluate the RMP process for potential military pavement applications, since the field experiences in Europe continued to be positive and improved materials and construction procedures had been reported. WES engineers conducted literature reviews, made site evaluations in France, Great Britain, and Australia, and constructed and evaluated a new test section at WES (Ahlrich and Anderton 1991b). The results of this evaluation were favorable, prompting pilot projects at several military installations in the following years. The Federal Aviation Administration (FAA), also eager to develop an alternative paving material technology, used the positive WES experiences and preliminary guidance to construct several pilot projects at commercial airports (Ahlrich and Anderton 1993). Today, the RMP process is recommended as an alternative pavement surfacing material by the U.S. Army, the U.S. Air Force, U.S. Navy, and the FAA.

Applications

RMP may be used in new pavement construction or in the rehabilitation of existing pavement structures. A new RMP surfacing may be placed as an overlay over existing flexible or rigid pavements. RMP is typically used as a low-cost alternative to a PCC rigid pavement or as a means of improving the pavement performance over an AC surfaced flexible pavement. Field experience indicates that RMP may be used in practically any environmental conditions.

In general, the RMP is best suited for pavements that are subjected to low-speed traffic that is channelized or abrasive by nature. Pavement areas with heavy static point loads and heavy fuel spillage are also ideal RMP application candidates. The RMP process has been used in a variety of applications on the international market, including airport and vehicular pavements, industrial and warehouse floorings, fuel depots and commercial gasoline stations, city plazas and malls, railway stations, and port facilities. Since its first commercial application in the Unites States in 1987, RMP has been used mostly on airport and airfield pavement projects. A listing of the known RMP projects in the United States is given in Table 1.

Design Methods

The current practice for designing the RMP layer thicknesses involves a simple adaptation of the standard Corps of Engineers (CE) flexible pavement design method (Headquarters, Departments of the Army and Air Force 1989 and 1992). The pavement is designed as if it were a typical dense-graded AC surfaced pavement, and then the top 50 mm of AC is substituted with an equal thickness of RMP. Equating the RMP material with AC undoubtedly renders an over-designed pavement in terms of the strength and durability provided by the surfacing. A recent study conducted under the Strategic Highway Research Program (SHRP) on potential new bridge deck materials showed that the RMP material had approximately a two-fold increase in Marshall stability, indirect tensile strength, and resilient modulus when compared to a typical high-quality AC material (Al-Qadi, Gouru, and Weyers 1994). Even with the new SHRP results, there are not enough data on the engineering properties of the RMP to develop a suitable mechanistic design methodology. Until such a mechanistic design method is developed, the current method of adapting the results of the standard CE flexible pavement design will continue to be used.

Table 1
RMP Project Locations in the United States

Location	Area (m^2)	Date of Construction
Newark Airport, NJ (Aircraft Apron)	420	May 1987
Springfield, VA (GSA Parking Lot)	1,670	Oct 1988
Vicksburg, MS (WES Test Section)	835	Aug 1989
Orange County, CA (Aircraft Taxiway)	8,350	Oct 1990
Tampa International Airport, FL (Aircraft Apron)	3,350	Jan 1991
Miami International Airport, FL (Aircraft Apron)	3,350	Jan 1991
Concord, CA (Port Facilities)	4,170 4,170 70,000	Jun 1991 Oct 1993 1995
McChord AFB, WA (Loading Facilities)	8,350	Aug 1991
Fort Campbell AAF, KY (Aircraft Apron)	6,250	Aug 1992
Malmstrom AFB, MT (Fuel Storage Areas)	10,835	Jun 1993
Fort Belvoir, VA (Loading Facilities)	8,350	Jun 1994
Pope AFB, NC (Aircraft Aprons)	29,170	Jun 1994
Altus AFB, OK (Aircraft Taxiway)	10,500	Jun 1995

RMP has been successfully constructed as an overlay material over rigid and flexible pavements as well as in original construction. No transverse or longitudinal joints are required for original, full-depth RMP designs, although joints have been cut in RMP when overlaying jointed concrete pavement. Pavement joints are required between RMP and adjacent PCC pavements but are not required between RMP and adjacent AC pavements. These joints are constructed by saw cutting to the bottom of the RMP layer, once the RMP material has sufficiently cured, and then filling the joint with a sealant material suitable for the particular site conditions.

Materials

Open-graded AC

Aggregates. The aggregates used in the open-graded AC must consist of sound, tough, durable particles crushed and sized to provide a relatively uniform gradation. The aggregates are tested against standard Los Angeles abrasion, sodium sulfate soundness, percent fractured faces, and percent flat and elongated requirements (Headquarters, Department of the Army 1993). These requirements help to ensure a stable, open-graded asphalt layer with a high internal void structure. The general requirement is 25- to 35-percent voids in the compacted mixture. Any amount less than this might not allow the slurry grout to fully penetrate the open-graded mixture, resulting in a structurally unsound surface course which would likely deteriorate under traffic rather quickly. Void contents greater than this amount would increase the cost of the pavement without providing significant structural improvements and could also reduce the pavement strength by eliminating some of the aggregate to aggregate interlock.

Asphalt cement. The type or grade of asphalt cement used in the open-graded AC is not very critical, since the asphalt cement has a limited role in the pavement's performance once the slurry grout has filled all of the void spaces. The asphalt cement is required to be a paving grade material, however, with an original penetration of 40 to 100. Asphalt cements within this penetration range are typically categorized by American Society for Testing and Materials (ASTM) D 3381 as an AC-10, AC-20, or AC-30 viscosity grade (ASTM 1995a). These asphalt cement grades are generally considered to be of medium viscosity. Lower viscosity asphalt cements could drain off of the large aggregates during mixing and transporting, which would reduce the permeability of the open-graded layer and hinder grout penetration. Asphalt cements stiffer (or higher viscosity grade) than the specified range might not allow for sufficient coating of the aggregates with the typical low asphalt contents used.

Mix design. The object of the open-graded AC mix design is to determine an aggregate gradation and asphalt content which will provide a compacted layer containing 25- to 35-percent voids. Sieve analyses of proposed aggregate stockpiles provide the necessary information for an aggregate gradation design. The gradation requirements of the final blended aggregates to be used in the open-graded mixture are given in Table 2.

An estimate of the optimum asphalt content is made to determine a suitable range of asphalt cement contents for a subsequent laboratory analysis. The asphalt content estimate is made using a design equation based on aggregate properties (Roffe 1989b). The design equation is as follows:

Table 2 Open-Graded Mixture Aggregate Gradation	
Sieve Size	**Percent Passing by Weight**
19 mm (3/4 in.)	100
12.5 mm (1/2 in.)	54-76
9.5 mm (3/8 in.)	38-60
4.75 mm (No. 4)	10-26
2.36 mm (No. 8)	8-16
600 μm (No. 30)	4-10
75 μm (No. 200)	1-3

Optimum asphalt content = $3.25\ \alpha\Sigma^{0.2}$

where

α = 2.65/SG

SG = apparent specific gravity of the combined aggregates

Σ = conventional specific surface area
= 0.21G + 5.4S + 7.2s + 135f

G = percentage of material retained on 4.75 mm sieve

S = percentage of material passing 4.75 mm sieve and retained on 600 μm sieve

s = percentage of material passing 600 μm sieve and retained on 75 μm sieve

f = percentage of material passing 75 μm sieve

Once the optimum asphalt content is estimated using this equation, two asphalt contents below this amount and two asphalt contents above this amount are used, along with the estimated optimum, in the laboratory production and evaluation of 75-mm (6-in.) diameter Marshall specimens. The open-graded AC specimens are compacted with 25 blows from a 4.5-kg (10-lb) Marshall hand hammer on one side of each specimen. The temperature of the laboratory produced asphalt mixture during compaction is usually around 121 C (250 F). After the laboratory specimens have been compacted and cooled, they are weighed in air and water to determine bulk density and void contents. The optimum asphalt content is typically selected where the resulting void content is nearest to 30 percent.

Resin modified grout

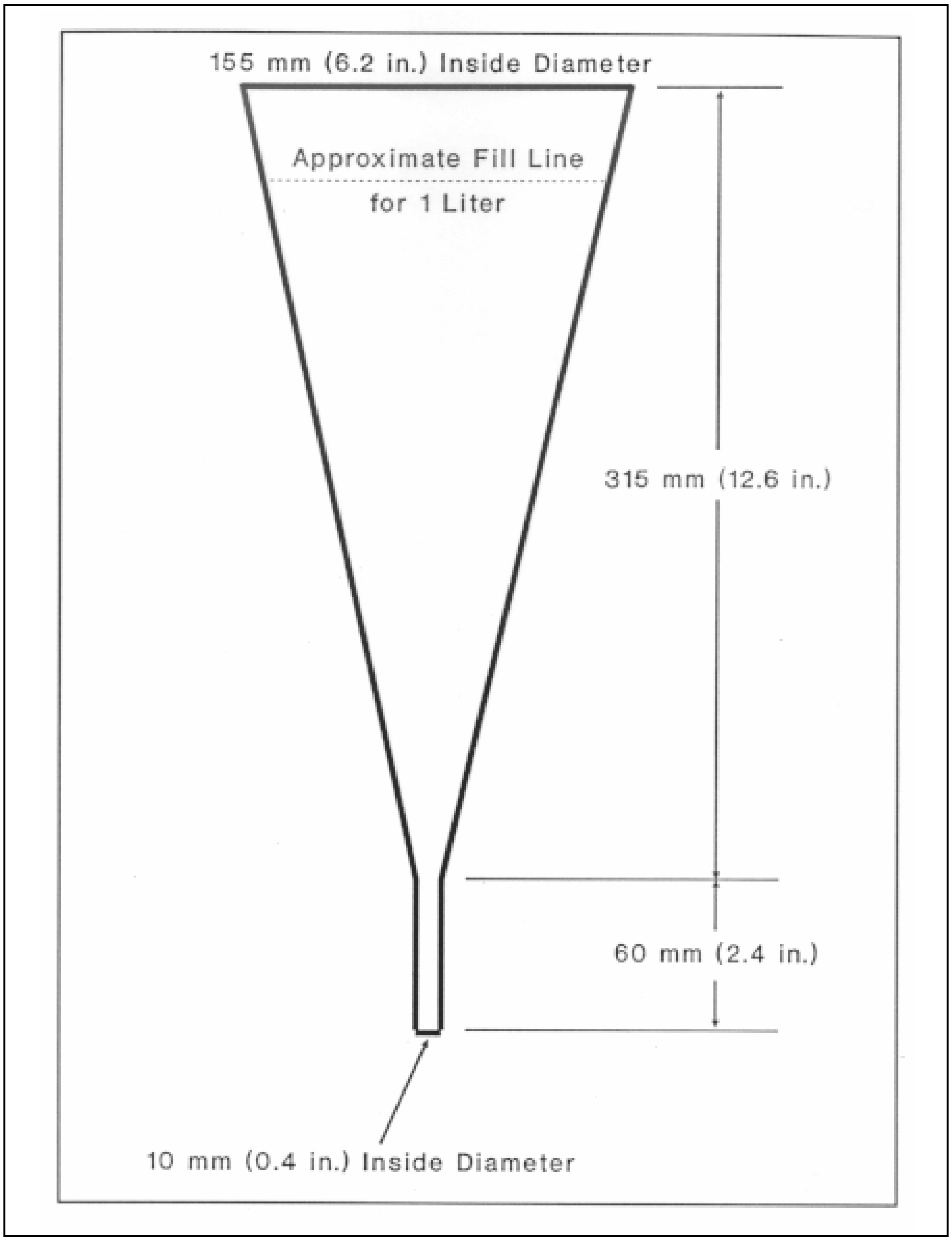
Standard ingredients. The standard ingredients in the resin modified grout include four materials common to PCC production: portland cement, sand, fly ash, and water. No special requirements on portland cement are necessary for a quality grout. A Type I cement should be used unless special conditions require another cement type. A clean, sound, durable, and angular silica sand with a gradation between the 1.18 mm (No. 16) sieve and 75 μm (No. 200) sieve is specified to provide a high quality sand that will stay in suspension in the grout during mixing and application. An ASTM C 618 Type F or Anonhydraulic@ fly ash (ASTM 1995b) is used to help provide a consistent grout viscosity without speeding up the grout's rate of setting. Water is added to the grout in an amount that renders a w/c ratio from 0.65 to 0.70. The allowable tolerances for the resin modified grout mix proportions are given in Table 3.

Table 3
Resin Modified Cement Grout Mixture Proportions

Material	Percent by Weight
Type I Cement	34-40
Silica Sand	16-20
Fly Ash	16-20
Water	22-26
Resin Additive	2.5-3.5

Resin additive. The resin additive used in the slurry grout is a proprietary material produced in the United States by the Alyan Corporation under the international trade name Prosalvia-7 or PL7. The additive is generally composed of five parts water, two parts of a cross polymer resin of styrene and butadiene, and one part water reducing agent. The additive significantly aids the construction process by acting as a super-plasticizer in reducing the grout viscosity. The reduced grout viscosity allows the grout to fully penetrate the open-graded asphalt concrete layer more easily. The additive also increases the flexural and compressive strength of the hardened grout, improves the grout's chemical and abrasion resistance, and reduces the grout's permeability after curing.

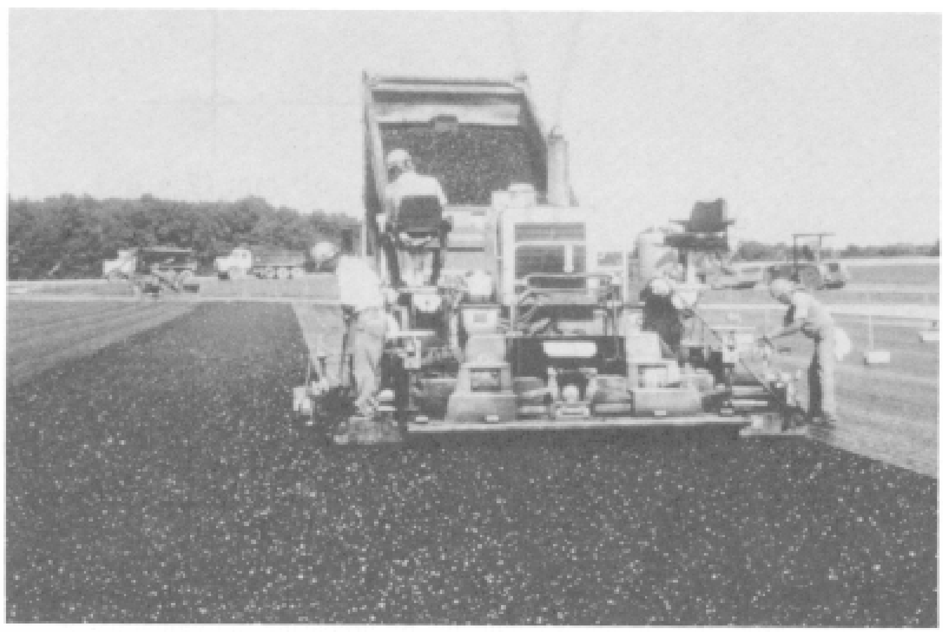
Mix design. The goal of the slurry grout mix design is to determine the proportions of mix ingredients that will produce a slurry grout of the proper viscosity. Grout viscosity is measured by the Marsh flow cone (schematically shown in Figure 1). The Marsh flow cone is used to measure the time of flux of 1 L (0.264 gal) of grout through the cone. A high flow-time (too thick or viscous) grout does not penetrate the open-graded asphalt layer completely, while a low flow-time grout may not gain sufficient strength and may promote excessive shrinkage cracking and segregation. Grouts with an acceptable initial viscosity will have a flow time between 8.0 and 10.0 sec.



The slurry grout mix design is conducted by preparing individual batch samples in the laboratory and testing them with the Marsh flow cone. The batch samples are prepared by first dry mixing the cement, sand, and fly ash in a blender until thoroughly mixed. The appropriate amount of water is then added, and the grout mixture is blended for 5 min. After the 5-min mixing period, the resin additive is added and mixed with the grout for an additional 3 min. Immediately after the 3-min mixing period, the grout is poured into the Marsh flow cone and tested for viscosity. The individual components of the grout may be adjusted within the prescribed tolerances to obtain a desired flow time.

Construction Techniques

Open-graded AC



The open-graded AC layer is generally produced and constructed in the same manner as conventional AC pavements. The mixture may be produced in either a batch plant or drum-mix plant and is usually mixed at about 121 to 135C (250 to 275F). It is hauled to the construction site in large haul trucks where it is dumped into a standard asphalt paver. The temperature of the open-graded material when being placed is less critical than for standard AC mixtures, since densification is not required. In fact, once the open-graded mixture is placed by the asphalt paver (Figure 2), the surface is simply smoothed over with a small 3-tonne steel wheel roller (Figure 3). Usually, one roller pass when the open-graded material has cooled to about 71 C (160 F) and one roller pass at about 55 C (130 F) is all that is needed to complete the open-graded asphalt construction phase.

Resin modified grout

The resin modified slurry grout material may be produced at a concrete batch plant for larger projects or with portable concrete mixers for smaller projects. For the typical batch plant-produced grout, the proper proportions of cement, sand, fly ash, and water are dumped into transit mix trucks and mixed for 5 min. When the haul distance from the concrete batch plant to the job site is less than 20 min, the cross polymer resin is poured into the mixing drum at the plant site. The slurry grout is continuously mixed in transit and until actual application to prevent the sand material from settling out of the slurry grout mixture. Once the transit mix truck reaches the job site, the mixing drum is rotated at maximum speed for an additional 10 min to ensure complete mixing of the slurry grout. If the haul distance from the concrete batch plant to the job site is greater than 20 min, then the cross polymer resin is added at the job site, followed by an additional 10 min of mixing before application.

Before placement, a sample of grout from each truck is taken and tested against the appropriate Marsh flow cone viscosity requirement (Figures 4, 5, and 6). The appropriate grout viscosity range depends upon the amount of time passed after addition of the resin additive. The slurry grout viscosity requirements are listed in Table 4.

Once the slurry grout has passed the viscosity test, it is poured onto the surface of the open-graded asphalt material from the pivoting delivery chute of the transit mix truck (Figure 7). The slurry grout is applied until the area is

fully saturated. When an area becomes saturated, the transit mix truck moves forward, continuing the grout application. Grout placement is usually conducted in wide lanes (3 to 6 m or 15 to 20 ft) separated by strips of lumber (Figure 8). Grout application in this manner provides an orderly approach and keeps the grout from spilling over onto previously grouted areas. For small projects when the grout is mixed on site in portable mixers, a quick wheelbarrow delivery is suitable.

Hand-operated squeegees are used to push and pull the excess slurry grout material to the under-saturated areas (Figure 9). When the open-graded asphalt material is designed and constructed properly, the majority of the internal voids are quickly filled by gravity upon initial grout application. Immediately after placing the grout, the small 3-tonne steel wheel roller

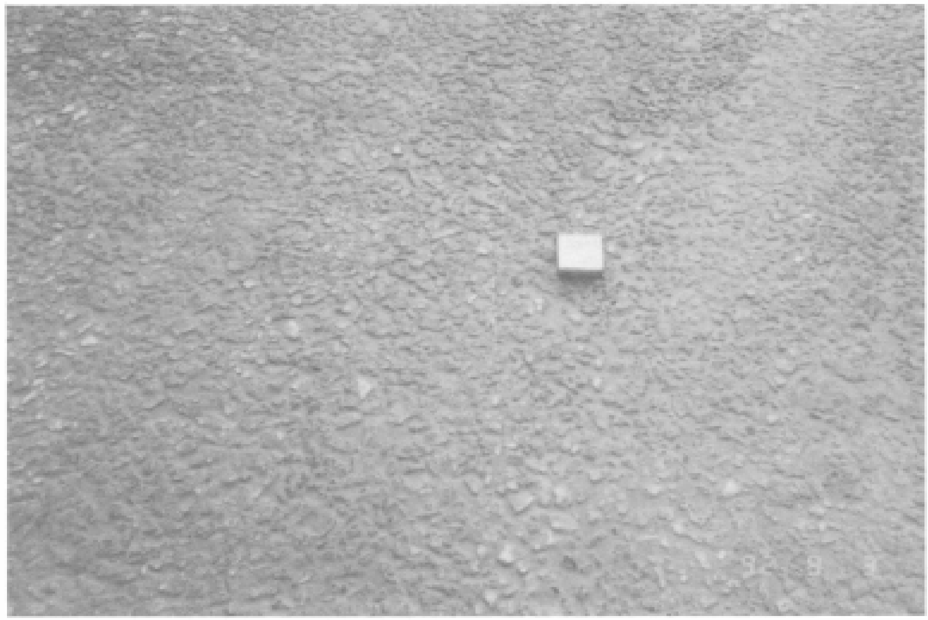
Table 4
Slurry Grout Viscosity Requirements

Time Elapsed after Addition of PL7, min	Marsh Flow Cone Viscosity, sec
0-5	8-10
>15	9-11

makes several vibratory passes over the grout filled pavement (Figure 10). The vibratory action of the roller ensures that the grout is filling all of the accessible internal voids. After an area is saturated with grout and the voids are completely filled, the excess grout is squeegeed off to produce the desired final surface texture (Figures 11 and 12).

Curing

Experience has indicated that the short-term curing protection provided by membrane-forming curing compounds is sufficient for the typical RMP project. The curing compound is typically white-pigmented to reflect the sun's



rays. The suggested application rate is 1 L/14 m^2 (1 gal/400 ft^2), which is about one-half of the typical rate used for PCC pavements. Portable hand application of curing compound is allowable immediately after grout placement (when foot tracking is not a problem) since the open-graded asphalt layer provides enough strength to immediately support light loads.

Benefits

RMP provides many of the more attractive benefits associated with both AC and PCC. It offers the ease of construction, the jointless surface, and the cost competitiveness of an AC material. It has the fuel, abrasion, and wear resistance of a PCC. RMP has successfully demonstrated resistance to permanent deformation damage from heavy, high-pressure tire loads. It has also proven its capability in carrying tracked vehicle traffic by resisting the abrasive action of the turning tracks (Ahlrich and Anderton 1991b). The RMP material is well-suited for practically any environment, as evidenced by its international history in regions ranging from the Scandinavian countries to the deserts of Saudi Arabia (Jean Lefebvre Enterprise 1990).

Limitations

RMP should only be used for relatively low-speed (less than 65 km/hr or 40 mile/hr) traffic applications. Initial construction experience indicates that the surface texture of RMP can be irregular, with some areas containing excess grout on the surface. These areas may have a reduced skid resistance, especially at the beginning of the pavement's life. Skid resistance improves during the life of an RMP as surface grout is worn away, exposing the surface of the large-stone open-graded material. When skid resistance is a critical factor, surface texturing (brooming) immediately after grout application has been used successfully.

Because of the fluidity of the slurry grout, it is very difficult to construct an RMP surfacing on steep pavement slopes. The practical limit for the surface slope of an RMP section is 2 percent. Pavement slopes slightly higher than 2 percent can be constructed, but excess hand work and grout overruns are to be expected.

Since the RMP is a relatively new paving process in the United States, the design and construction experience is somewhat limited. As previously discussed, the current thickness design approach is highly empirical with little known about the engineering properties of the RMP material. The lack of construction experience in the United States usually increases the construction time on most projects. Construction and evaluation of test sections are important to ensure that the production of paving materials meets the specified job-mix formulas. Test sections also allow the contractor's paving crews to become familiar with the unique RMP construction techniques. Even with a thorough test section evaluation, full-scale RMP production rates generally start off slowly at the beginning of most projects and increase substantially as the construction process continues.

Costs

The initial construction costs of RMP generally fall somewhere between those of an AC pavement design and a PCC pavement design. In most instances, the RMP pavement design cost will be closer to the AC pavement design cost than to the PCC pavement design cost. Bid experiences from recent RMP construction projects indicate a current cost of about $9.60 to 19.20 per square meter ($8 to $16 per square yard) of 50-mm-thick RMP surfacing.

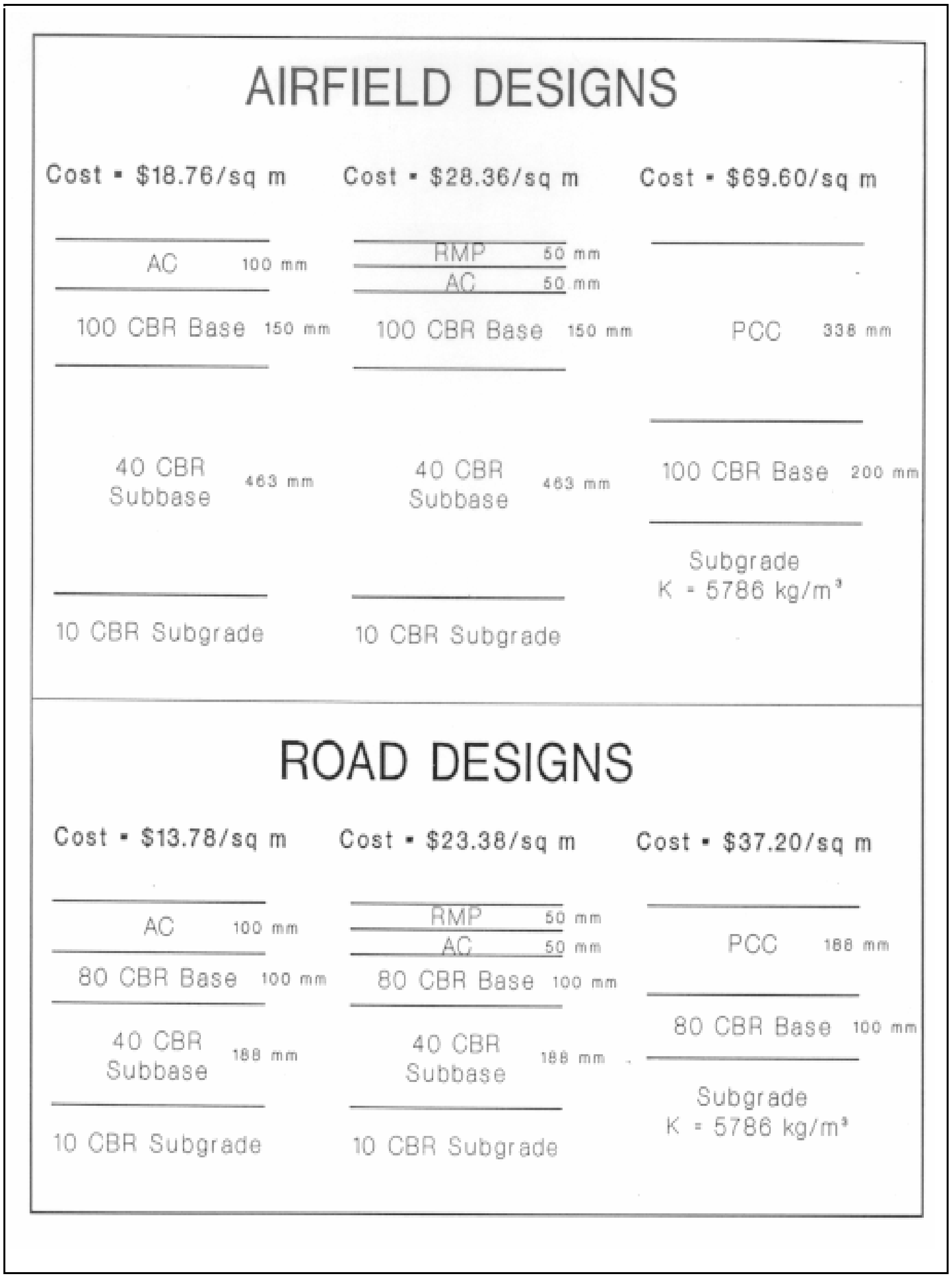
A cost comparison of AC, PCC, and RMP designs for two hypothetical pavement systems is provided to illustrate the typical differences in first costs for these three pavement types. Pavement designs were conducted using standard CE design methodologies (Headquarters, Departments of the Army and Air Force 1989 and 1992). Flexible and rigid airfield designs were conducted using the following input data:

Design Traffic = C-141 Aircraft at 156,109 kg (345,000 lb)
Design Passes = 100,000
No frost penetration considered
Subgrade California Bearing Ratio (CBR) = 10
Modulus of Subgrade Reaction (K) = 5.5 x 10^6 kg/m^3 (200 lb/in.^{3})
Subbase CBR = 40
Base CBR = 100
Rigid Design Base Thickness = 200 mm (8 in.)
PCC Flexural Strength = 5.2 MPa (750 lb/in.^{2})

Flexible and rigid road designs were also conducted for the same conditions, except for the following design parameters:

Traffic Design Index = 8
Base CBR = 80
Rigid Design Base Thickness = 100 mm (4 in.)

The thickness profiles resulting from these hypothetical pavement designs are collectively illustrated in Figure 13.



The pavement cost in terms of dollars per square meter for each 25 mm of thickness was based on the following cost assumptions:

Asphalt Concrete = $2.40/sq m
Portland Cement Concrete = $4.80/sq m
Resin Modified Pavement = $7.20/ sq m
100 CBR Base = $0.60/sq m
80 CBR Base = $0.48/sq m
40 CBR Subbase = $0.30/sq m

A quick comparison of the construction costs for these two hypothetical pavement design examples indicates the typical cost of RMP relative to the two standard pavement types: AC and PCC. Cost savings for the RMP designs versus the PCC designs are significant in each of these cases. This cost analysis clearly illustrates a critical design principal for RMP as an alternative pavement surfacing, namely:

> When an AC surfacing cannot effectively meet the pavement performance requirements where both an RMP and PCC surfacing can, then the RMP alternative will generally provide significant initial cost savings in terms of total thickness design costs.

In addition to the initial cost savings for using an RMP design instead of a PCC design, an RMP surfacing can be expected to cost much less in terms of maintenance expenditures given a proper design. The most significant maintenance cost savings will result from the lack of joints to maintain and reseal with the typical RMP surfacing. These cost savings will obviously not apply to situations where RMP is overlaid over jointed PCC pavements and joints are cut in the RMP surfacing to trace the PCC joints.

3 Acquisition/Procurement

Potential Funding Sources

Typically, installations fund the implementation of pavements and railroads technologies from their annual budgets. However, the installation's annual budget is usually underfunded and the pavements and railroads projects do not compete well with other high-visibility or high-interest type projects. As a result, it is prudent to seek out additional funding sources when the project merits the action. Listed below are some sources commonly pursued to fund projects.

a. Productivity program. See AR 5-4, Department of the Army Productivity Improvement Program (Headquarters, Department of the Army 1982) forguidance to determine if the project qualifies for this type of funding.

b. Facilities Engineering Applications Program (FEAP). In the past, a number of pavement and railroad maintenance projects located at various installations were funded with FEAP demonstration funds. At that time, emphasis was placed on demonstrating new technologies to the Directorate of Engineering and Housing (DEH) community. Now that these technologies have been demonstrated, the installations will be responsible for funding their projects through other sources. However, emphasis concerning the direction of FEAP may change in the future; therefore, one should not rule out FEAP as a source of funding.

c. Special programs. Examples of these are as follows:

(1) FORSCOM mobilization plan which may include rehabilitation or enlargement of parking areas and the reinforcement of bridges.

(2) Safety program which may include the repair of unsafe/deteriorated railroads at crossings and in ammunition storage areas.

(3) Security upgrade which may include the repair or enlargement of fencing.

d. Reimbursable customer. Examples of this source are roads to special function areas such as family housing or schools and airfield pavements required to support logistical operations.

e. Special requests from MACOM's.

f. *Year end funds*. This type of funding should be coordinated with the MACOM's to ensure that the funds will not be lost after a contract is advertised.

g. *Operations and Maintenance Army*. These are the normal funds used for funding pavement and railroad projects.

Technology Components and Sources

Components of the technology which must be procured for the use of resin modified pavement are: section design (may be in-house or contracted out) and a contractor to construct the RMP surfacing. The construction contractor must have the materials and mixing plant capable of producing the RMP open-graded asphalt mixture and, if required, a standard dense-graded asphalt mixture. In addition to the standard asphalt paving equipment, the contractor will need a small (3-tonne maximum) steel wheel roller to smooth out the open-graded material after placement.

For the modified slurry grout phase, the construction contractor will need to have access to either a nearby concrete batch plant or one or more portable concrete mixers on site. The grout batching equipment will depend upon job size and is almost always required to be the larger central batch plant. Transit mix trucks are needed to transport the grout to the job site and for placement. Hand squeegees and squeegee operators (typically three to five are sufficient) aid in the grout application. While the grout is being applied, the small 3-tonne steel wheel roller is used to vibrate the grout into the open-graded layer. Curing compounds and application equipment typical to the PCC industry are used to complete the RMP construction process.

The only unusual material required to produce an RMP surfacing is the resin additive used in the cement slurry grout. Currently, the resin additive required for grout production (Prosalvia-7 or PL7) is available only from a single source by contacting the following manufacturer's representative:

Alyan Corporation
P.O. Box 788
Vienna, VA 22183
ATTN: Mr. Ibrahim Murr
Tel: 703-255-1381
FAX: 703-255-1384

Procurement Documents

Technical reports

The Corps of Engineers has published two technical reports on the research and construction experiences of RMP:

AConstruction and Evaluation of Resin Modified Pavement,@ Technical Report GL-91-13, USAE Waterways Experiment Station, 1991 (Ahlrich and Anderton 1991b).

ADesign, Construction, and Performance of Resin Modified Pavement at Fort Campbell Army Airfield, Kentucky,@ Technical Report GL-94-5, USAE Waterways Experiment Station, 1994 (Anderton and Ahlrich 1994).

Applicable specifications

Several guide specifications are available to provide assistance in completing an RMP construction project. One of two applicable guide specifications is to be used for the construction of the AC layer beneath the RMP surfacing (unless the RMP is to be overlaid directly over an existing pavement surface). The choice of asphalt concrete specifications will depend upon the traffic requirements. There is also a guide specification available for the construction of the RMP layer itself. These specifications are as listed below:

CEGS-02551, ABituminous Paving for Roads, Streets, and Open Storage Areas (Central Plant Hot Mix),@ Department of the Army, Corps of Engineers Guide Specification, Washington, DC, April 1989 (Headquarters, Department of the Army 1989).

CEGS-02556, AAsphaltic Bituminous Heavy-Duty Pavement (Central-Plant Hot Mix),@ Department of the Army, Corps of Engineers Guide Specification, Washington, DC, June 1991 (Headquarters, Department of the Army 1991).

CEGS-02548, AResin Modified Pavement,@ Department of the Army, Corps of Engineers Guide Specification, Washington DC, October 1993 (Headquarters, Department of the Army 1993).

GSA listing

None

Vendors list and recent prices

Local contractors with experience in AC paving and PCC production should be able to successfully construct an RMP. Recent RMP construction projects indicate a price range of $9.60 to 19.20 per square meter ($8 to 16 per square yard) for a 50-mm- (2-in.-) thick RMP layer in place. Prices for any underlying AC, base course, and subbase course layers should be based upon recent local bid experiences.

Procurement Scheduling

Normal construction contract schedules should be established that allow adequate design and plan preparation time, design and review approval, contract preparation, advertising and award, and construction time. A typical pavement project is designed 1 to 2 years before it is constructed; however, plans and specifications for relatively small projects can be completed within a few months. Once construction is completed, the new RMP surfacing usually achieves full strength in about 21 days, but it may be opened to pedestrian traffic in 24 hr and light automobile traffic in 3 days.

4 Post Acquisition

Initial Implementation

Equipment

Conventional AC mixing plant and paving equipment are used to construct the RMP open-graded layer. One or two small (3-tonne maximum) steel wheel rollers are used to finish the open-graded layer after paving. Polyethylene sheeting is required to protect the open-graded layer from rain when inclement weather is expected before the grout is applied.

The modified slurry grout is typically batched in standard concrete batch plants unless the pavement area is small enough to warrant portable batch mixing equipment. For the typical plant-mixed grout scenario, transit mixer trucks are used to carry the grout to the job site and place the grout onto the pavement. If the portable mixing equipment is used, wheelbarrows may be used to dump the grout onto the pavement. In either case of grout placement, hand-operated squeegees are used to spread the grout around as it is being placed. The small, 3-tonne steel wheel roller is used in the vibratory mode to promote full penetration of the grout into the open-graded layer during the grouting operation. Curing compound is applied to the finished RMP surface by means of a mechanical or hand-operated pressurized spraying apparatus.

Materials

The materials required for the production of an RMP open-graded AC layer are basically the same as those required for typical AC production. The slurry grout materials are also fairly common to the paving industry, with the exception of the resin additive. The resin additive is a specialized formulation of a styrene-butadiene polymer latex, which serves as a plasticizing and strengthening agent in the cement grout. The resin additive is currently available from only one source and is the only known additive with a proven record of successful use in such a composite pavement material.

Personnel

The personnel normally required at an AC plant and those required for AC construction are basically the same as those needed for construction of the RMP open-graded AC layer. Typical personnel required for PCC plant production and transit mix truck hauling are also virtually the same as those needed for production and transportation of the slurry grout. The following personnel are generally required for grout application: two to three transit mixer truck drivers; one mixer truck delivery chute operator; three to four squeegee operators; one vibratory roller operator; one to two personnel to move joint battens and clean grout joints.

As time allows, some of the previously mentioned personnel may be used to measure the grout viscosity of each truck batch, apply curing compound, or apply a broom finish to the freshly grouted surface if required. The quality control testing required for RMP construction is considerably less than for more traditional AC or PCC paving and can be readily handled by one or two personnel from any commercial testing laboratory qualified for both AC and PCC testing. The exact number of personnel required for an RMP construction project will depend upon project size and other site-specific conditions.

Procedure

The general procedure used to construct an RMP pavement includes the following:

a. Construct the required subgrade, subbase, base, and dense-graded AC layers in a fashion similar to that used for other flexible pavements.

b. Construct a 50-mm-thick layer of open-graded AC using typical AC paving equipment and a small (3-tonne maximum) steel wheel roller to smooth out the open-graded surface.

c. Allow the freshly placed open-graded material to cool down to at least 38 C (100 F) before applying slurry grout. Cover the open-graded layer with polyethylene sheeting if rain is imminent.

d. Secure wooden battens (50-mm by 100-mm or 2-in. by 4-in. strips of lumber) to the surface of the cooled open-graded layer to create grouting lanes. Create grouting lanes in the 3.7- to 7.3-m- (12- to 24-ft-) wide range to suit the grouting crew size.

e. Apply slurry grout to open-graded layer from transit mix trucks.

f. Vibrate the slurry grout into open-graded layer void spaces with several passes of the vibratory steel wheel roller. *a.*

g. Once a sizeable area of the grouting lane is completed, pull excess grout off of the surface by continuous squeegeeing in one longitudinal direc tion. Also, remove wooden battens and clean off excess grout in these areas with square-blade shovels, stiff-bristled brooms, and/or squeegees.

h. Once the surface sheen has disappeared from the freshly grouted RMP surface, apply curing compound in a manner and in amounts similar to that for standard PCC pavement.

Operation and Maintenance

Operations and maintenance on an RMP are similar to that of a PCC pavement. Under normal circumstances, the only joints for an RMP surfacing will be those between the RMP material and any adjacent PCC pavement or building. Any cracks that may develop should remain hairline-sized, thus requiring virtually no maintenance efforts. Slight wearing off of the surface grout is normal and actually improves skid resistance. The life expectancy of an RMP surfacing should be approximately 15 to 25 years, depending heavily upon the performance of the underlying pavement layers.

Service and Support Requirements

A representative of the Airfields and Pavements Division, Geotechnical Laboratory (GL), WES, should be consulted in the planning and designing of an RMP project. It is recommended that the job-mix-formula for the open-graded bituminous mixture and the mixture proportions for the grout be produced and/or approved by the appropriate WES representative. Besides these recommendations, no other special services or support is required to implement or maintain this technology.

Performance Monitoring

Installation personnel can monitor and measure the performance of the RMP surfacing by making periodic inspections of the pavement for signs of distress (cracking, raveling, rutting, etc.). This monitoring of performance would be no more than that required for any AC pavement. The performance monitoring can be adjusted to fit into existing pavement management systems. The unique design and combination of materials do not allow for RMP to be classified as a typical flexible or rigid pavement system, however. This factor will require an independent pavement classification or category when including an RMP surfacing in a pavement management system.

References

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APPENDIX H
PG 82-22 HMA DATA

Figure H1 – PG 82-22 HMA Job Mix Design

TMD-042cg
Rev.06/2000

Mississippi Department of Transportation
Approval of Bituminous Mix Design Course by Materials Div.
HT 12.5mm

MDOT # 9745434
Proj. No : 91-1072-02-005-10/302020-301000
Contractor APAC-MS INC
Date: 04/03/2001
Sub Contr.
County : ALCORN
Dist. No. : 1
Test Data: Polymer Modified
From Proj.:
From Lab No:

Type Mix: = HT 12.5mm

TYPE MTL	3/4 CR GR	1/2 CR GR	RAM	CS	#893 LST	#901 LST	#7 LST	HL	AGG BLEND	JOB MIX	SPECS.
AGG SOURCE	R&S HAULERS TREMONT	R&S HAULERS TREMONT	APAC CORINTH	R&S HAULERS TREMONT	VULCAN CHEROKEE	VULCAN CHEROKEE	VULCAN CHEROKEE	BLUE CIRCLE CALERA AL			
% USED	32	14	15	8	12	8	10	1	% PASSING	% PASSING	DESIGN RANGE
1.5"/37.5mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	
1.0"/25.0mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	
3/4"/19.0mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100	100
1/2"/12.5mm	89.1	100.0	99.1	100.0	100.0	100.0	94.1	100.0	95.8	96	90-100
3/8"/9.5mm	76.8	92.5	96.8	100.0	95.9	100.0	62.5	100.0	86.8	87	89 Max
#4/4.75mm	50.0	51.8	76.3	93.7	24.8	99.5	13.1	100.0	55.4	55	
#8/2.36mm	30.7	26.8	59.6	74.3	3.2	70.0	2.0	100.0	35.6	36	20-60
#16/1.18mm	17.9	15.4	49.2	63.3	1.7	35.2	0.9	100.0	24.4	24	
#30/.600mm	10.6	10.0	41.1	56.9	1.5	20.4	0.6	100.0	18.4	18	
#50/.300mm	6.4	6.9	25.3	23.8	1.3	14.5	0.4	100.0	11.1	11	
#100/.150mm	4.2	5.0	15.3	1.5	1.2	11.4	0.3	100.0	6.5	7	
#200/.075mm	3.9	3.8	9.2	0.2	1.0	9.3	0.2	95.0	5.0	5.0	4.0-9.0
									%AC	5.20	
Gsa	2.578	2.573	2.576	2.626	2.697	2.710	2.697	2.240	2.612	MIX TEMP	310
Gsb	2.402	2.399	2.493	2.559	2.615	2.615	2.618	2.240	2.487	VOIDS	4.0
%CR +#4	92.3	93.6	82.8	0.0	100.0	100.0	100.0	100.0	93.8	VMA	14.1
HUMPRATIO	>>>>>>>	>>>>>>>	>>>>>>>	>>>>>>>	>>>>>>>	>>>>>>>	>>>>>>>	>>>>>>>	43.6	VFA	71
%CLAY				1					0.1	Gmm	2.360
PI -#40 MTL				NP						Gsb	2.487
%ABS MOIST	2.84	2.82	1.29	1.00	1.16	1.34	1.12	0.00	1.94	Pba(mix)	0.84
	Comp.Temp.=	Approx 310 F	Mixing Temp.=	Approx 340 F						Pbe	4.36
ANTI STRIP	NONE	RATE	% By Wgt of AC.							D/B	1.15
AC SOURCE	Ergon PG 82-22	TSR	95.3	F/E=	0.2	FAA=	N/A			Gse	2.541
	Ni 8		Nd 96		Nm 152					Gb	1.027

REMARKS: % Rap used = 15 % AC (Rap) = 5.30 % AC(Add) = 4.41 % AC (Total) = 5.20

The percentage of asphalt cement Ergon PG 82-22 used with the above blend of mineral aggregates for the HT 12.5mm Polymer Mod.
Course is 4.41

Table H2 – PG 82-22 Designs with different AC Contents

Mississippi Department of Transportation
Bituminous Design Laboratory
Materials Div
Jackson MS
Date: 3/03/2000
Polymer Modified

Proj #--- 91-1072-02-005-10
County- ALCORN
Contr.--- APAC-MS INC
Sub------
Mix HT 12.5mm

G_{se}= 2.541 G_b= 1.0270

Mix # 1 Samp #1 — Asphalt Content 4.50

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4603.5	2.383	2.240	2.487	95.5

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	132.3	1.969	2.006	84.2	22.9	15.8	31.1
Nd 96	120	2.171	2.212	92.8	15.0	7.2	52.4
Nm 152	118.5	2.198	2.240	94.0	14.0	6.0	57.1

Mix #1 Samp #2 — Asphalt Content 4.50

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4593.2	2.383	2.231	2.487	95.5

Gyratn	Height	Est.Gmb	COR. Gmb	% Gmm	% VMA	%Voids	%VFA
Ni 8	133.2	1.951	1.993	83.6	23.5	16.4	30.3
Nd 96	120.5	2.157	2.203	92.5	15.4	7.5	51.0
Nm 152	119	2.184	2.231	93.6	14.3	6.4	55.5

Average

	% Gmm	% VMA	%Voids	%VFA
Ni 8	83.9	23.2	16.1	30.7
Nd 96	92.6	15.2	7.4	51.7
Nm 152	93.8	14.1	6.2	56.3

Mix #2 Samp #1 — Asphalt Content 5.00

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4611.1	2.366	2.278	2.487	95.0

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	130.7	1.996	2.037	86.1	22.2	13.9	37.3
Nd 96	118.5	2.202	2.247	95.0	14.1	5.0	64.4
Nm 152	116.9	2.232	2.278	96.3	13.0	3.7	71.2

Mix #2-- Samp #2 — Asphalt Content 5.00

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4604.3	2.366	2.271	2.487	95.0

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	131	1.989	2.030	85.8	22.4	14.2	36.7
Nd 96	118.7	2.195	2.240	94.7	14.4	5.3	63.0
Nm 152	117.1	2.225	2.271	96.0	13.2	4.0	69.5

Average

	% Gmm	% VMA	%Voids	%VFA
Ni 8	85.9	22.3	14.1	37.0
Nd 96	94.8	14.3	5.2	63.7
Nm 152	96.1	13.1	3.9	70.3

Mix #3 Samp #1 — Asphalt Content 5.50

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4633.7	2.350	2.291	2.487	94.5

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	131.3	1.997	2.038	86.7	22.5	13.3	41.1
Nd 96	118.4	2.215	2.260	96.2	14.1	3.8	72.8
Nm 152	116.8	2.245	2.291	97.5	12.9	2.5	80.5

Mix #3 Samp #2 — Asphalt Content 5.50

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4646.3	2.350	2.292	2.487	94.5

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	130.4	2.016	2.044	87.0	22.3	13.0	41.6
Nd 96	117.8	2.232	2.263	96.3	14.0	3.7	73.4
Nm 152	116.3	2.261	2.292	97.5	12.9	2.5	80.8

Average

	% Gmm	% VMA	%Voids	%VFA
Ni 8	86.8	22.4	13.2	41.3
Nd 96	96.2	14.1	3.8	73.1
Nm 152	97.5	12.9	2.5	80.6

Mix #4 Samp #1 — Asphalt Content 6.00

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4669.1	2.334	2.293	2.487	94.0

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	132.1	2.000	2.038	87.3	23.0	12.7	44.7
Nd 96	119	2.220	2.262	96.9	14.5	3.1	78.6
Nm 152	117.4	2.251	2.293	98.2	13.3	1.8	86.7

Mix #4 Samp #2 — Asphalt Content 6.00

Mix.wgt (gms)	Max.Sg (Gmm)	Corrected Gmb@Nm	BSG of agg. (Gsb)	%Aggr. (Ps)
4665.5	2.334	2.298	2.487	94.0

Gyratn	Height	EST. Gmb	COR. Gmb	% Gmm	%VMA	%Voids	%VFA
Ni 8	132	2.000	2.040	87.4	22.9	12.6	44.9
Nd 96	118.9	2.220	2.265	97.0	14.4	3.0	79.3
Nm 152	117.2	2.253	2.298	98.4	13.1	1.6	88.1

Average

	% Gmm	% VMA	%Voids	%VFA
Ni 8	87.3	22.9	12.7	44.8
Nd 96	97.0	14.4	3.0	79.0
Nm 152	98.3	13.2	1.7	87.4

Figure H3 – Summary of PG 82-22 Mix Designs

Type Mix--------- **HT 12.5mm** **Polymer Modified**

DATE: *04/03/2001*

PROJECT NO: *91-1072-02-005-10/302020-301000*

COUNTY: *ALCORN*

CONTRACTOR: *APAC-MS INC*

Sub Contractor:

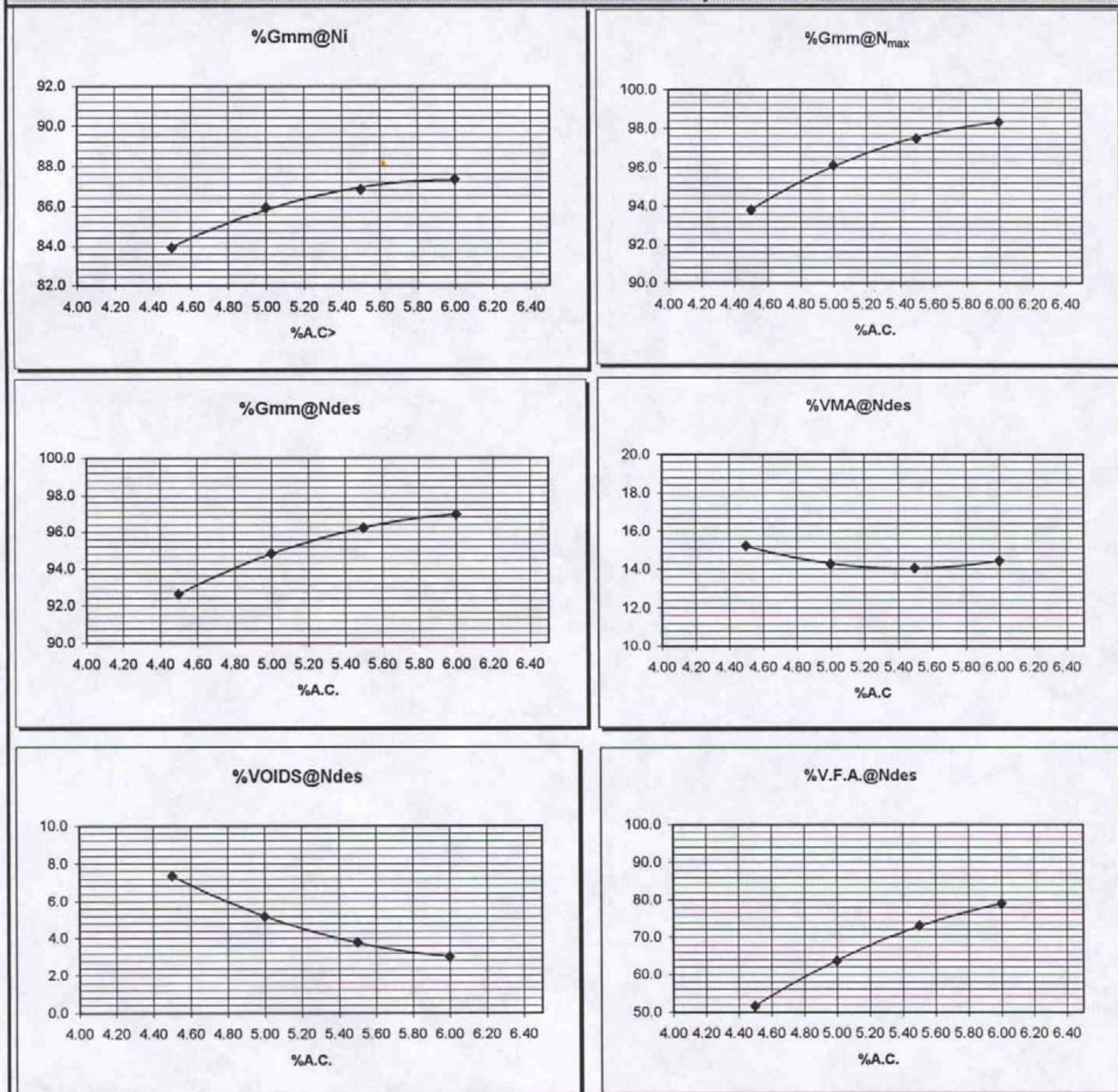
Ni 8

Nd 96

Nm 152

Polymer Modified

Materials Division



SUMMARY OF MIX DESIGN

%AC	%Gmm @ N_i	%G_{mm} @ N_{max}	%G_{mm} @ N_{des}	%Voids @ N_{des}	%VMA@N_{des}	%VFA@N_{des}
4.50	83.9	93.8	92.6	7.4	15.2	51.7
5.00	85.9	96.1	94.8	5.2	14.3	63.7
5.50	86.8	97.5	96.2	3.8	14.1	73.1
6.00	87.3	98.3	97.0	3.0	14.4	79.0

Table H4 – PG 82-22 Gradation Chart

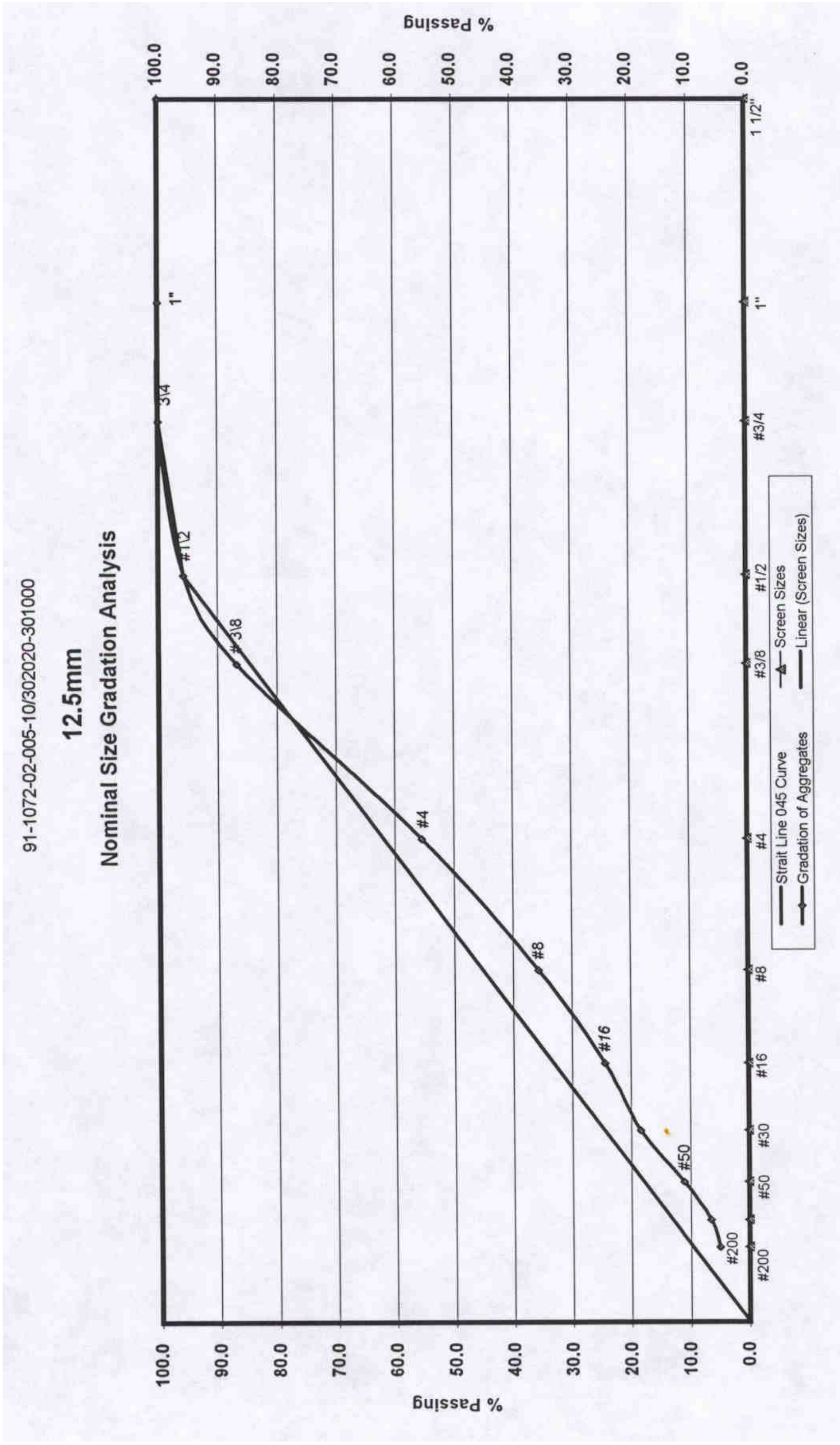


Figure H5 – Chemical Analysis of PG 82-22 Binder

86-01

-- MISSISSIPPI DEPARTMENT OF TRANSPORTATION --
MATERIALS DIVISION

TMD-019cg PERFORMANCE GRADED ASPHALT BINDER MAY 21 2001

Test	Code	Fund	Accnt	Func	Obj	Detail Code	Par	Quantity
0	012			113	846	00 0000 00 262 1 0	1	1.0

MDOT Lab Number: 9751205 Accept Code: 1 Responsibility Code: 00
Mtl: BIT MTL PG 82-22 Qty: 0.0
Project: 103152-001000 7599999913710 County: STATEWIDE
Producer: NOT SUPPLIED Address: (?).
Manufacturer: ERGON INC Address: VICKSBURG, MS VICKSBURG
Sampled By: MANUFACTURER MANUFACTURER Samp Id: CAS MIXTURE Date: 10/23/2000
Submitted By: ASSISTANT MATL ENG RICHARD H SHEFFIELD Date: 05/15/2001
Reported To: ASSISTANT MATL ENG RICHARD H SHEFFIELD Date: 05/21/2001
Intended Use: RESIN MODIF. PAVE DTFH71 Test Desired: USUAL
Remarks: JOB CONTROL SAMPLE.
CORINTH PROJECT - REPORT TO JOHNNIE BENNETT (11-15), RANDY BATTEY
(86-01) AND RICHARD SHEFFIELD (72-01)

TESTS ON PERFORMANCE GRADED '82-22' ASPHALT BINDER
(T48, ASTM D4402, TP5, TP1, PP1, TP48, T179)

P/F	Test	Result	Min	Max
	TESTS ON UNAGED MATERIAL			
_	Flash Point Temperature, C	- —	230	
P	Brookfield Viscosity @ 135.0 C, 20 rpm, spindle no.27,torque % 28.0 , Pa.s	3.00		3
P	G*/sin delta @ 10 rad/sec, 82 C, kPa	1.43	1.00	
	TESTS ON RTFO RESIDUE			
P	Mass Loss, %	.24		1.00
P	G*/sin delta @ 10 rad/sec, 82 C, kPa	3.32	2.20	
	TESTS ON PAV RESIDUE			
	PAV Temperature @ 100 C			
P	G*/sin delta @ 10 rad/sec, 34 C, kPa	0484		5000
	Bending Beam			
P	Creep Stiffness, S, 60 sec,-12 C, MPa	138		300
P	Slope, m, 60 sec,-12 C	0.326	0.300	

Remarks
THE BROOKFIELD VISCOSITY AT 135.0C WAS 3.45 PA.S WHICH MEETS THE WHOLE NUMBER 3 MAXIMUM SPECIFICATION FOR THIS TEST.
This material DOES meet the requirements of Section BIT MTL PG 82-22 on the basis of the above tests.

Tested By CHEMICAL LAB-JAMES GRICE

** SAMPLE ACCEPTED **

ACCEPTED
MAY 2 , 2001
MDOT

Table H6 – PG 82-22 Inspectors Daily Report

TMD-004
Rev.: 2-93

MISSISSIPPI DEPARTMENT OF TRANSPORTATION
ASPHALT PAVING INSPECTORS DAILY REPORT

~~Lot~~ Report No. 7 Date 6-18-01 Project 91-1072-02-005-10 Co. ALCORN Temp: 66° AM 93° PM

Beginning Sta. No. ______ Ending Sta. No. ______ Lot Length * Ft.

No. and Type of Pavers 1 PF 3200 BLAW KNOX

No. and Type of Rollers 2 STeeL Wheel

Thickness of Course 2 In.

Tons (✓) Sq. Yds. ( )	Base	Leveling	Binder	Surface
Total Contract				6000
Total Today				1650.11
Theo. Total Today (1)				1793.42
~~O.R.~~ / U.R. Today				-143.31
Total to Date				5097.39
Theo. Total to Date (1)				5209.68
~~O.R.~~/U.R. to Date				-112.29

CONTROL STRIP DENSITY

Sublot	1	2	3	4	5	Av.
Station						
Location						
Core Density, PCF						
Nuclear Density, PCF						
Gauge Correlation (± Bias) PCF						

LOT DENSITY

Sublot	1	2	3	4	5	Av.	Pay Factor
Station							
Location							
Nuclear Density, PCF							
Bias (±) PCF							
Corr. Nuclear Density, PCF							
Max. Density, PCF							
Density,%							

PAY FACTOR FOR NON-CONFORMING MIXTURE (2)

Mixture Characteristic	Production Time From	To	Quantity of Material Placed, Tons	Pay Factor

REMARKS: * 199+56 - 241+65, 246+25 - 268+40 outside LN LT of ℄

199+56 - 204+26, 207+10 - 240+00, 243+06 - 268+40 outside LN Rt of ℄

Note: (1) Based on unit weight of roadway density. 146.1 Lbs/CF
Note: (2) Info from TMD-005. If entire lot meets for 100% pay, enter 1.0 under Pay Factor.

DISTRIBUTION:
- Original to State Materials Engineer
- Copy to State Construction Engineer
- Copy to District Materials Engineer
- Copy to Project Engineer
- Copy to Field Lab File

Signed [signature] Paving Inspector

Figure H7 – PG 82-22 Density Report

MDOT QMP ASPHALT DENSITY REPORT
Project Number 91-1072-02-005-10
County Alcorn

DAY	Contractor Report No.'s 6/18/2001	M.D.O.T. Dist. 1 Report No.'s	File Density No. 960

MDOT Mix No. 9745434B Type Mix HT 12.5 mm/Poly A.C. Source Ergon Placed As SURFACE

Contractor APAC MS. (Corint Sub Contr. Agg. BSG. 2.487 Job Mix AC 5.4

Date Mix Produced 6/18/2001 Date Density Taken 6/19/2001

Producer of Mix APAC MS. (Corinth) DAY BEGIN STA. / Lane SEE REMARKS DAY END STA. / Lane

Total Tons Mix Placed 1646.0 Req. No. Lots Lot Length

Air Temperature: AM PM

Contractor Maximum Specific Gravity 2.348

MINUIMUM DENSITY REQ'D. FOR 100% PAY 92

Evaluation Section / Bias Update

Sta. Limits of 300' Evaluation Section		Beginning Station		Ending Station		Lane		
Sublot No.	1	2	3	4	5	6	7	Average
Test Station								*************
Location from Lt. Edge								*************
Offset								*************
Core Density (PCF)								
Nuclear Density (PCF)								
Calculated Bias, (PCF)								

Below for Bias Update Only (Min. of 4 Lots for Bias Update)

Maximum Density (PCF)								*************
Core Compaction %								
Pay Factor								*************

Previous Guage	3.85		3.85	3.85	3.85	3.85	3.85	*************
Biases:								3.9

Test Section / Lot Compaction Nuclear Density Information

Sublot No.	1	2	3	4	5	6	7	Average
# 1 Station No.	217+64	239+07	265+01	229+97	280+63			*************
# 1 Lane / offset	2'	5'	3'	6'	3'			*************
# 1 Nuclear Den. PCF	133.5	134.2	134.0	133.8	132.9			*************
# 2 Station No.	202+16	249+97	206+75	250+43	271+39			*************
# 2 Lane / offset	7'	7'	5'	9'	7'			*************
# 2 Nuclear Den. PCF	133.8	132.9	135.1	134.0	134.1			*************
Sites # 3 through # 5 used only when the difference between nuclear density # 1 and nuclear density # 2 exceeds 3 PCF.								
# 3 Station No.								*************
# 3 Lane / offset								*************
# 3 Nuclear Den. PCF								*************
# 4 Station No.								*************
# 4 Lane / offset								*************
# 4 Nuclear Den. PCF								*************
# 5 Station No.								*************
# 5 Lane / offset								*************
# 5 Nuclear Den. PCF								*************
Avg. Nuclear Den.	133.7	133.6	134.6	133.9	133.5			*************
Bias(+/-) PCF	3.9	3.9	3.9	3.9	3.9	3.9	3.9	*************
Corr. Nuclear Density	137.5	137.4	138.4	137.8	137.4			*************
Max Density. PCF	146.1	146.1	146.1	146.1	146.1	146.1	146.1	*************
% Density	94.1	94.0	94.7	94.3	94.0			94.2
LOT PAY FACTOR	100 %	100 %	100 %	100 %	100 %			

Note: Max Density, PCF = Average Gmm for the day x 62.24

Remarks
Densities as reported hereon are dependent on verification of Contractor QC results.
199+56-204+26 , 207+10-240+00 , 243+06-268+40 LTLN,LTSIDE . 199+56-241+65 . 246+25-286+46 RTLN,RT SIDE

DISTRIBUTION:
Original to State Testing Engineer
Copy to State Construction Engineer
Copy to District Testing Engineer
Copy to Project Engineer (R. Parks)
Copy to Producer Lab File

Signed

Figure H8 – PG 82-22 Quality Control Report

QMP HOT-MIX ASPHALT

Q.C. Mixture Report

Project Number MP-1072-02(005)

Contractor Report No.'s				CONTRACTOR	
DATE	06/18/2001	LOT #	06/18/2001	SAMPLE LAB NUMBER =	170

MDOT Mix No.	9745434	Type Mix	HT 12.5 mm	A.C. Source	ERGON	Placed As	SURFACE
Contractor	APAC INC. (CORINTH)	Sub Contr.		Agg. BSG.	2.487	Job Mix AC	5.4
J. M. VMA	14.1	J. M. Voids	4	J.M. % Cr. Mat'l.	93.8	J.M. % L. S. Ret.	
Producer of Mix	APAC - Corinth			% Crush Count		% L. S. Ret.	
Date Mix Produced		06/18/2001		Sample Tonage	RESEARCH	Sample Temp	335

Extraction

Sample Mass, g	2183
Dry Mass, g	2182.1
Extr. Mass, g	2066.9

Job Mix	Sieve Size	CONTRACTOR Mass Ret.	CONTRACTOR % Passing	DEVIATION FROM JMF
100	1 1/2"	0.0	100	0.0
100	1"	0.0	100	0.0
100	3/4"	0.0	100	0.0
96	1/2"	86.6	95.8	0.2
87	3/8"	299.4	85.5	1.5
55	#4	931.4	54.9	0.1
36	#8	1351.4	34.6	1.4
	#16			
18	#30	1672.4	19.1	-1.1
11	#50	1815.8	12.1	-1.1
5	#200	1962.2	5.1	-0.1

Max. Sp. Gr.

Sam. Mass	1787.5	1892.6
Cali. Mass	1412.3	1412.3
Final Mass	2438.8	2499.9
SSD Mass		
Dry Back Factor	0.004	0.004
Max Sp. Gr.	2.345	2.347
MRCF	1	1
Cor. Max. SG	2.345	2.347
AVERAGE OF 2 TESTS		2.346

AC Content / Moisture Corr.

% AC	5.32
Sample Mass	517.8
Dry Mass	517.6
% Moistue	0.04
% Corr. AC	5.28

Laboratory Compaction / Void Analysis

Specimen No.	1	2	3	4	Average
Comp. Temp.	310	310			************
Mass in Air	4609.1	4610.0			************
Mass in Water	2581.5	2585.6			************
Mass SSD	4615.2	4615.3			************
Volume	2033.7	2029.7			2031.7
Bulk Gr.	2.266	2.271			2.269
Height (N-MAX)	117.4	117.5			************
Height (N-DES)	119.0	119.0			************
Bulk Gr.(N-DES)	2.236	2.242			2.239
EQ. Corr. Factor	1	1	1	1	************
BRCF	1	1	1	1	************
Corr. Bulk Gr.	2.236	2.242			2.239
Total Voids %	4.7	4.4			4.6
VMA %	14.8	14.6			14.7

DESIGN # GYRATIONS

N (ini) =	8
N(des)=	96
N(max)=	152

ADDITIONAL MIX DESIGN NUMBERS FOR PROJECTS SAMPLE COVERS

ADDITIONAL #1	ADDITIONAL #2	ADDITIONAL #3

Remarks THIS MIX LAYED ON RESEARCH AERA ON HWY. 72

Signed

Figure H9 – PG 82-22 Truck Tickets

APAC - Mississippi, Inc.
Northern Division
P.O. Box 1388
Columbus, MS 39701

apac

CUSTOMER/OWNER

434081

SOLD TO:	SHIP TO:	TICKET	DATE	TIME
MS DEPT OF TRANSPORTATION MP-1072-02(005)/302020 ALCORN COUNTY	HWY. 72 MILL & OVERLAY	0434081	06/18/2001	11.54.43
		PLANT	OPERATOR	ORDER
		460	TED/BO	

CUSTOMER	QUOTE	JOB - ITEM		PURCHASE ORDER	SUB-PURCHASE ORDER	CHECK	STATUS	TAX AREA
50003631	3620	2027	2					MISS
VEHICLE	TYPE	ZONE	LOAD	DAILY TOTAL				
600822	3A		7	111.74	LEGAL GROSS 54,000 LEGAL NET 32,540			

PRODUCT DESCRIPTION UNIT GROSS/lbs TARE/lbs NET/lbs NET/TON UNIT PRICE AMOUNT
444 MDOT HT 12.5 MM POLY TON 53,720 21,460 32,260 16.13
LOAD #46 SHIFT 772.65 TO-DATE 4,223.64 PRICE CODE HAUL CODE IX

12:15

G. Caldwell

207+50
206+00

Lt Lt Lane

320

RECEIVED BY DRIVER

APAC - Mississippi, Inc.
Northern Division
P.O. Box 1388
Columbus, MS 39701

apac

CUSTOMER/OWNER

434080

SOLD TO:	SHIP TO:	TICKET	DATE	TIME
MS DEPT OF TRANSPORTATION MP-1072-02(005)/302020 ALCORN COUNTY	HWY. 72 MILL & OVERLAY	0434080	06/18/2001	11.52.50
		PLANT	OPERATOR	ORDER
		460	TED/BO	

CUSTOMER	QUOTE	JOB - ITEM		PURCHASE ORDER	SUB-PURCHASE ORDER	CHECK	STATUS	TAX AREA
50003631	3620	2027	2					MISS
VEHICLE	TYPE	ZONE	LOAD	DAILY TOTAL				
0837	2X		8	129.86	LEGAL GROSS 54,000 LEGAL NET 32,900			

PRODUCT DESCRIPTION UNIT GROSS/lbs TARE/lbs NET/lbs NET/TON UNIT PRICE AMOUNT
444 MDOT HT 12.5 MM POLY TON 53,180 21,100 32,080 16.04
HAUL BY THE UNIT 16.04
LOAD #45 SHIFT 756.52 TO-DATE 4,207.51 PRICE CODE HAUL CODE A1

12:03

G. Caldwell

208+50 -
207+50

LT LT Lane

335

MARTY

RECEIVED BY DRIVER

Figure H10 – PG 82-22 Truck Tickets

APAC - Mississippi, Inc.
Northern Division
P.O. Box 1388
Columbus, MS 39701

apac

CUSTOMER/OWNER
434077

SOLD TO:	SHIP TO:	TICKET	DATE	TIME
MS DEPT OF TRANSPORTATION MP-1072-02(005)/302020 ALCORN COUNTY	HWY. 72 MILL & OVERLAY	0434077	06/18/2001	11.40.14
		PLANT	OPERATOR	ORDER
		460	TED/BO	

CUSTOMER	QUOTE	JOB - ITEM		PURCHASE ORDER	SUB-PURCHASE ORDER	CHECK	STATUS	TAX AREA
50003631	3620	2027	2					MISS

VEHICLE	TYPE	ZONE	LOAD	DAILY TOTAL	
0399	2X		8	136.48	LEGAL GROSS 54,000 LEGAL NET 34,120

PRODUCT	DESCRIPTION	UNIT	GROSS/lbs	TARE/lbs	NET/lbs	NET/TON	UNIT PRICE	AMOUNT
444	MDOT HT 12.5 MM POLY	TON	53,460	19,880	33,580	16.79		
		HAUL BY THE UNIT				16.79		

LOAD #43 SHIFT 724.31 TO-DATE 4,175.30 PRICE CODE HAUL CODE A1

G. Caldwell
340°

T. Gant 11:48
210+23 – 21+50
LT LN, LT

RECEIVED BY

DRIVER JOHN L. HARDWICK

APAC - Mississippi, Inc.
Northern Division
P.O. Box 1388
Columbus, MS 39701

apac

CUSTOMER/OWNER
434078

SOLD TO:	SHIP TO:	TICKET	DATE	TIME
MS DEPT OF TRANSPORTATION MP-1072-02(005)/302020 ALCORN COUNTY	HWY. 72 MILL & OVERLAY	0434078	06/18/2001	11.47.40
		PLANT	OPERATOR	ORDER
		460	TED/BO	

CUSTOMER	QUOTE	JOB - ITEM		PURCHASE ORDER	SUB-PURCHASE ORDER	CHECK	STATUS	TAX AREA
50003631	3620	2027	2					MISS

VEHICLE	TYPE	ZONE	LOAD	DAILY TOTAL	
0163	2X		8	130.47	LEGAL GROSS 54,000 LEGAL NET 32,740

PRODUCT	DESCRIPTION	UNIT	GROSS/lbs	TARE/lbs	NET/lbs	NET/TON	UNIT PRICE	AMOUNT
444	MDOT HT 12.5 MM POLY	TON	53,600	21,260	32,340	16.17		
		HAUL BY THE UNIT				16.17		

LOAD #44 SHIFT 740.48 TO-DATE 4,191.47 PRICE CODE HAUL CODE A1

G. Caldwell
335°

11:58
210+25
208+50
LT LT lane

333

RECEIVED BY

DRIVER C & G FARMS

Table H11 – PG 82-22 Mat Temperatures @ Cass Street (Inside Lane)

85 Degrees F with no wind		
Station	**Paver Time**	**Mat Temp (F)**
0+00	2:20 PM	288
0+50	2:21 PM	308
1+00	2:23 PM	316
1+50	2:24 PM	308
2+00	2:26 PM	299
2+50	2:27 PM	307
3+00	2:28 PM	289
3+50	2:30 PM	293
4+00	2:31 PM	315
4+50	2:32 PM	312

Table H12 – PG 82-22 Mat Temperatures @ Cass Street (Outside Lane)

90 Degrees F with no wind		
Station	**Paver Time**	**Mat Temp (F)**
0+00	12:23 PM	242
0+50	12:24 PM	253
1+00	12:25 PM	252
1+50	12:26 PM	240
2+00	12:28 PM	249
2+50	12:29 PM	252
3+00	12:31 PM	271
3+50	12:32 PM	275
4+00	12:33 PM	281
4+50	12:34 PM	293

Table H13 PG 82-22 Rut Measurements

US72 Westbound @ Cass St.				US72 Westbound @ Cass St.		
(PG 82-22 HMA Location)				(PG 82-22 HMA Location)		
07/05/2001	Ruts (1/16 th inch)			**12/19/2001**	Ruts (1/16 th inch)	
Station	LWP	RWP		Station	LWP	RWP
0+00	1	2		0+00	1	3
0+25	2	1		0+25	2	1
0+50	0	1		0+50	0	2
0+75	1	2		0+75	1	2
1+00	0	1		1+00	0	1
1+25	0	0		1+25	0	1
1+50	1	1		1+50	2	1
1+75	1	1		1+75	1	1
2+00	2	1		2+00	2	1
2+25	1	0		2+25	2	1
2+50	3	1		2+50	4	2
2+75	2	0		2+75	3	1
3+00	2	0		3+00	4	2
3+25	2	1		3+25	4	2
3+50	2	1		3+50	6	3
3+75	3	0		3+75	5	1
4+00	2	0		4+00	2	0
4+25	0	0		4+25	1	0
4+45	1	0		4+45	1	0

Table H14 – PG 82-22 Asphalt Pavement Analyzer Results

Project No.	91-1072-02-005-10		Test No.	R0406-0		Temperature:	64 deg C
Mix ID No.	9745434		Test Date:	04/09/2001		Wheel Load:	100 lbs
Mix Type	HT 12.5mm/PG 82-22		Data File:	R0406_0.ptd		Hose Pressure:	100 psi
Contractor	APAC		Run Status:	Complete		Run Time:	2hrs 15min 11sec
Left Sample ID: 13&14			Bulk Spec Gravity: 2.193			% Air Voids: 6.90%	
	Stroke Count		Avg. Depth of Rut (mm)				
	0		0.000				
	500		0.993				
	1000		1.284				
	1500		1.481				
	2000		1.520				
	3000		1.909				
	4000		2.137				
	5000		2.307				
	6000		2.477				
	7000		2.629				
	8000		2.752				
Middle Sample ID: 15&16			Bulk Spec Gravity: 2.197			% Air Voids: 6.70%	
	Stroke Count		Avg. Depth of Rut (mm)				
	0		0.000				
	500		0.919				
	1000		1.149				
	1500		1.318				
	2000		1.430				
	3000		1.643				
	4000		1.757				
	5000		1.861				
	6000		1.940				
	7000		2.208				
	8000		2.348				
Right Sample ID: 17&18			Bulk Spec Gravity: 2.196			% Air Voids: 6.70%	
	Stroke Count		Avg. Depth of Rut (mm)				
	0		0.000				
	500		1.019				
	1000		1.327				
	1500		1.458				
	2000		1.659				
	3000		1.854				
	4000		2.003				
	5000		2.127				
	6000		2.310				
	7000		2.440				
	8000		2.543				

Table H15 – PG 82-22 Smoothness Data Collected in the Outside Lane

Date Collected	IRI (mm/m)	PI (0.2" Blanking Band) (in/mi)	PI (Zero Blanking Band) (in/mi)
June 18, 2001	n/a	16.03	35.24
July 6, 2001	1.41**	n/a	n/a
August 22, 2001	1.32**	n/a	n/a

Note: PI data was collected in the right wheelpath using a "California Type" Profilograph with a 2' low pass Butterworth filter.
** - July 6 & August 22 IRI is the average IRI of both wheelpaths collected using MDOT's High Speed "South Dakota Type" Profiler.

Table H16 – PG 82-22 Friction Data Collected in the Outside Lane

Date	Skid No	Avg Speed (mph)	Temp (F)	Time (CST)
July 6, 2001	35.4	n/a	n/a	n/a
July 6, 2001	35.6	n/a	n/a	n/a
July 6, 2001	36.3	n/a	n/a	n/a
	35.8			
August 22, 2001	35.4	39.8	n/a	11:01 PM
August 22, 2001	38.4	38.8	84	11:06 PM
August 22, 2001	36.9	39.3	84	11:10 PM
	36.9			
December 4, 2001	33.8	39.4	59	12:09 AM
December 4, 2001	35.1	39.7	59	12:14 AM
December 4, 2001	35.8	39.4	59	12:19 AM
	34.9			

Table H17- Long Term Data for PG 82-22

Cass Street PG 82-22								
Year	**Inside Lane**				**Outside Lane**			
	SN	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**	**SN**	**Rut Avg. (in)**	**IRI Avg. (mm/m)**	**PCR**
2002	34.8	-	-	-	30.9	-	-	-
2003	35.1	0.03	1.09	91.3	35.4	0.17	1.62	87
2004	-	0.13	1.02	91.9	-	0.02	1.54	87.7
2005	28.1	0.04	1.12	91	28.5	0.25	1.53	87.8
2006	-	0.16	1.11	90.9	-	0.24	1.62	88.6

APPENDIX I
COST DATA

Table I1 - Ultra-Thin Whitetopping Cost Data
(Note: Milling and Traffic Control Costs are not included)

Estimated Cost			
Plan Area = 1264 sq. yds.			
APAC Construction Cost			
	Labor	$5988	
	Sundry Material (curing compound, misc. forming matls)	$1600	
	Equipment	$6250	
	Rental Equipment (air compressor)	$ 400	
	Sub-contractor (concrete sawing @ $0.90/ft)	$5972	
	Indirect costs (payroll indirects, taxes, etc)	$5222	
			$25,432
B & B Concrete Supply Cost			
	5000 psi concrete		**$ 9986**
			$35,418

Estimated Cost for 3” thickness = $28.02/sq. yd.

Actual Cost

Due to excess milling in some areas an additional 19 cubic yds of concrete was required @ $83.90/cubic yd

B & B Concrete Supply Cost		
	19 additional yds of 5000 psi concrete	**$ 1594**
		$37,012

Actual Cost for 3” thickness = $29.28/sq. yd.

Table I2 – Resin Modified Pavement Cost Data
(Note: Milling and Traffic Control Costs are not included)

Estimated Cost

Estimated Plan Area = 2533 sq. yds. (including test strip)

APAC Construction Cost

Labor	$6353	
Material (open graded HMA)	$5940	
Sundry Material	$ 883	
Haul cost	$ 667	
Equipment	$2162	
Sub-contractor (sawing @ $1.00/ft)	$ 910	
Indirect costs (payroll indirects, taxes, etc)	$8355	
		$25,270
B & B Concrete Supply Cost		
Resin modified grout		**$38,760**
		$64,030

Estimated Cost for 2" thickness = $25.28/sq. yd.

Actual Cost

Due to excess milling in some areas and a limited amount of PL7 additive, 600 sq yds were eliminated from the test area to insure there would be enough grout to finish the project.

An additional 200 sq. yds of test area was eliminated when the 75' portion of one the sites had to be removed due to the lack of full depth grout penetration.

Actual Cost for 2" thickness = $36.95/sq. yd.

Table I3 – PG 82-22 HMA Cost Data
(Note: Milling and Traffic Control Costs are not included)

Estimated Cost

Estimated Plan Area = 1200 sq. yds.

APAC Construction Cost

APAC bid cost of PG 82-22 HMA = $45.56 per ton in place
@ 135 lbs/ft^3 - 243 tons of PG 82-22 HMA were placed **$11,070**

Estimated Cost for 4” thickness = $9.23/sq. yd.

Actual Cost

Actual cost did not deviate from estimated

Actual Cost for 4” thickness = $9.23/sq. yd.