FINAL REPORT

STATE STUDY NO. 105

Evaluation of Structural Factors in the Design of HMA Pavements Over CRCP

Prepared by

William F. Barstis, PE

Muralidhar Seshadri, PE

May 2000

Conducted by

Research Division
Mississippi Department of Transportation

In Cooperation with the

U.S. Department of Transportation
Federal Highway Administration

Technical Report Documentation Page

1.Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/MS-DOT-RD-00-105		

4. Title and Subtitle	5. Report Date
Final Report Evaluation of Structural Factors in the Design of HMA Pavements Over CRCP	May 2000
	6. Performing Organization Code
7. Author(s) William F. Barstis and Muralidhar Seshadri	8. Performing Organization Report No. MS-DOT-RD-00-105
9. Performing Organization Name and Address Mississippi Department of Transportation Research Division P O Box 1850 Jackson MS 39215-1850	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Federal Highway Administration	13. Type Report and Period Covered Final Report 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

From the nineteen sixties to the nineteen eighties, the Mississippi Department of Transportation (MDOT) constructed continuously reinforced concrete pavements for almost all of its rigid pavement construction. The design load has been exceeded on most of this pavement type and has already received or will soon require major rehabilitation or reconstruction. Most of this CRCP is on the interstate or principal arterial systems where frequent maintenance is both costly and extremely hazardous. In view of these facts, it is of great interest to MDOT to develop cost - effective ways to rehabilitate or reconstruct the network of this pavement type.

Federal Aid Project No. 54-0055-03-067-11, 12, 13 is a 14.2 mi. long CRCP rehabilitation / reconstruction project located on divided four-lane Interstate 55 in Montgomery, Carroll and Grenada Counties in North Mississippi. The rehabilitation design for the southbound lanes involved repair of working punchouts and then overlay with HMA. Eight 500 ft.-long test sections were evaluated in this direction. Each test section received a uniform thickness of overlay throughout its length with the thickness among the sections varying from 1.4 in. to 6.4 in. The reconstruction design for the two northbound lanes included the installation of edge drains, rubblization of the 8 inch thick CRCP surface and the placement of 6.5 in. of HMA over the rubblized concrete.

Primary conclusions and recommendations resulting from this study include the following:

1. The minimum southbound overlay thickness section of 1.4" is providing good performance to date in regard to both rutting and cracking.
2. Sufficient damage resulting from the rubblization process occurred to the stabilized base course layer in the northbound direction to consider the pavement structure in this direction as a three layer instead of a four layer system for the purpose of backcalculating the pavement layer moduli.
3. For the rubblized CRCP layer in the northbound lanes of this project a structural layer coefficient of 0.25 should be used for pavement design.
4. For CRCP having any working punchouts repaired and having an initial pavement condition equal to or exceeding that of the southbound pavement in this study a minimum overlay thickness will be sufficient for rehabilitation.
5. The use of a polymer modified asphalt binder in the HMA should further reduce the extent of rutting experienced in the overlay.
6. Subsequent to rubblization of an overlying CRCP layer the integrity of stabilized subbase and subgrade courses may be reduced to such an extent that they should not be considered as a unique layer for subsequent backcalculation analyses.
7. The use of the value of 0.25 for the layer coefficient of rubblized CRCP should not be considered as a unique value. The layer coefficient of 0.25 is applicable for rubblized CRCP layers having a similar degree of rubblization as that obtained in the project used for this study.

17. Key Words	18. Distribution Statement
HMA Overlay of CRCP, AASHTO Structural Layer Coefficient for Rubblized CRCP	Unclassified

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	71	

Form DOT F 1700.7 (8-72)

Reproduction of completed page authorized

NOTICE

ACKNOWLEDGMENT

The study reported herein was conducted by the Mississippi Department of Transportation (MDOT) under the sponsorship of the Federal Highway Administration, Mississippi Division Office. This work was accomplished during the period October 1994 through April 2000 under the supervision of Mr. Alfred B. Crawley, State Research Engineer followed by Ms. Joy F. Portera, State Research Engineer. This report was prepared by Messrs. William F. Barstis and Muralidhar Seshadri of the MDOT Research Division.

The authors wish to express their appreciation to the many people whose efforts contributed to the success of this study. Acknowledgment is made to Mr. Gary S. Browning for his support in preparing some of the graphs for this report and laboratory testing. Messrs. Johnny L. Hart and Allan Hatch supported the project by collecting the field distress survey and rut measurements.

During the period of this study, the Executive Director of MDOT was Dr. Robert L. Robinson followed by Mr. Kenneth I. Warren. The Deputy Executive Director / Chief Engineer was Mr. James D. Quin, Mr. Kenneth I. Warren, and Mr. James Kopf, respectively.

TABLE OF CONTENTS

Section	Page
CHAPTER 1. INTRODUCTION	1
BACKGROUND	
OBJECTIVES	
RESEARCH APPROACH	
CHAPTER 2. DESIGN AND CONSTRUCTION	4
CONSTRUCTION COSTS	
CHAPTER 3. POST CONSTRUCTION EVALUATION	21
DELFLECTION USING FWD	
DISTRESS SURVEY	
CHAPTER 4. ANALYSIS	31
DISCUSSION	
CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS	42
CONCLUSIONS	
RECOMMENDATIONS	
REFERENCES	43
APPENDIX A. DEFLECTION DATA	44
APPENDIX B. MDOT Special Provision No. 907-507-2	68

LIST OF FIGURES

Figure		Page
1.	Typical section – I-55 North	8
2.	Typical section – I-55 South	9
3.	Pre-Construction deflection measurements using a dynaflect on I-55 S in Grenada County	10
4.	Trench cutting using a Ripper Saw	11
5.	Trench for edge drain	11
6.	Installation of pipes	12
7.	Guillotine Hammer used prior to rubblizing	12
8.	Rubblizing CRCP with a resonant pavement breaker	13
9.	Rubblizing	13
10	Rubblized continuously reinforced concrete surface	14
11.	Rubblized CRCP below the reinforcing (at half depth)	14
12.	Cracks on the first lift of HMA (1)	15
13.	Cracks on the first lift of asphalt (2)	15
14.	Average deflection at each I-55 North test section, September 1994	24
15.	Average deflection at each I-55 North test section, February 1996	25
16.	Average deflection at each I-55 North test section, April 1997	26
17.	Resilient Modulus of HMA Vs Temperature	27
18.	Average rut depth for ISWP and OSWP of Southbound Outside Lane	28
19.	Confidence level vs. modulus of rubblized CRCP layer	33

LIST OF TABLES

Table		Page
1.	Summary of pavement structure information of continuously reinforced concrete pavements in Mississippi	3
2.	Most common pavement structure of CRCP in Mississippi	3
3.	80 kN ESAL estimates between 1969 to 1994, 4 Lane road - one direction	16
4.	Estimate of design traffic data for the location	17
5.	Condition survey of I 55 North – Montgomery, Carroll and Grenada counties	17
6.	Condition survey on I 55 South – Montgomery, Carroll and Grenada counties	18
7.	Sieve analysis of rubblized concrete, Sample Weight = 859 kg	18
8.	Rut depth at test sites	19
9.	Contractor's estimate of punchout repair items (I-55 South)	19
10.	Contractor's estimate of rubblizing and edge drain installation costs	20
11.	Average in-situ thickness of HMA layer of test sections: I-55 South	29
12.	Average in-situ thickness of HMA layer of test sections: I-55 North	29
13.	Resilient Modulus test results of HMA cores	29
14.	Results of distress survey	30
15.	Northbound pavement idealization for backcalculation using Modulus 5	34
16.	Comparison of soil-cement moduli between north and south directions	34
17.	Confidence levels for rubblized CRCP moduli and AASHTO layer coef.	34
18.	I-55 North backcalculation results, Sept. 1994 data, 3 layer idealization	35
19.	I-55 North backcalculation results, Feb. 1996 data, 3 layer idealization	36
20.	I-55 North backcalculation results, April 1997 data, 3 layer idealization	37
21.	I-55 North backcalculation results, Sept. 1994 data, 4 layer idealization	38

22. I-55 North backcalculation results, Feb.1996 data, 4 layer idealization 39

23. I-55 North backcalculation results, April 1997 data, 4 layer idealization 40

24. Data for graph of Confidence level vs. Modulus of Rubblized CRCP 41

CHAPTER 1: INTRODUCTION

BACKGROUND

From the nineteen sixties to the nineteen eighties, the Mississippi Department of Transportation (MDOT) constructed continuously reinforced concrete pavements for almost all of its rigid pavement construction. As of 1992 the state maintained system had 720 miles of continuous reinforced concrete pavement (CRCP) comprising 5.4 % of the total mileage in this system. The design load has been exceeded on most of this pavement type and has already received or will soon require major rehabilitation or reconstruction. Most of this CRCP is on the interstate or principal arterial systems where frequent maintenance is both costly and extremely hazardous. In view of these facts, it is of great interest to MDOT to develop cost - effective ways to rehabilitate or reconstruct the network of this pavement type. Tables 1 and 2 provide information about the pavement structure of the state maintained CRCP system.

Federal Aid Project No. 54-0055-03-067-11, 12, 13 is a 14.2 mi. long CRCP rehabilitation / reconstruction project located on divided four-lane Interstate 55 in Montgomery, Carroll and Grenada Counties in North Mississippi. This project was adopted for the current study. The pavement sections in both the north and south bound directions were originally constructed at the same time with similar design and construction features; however, with time considerable difference developed in the pavement condition between these two directions. The southbound lanes had significantly less punchouts per mile than the northbound lanes. This difference in the pavement condition dictated the use of separate rehabilitation / reconstruction strategies thus enabling a comparative study in the same locale.

OBJECTIVES

The objective of this study was to develop methodologies to rehabilitate or reconstruct CRCP. The following specific items were to be examined as a minimum:

1. Determine a layer coefficient for rubblized CRCP for use in design of overlay thickness over rubblized CRCP.
2. Thickness of overlay over existing CRCP.

RESEARCH APPROACH

The reconstruction design for the two northbound lanes included the installation of edge drains, rubblization of the 8 inch thick CRCP surface and the placement of 6.5 in. of HMA over the rubblized concrete. There were seven 300-ft. long research test sections in this direction each having the same reconstruction design. These sections were used to estimate the layer coefficient of the rubblized CRCP.

The rehabilitation design for the southbound lanes involved repair of working punchouts and then overlay with HMA. Eight 500 ft.-long test sections were evaluated in this direction. Each test section received a uniform thickness of overlay throughout its length with the thickness among the sections varying from 1.4 in. to 6.4 in. These sections were monitored to study the effects of varying HMA overlay thickness on the performance of the rehabilitated CRCP. The results of this monitoring were then used to meet the second objective of this research study.

Prior to construction the Dynaflect was used to obtain deflection measurements in both the north and southbound directions. During the course of construction MDOT acquired a falling weight deflectometer (FWD) which was used to obtain subsequent deflection measurements in September 1994, February 1996 and April 1997.

Cores of the asphalt layer were collected in conjunction with the 1994 and 1996 deflection measurements to determine the in-situ thickness of the asphalt layer in each section and for use in resilient modulus testing. Cores of the CRCP were collected for elastic moduli testing and cores of the cement treated base were collected for unconfined compressive strength tests. The objective of these laboratory tests was to establish seed moduli for the backcalculation of elastic moduli of the pavement layers.

MDOT – Pavement Management System (PMS) distress survey results were used in the evaluation of the existing pavement condition of both north and southbound lanes prior to construction. A distress survey and manual rut measurements were obtained subsequent to construction to evaluate the relative performance of each of the southbound test sections.

Table 1. Summary of pavement structure information of continuously reinforced concrete pavements in Mississippi as of 1992.

TOTAL TWO-LANE CRCP -	1155 km	718 miles
TIME OF CONSTRUCTION -	FROM 1958 TO 1987	
(NOTE :- MOSTLY CONSTRUCTED BETWEEN 1963 AND 1979)		
NUMBER OF LAYERS IN THE PAVEMENT STRUCTURE	LENGTH (km)	LENGTH (miles)
ONE LAYER	1.4	0.874
TWO LAYERS	100	62
THREE LAYERS	881	548
FOUR LAYERS	172	107
BASE TYPE	LENGTH	THICKNESS
CEMENT TREATED BASE	819 km (509 miles)	150 mm (6 in)
ASPHALT TREATED BASE	291 km (181 miles)	100 mm (4 in)
SUBBASE TYPE	LENGTH, km	LENGTH, miles
LIME TREATED MATERIAL	470	292
SAND OR SAND CLAY	217	135
CLAY GRAVEL	183	114
CEMENT TREATED MATERIAL	145	90
OTHER TYPES	119	74
LIME-CEMENT TREATED	53	33
CRUSHED STONE	0	0
ASPHALT TREATED MATERIAL	0	0
SEMI-GRAVEL	0	0
SOIL TYPE	LENGTH, km	LENGTH, miles
A4, A5 - SILTY SOILS	549	341
A6, A7 - CLAY SOILS	471	293
FINE SAND	72	45
UNKNOWN	63	39

Table 2 . Most common pavement structure of CRCP in Mississippi as of 1992.

LAYER	TYPE	THICKNESS
SURFACE	CRC	200 mm (8 in)
BASE	CEMENT TREATED	150 mm (6 in)
SUBBASE	VARIES	150 mm (6 in)
SUBGRADE	A4, A5 (SILTY) OR A6, A7 (CLAY)	
AVERAGE TOTAL THICKNESS 475 mm (19 in.)		

CHAPTER 2: DESIGN AND CONSTRUCTION

The segment of Interstate 55 used in the current study was opened to traffic in 1967. From 1967 to the onset of this project each direction experienced an estimated 13 million 80 KN equivalent single axle loads (ESALS). Table 3 provides estimates of the ESALs applied to the pavement on a yearly basis between 1969 and 1994. Between 1995 and 2015 more than 30 million ESALS are projected to be experienced by the pavement (Table 4).

The original pavement structure included an 8 in. thick CRCP with a longitudinal steel percentage of 0.59%. The concrete was placed using the slip form method. The 6-in. base consisted of a mixed-in-place cement treated material. The 6-in. sub-base consisted of a class 1 group "B" (clay gravel) material that was sealed with a double bituminous surface treatment prior to placement of the base course. Portions of the subgrade having significant clay contents were lime treated.

In 1987 a significant amount of punchout repair was performed in the same area as the current project. During that project (Federal Aid Project No. IR-55-3(50)189) approximately 18 % of the northbound outside lane and approximately 1 % of the southbound lane were patched full-depth with the continuity of the reinforcing steel being maintained or re-established. A number of short intermittent sections each received a thin hot mix asphalt (HMA) overlay during the punchout repair to correct areas having a distorted surface profile.

As part of MDOT's Pavement Management System, a pavement condition survey was performed in the fall of 1991 prior to construction of the current project. The results of that survey are summarized in Tables 5 and 6. The survey consisted of categorizing, according to the LTPP Distress Identification Manual, all distresses in two 500 ft.-long segments per mile (20 %) of the outside lane. The International Roughness Indexes (IRI) represent the entirety of the outside lane.

Tables 5 and 6 illustrate that the northbound lanes experienced a much larger number of punchout failures than the southbound lanes. The estimated number of high severity punchouts in the northbound outside lane was 4.15 times that of the southbound outside lane. At this time, no satisfactory explanation has been developed to explain the difference in performance between the two directions. Due to this large difference in pavement condition, separate designs were developed for each direction of travel. These designs are shown in figures 1 and 2.

The rehabilitation of the southbound lanes consisted of repairing the working punchouts followed by the placement of a total of 6 inches of HMA. This overlay consisted of one 1.5-in. and variable binder course to correct the existing cross-slope from 1.56 % to 2.0 %, two 1.5-in. binder courses and a 1.5-in. surface course. The total thickness was determined from a deflection-based empirical procedure utilizing a deflection reduction concept with dynaflect measurements (Reference 1). These measurements are shown in Figure 3. The construction of the project began in May 1992 and the southbound lanes were completed in June of 1993.

The reconstruction sequence selected for the northbound lanes consisted of installing edge drains, rubblization of the CRCP and placement of 6.5 in. of HMA. These lanes were constructed in three approximately 5 mile long phases where construction progressed one lane at a time from the beginning of the project.

The installation of the edge drains in the northbound lanes was accomplished prior to rubblization of the CRCP. Figures 4 and 5 illustrate the excavation of a 9-in. wide by 10-in. deep trench to accommodate the drain. As shown in Figure 1, the trench was designed to extend 2 in. below the rubblized CRCP base of the new pavement structure. This trench was lined with a geotextile fabric to prevent any fines from contaminating the trench backfill material. The backfill material was untreated permeable size 57 coarse aggregate. Figure 6 illustrates the placement of the 3-in. drainage pipe. Appendix A includes the specification for the construction of edge drains.

Two devices were used to destroy the integrity of the CRCP. First a guillotine hammer was used as a precracking device (figure 7). Then rubblization was accomplished with a resonant frequency pavement breaker as shown in figures 8 and 9. This rubblizing device was required to produce low amplitude, 2713 N-m blows at a rate exceeding 44 per second. A test strip was set up in order to determine the proper speed and coverage to rubblize the concrete pavement with a minimum number of passes. Additional passes were allowed in the specification if larger sizes remained above the reinforcement.

During rubblization, reinforcement of the existing CRCP was left in place. The breaking pattern proceeded in a longitudinal direction via transverse strips beginning at a free edge (shoulder or previously broken edge) and progressing towards the opposite shoulder. The compaction sequence of the rubblized material was an initial pass with a steel wheel vibratory roller, a pass with a pneumatic roller and a final pass with the steel wheel roller. Immediately prior to placing the first lift of HMA, a fourth pass was required using the vibratory roller. The steel wheel vibratory roller was specified to have a nominal gross weight of not less than 10 tons when operated in the vibration mode and the pneumatic roller was required to produce uniform ground contact pressures of more than 551 kPa. Rubblization of the CRCP was completed in August 1993.

MDOT's Special Provision No. 907-507-2, Rubblizing Continuously Reinforced Cement Concrete Pavement is included as Appendix B. This provision, dated October 23, 1991, was in effect at the time of the rubblization of the northbound lanes of this project and addresses this issue of the method of rubblization. The latest revision to this provision is dated February 18, 1994.

An effort was made to collect samples of the rubblized concrete to determine its gradation. First the reinforcing steel was removed from five sampling areas each encompassing approximately one square yard. Utilizing a backhoe an attempt was then made to remove all of the material within these areas down to the underlying cement treated base. The top 4 inches could be removed but below this depth, i.e. below the steel reinforcement, it was not possible to remove additional material even after using considerable effort with the backhoe. The material was predominantly in rubble form in the top 4 in. and below the reinforcing steel the material was fractured but not to the extent of a rubblized condition (figures 10 and 11). 1894 pounds of rubblized material was removed and analyzed for gradation. The results of this analysis are shown in Table 7.

The 6.5-in. HMA overlay thickness for the northbound lanes was determined using a layer coefficient concept wherein the rubblized concrete was assigned a layer coefficient of 0.14 per inch. This overlay consisted of one two-inch HMA binder course to correct the existing cross slope from 1.56 % to 2.0 %, two 1.5-in. binder courses and a 1.5-in. surface course. Traffic was allowed on the pavement subsequent to the placement of the second lift of binder. The first five-mile long phase in the northbound direction was opened to traffic by the end of the summer of 1992. Three lifts of binder were placed in Montgomery County and two lifts in Carroll and Grenada counties by the end of 1993.

In April 1993, longitudinal cracks were noticed at a few locations on the first course of asphalt placed over the rubblized concrete (figures 12 and 13). Deflection testing using the Dynaflect was performed May 5, 1993 on some of the cracks located in the northbound left lane in Grenada County between Sta. 108+00 and Sta. 253+00. The rigid wheels of the Dynaflect were positioned on either side of a given crack in some locations and on the crack itself at other locations. The results of these tests indicated very little variance in the surface curvature index (SCI) regardless of the location of the rigid wheels relative to the crack. Tests were also run at locations where there were no visible cracks to constitute a control section. A significant reduction in the deflection readings for the control section was noted as compared to the crack locations and the control section SCI value was approximately one half of the SCI value of the crack locations. The cracks were tentatively attributed to the steel reinforcement that was left in place.

Beginning at the b.o.p. an 8.2-mile section of the northbound lanes was opened to traffic in the summer of 1992. During April of 1993, premature rutting was observed in these lanes. Manual rut measurements indicated significant rutting in the inside wheel path relative to the outside wheel path. A South Dakota Profiler (SDP) with a three-sensor configuration was also used to evaluate this rutting. SDP results indicated inside wheel rut depths varying between 2.54 mm and 9.7 mm with an average of 5.4 mm. There was good correspondence between the manual and SDP measured values. The rutting in the inside wheel path was attributed to insufficient compaction of the HMA near the centerline of the pavement due to the increase in the thickness of the HMA in this same area. This increase in pavement thickness was a result of the change in the cross-slope from 1.59 % to 2.0 %.

The rutting problem was also observed in the southbound lanes. By September 1994, rutting had progressed to an unacceptable level for 7.5 miles beginning at the b.o.p.

The MDOT Materials Division conducted tests in May of 1994 to address the issue of premature rutting in the north and southbound outside lanes. Stations 32+00 and 886+00 of the southbound lane and station 980+00 of the northbound lane were selected as test locations. Rut depth and layer thickness measurements and cores were obtained for each of these locations (Table 8). Density-void analysis of each layer was performed on the cores. In addition, a test pit was excavated at stations 886+00 and 980+00 by sawing through the overlay and removing the material. This material was used for determining gradation, asphalt binder content, and analysis of the extracted asphalt binder.

The tests showed that rutting resulted from densification in each of the binder lifts and was reflected through the overlying layers to the pavement surface. Low viscosity values of the asphalt binder were found at station 886+00. Where the cross-slope was increased to two percent in the first lift, compaction was not sufficient on the thicker side of the lane; i.e., the inside wheel path side. The roundness of the natural sand used in these mixtures was also suspected as contributing to the rutting.

To mitigate the rutting problem changes were made in the HMA mix designs. The maximum allowable uncrushed natural sand was lowered from 20% to 10% and a polymer modifier was added to the HMA mix. Additional compactive effort was also recommended to increase the as-constructed density of the asphalt layers.

In both northbound lanes, the surface course in Montgomery County and the top binder and surface courses in Carroll and Grenada counties were polymer modified HMA mixes. The paving using polymer modified binder mix began on 4-18-94 at the Carroll County line and was completed on 5-2-94 at the end of project (e.o.p.) in Grenada County. The paving of the polymer modified HMA surface course began at the beginning of project (b.o.p.) on 5-7-94 and was completed at the e.o.p. on 6-15-94. The reduction in the maximum percentage of natural sands allowed in the HMA mix was effected in the third phase of construction of the northbound lanes.

The 7.5 mile stretch of aforementioned southbound outside lane and portions of the southbound inside lane where excessive rutting had occurred were milled to a depth of 3 inches. These milled areas were then paved with the modified HMA mixes.

CONSTRUCTION COSTS

The number of high severity working punchouts in the northbound lanes was estimated to be over four times that of the southbound lanes. The estimated cost of punchout repair for the northbound lanes was potentially in excess of $2,000,000. The as constructed cost for rubblizing the CRCP and the installation of edge drains in these lanes was $718,131.

The layer coefficient or the stiffness decreases with a decrease in the fractured slab fragment size. Thus rubblizing is likely to increase the required thickness of HMA overlay since it results in the complete destruction of slab action. Any increase in HMA overlay thickness translates into increased construction costs.

Even with the additional cost of a potential increase in the thickness of the HMA overlay, sufficient economic justification existed for the selection of the rubblization / edge drain construction alternative to the punchout repair construction alternative in the northbound lanes. Tables 9 and 10 give the contractor's estimate of punchout repair items in the southbound lanes and the cost of rubblizing and edge drains in the northbound lanes respectively.

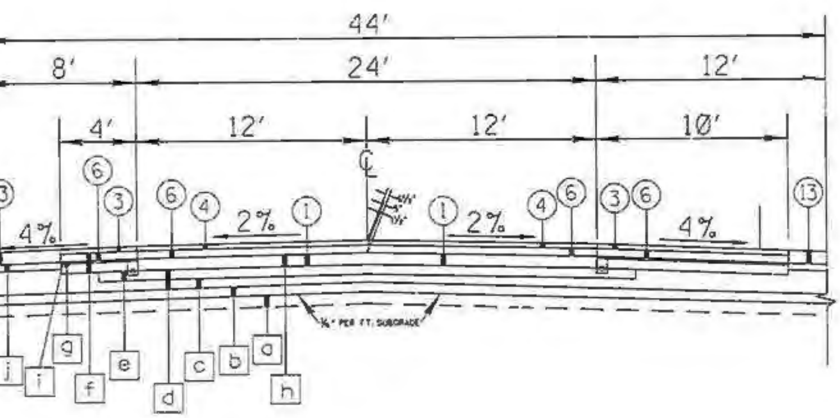

Figure 1. Typical Section - I-55 North

LEGEND
(PROPOSED CONSTRUCTION)

1. RUBBLIZE EXISTING 8" CONT. REINF. CONC. PAVEMENT REQUIRED (24' WIDE)
2. REMOVAL OF EXISTING 8" CONT. REINF. CONC. PAVEMENT REQUIRED (24' WIDE)
3. 1-1/2" HOT BITUMINOUS PAVEMENT SURFACE COURSE WITH RUMBLE STRIPS (ON PAVED SHOULDERS) REQUIRED.
4. 1-1/2" HOT BITUMINOUS PAVEMENT SURFACE COURSE REQ'D.
5. 4-1/2" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D. (1@1-1/2" & VAR.: 2@1-1/2" LIFTS)
6. 5" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D (1@2" & VAR.: 2@1-1/2" LIFTS)
7. 7-1/2" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D. (1@1-1/2" & VAR.: 4@1-1/2" LIFTS)
8. CLASS "C" CONC. AS NECESSARY TO RESTORE SECTION REQ'D. (VARIABLE WIDTH)
9. DAMAGED 8" CONT. REINF. CONCRETE TO BE REPLACED AS REQ'D. (VARIABLE WIDTH)
10. FILTER MAT'L FOR UNDERDRAINS. TYPE "A" SIZE 57. (F.M.) REQ'D.
11. GEOTEXTILE FABRIC FOR SUBSURFACE DRAINAGE (TYPE 3) REQUIRED
12. 3" PERFORATED SEWER PIPE FOR UNDERDRAINS (SDR 23.5) REQ'D.
13. GRANULAR MATERIAL (L.V.M.) (CLASS 3, GROUP "D")
14. 6-1/2" & VAR. HOT BITUMINOUS PAVEMENT BINDER COURSE (ON PAVED SHOULDERS) REQ'D.

LEGEND
(EXISTING CONSTRUCTION)

- a. 6" SOIL CEMENT OR LIME TREATED SUBGRADE (VAR. WIDTH) IN PLACE
- b. 6" & VAR. DEPTH ROADBED TOPPING (CLASS 1, GROUP "B") IN PLACE
- c. D.B.S.T. LIMESTONE AGGREGATE IN PLACE
- d. 7" & VAR. DEPTH ROADBED TOPPING IN PLACE
- e. 6" CEMENT TREATED BASE IN PLACE
- f. 4-1/4" & VAR. DEPTH CEMENT TREATED BASE (UNDER PAVED SHOULDERS) IN PLACE
- g. 2" BINDER MIX IN PLACE (ON PAVED SHOULDERS)
- h. 8" CONT. REINF. CONCRETE PAVEMENT IN PLACE
- i. S.B.S.T. SEAL IN PLACE (ON SHOULDERS)
- j. GRANULAR MAT'L. (CLASS 3, GROUP "E") IN PLACE

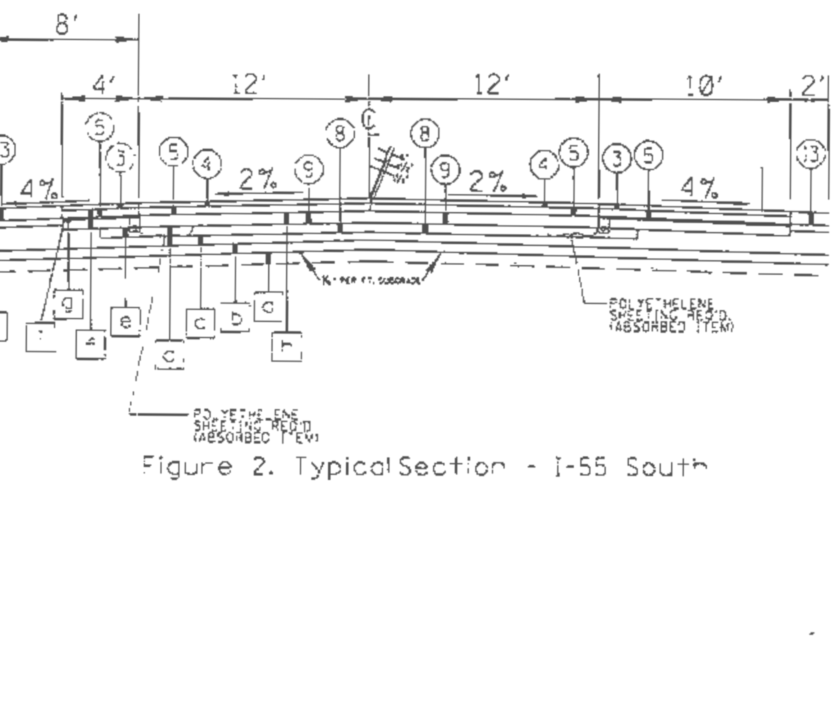

Figure 2. Typical Section - I-55 South

LEGEND
(PROPOSED CONSTRUCTION)

1. RUBBLIZE EXISTING 9" CONT. REINF. CONC. PAVEMENT REQUIRED (24' WIDE)
2. REMOVAL OF EXISTING 8" CONT. REINF. CONC. PAVEMENT REQUIRED (24' WIDE)
3. 1-1/2" HOT BITUMINOUS PAVEMENT SURFACE COURSE WITH RUMBLE STRIPS (ON PAVED SHOULDERS) REQUIRED.
4. 1-1/2" HOT BITUMINOUS PAVEMENT SURFACE COURSE REQ'D.
5. 4-1/2" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D (1@1-1/2" & VAR.; 2@1-1/2" LIFTS)
6. 5" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D (1@2" & VAR.; 2@1-1/2" LIFTS)
7. 7-1/2" HOT BITUMINOUS PAVEMENT BINDER COURSE REQ'D. (1@1-1/2" & VAR.; 4@1-1/2" LIFTS)
8. CLASS "C" CONC. AS NECESSARY TO RESTORE SECTION REQ'D. (VARIABLE WIDTH)
9. DAMAGED 8" CONT. REINF. CONCRETE TO BE REPLACED AS REQ'D. (VARIABLE WIDTH)
10. FILTER MAT'L FOR UNDERDRAINS, TYPE "A" SIZE 57 (F.M.) REQ'D.
11. GEOTEXTILE FABRIC FOR SUBSURFACE DRAINAGE (TYPE 3) REQUIRED
12. 3" PERFORATED SEWER PIPE FOR UNDERDRAINS (SDR 23.5) REQ'D.
13. GRANULAR MATERIAL (G.V.M.) (CLASS 3, GROUP "D")
14. 5-1/2" & VAR. HOT BITUMINOUS PAVEMENT BINDER COURSE (ON PAVED SHOULDERS) REQ'D.

LEGEND
(EXISTING CONSTRUCTION)

a. 6" SOIL CEMENT OR LIME TREATED SUBGRADE (VAR. WIDTH) IN PLACE
b. 6" & VAR. DEPTH ROADBED TOPPING (CLASS 1, GROUP "B") IN PLACE
c. S.B.S.T. LIMESTONE AGGREGATE IN PLACE
d. 7" & VAR. DEPTH ROADBED TOPPING IN PLACE
e. 6" CEMENT TREATED BASE IN PLACE
f. 4-1/4" & VAR. DEPTH CEMENT TREATED BASE (UNDER PAVED SHOULDERS) IN PLACE
g. 2" BINDER MIX IN PLACE (ON PAVED SHOULDERS)
h. 8" CONT. REINF. CONCRETE PAVEMENT IN PLACE
i. S.B.S.T. SEAL IN PLACE (ON SHOULDERS)
j. GRANULAR MAT'L. CLASS 3, GROUP "E" IN PLACE

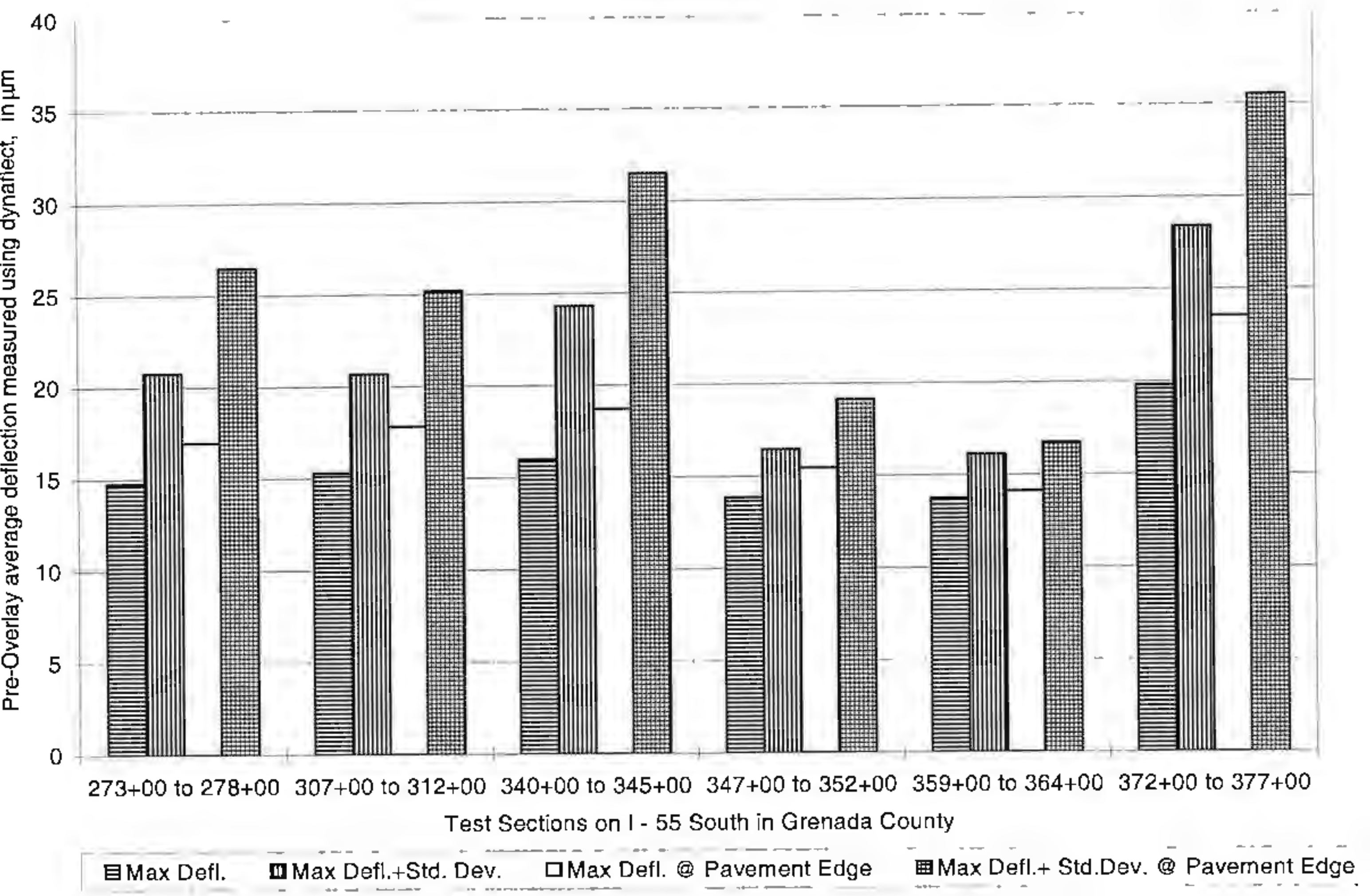

Figure 3. Pre-Construction deflection measurements using a dynaflect on I-55 S in Grenada County

Figure 4. Trench cutting using a Ripper Saw

Figure 5. Trench for edge drain

Figure 6. Installation of pipes

Figure 7. Guillotine Hammer used prior to rubblizing

Figure 8. Rubblizing CRCP with a resonant pavement breaker

Figure 9. Rubblizing

Figure 10. Rubblized continuously reinforced concrete surface

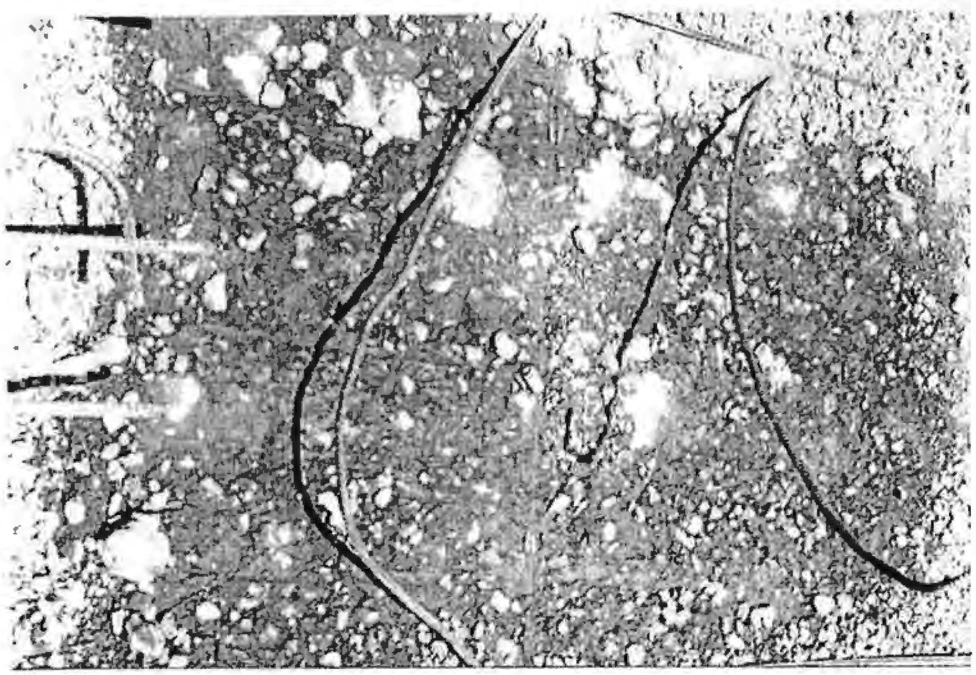

Figure 11. Rubblized CRCP below the reinforcing (at half depth)

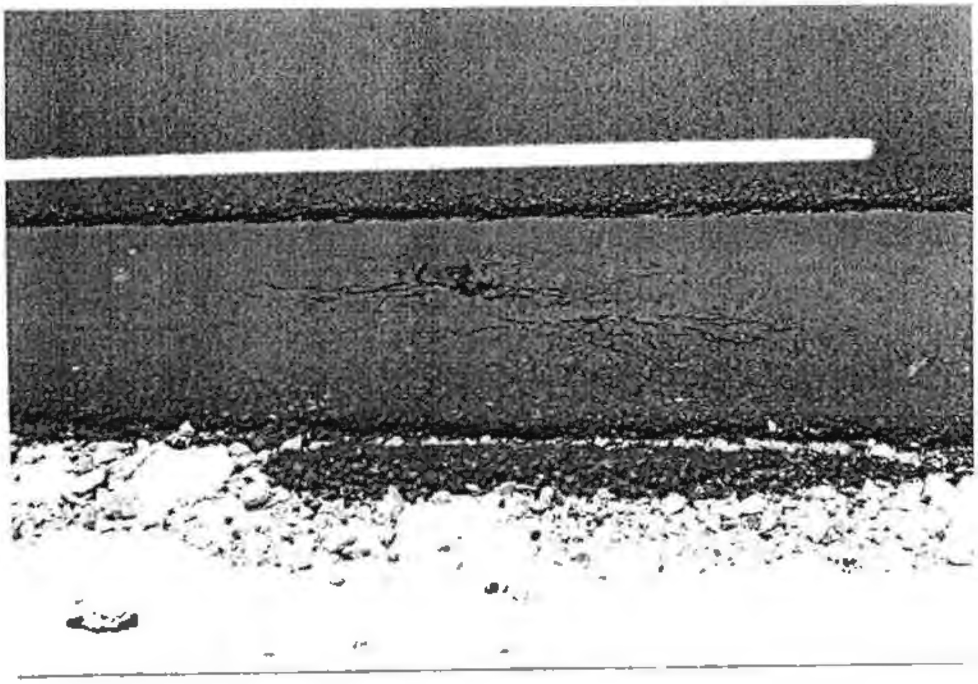

Figure 12. Cracks on the first lift of HMA (1)

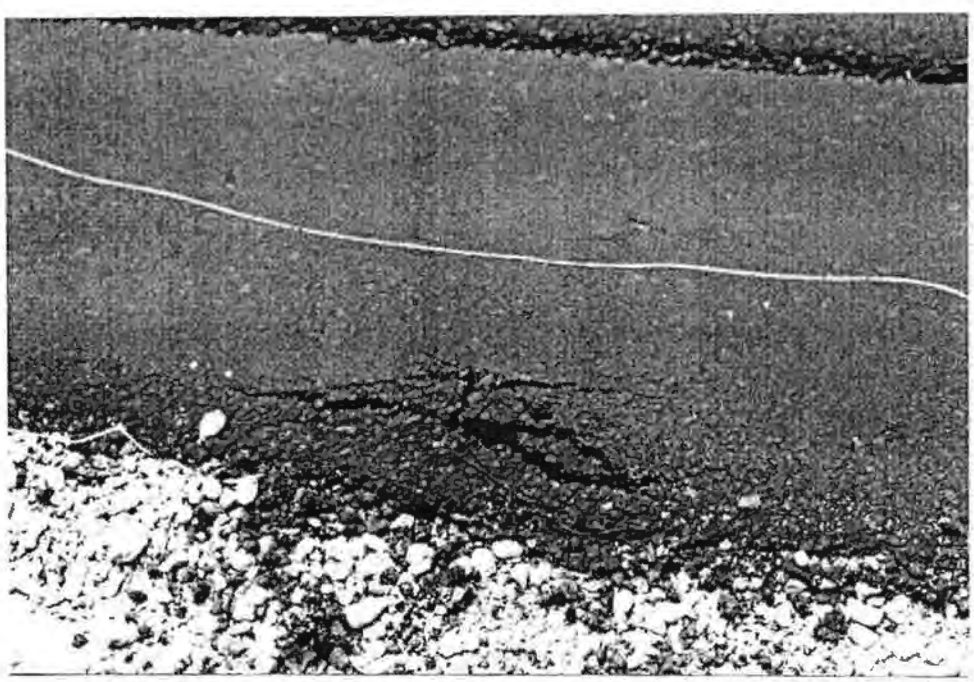

Figure 13. Cracks on the first lift of asphalt (2)

Table 3 . 80 kN ESAL estimates between 1969 to 1994, 4 Lane road - one direction

Year	ADT	TRUCKS, %	K_Factor	Rigid 80 kN	Flex. 80 kN
1994	12000	30	1486	976302	634596
1993	11758	30	1459	923681	600393
1992	11518	29	1431	873259	567619
1991	11280	29	1404	824915	536195
1990	11043	28	1377	778542	506052
1989	10806	28	1350	734048	477131
1988	10571	27	1323	691349	449377
1987	10336	27	1296	650374	422743
1986	10102	26	1269	611060	397189
1985	9868	26	1243	573352	372679
1984	9634	25	1216	537201	349181
1983	9399	25	1189	502565	326668
1982	9165	24	1162	469408	305115
1981	8930	24	1135	437694	284501
1980	8695	23	1108	407396	264807
1979	8460	23	1081	378485	246015
1978	8225	22	1054	350936	228108
1977	7989	22	1027	324726	211072
1976	7753	21	1000	299830	194890
1975	7518	21	973	276226	179547
1974	7283	20	946	253891	165029
1973	7048	20	919	232800	151320
1972	6813	19	892	212928	138403
1971	6579	19	866	194249	126262
1970	6347	18	839	176733	114877
1969	6115	18	812	160352	104229
			TOTAL	12852302	8353997

Table 4 . Estimate of design traffic data for the location

Year	Projected ADT	Average 80 kN Axle Loads per 1,000 vehicles		Cumulative thousands of 80 kN ESALS from base year	
		RIGID	FLEX	RIGID	FLEX
1995	12,000	1,485	926	0	0
2000	15,000	1,495	970	5,225	3,396
2003	16,000	1,505	975	8,976	5,835
2005	18,000	1,515	985	11,775	7,654
2015	26,000	1,545	1,005	30,282	19,683
YEAR 2015 DESIGN DATA					
DHV	D % of DHV	T % of DHV	T-total % of ADT		
2,900	55	18	30		

Table 5 . Condition survey on I 55 North - Montgomery, Carroll and Grenada counties

Distress	Severity	Total of all sections (30)	Average per section (152 m)	Estimated avg. per km
Punchouts	Low	35	1.17	7.7
Punchouts	Medium	47	1.57	10.3
Punchouts	High	81	2.7	17.76
Transverse crack	Low	12.8 m	0.43 m	2.83 m
Transverse crack	Medium	184.7 m	6.16 m	65 m
Transverse crack	High	18.3 m	0.61 m	6.43 m
Longitudinal crack	Low	114.3 m	3.81 m	40.23 m
Longitudinal crack	Medium	18.9 m	0.63 m	6.65 m
Longitudinal crack	High	0	0	0
Patch	Low	175 m^2	5.85 m^2	61.6 m^2
Patch	Medium	0	0	0
Patch	High	0	0	0
IRI			1.67 mm/m	
Distress rating			96.73 %	
Pvmt. Condition Rating			82.93 %	
% Area of punchouts & patches			9.2 %	

Table 6 . Condition survey on I 55 South - Montgomery, Carroll and Grenada counties

Distress	Severity	Total	Average per section (152 m)	Estimated average per km
Punchouts	Low	12	0.41	2.7
Punchouts	Medium	10	0.34	2.23
Punchouts	High	19	0.65	4.28
Transverse crack	Low	0.61 m	0.021 m	0.22 m
Transverse crack	Medium	111.5 m	3.85 m	40.61 m
Transverse crack	High	7.31 m	0.25 m	2.66 m
Longitudinal crack	Low	92 m	3.17 m	33.51 m
Longitudinal crack	Medium	0	0	0
Longitudinal crack	High	0	0	0
Patch	Low	38.18 m^2	1.32 m^2	13.9 m^2
Patch	Medium	0.74 m^2	0.025 m^2	0.27 m^2
Patch	High	0	0	0
IRI			1.58 mm/m	
Distress rating			96.44 %	
PCR			83.36 %	
% Area of Punchouts & Patches			1.8 %	

Table 7. Sieve analysis of rubblized concrete, Sample Weight = 859 kg

Size	Weight retained	% Passing
250 mm	0	100
150 mm	32.6 kg	96.2
50 mm	303 kg	64.3
38.1 mm	378 kg	55.5
25 mm	496 kg	41.6
12.5 mm	657.5 kg	22.6
4.75 mm	768.3 kg	9.5
1.9 mm	808.5 kg	4.8

Table 8 . Rut depth at test sites

Station	Rut depth (Inside Wheel Path), mm	Rut depth (Outside Wheel Path), mm
I-55 S - 32+00	8.89	7.62
I-55 S - 886+00	10.16	7.62
I-55 N - 980+00	7.62	3.81

Table 9. Contractor's estimate of punchout repair items (I-55 South)

ITEM NO.	ITEM	UNIT PR.	AMOUNT
GRENADA COUNTY	PUNCHOUT REPAIR AREA - 3150.72 SY		
907-503-A	8" & VAR CRCP BROOM FINISH (SY)	$56.39	$177,669
907-503-B	SAW CUT LONG. JOINTS (LF)	$8.00	$6,496
907-503-C	SAW CUT 8" DEPTH (LF)	$8.50	$48,619
907-503-C	SAW CUT 3" DEPTH (LF)	$3.25	$9,475
907-503-D	CONCRETE FOR BASE REPAIR (CY)	$133.00	$0.00
907-503-E	TIE BAR #5 DEF DRILLED & EPOX. (E)	$7.00	$12,586
202-B	REM OF 8" CONC PAVE PUNCHOUT	$45.81	$144,334
GRENADA COUNTY	TOTAL PUNCH OUT REPAIR COSTS		$399,179
MONTGOMERY CO.	PUNCHOUT REPAIR AREA - 559.53 SY		
907-503-A	8" & VAR CRCP BROOM FINISH (SY)	$56.39	$31,551
907-503-B	SAW CUT LONG. JOINTS (LF)	$8.00	$952
907-503-C	SAW CUT 8" DEPTH (LF)	$8.50	$8,845
907-503-C	SAW CUT 3" DEPTH (LF)	$3.25	$1,623
907-503-D	CONCRETE FOR BASE REPAIR (CY)	$133.00	$0.00
907-503-E	TIE BAR #5 DEF DRILLED & EPOX. (E)	$7.00	$2,226
202-B	REM OF 8" CONC PAVE PUNCHOUT	$45.81	$25,632
MONTGOMERY CO.	TOTAL PUNCH OUT REPAIR COSTS		$70,830
CARROLL COUNTY	PUNCHOUT REP AREA - 467.4 SY		
907-503-A	8" & VAR CRCP BROOM FINISH (SY)	$56.39	$26,356
907-503-B	SAW CUT LONG. JOINTS (LF)	$8.00	$416
907-503-C	SAW CUT 8" DEPTH (LF)	$8.50	$7,709
907-503-C	SAW CUT 3" DEPTH (LF)	$3.25	$1,249
907-503-D	CONCRETE FOR BASE REPAIR (CY)	$133.00	$234
907-503-E	TIE BAR #5 DEF DRILLED & EPOX. (E)	$7.00	$1,932
202-B	REM OF 8" CONC PAVE PUNCHOUT	$45.81	$21,411
CARROLL COUNTY	TOTAL PUNCH OUT REPAIR COSTS		$59,309
ALL 3 COUNTIES	GRAND TOTAL FOR PUNCHOUT REPAIRS		$529,319
	TOTAL PUNCHOUT REPAIR AREA		4177 SY
	COST OF PUNCHOUT REPAIR / SY		$126.70

Table 10. Contractor's estimate of rubblizing and edge drain installation costs (I-55 N)

ITEM NO.	ITEM	UNIT PR.	AMOUNT
GRENADA	AREA OF RUBBLIZATION - 98933.34 SY		
907-605-CC	3" EDGE DRAIN TYPE 1	$1.25	$91,425
907-605-DD	3"EDGE DRAIN OUTLET/VENTS	$3.33	$13,187
907-605-EE	PREPARATION OF TRENCH	$0.22	$16,855
605-W	FIL MAT FOR COMB STORM DRAIN...	$25.66	$36,188
605-AA	GEOTEX FABRIC FOR SUB SUR DR	$0.66	$17,843
907-507-A	RUBBLIZATION OF EXISTING CRCP	$2.10	$207,760
GRENADA	TOTAL EDGE DRAIN + RUBBLIZATION		$383,258
MONTGOMERY	AREA OF RUBBLIZATION - 31672 SY		
907-605-CC	3" EDGE DRAIN TYPE 1	$1.25	$33,442
907-605-DD	3"EDGE DRAIN OUTLET/VENTS	$3.33	$3,096
907-605-EE	PREPARATION OF TRENCH	$0.22	$6,090
605-W	FIL MAT FOR COMB STORM DRAIN...	$25.66	$13,250
605-AA	GEOTEX FABRIC FOR SUB SUR DR	$0.66	$6,533
907-507-A	RUBBLIZATION OF EXISTING CRCP	$2.10	$66,511
MONTGOMERY	TOTAL EDGE DRAIN + RUBBLIZATION		$128,924
CARROLL	AREA OF RUBBLIZATION - 50728 SY		
907-605-CC	3" EDGE DRAIN TYPE 1	$1.25	$54,186
907-605-DD	3"EDGE DRAIN OUTLET/VENTS	$3.33	$4,428
907-605-EE	PREPARATION OF TRENCH	$0.22	$9,829
605-W	FIL MAT FOR COMB STORM DRAIN...	$25.66	$20,974
605-AA	GEOTEX FABRIC FOR SUB SUR DR	$0.66	$9,999
907-507-A	RUBBLIZATION OF EXISTING CRCP	$2.10	$106,528
CARROLL	TOTAL EDGE DRAIN + RUBBLIZATION		$205,948
ALL THREE	GRAND TOTAL EDGE DRAIN + RUBBL.		$718,131
COUNTIES	TOTAL AREA OF RUBBLIZATION IN SY		181333
	COST OF RUBB. & EDGE DRAIN / SY		$3.96

CHAPTER 3: POST CONSTRUCTION EVALUATION

Cores of the asphalt layer were obtained in September of 1994 and February of 1996 to determine the average thickness of the HMA overlay in each test section and to provide samples for resilient modulus, M_r, tests. The measurement of cores collected in September 1994 indicated that there was no southbound test section included in this study that had received an overlay of 6 in.; therefore, southbound section 1 was established to include a comparable thickness of overlay for this study. Tables 11 and 12 provide the average thickness of the HMA layer for each section of this study.

The cores were saw cut to fabricate 2.25-in. diameter M_r test samples. These samples were tested as per ASTM D 4123, Standard Test Method for Indirect Tension Test for Resilient Modulus of Bituminous Mixtures, at 25 °C. The test results are summarized in Table 13. A M_r value of 2,068,427 kPa was selected as representative of the laboratory determined values.

DEFLECTION USING FWD

Deflection surveys using the FWD were conducted in September 1994, February 1996 and April 1997. The deflection measurements in the three surveys were taken every 50 ft. on all sections shown in Table 12 on the outside wheel path of the outside northbound lane. The average deflection at each sensor per test section is plotted in Figures 14, 15 and 16. The spacing of the seven sensors adopted for FWD testing was that used in the Long-Term Pavement Performance Program (LTPP). The spacings were at 0, 8, 12, 18, 24, 36 and 60 inches from the center of the load plate. Detailed deflection data are provided in Appendix [A].

Results from FWD field testing are used in backcalculation analysis procedures to determine the pavement layer moduli. Some of these procedures require seed moduli to complete the calculations. The asphalt M_r value obtained from the laboratory testing of cores could not be directly utilized as seed moduli because asphalt properties vary with load duration and temperature. Neither of these factors corresponded between the FWD field testing and the laboratory testing.

The load duration for FWD testing is shorter than laboratory testing; therefore, the laboratory M_r result was corrected to account for this factor. This correction was accomplished by utilizing the Asphalt Institute regression equation (Equation 2.4 on page 2-25 of reference 2) which resulted in the laboratory determined M_r value being increased by a factor of 1.8.

The temperature at the mid-depth of the asphalt layer for the 1994 and 1996 surveys were predicted using the procedure in the AASHTO Design Guide (Reference 3). The mid-depth temperature was measured during the 1997 deflection survey.

The FWD tests were conducted at the various asphalt layer temperatures encountered during field testing whereas the laboratory M_r tests were conducted at 77 ^{0}F. A relationship between HMA moduli and temperature was used to modify the laboratory M_r value for any field testing temperature. In a previous study by K.P. George (Reference 4) a Marshall hammer was used to compact laboratory samples of the various MDOT HMA mixes and M_r tests were conducted on these samples at various temperatures. From the results of these tests an equation modeling the relationship between temperature and M_r was developed for each of the HMA mixes used in that study. One of these equations was utilized in the current study to develop the required relationship between HMA moduli and temperature for the field core samples tested in this study. The following is that equation in slightly modified form:

$$M_R \text{ (in psi)} = 10^{(6.7101429 - 0.000153723*T\wedge2)}$$

T is in ^{0}F.

This equation could not be directly used in the current study. The stiffness of the laboratory compacted samples used in the previous study was significantly higher than the stiffness of the core samples used in the current study. The same was indicated by indirect tension tests. This discrepancy could be attributed to the difference in the way that the HMA is compacted in the laboratory as compared to that in the field. Since the same type of asphalt binder and similar aggregate gradations were used in the HMA mixes for both studies, the variation of stiffness properties with respect to temperature was assumed to be the same for both field and laboratory compacted HMA samples. This assumption was given credence by two mathematical observations.

The derivative of the equation adopted from the previous study results in the following equation:

$$\delta(M_R)/\delta T = - 0.000707922 * T * 10^{(6.7101429-0.000153723*T\wedge2)}$$

The derivative of each of the equations produced in the previous study had a similar mathematical form as that shown above and the constant factor shown in this derivative did not significantly vary among the other derivatives. The significance of this differential equation with the noted mathematical similarities is that it establishes the slope of the curve M_r versus temperature for MDOT HMA mixes with the same binder type and similar aggregate gradations. Given these considerations this derivative was used to generate a curve modeling a correlation between M_r and temperature of the field core samples tested in the current study.

The laboratory determined field core M_r value corrected for load duration of the current study and a temperature of 77 ^{0}F represent the coordinates of a point on the curve modeling the desired relationship of M_r vs. temperature. These values were substituted into the above differential equation to yield the slope of the curve at that point. A slope and the coordinates of one point can be used to define a linear equation of a line through that point. Substituting this slope value at that point and a temperature slightly different than 77 ^{0}F into the linear equation yields a M_r value at the slightly different temperature. This new M_r value and the slightly different temperature are the coordinates of a second point located on the desired curve. Due to the use of a temperature only slightly different than 77 ^{0}F in this linear equation the two points are in close proximity to each other on that curve. This close proximity of these two points validates the use of that linear relationship to locate this second point without compromising the overall shape of the curve. The field core M_r value at the different temperature and the different temperature were then substituted into the above differential equation to determine a different slope value of the M_r vs. temperature curve at the second point. The same steps were repeated for subsequent small temperature differences to generate the curve of M_R versus temperature shown in figure 17.

DISTRESS SURVEY

Manual rut measurements and a distress survey were obtained in the southbound test sections in April 2000. Figure 18 illustrates the rutting observed in both the inside and outside wheel paths of these test sections. Note that in all of the sections the inside wheel path depth of rutting exceeds the outside wheel path. This relative increased rutting in the inside wheel path may be because of insufficient compaction of the asphalt near the centerline of the pavement. The cross slope of the CRCP was 1.59% and the cross slope of the overlay is 2% so a slight increase in asphalt thickness occurs from the edge to the center of the pavement. It was speculated that some of this increased rutting of the inside wheel path relative to the outside wheel path was due to that slight increase in asphalt thickness but this is refuted by a second observation of figure 18.

It was expected that rut depth would increase with an increase in overlay thickness. The section with the least thickness of overlay, the 1.4 in. average overlay section, did experience the least amount of rutting relative to the other sections; however, the 6.4 in. overlay section actually experienced less rutting than three other sections with less overlay thickness. The use of a polymer modified asphalt binder in the HMA should further reduce the extent of rutting experienced in the overlay.

It was assumed that the number of cracks per section would increase with a decrease in overlay thickness; i.e., the 1.4-in. overlay section would have the greatest number of cracks and the 6.4-in. section would have the least number of cracks. The results of the distress survey are shown in Table 14 and these results do not support this assumption. The 1.4-in. overlay section did not experience any cracking.

The minimum overlay thickness section of 1.4" is providing good performance to date in regard to both rutting and cracking. This is almost 77 percent less than the design thickness of 6 in. for the southbound overlay. Given these observations it may be concluded that for CRCP having an initial pavement condition equal to or exceeding that of the pavement in this study a minimum overlay thickness will be sufficient for rehabilitation.

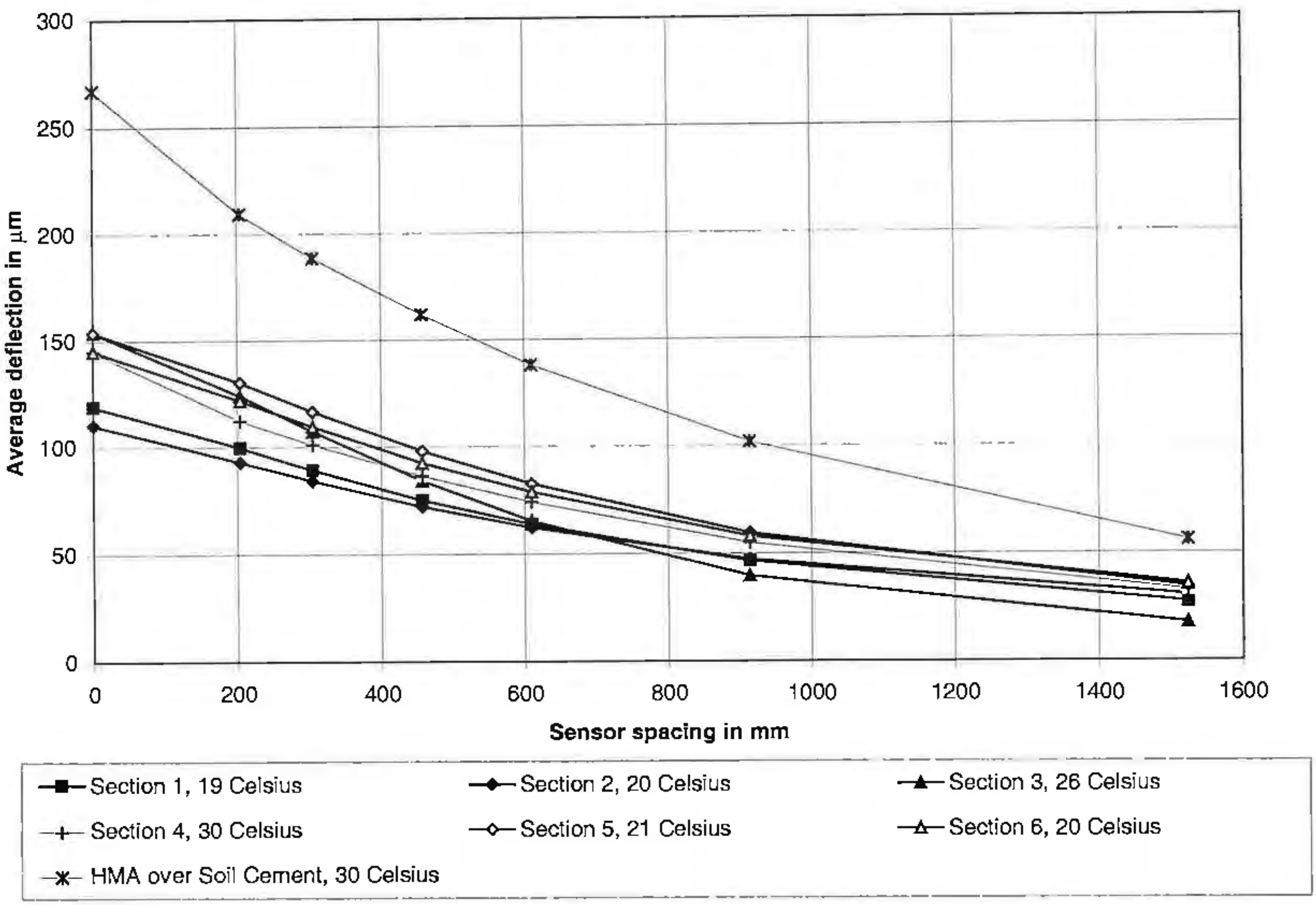

Figure 14. Average deflection at each I-55 North test secion, September 1994

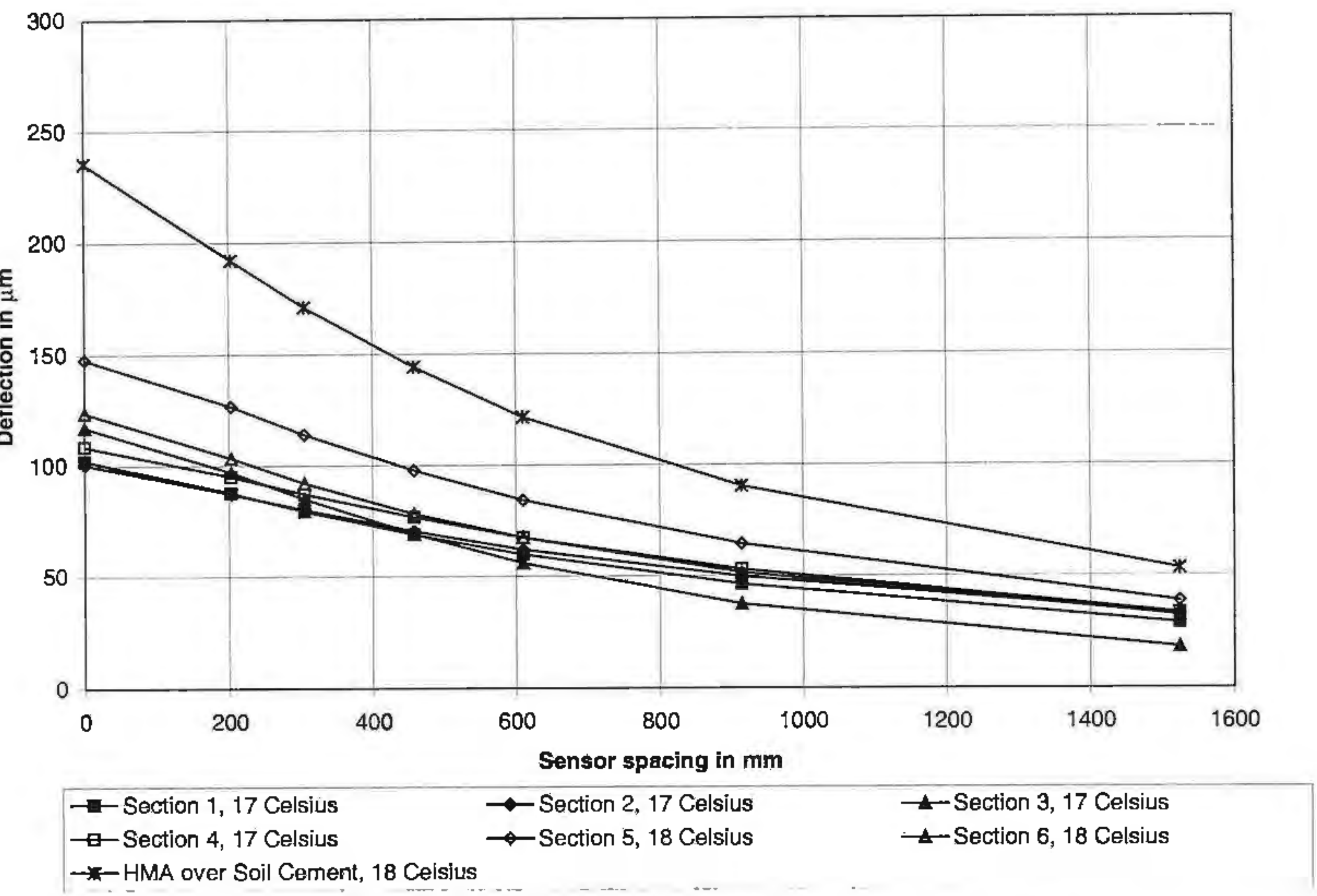

Figure 15 . Average deflection at each I-55 North test section, February 1996

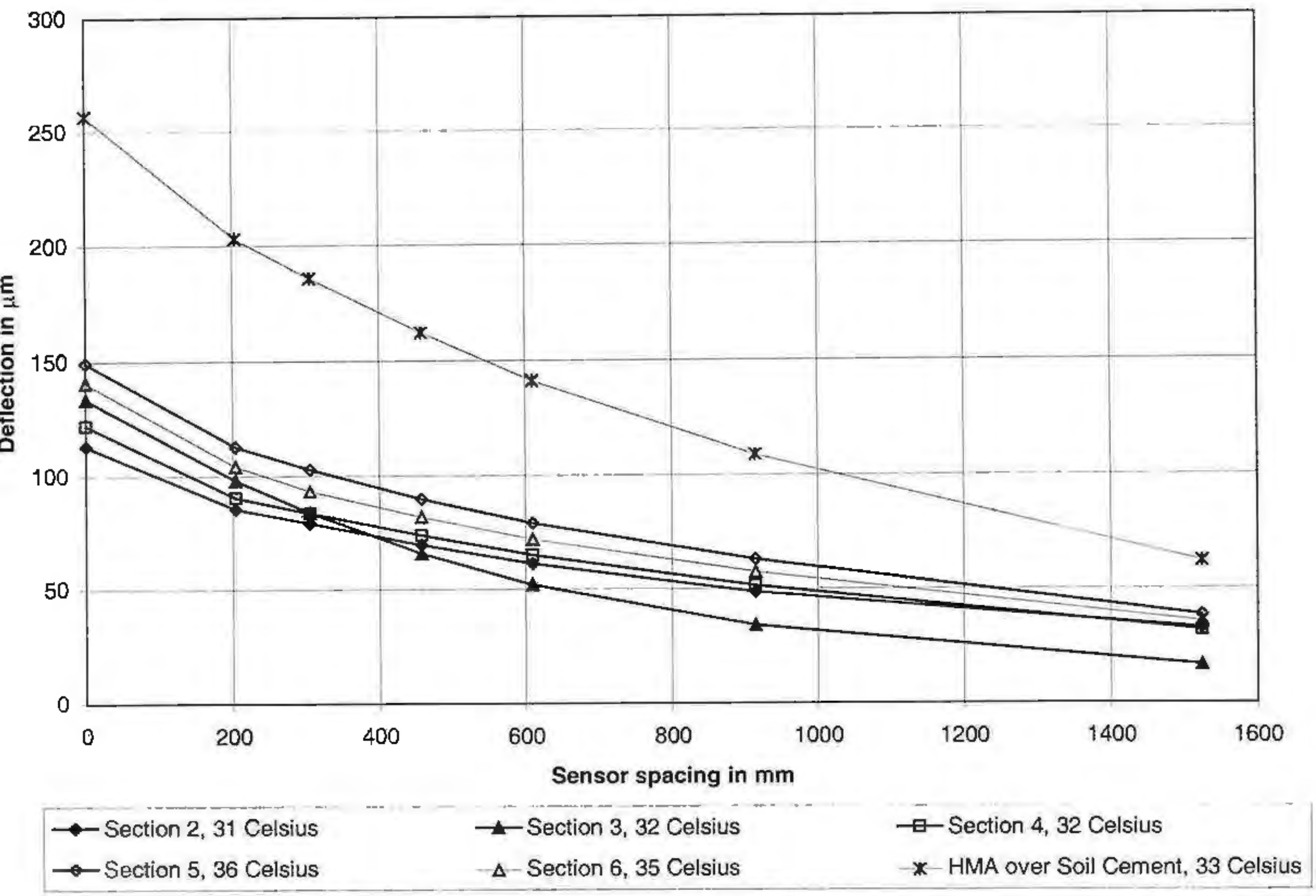

Figure 16 . Average deflections at each I-55 North test section, April 1997

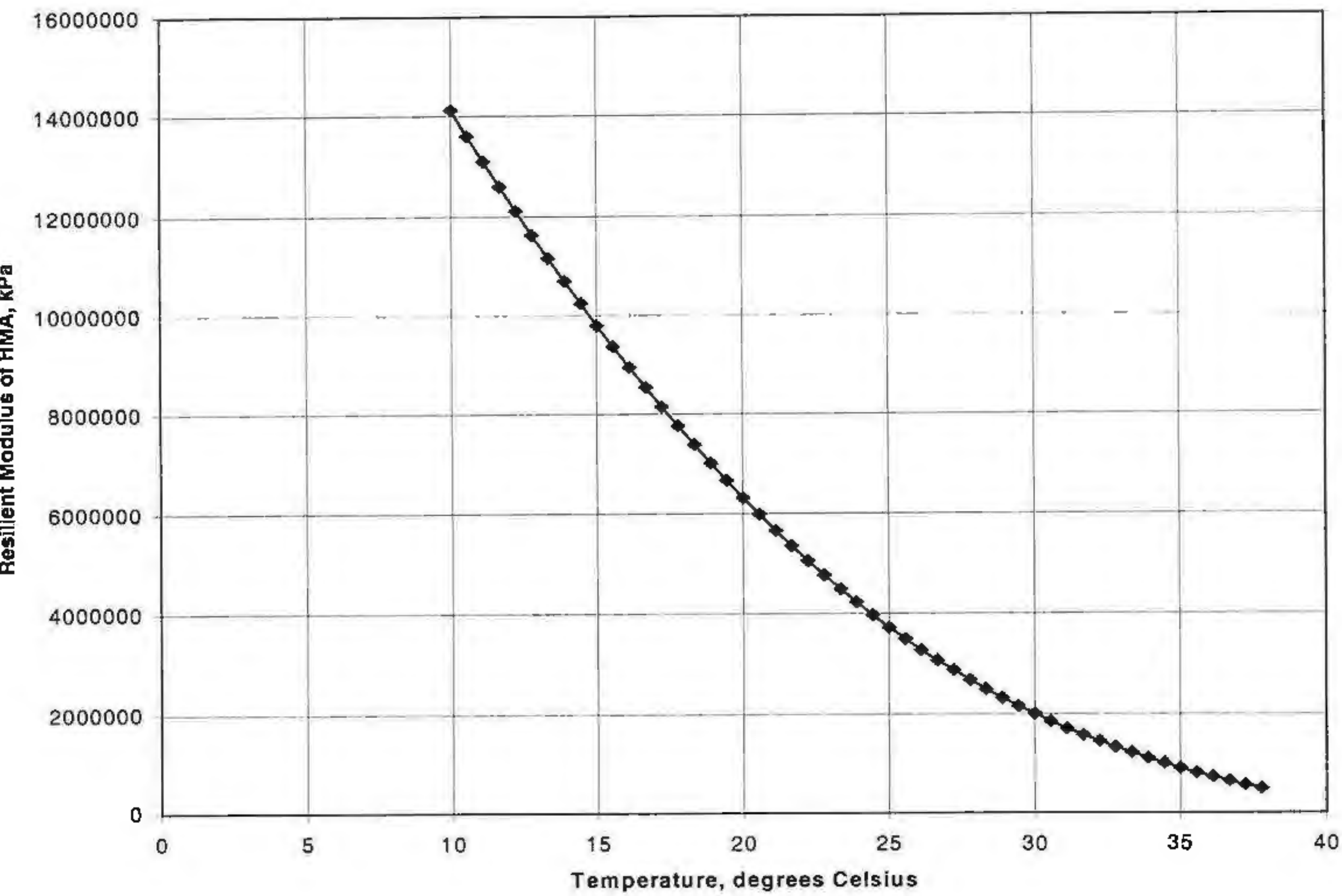

Figure 17. Resilient Modulus of HMA Vs Temperature

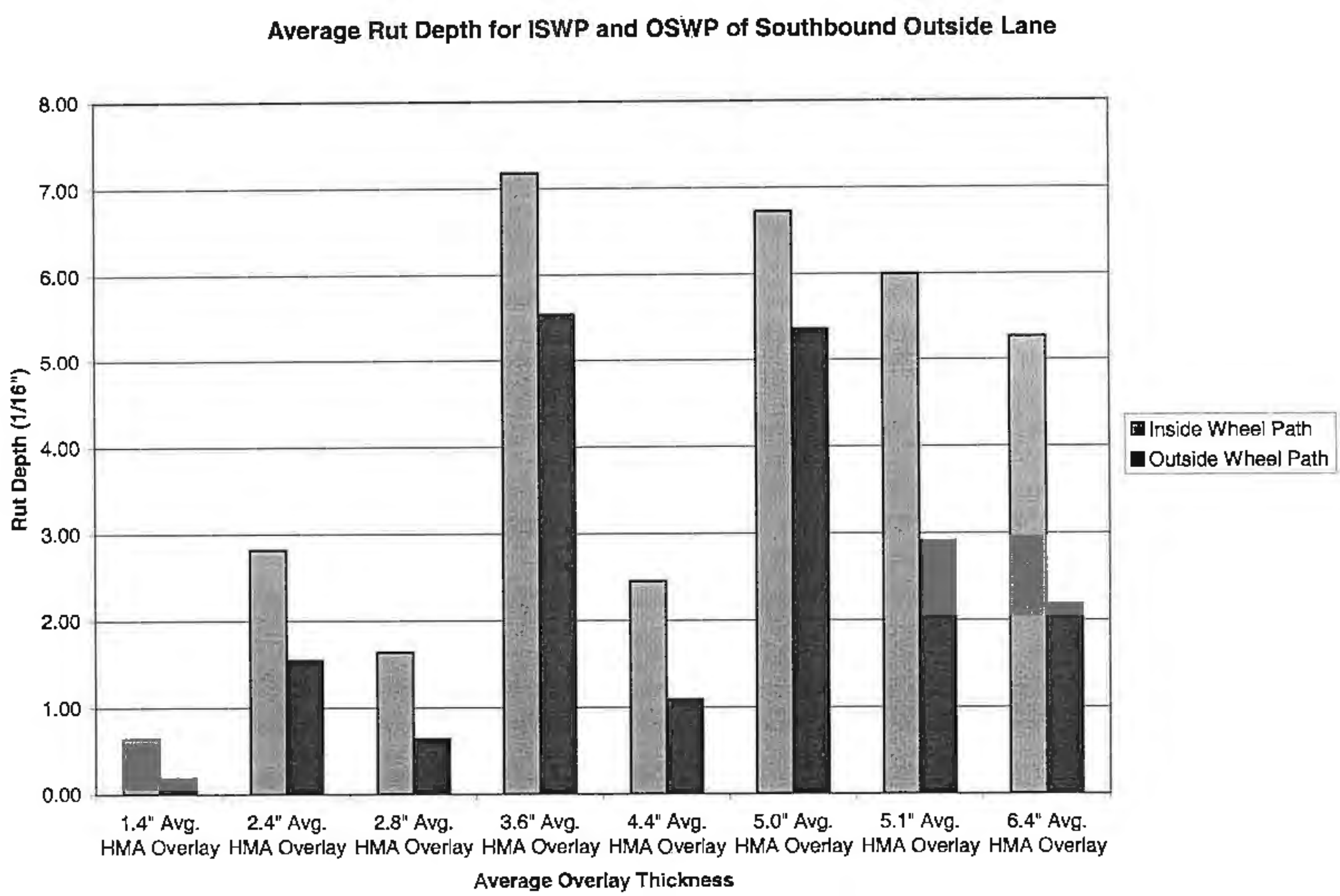

Figure 18. Average rut depth for ISWP and OSWP of Southbound Outside Lane

Table 11 . Average in-situ thickness of HMA layer of test sections: I-55 South

Section No.	Station limits	Average thickness, mm
1	392+00 - 387+00	6.4"
2	377+00 - 372+00	5.1"
3	364+00 - 359+00	4.4"
4	352+00 - 347+00	2.8"
5	345+00 - 340+00	1.4"
6	312+00 - 307+00	2.4"
7	304+00 - 299+00	3.6"
8	274+00 - 269+00	5.0"

Table 12 . Average in-situ thickness of HMA layer of test sections: I-55 North

Section No.	Station limits	Average thickness, mm
1	772+00 - 775+00 (Montgomery County)	6.9"
2	843+00 - 846+00 (Carroll County)	6.9"
3	985+00 - 988+00 (Carroll County)	6.2"
4	48+00 - 51+00 (Grenada County)	6.8"
5	338+00 - 341+00 (Grenada County)	5.0"
6	380+00 - 383+00 (Grenada County)	5.7"
7	216+00 - 219+00 (Grenada County, Soil-Cement Base)	7.8"

Table 13 . Resilient Modulus test results of HMA cores extracted in September 1994 and May 1996 from the test sites on I - 55 North and South

	1994 - North	1994 - South	1996 - North	1996 - South
Average MR, kPa	2172524	2082885	2003195	2204074
Standard Deviation	455681	249955	389443	203953
No. of Samples	12	10	6	5

Table 14. Results of distress survey

Section #	Overlay Thickness	Transverse Cracking		Longitudinal Cracking	
		Low Severity Number - Length	Medium Severity Number - Length	Low Severity Number - Length	Medium Severity Number - Length
1	6.4"				
2	5.1"	1 - 4 ft.			
3	4.4"				
4	2.9"				
5	1.4"				
6	2.4"	1 - 1 ft. 2 - 2 ft. 4 - 3 ft. 1 - 5 ft.	1 - 6.5 ft. (reflective)	1 - 1 ft. 1 - 3 ft.	
7	3.6"	1 - 6 ft.	1 - 6.5 ft. (reflective)	1 - 10 ft.	
8	5.0"	*			

* 20 approximately 1 ft. long diagonal cracks located adjacent to the shoulder line.
Note: Longitudinal cracks located in center of outside lane.
Note: Transverse cracks located adjacent to edge of pavament.

CHAPTER 4: ANALYSIS

The northbound test sections after rubblizing were considered to be flexible pavement systems. "Modulus 5.0" (Reference 5) is a program based on layered elastic theory and this program was used to backcalculate the layer moduli of these sections using FWD deflection data. Two sets of analyses were performed on each of the sections where the pavement structure was in one set idealized as a three layer system and in the other set as a four layer system (Table 15). The results of both analyses are summarized in Tables 18 through 23.

It was speculated that some damage could have occurred to the soil-cement base course in the northbound lanes due to the rubblization of the CRCP in this direction. Since the southbound CRCP was not rubblized a comparison of the moduli of the soil-cement base course in the southbound direction with that of the northbound direction was made to provide an indication of any potential damage to this base course due to the rubblization process.

There was an area in the northbound direction of the project that required the complete removal of the rubblized concrete and HMA was placed directly over the soil-cement base course. FWD tests were performed on a section of this area and the moduli of the base course was backcalculated for this direction. FWD tests were performed on the southbound test sections and the moduli of the soil-cement base course was backcalculated for this direction. Table 16 tabulates the results of the backcalculations for both the north and southbound directions. Note that for all three survey years the modulus of the soil-cement base course for the northbound direction is significantly less than that for the southbound direction. Due to this difference in moduli values it is concluded that there is sufficient damage to the stabilized base course layer in the northbound direction to consider the pavement structure in this direction as a three layer system.

DISCUSSION

A confidence level for the modulus of the rubblized CRCP layer is the probability of obtaining or exceeding a given modulus for that layer at any location across the pavement. Table 18 includes the idealized three layer backcalculated modulus value for the rubblized CRCP layer at each location that a FWD test was performed in 1994. These forty-five values are listed in Table 24 in descending order. Note that the individual values range from 7929.25 to 689.5 MPa over the five test sections.

Figure 19 is a graph of the data provided from Table 24. The vertical axis labeled "Percent Equal to or Greater than" is equivalent to a confidence level. From this figure there is a 75% confidence level that the modulus of the rubblized CRCP layer will be equal to or greater than 1316 MPa at any location across the pavement. A similar analysis has been performed with the 1996 and 1997 FWD data. Table 17 shows four different confidence levels for each of the three years that FWD data was collected and the average modulus of the three years at each of the four given confidence levels.

Figure 4.2 (Reference 6) shows a relationship between the AASHTO Structural Layer Coefficient and the Fracture Slab Modulus. Entering this figure with the average modulus for a given confidence level from Table 17 a corresponding design layer coefficient can be obtained for the rubblized CRCP layer.

MDOT uses a confidence level of 85 percent for interstate pavements. From Table 17 this confidence level corresponds to a layer coefficient of 0.25 for pavement design. This value is within the AASHTO Design Guide suggested range from 0.14 to 0.30 for the layer coefficient of rubblized CRCP.

The use of the value of 0.25 for the layer coefficient of rubblized CRCP should not be considered as a unique value. A decrease in the size of the fractured slab fragments reduces the stiffness; i.e. modulus, of the rubblized CRCP layer; therefore, the layer coefficient of 0.25 is applicable for rubblized CRCP layers having a similar degree of rubblization as that obtained in the project used for this study. Many factors affect the degree of rubblization actually achieved and one of these factors is the method of rubblization. This method was addressed in Chapter 2.

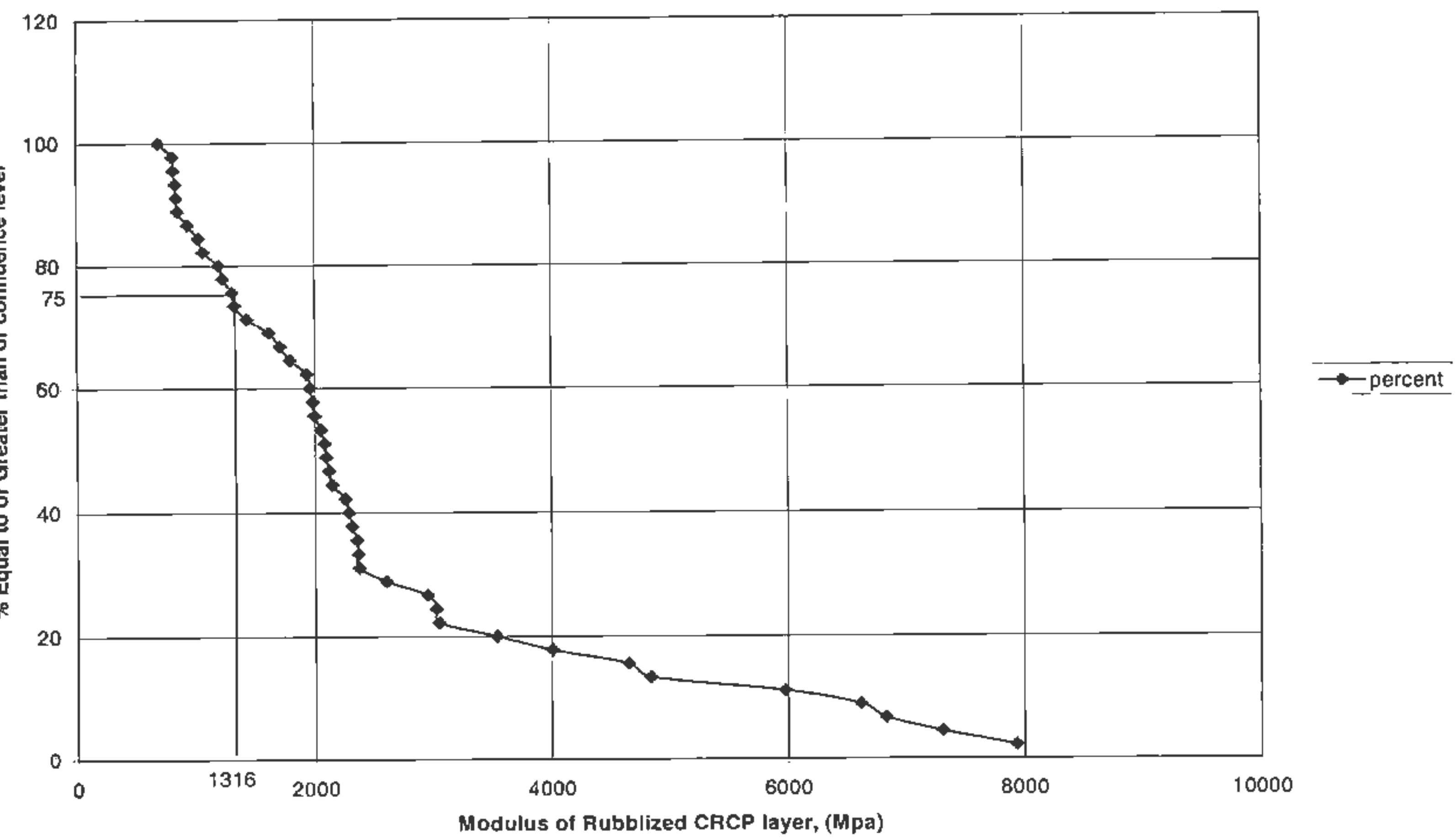

Figure 1. Confidence level vs. modulus of rubblized CRCP layer

Table 15. North bound pavement idealization for backcalculation using "Modulus 5.0"

3 Layer Approach		4 Layer Approach	
Layer	Thickness	Layer	Thickness
HMA	Average core thickness of the section including all lifts	HMA	Avg. core thickness of the section including all lifts
Rubblized CRC	8 IN.	Rubblized CRC	8 IN.
Subgrade	Infinite	Soil-Cement	6 IN.
		Subgrade	Infinite

Table 16. Comparison between soil-cement moduli of one section consisting of HMA over soil-cement base (rubblized material removal section) and the average soil-cement moduli in all south bound sections

Data	Soil-cem. moduli,MPa/north bound			Soil-cem. moduli,MPa/south bound		
	Average	Std. Dev.	% CV	Average	Std. Dev.	% CV
1994	2532	1551	61	6931	4029	58
1996	1238	634	51	5404	3110	58
1997	2322	1696	73	5606	4245	76

Table 17. Confidence levels for rubblized CRCP moduli, MPa and AASHTO layer coefficient

Confidence level	1994 Data	1996 Data	1997 Data	Average Moduli , MPa	Design layer coefficient
75	1316	2241	3586	2431	0.31
85	1005	1909	915	1276	0.25
90	844	1687	725	1086	0.24
95	767	1316	535	873	0.22

Table 18. I-55 North backcalculation results, September 1994 data, 3 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Subgrade (MPa)	Absolute ERR/Sensor	Depth to bedrock
772+00	7749.98	2000.929	176.512	0.89	170.68
772+25	7756.875	1794.079	182.7175	0.76	166.94
772+50	7019.11	2095.3905	193.7495	0.71	197.5
772+75	7350.07	1960.2485	181.3385	0.68	202.63
773+00	6798.47	1932.6685	182.7175	0.73	148.95
773+25	8239.525	1706.5125	190.9915	0.69	133.2
773+50	5943.49	2362.9165	178.5805	0.8	182.49
774+00	7756.875	2286.382	180.649	0.68	166.32
774+50	7736.19	2080.2215	172.375	0.54	167.52
775+00	8163.68	5975.8965	186.165	0.7	159.42
843+00	9025.555	1618.2565	300.622	0.57	300
843+25	7260.435	2050.573	285.453	0.45	300
843+50	7991.305	2120.2125	275.8	0.16	300
843+75	8115.415	3025.526	276.4895	0.27	300
844+00	10004.645	2355.332	276.4895	0.41	300
844+25	13286.665	1428.644	237.188	0.15	300
844+50	9859.85	3538.514	274.421	0.29	300
845+00	10963.05	1228.689	249.599	0.24	300
845+50	9239.3	850.1535	221.3295	0.14	300
846+00	7598.29	4005.3055	240.6355	0.28	300
985+00	4985.085	2602.173	142.7265	1.89	110.34
985+25	6564.04	816.368	128.9365	0.87	82.26
985+50	5460.84	1327.2875	144.1055	0.74	95.88
985+75	5805.59	689.5	140.658	1.19	68.10 *
986+00	5715.955	806.715	139.279	0.94	83.34
986+25	3888.78	2373.9485	175.8225	1.98	87.78
986+50	5998.65	1023.218	128.247	0.75	95.22
987+00	7639.66	934.962	130.3155	0.57	78.08
987+50	7067.375	830.8475	144.795	0.48	75.52
48+00	3709.51	4836.8425	135.142	0.36	300
48+25	4909.24	7929.25	146.8635	1.56	300.00 *
48+50	3330.285	1983.002	147.553	0.58	225.87
48+75	3316.495	6617.1315	177.2015	0.57	300
49+00	3082.065	7310.079	170.996	0.49	151.81
49+25	3392.34	2951.7495	182.7175	0.86	300
49+50	3330.285	1062.5195	214.4345	0.73	189.66
50+00	3247.545	1191.456	255.8045	0.63	139.14
50+50	3688.825	1305.913	207.5395	0.7	99.92
380+00	7419.02	6830.187	239.2565	0.29	300
380+25	6501.985	2144.345	237.8775	0.7	300
380+50	10390.765	3046.9005	250.978	0.64	300
380+75	7632.765	4651.367	259.252	0.33	300
381+00	8094.73	2309.825	229.6035	0.65	300
381+25	7936.145	2253.9755	202.713	0.28	300
381+50	9356.515	840.5005	180.649	0.18	181.05
Average	6896.072556	2557.478078	199.4953333	0.646666667	211.4306977
Std. Dev.	2335.444657	1844.727436	49.36375254	0.396914234	86.60528029
% CV	33.86630054	72.13072332	24.74431442	61.37848978	40.96154496

Table 19. I-55 North test sections backcalculation results, 1996 data, 3 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Subgrade (MPa)	Absolute Error/Sensor	Depth to bedrock
772+00	9928.8	2657.333	211.6765	0.94	300
772+50	7722.4	2850.393	204.7815	0.69	300
773+00	8046.465	2993.809	208.9185	0.66	300
773+50	6736.415	4446.5855	219.261	0.85	300
774+00	9701.265	4445.2065	222.019	0.64	300
774+50	13879.635	2248.4595	204.7815	0.7	300
775+00	16492.84	2241.5645	241.325	0.6	300
843+00	10942.365	2131.934	250.2885	0.5	300
843+50	8880.76	2177.441	241.325	0.74	300
844+00	11238.85	5338.7985	256.494	0.44	300
844+50	12755.75	3617.8065	246.841	0.61	300
845+00	10859.625	2678.018	243.3935	0.62	300
845+50	9197.93	2381.533	193.7495	0.64	300
846+00	16885.855	6895	237.188	0.45	300.00 *
985+00	6908.79	5483.5935	137.2105	2.05	133.4
985+50	9790.9	2040.2305	173.0645	1.38	101.89
986+00	8329.16	1490.0095	151.0005	1.11	78.55
986+50	9735.74	1700.307	131.005	1.02	90.07
987+00	4557.595	2338.0945	136.521	1.57	86.64
987+50	8025.78	2192.61	162.0325	1.13	79.23
48+00	18251.065	6895	110.32	0.84	300.00 *
48+50	10921.68	3371.655	118.594	0.82	300
49+00	10239.075	6373.738	152.3795	0.75	300
49+50	9046.24	2450.483	182.7175	0.69	300
50+00	8329.16	2157.4455	238.567	1.04	134.72
50+50	11962.825	1622.3935	175.133	0.35	107.52
51+00	10763.095	6895	126.868	0.51	300.00 *
338+00	7377.65	3288.2255	124.11	0.83	216.74
338+50	5950.385	4790.646	145.4845	1.21	300
339+00	12990.18	5110.574	140.658	0.16	203.17
339+50	8708.385	2524.2595	142.7265	1.49	165.41
340+00	6046.915	2089.185	130.3155	1.1	174.46
340+50	10390.765	1622.3935	135.142	0.71	111.65
341+00	20319.565	6895	133.0735	2.2	300
380+00	10976.84	6895	240.6355	0.95	300.00 *
380+50	7467.285	6830.8765	260.631	1.38	300
381+00	7377.65	4343.1605	235.809	1.09	300
381+50	12155.885	1687.2065	218.5715	0.15	159.09
382+00	9721.95	945.3045	203.4025	0.19	147.94
382+50	6584.725	2854.53	244.083	0.41	300
383+50	9411.675	4138.379	266.8365	1.46	300
Average	10136.8272	3564.126402	190.2179146	0.87	232.1751351
Std. Dev.	3341.024135	1851.044872	49.05883232	0.458595682	87.7449787
% CV	32.95926892	51.93544399	25.79085804	52.71214741	37.79258216

Table 20. I-55 North test sections backcalculation results, April 1997 data, 3 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Subgrade (MPa)	Absolute Error/Sensor	Depth to bedrock
843+00	3488.87	7847.20	231.67	0.90	300.00
853+50	3033.80	5763.53	222.71	0.54	300.00
844+00	4495.54	13790.00	217.19	0.79	300.00
844+50	4860.98	13790.00	197.89	1.05	300.00
845+00	2840.74	7064.62	199.96	0.96	300.00
845+50	2378.78	4248.01	183.41	0.89	300.00
846+00	3675.04	13790.00	198.58	1.83	300.00
985+00	3475.08	3586.09	301.31	0.53	97.57
985+50	5550.48	931.51	404.74	0.25	95.26
986+00	5081.62	344.75	344.06	2.08	81.53
986+50	4385.22	725.35	327.51	1.83	92.08
987+00	5109.20	1103.89	364.75	1.51	83.37
987+50	4709.29	611.59	367.50	1.92	84.83
48+00	2109.87	621.24	90.32	0.29	196.35
48+50	2351.20	948.75	101.36	0.43	215.92
49+00	1730.65	1427.27	106.18	0.38	196.01
49+50	2558.05	2107.80	105.49	0.38	217.16
50+00	1868.55	4343.85	126.18	0.49	207.49
50+50	2302.93	4481.75	131.69	0.55	254.31
51+00	3282.02	13790.00	189.61	4.31	300.00
338+00	1778.91	13371.47	143.42	1.72	175.83
338+50	1889.23	13790.00	168.93	1.94	300.00
339+00	4047.37	13790.00	145.48	1.13	300.00
339+50	1551.38	9506.83	165.48	2.67	192.24
340+00	1565.17	6166.89	152.38	2.44	210.18
340+50	2378.78	3976.35	164.10	0.99	142.51
341+00	3971.52	13790.00	147.55	5.79	300.00
380+00	2951.06	13790.00	179.96	2.52	300.00
380+50	3026.91	13790.00	202.71	3.69	300.00
381+00	2523.57	13790.00	175.13	2.17	300.00
381+50	1558.27	5325.01	180.65	1.96	300.00
Average	3113.87	7174.31	201.22	1.58	227.18
Std. Dev.	1200.57	5424.81	84.10	1.27	83.42
% CV	0.39	0.76	0.42	0.80	0.37

Table 21. I-55 North test sections backcalculation results, 1994 data, 4 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Soil Cement (MPa)	Subgrade (MPa)	Absolute Error/Sensor	Depth to bedrock
772+00	9542.68	749.4865	1268.68	155.1375	0.31	170.68
772+25	9390.99	695.016	1118.369	162.722	0.31	166.94
772+50	8777.335	843.948	1090.0995	174.4435	0.34	197.5
772+75	9253.09	689.5	1427.9645	157.8955	0.06	202.63 *
773+00	8632.54	715.701	1183.182	163.4115	0.16	148.95
773+25	9797.795	689.5	1062.5195	172.375	0.22	133.20 *
773+50	7501.76	900.487	1382.4475	155.1375	0.25	182.49
774+00	10239.075	696.395	2005.066	152.3795	0.13	166.32
774+50	9963.275	692.9475	1499.6625	149.6215	0.14	167.52
775+00	12162.78	1390.7215	4501.056	141.3475	0.35	159.42
843+00	10494.19	704.669	2286.382	217.882	0.38	300
843+25	9191.035	756.3815	2897.9685	200.6445	0.24	300
843+50	9204.825	1109.4055	1334.872	204.7815	0.29	300
843+75	10590.72	1095.6155	2880.731	190.9915	0.61	300
844+00	12748.855	698.4635	5719.4025	179.27	0.22	300
844+25	14465.71	748.797	1143.191	174.4435	0.22	300
844+50	10969.945	2108.491	1352.1095	199.955	0.25	300
845+00	11693.92	689.5	1126.643	185.4755	0.18	300.00 *
845+50	8363.635	689.5	689.5	166.859	0.58	300.00 *
846+00	9487.52	1866.4765	1848.5495	168.9275	0.31	300
985+00	7177.695	836.3635	1555.512	110.32	0.58	110.34
985+25	4461.065	689.5	689.5	101.3565	3.55	82.26 *
985+50	5853.855	689.5	689.5	122.731	1.21	95.88 *
985+75	3537.135	689.6	689.5	108.2515	5.71	68.10 *
986+00	3923.255	689.5	689.5	110.32	3.65	83.34 *
986+25	5640.11	748.797	1756.1565	136.521	0.48	87.78
986+50	4943.715	689.5	689.5	103.425	2.41	95.22 *
987+00	5846.96	689.5	689.5	104.804	2.51	78.08 *
987+50	5026.455	689.5	689.5	115.836	3.3	75.52 *
48+00	4943.715	1888.5405	689.5	173.0645	1.35	300.00 *
48+25	4143.895	5076.099	1441.7445	188.923	0.92	300
48+50	4523.12	689.5	689.5	178.5805	1.02	225.87 *
48+75	4095.63	2875.215	689.5	227.535	0.4	300.00 *
49+00	3757.775	3195.8325	689.5	221.3295	0.68	151.81 *
49+25	4957.505	817.0575	1341.0775	215.8135	0.95	300
49+50	2889.005	721.217	721.217	239.946	3.64	169.66 *
50+00	2785.58	844.6375	844.6375	281.316	4.41	139.14 *
40+50	3757.775	717.7695	717.7695	239.2565	2.66	99.92 *
51+00	3213.07	2316.72	689.5	189.6125	0.86	300.00 *
338+00	14582.925	483.3395	1467.256	104.804	0.57	175.78 *
338+25	10783.78	908.761	801.8885	132.384	0.25	130.76
338+50	10480.4	1488.6905	490.2345	137.2105	0.26	152.43
338+75	9087.61	3690.8935	4647.9195	120.6625	0.2	300
339+00	14582.925	344.75	13790	158.585	10.56	212.55 *
339+25	14582.925	726.0435	989.4325	132.384	0.64	127.86 *
339+50	14582.925	490.924	744.66	142.7265	2.13	143.48 *
340+00	8804.915	590.9015	344.75	117.9045	0.49	136.84 *
340+50	14334.705	344.75	838.432	117.215	0.78	105.63 *
341+00	7701.715	3184.8005	1235.584	93.772	0.47	300
380+00	12872.965	1956.801	3683.9985	155.1375	0.61	300
380+25	7618.975	1246.616	914.9665	179.9595	0.53	300
380+50	11300.905	2042.9885	908.761	188.2335	0.6	300
380+75	8170.575	3450.9475	905.3135	195.818	0.36	300
381+00	12273.1	646.751	4245.941	151.0005	0.14	300
381+25	13369.405	534.3625	4789.267	130.3155	0.94	300

Table 22. I-55 north test sections backcalculation results, 1996 data, 4 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Soil Cement (MPa)	Subgrade (MPa)	Absolute Error/Sensor	Depth to bedrock
772+00	13341.825	668.1255	3879.127	175.133	0.22	300
772+50	10452.82	834.295	2561.4925	174.4435	0.07	300
773+00	11514.65	768.103	3208.933	175.8225	0.34	300
773+50	10680.355	948.0625	5354.657	175.8225	0.31	300
774+00	11149.215	2566.319	917.035	207.5395	0.34	300
774+50	17568.46	650.1985	1974.728	182.028	0.27	300
775+00	18919.88	577.1115	6322.0255	194.439	0.35	300.00 *
843+00	13865.845	615.7235	5235.3735	161.343	0.14	300
843+50	11755.975	619.171	4797.541	157.206	0.23	300
844+00	15306.9	1568.6125	4843.7375	159.2745	0.42	300
844+50	14679.455	1762.362	1872.682	171.6855	0.4	300
845+00	13617.625	821.884	4199.7445	157.206	0.27	300
845+50	9184.14	1947.8375	541.947	146.174	0.72	300
846+00	14872.515	5929.0105	1584.471	164.101	0.26	300
985+00	10859.625	1247.995	3897.7435	94.4615	0.63	133.4
985+50	12866.07	657.0935	1706.5125	141.3475	0.56	101.89
986+00	11080.265	455.07	1445.192	124.7995	0.32	78.55
986+50	10383.87	1153.5335	365.435	121.352	0.76	90.07
987+00	7315.595	614.3445	2162.272	102.046	0.36	86.64
987+50	11169.9	704.669	1576.197	132.384	0.24	79.23
48+00	16223.935	4268.6945	1817.522	96.53	0.34	300
48+50	12211.045	1827.8645	788.788	108.941	0.6	300
49+00	11100.95	4765.1345	526.0885	146.174	0.68	300
49+50	13624.52	446.1065	8982.1165	135.142	0.22	300
50+00	9721.95	1159.0495	703.9795	225.4665	0.76	134.72
50+50	14941.465	472.3075	1572.7495	155.1375	0.24	107.52
51+00	10638.985	4973.3635	873.5965	118.594	0.34	300
380+00	11466.385	2488.4055	3278.5725	145.4845	0.2	300
380+50	13569.36	1118.369	11578.7735	129.626	0.26	300
381+00	9742.635	1381.758	2391.186	148.2425	0.34	300
381+50	13224.61	442.659	3874.3005	137.9	0.55	159.09
Average	12485.51048	1563.007532	3059.178048	150.5111774	0.378709677	242.3703333
Std. Dev.	2539.324327	1470.943278	2547.235578	31.18044412	0.186041965	90.77483027
%CV	0.203381698	0.94109801	0.832653588	0.207163645	0.491252209	0.374529461

Table 23. I 55 North test sections backcalculation results, April 1997 data, 4 layer idealization

Station (feet)	HMA (MPa)	Rubblized CRC (MPa)	Soil Cement (MPa)	Subgrade (MPa)	Absolute ERR/Sensor	Depth to bedrock
772+50	3151.02	2483.58	1379.00	206.16	0.55	300.00
773+00	3385.45	2351.20	1876.82	200.64	0.98	300.00
773+50	2165.03	5429.12	1779.60	212.37	0.91	300.00
774+00	3792.25	3088.27	2191.92	204.78	0.81	300.00
774+50	3916.36	2097.46	2003.69	186.17	0.81	300.00
775+00	2454.62	10342.50	2127.80	197.20	1.14	181.07
843+00	4474.86	2576.66	1923.71	206.85	0.85	300.00
843+50	3226.86	3678.48	689.50	211.68	0.67	300.00
844+00	5040.25	5855.23	2105.73	197.89	0.48	300.00
844+50	5419.47	6043.47	1925.08	181.34	0.77	300.00
845+00	3295.81	2976.57	1321.08	182.72	0.68	300.00
845+50	2737.32	2178.13	703.29	171.00	0.79	300.00
846+00	3550.93	4950.61	5122.99	162.03	0.74	300.00
985+00	3716.41	2263.63	2609.76	96.53	0.87	97.57
985+50	5516.00	740.52	3160.67	146.17	0.62	95.26
986+00	3309.60	689.50	689.50	145.48	2.86	81.53
986+50	3854.31	787.41	1244.55	132.38	0.71	92.08
987+00	4550.70	1185.94	1310.74	146.17	0.94	83.37
987+50	3675.04	929.45	718.46	162.72	0.82	84.83
48+00	3854.31	7304.56	3186.18	108.94	0.54	300.00
48+50	3164.81	5078.17	1185.25	125.49	0.63	300.00
49+00	3288.92	6184.82	4823.05	131.01	0.84	300.00
49+50	2620.10	3164.12	1091.48	190.30	0.65	179.89
50+00	2758.00	4454.86	2831.09	238.57	1.13	145.74
50+50	3771.57	2947.61	689.50	192.37	1.22	105.45
51+00	1923.71	10342.50	2069.88	134.45	0.75	300.00
338+00	2751.11	3379.24	1198.35	184.10	0.78	175.83
38+50	2599.42	3942.56	1376.24	214.43	0.76	300.00
339+00	3716.41	9790.21	689.50	192.37	0.67	300.00
339+50	3233.76	1528.62	1894.06	196.51	0.34	192.24
340+00	3095.86	1347.97	1094.24	181.34	0.60	210.18
340+50	4626.55	1250.75	689.50	196.51	1.38	142.51
341+00	2082.29	7250.09	11529.82	154.45	0.25	300.00
380+00	2820.06	4430.04	6095.87	142.73	0.28	300.00
380+50	2813.16	3912.91	12673.01	146.17	0.79	300.00
381+00	2702.84	3950.15	4945.78	142.73	0.50	300.00
381+50	2351.20	1454.16	1529.31	157.21	0.61	300.00
Average	3389.36	3847.60	2553.40	172.43	0.80	236.96
Std. Dev.	880.62	2630.55	2676.62	33.18	0.42	86.63
% CV	25.98	68.37	104.83	19.24	52.44	36.56

Table 24. Data for graph of Confidence level vs. modulus of Rubblized CRCP layer.

STATION NUMBER	Rubblized CRC (Mpa)	Number equal to or greater than	Percent equal to or greater than
48+25	7929.2500	1	2.22
49+00	7310.0790	2	4.44
380+00	6830.1870	3	6.67
48+75	6617.1315	4	8.89
775+00	5975.8965	5	11.11
48+00	4836.8425	6	13.33
380+75	4651.3670	7	15.56
846+00	4005.3055	8	17.78
844+50	3538.5140	9	20.00
380+50	3046.9005	10	22.22
843+75	3025.5260	11	24.44
49+25	2951.7495	12	26.67
985+00	2602.1730	13	28.89
986+25	2373.9485	14	31.11
773+50	2362.9165	15	33.33
844+00	2355.3322	16	35.56
381+00	2309.8250	17	37.78
774+00	2286.3820	18	40.00
381+25	2253.9755	19	42.22
380+25	2144.3450	20	44.44
843+50	2120.2125	21	46.67
772+50	2095.3905	22	48.89
774+50	2080.2215	23	51.11
843+25	2050.5730	24	53.33
772+00	2000.9290	25	55.56
48+50	1983.0020	26	57.78
772+75	1960.2485	27	60.00
773+00	1932.6685	28	62.22
772+25	1794.0790	29	64.44
773+25	1706.5125	30	66.67
843+00	1615.2565	31	68.89
844+25	1428.6440	32	71.11
985+50	1327.2875	33	73.33
50+50	1305.9130	34	75.56
845+00	1228.6890	35	77.78
50+00	1191.4560	36	80.00
49+50	1062.5195	37	82.22
986+50	1023.2180	38	84.44
987+00	934.9620	39	86.67
845+50	850.1535	40	88.89
381+50	840.5005	41	91.11
987+50	830.8475	42	93.33
985+25	816.3680	43	95.56
986+00	806.7150	44	97.78
985+75	689.5000	45	100.00
Avg	2557.41		
Std. Dev.	1844.76		

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

1. The minimum southbound overlay thickness section of 1.4" is providing good performance to date in regard to both rutting and cracking.

2. Sufficient damage resulting from the rubblization process occurred to the stabilized base course layer in the northbound direction to consider the pavement structure in this direction as a three layer instead of a four layer system for the purpose of backcalculating the pavement layer moduli.

3. For the rubblized CRCP layer in the northbound lanes of this project a structural layer coefficient of 0.25 should be used for pavement design.

RECOMMENDATIONS

1. For CRCP having any working punchouts repaired and having an initial pavement condition equal to or exceeding that of the southbound pavement in this study a minimum overlay thickness will be sufficient for rehabilitation.

2. The use of a polymer modified asphalt binder in the HMA should further reduce the extent of rutting experienced in the overlay.

3. Subsequent to rubblization of an overlying CRCP layer the integrity of stabilized subbase and subgrade courses may be reduced to such an extent that they should not be considered as a unique layer for subsequent backcalculation analyses.

4. The use of the value of 0.25 for the layer coefficient of rubblized CRCP should not be considered as a unique value. The layer coefficient of 0.25 is applicable for rubblized CRCP layers having a similar degree of rubblization as that obtained in the project used for this study.

REFERENCES

1 Teng, T.C., Final Report, State Study No. 59-3, Pavement Rehabilitation Using Dynaflect Data, June 1981

2 National Highway Institute, "Pavement Deflection Analysis," Publication No. FHWA-HI-94-021, February 1994

3 American Association of State Highway and Transportation Officials, "AASHTO Guide for the Design of Pavement Structures," Washington, D.C., 1993

4. George, K. P., "AASHTO Layer Coefficients for Bituminous Materials," FHWA/MS-DOT-RD-97-114 for Mississippi Department of Transportation, December 1996

5. Michalak, C.H. and Scullion, T., "MODULUS 5.0: User's Manual," Research Report 1987-1, for Texas Department of Transportation, November 1995

6. PCS/Law Engineering, "Guidelines For Use of HMA Overlays To Rehabilitate PCC Pavements," for National Asphalt Pavement Association, 1994

APPENDIX A

DEFLECTION DATA

1994 Deflection Data

I 55 NORTH ; SECTION # 1 ; MONTGOMERY COUNTY ; STA. 772+00 - 775+00 AVG. HMA THICKNESS = 6.9 IN. SURFACE TEMP. 62 - 71 F Air temp. = 62 - 63 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
14.621	9447	5.08	4.29	3.85	3.23	2.74	2	1.17
14.626	9415	5.11	4.28	3.84	3.21	2.69	1.94	1.13
14.631	9399	4.87	4.03	3.6	3.02	2.52	1.82	1.09
14.635	9388	5.07	4.25	3.78	3.18	2.69	1.94	1.16
14.64	9428	5.17	4.3	3.83	3.2	2.69	1.93	1.1
14.645	9396	4.95	4.16	3.72	3.1	2.6	1.85	1.03
14.65	9356	5.11	4.2	3.75	3.16	2.67	1.96	1.16
14.659	9375	4.82	4.06	3.63	3.07	2.63	1.92	1.12
14.669	9380	5.06	4.26	3.83	3.25	2.76	2.01	1.17
14.678	9348	3.7	3.13	2.85	2.5	2.21	1.72	1.02
AVG.	9393.2	4.894	4.096	3.668	3.092	2.62	1.909	1.115
ST. DEV.	30.87898	0.434286	0.352363	0.300437	0.220646	0.159792	0.088625	0.055227
%C.V.	0.003287	0.088738	0.086026	0.081908	0.07136	0.060989	0.046425	0.049531

I 55 NORTH ; SECTION # 2 ; CARROLL COUNTY ; STA. 843+00 - 846+00 AVG. HMA THICKNESS = 6.9 IN. SURFACE TEMP. = 63 - 79 F Air temp. = 67 - 68 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
15.966	9780	4.54	3.78	3.37	2.83	2.38	1.79	1.16
15.971	9764	4.7	3.86	3.45	2.91	2.48	1.87	1.18
15.975	9650	4.6	3.81	3.43	2.93	2.53	1.89	1.14
15.98	9606	4.24	3.51	3.21	2.78	2.42	1.86	1.21
15.985	9645	4.29	3.64	3.3	2.83	2.46	1.89	1.23
15.99	9579	4.81	4.18	3.83	3.33	2.89	2.18	1.36
15.994	9534	3.93	3.33	3.06	2.67	2.36	1.85	1.24
16.004	9547	4.97	4.26	3.86	3.28	2.81	2.09	1.33
16.013	9431	5.85	4.99	4.48	3.79	3.2	2.34	1.48
16.023	9510	4.35	3.66	3.38	2.97	2.64	2.09	1.45
AVG.	9604.6	4.628	3.902	3.537	3.032	2.617	1.985	1.278
ST. DEV.	109.5001	0.525607	0.474032	0.413872	0.338323	0.271664	0.179273	0.120536
%C.V.	0.011401	0.113571	0.121484	0.117012	0.111584	0.103807	0.090314	0.094316

I 55 NORTH ; SECTION # 3 ; CARROLL COUNTY ; STA. 985+00 - 988+00								
AVG. HMA THICKNESS =6.2 IN. SURFACE TEMP. 83 - 91 F Air temp. = 71 - 73 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
18.655	9494	5.18	4.15	3.59	2.88	2.34	1.59	0.84
18.66	9431	6.91	5.67	4.89	3.84	2.94	1.77	0.76
18.665	9439	6.1	4.85	4.19	3.31	2.56	1.57	0.76
18.67	9372	7.09	5.74	4.94	3.81	2.86	1.56	0.57
18.674	9391	6.93	5.58	4.76	3.66	2.8	1.64	0.73
18.679	9455	5.23	3.96	3.36	2.62	2.07	1.34	0.64
18.684	9383	6.67	5.43	4.7	3.69	2.89	1.75	0.83
18.693	9359	6.35	5.2	4.57	3.65	2.84	1.71	0.7
18.703	9372	6.37	5.13	4.47	3.51	2.71	1.54	0.61
18.712	9383	6.58	5.35	4.67	3.69	2.88	1.76	0.76
AVG.	9407.9	6.341	5.106	4.414	3.466	2.689	1.623	0.72
ST. DEV.	44.25545	0.66985	0.615669	0.541381	0.410344	0.284075	0.133004	0.089938
%C.V.	0.004704	0.105638	0.120578	0.122651	0.118391	0.105644	0.081949	0.124914

I 55 NORTH ; SECTION # 4 ; CARROLL COUNTY ; STA. 48+00 - 51+00								
AVG. HMA THICKNESS = 6.8 IN. SURFACE TEMP. = 99 - 106 F Air temp. = 79 - 85 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
0.909	9407	5.93	4.82	4.47	3.98	3.52	2.69	1.69
0.909	9375	5.94	4.8	4.45	3.96	3.5	2.68	1.68
0.914	9367	4.8	3.82	3.58	3.28	2.98	2.4	1.49
0.919	9296	7.11	5.63	5.04	4.24	3.61	2.65	1.58
0.923	9296	5	3.9	3.52	3.11	2.73	2.12	1.29
0.928	9309	5.11	3.94	3.61	3.19	2.8	2.18	1.26
0.933	9245	5.78	4.49	3.99	3.38	2.87	2.15	1.3
0.937	9232	6.74	5.03	4.36	3.45	2.74	1.84	1.08
0.947	9208	6.03	4.37	3.74	2.95	2.32	1.52	0.85
0.956	9193	6.33	4.8	4.18	3.43	2.8	1.85	0.91
0.966	9213	5.98	4.59	4.18	3.68	3.24	2.49	1.52
AVG.	9285.545	5.886364	4.562727	4.101818	3.513636	3.01	2.233636	1.331818
ST. DEV.	73.83003	0.709708	0.543877	0.470315	0.405075	0.406103	0.388388	0.292055
%C.V.	0.007951	0.120568	0.1192	0.11466	0.115286	0.134918	0.173882	0.219291

I 55 NORTH ; SECTION #5 ; CARROLL COUNTY ; STA. 338+00 - 341+00								
AVG. HMA THICKNESS = 5.0 IN. SURFACE TEMP. = 66 - 69 F Air temp. = 67 - 69 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.402	9444	7.13	6.13	5.48	4.6	3.82	2.72	1.56
6.406	9439	6.46	5.39	4.78	3.96	3.3	2.35	1.28
6.411	9423	6.06	5.1	4.56	3.82	3.24	2.32	1.31
6.416	9518	3.99	3.35	3.07	2.74	2.49	2.02	1.36
6.425	9391	6.05	5.26	4.69	3.88	3.24	2.29	1.24
6.43	9316	6.53	5.53	4.89	4.03	3.35	2.36	1.31
6.439	9328	8.49	7.1	6.22	5.02	4.07	2.78	1.5
6.449	9280	7.74	6.51	5.81	4.78	3.92	2.61	1.28
6.458	9304	5.72	4.92	4.54	4.02	3.58	2.86	1.94
AVG.	9382.556	6.463333	5.476667	4.893333	4.094444	3.445556	2.478889	1.42
ST. DEV.	79.92827	1.284017	1.07014	0.905483	0.667628	0.474503	0.276923	0.22243
%C.V.	0.008519	0.198662	0.1954	0.185044	0.163057	0.137714	0.111712	0.156641

I 55 NORTH ; SECTION # 6 ; GRENADA COUNTY ; STA. 380+00 - 383+00								
AVG. HMA THICKNESS = 5.7 IN. SURFACE TEMP. 67 - 71 F Air temp. = 68 - 71 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
7.197	9351	4.14	3.51	3.24	2.88	2.59	2.07	1.41
7.202	9335	5.52	4.54	4.03	3.37	2.87	2.17	1.43
7.206	9332	4.53	3.87	3.5	3	2.61	2.03	1.36
7.211	9364	4.28	3.59	3.27	2.84	2.52	1.96	1.31
7.216	9316	5.31	4.48	4	3.39	2.92	2.23	1.45
7.221	9348	5.8	4.86	4.44	3.81	3.3	2.49	1.54
7.225	9261	7.31	6.21	5.57	4.65	3.91	2.8	1.61
7.235	9269	8.85	7.44	6.61	5.43	4.41	2.94	1.54
7.244	9261	7.56	6.3	5.63	4.7	3.91	2.7	1.47
7.254	9285	5.83	4.82	4.29	3.61	3.07	2.29	1.39
AVG.	9312.2	5.913	4.962	4.458	3.768	3.211	2.368	1.451
ST. DEV.	39.78498	1.547428	1.295821	1.129177	0.880427	0.655565	0.345247	0.091585
%C.V.	0.004272	0.261699	0.261149	0.253292	0.233659	0.204162	0.145797	0.063118

I 55 NORTH ; SECTION # 7 ; GRENADA COUNTY ; STA. 216+00 - 219+00 AVG. HMA THICKNESS = 7.9 IN. SURFACE TEMP. = 108 - 110 F Air temp. = 81 - 82 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
4.091	9161	13.14	10.55	9.46	8	6.73	4.85	2.59
4.096	9166	12.36	9.82	8.83	7.46	6.31	4.51	2.39
4.1	9089	12.55	9.9	8.87	7.48	6.27	4.52	2.39
4.105	9110	12.32	9.65	8.62	7.22	6.06	4.32	2.3
4.11	9126	10.81	8.48	7.64	6.55	5.61	4.13	2.23
4.115	9094	10.68	8.31	7.52	6.44	5.49	4.02	2.22
4.119	9142	10	8.11	7.39	6.45	5.63	4.22	2.32
4.129	9169	9.41	7.32	6.6	5.73	4.92	3.65	2.05
4.138	9145	9.08	6.88	6.26	5.45	4.75	3.58	2.06
4.148	9161	6.35	4.57	4.18	3.83	3.47	2.84	1.87
AVG.	9136.3	10.67	8.359	7.537	6.461	5.524	4.064	2.242
ST. DEV.	30.00759	2.06722	1.785089	1.568092	1.223297	0.949774	0.579716	0.206387
%C.V.	0.003284	0.193741	0.213553	0.208053	0.189335	0.171936	0.142647	0.092055

I 55 SOUTH ; SECTION # 2; GRENADA COUNTY ; STA. 377+00 - 372+00 AVG. HMA THICKNESS = 5.1 IN. SURFACE TEMP. = 74 - 85 F Air temp. = 76 - 78 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
7.14	9478	2.54	2.26	2.21	2.18	2.1	1.87	1.37
7.135	9391	2.62	2.24	2.19	2.1	2	1.74	1.31
7.131	9328	2.75	2.31	2.23	2.14	2.04	1.8	1.37
7.126	9300	4.27	3.62	3.39	3.02	2.74	2.25	1.58
7.121	9312	2.94	2.6	2.54	2.43	2.31	2.04	1.52
7.116	9272	3.64	3.13	3.05	2.88	2.67	2.24	1.54
7.112	9288	2.89	2.43	2.35	2.25	2.14	1.88	1.4
7.102	9264	2.99	2.6	2.51	2.37	2.24	1.95	1.42
7.093	9157	4.38	3.83	3.7	3.48	3.23	2.63	1.66
7.083	9253	3.81	3.45	3.4	3.31	3.16	2.67	1.8
7.074	9237	2.86	2.51	2.45	2.33	2.2	1.88	1.3
7.064	9208	2.7	2.32	2.23	2.13	2.01	1.7	1.2
7.055	9121	4.13	3.89	3.83	3.7	3.48	2.89	1.8
7.045	9129	2.48	2.03	1.93	1.84	1.71	1.43	1

AVG.	9267	3.21429	2.80143	2.715	2.58286	2.43071	2.06929	1.44786
ST. DEV.	97.7611	0.68114	0.64584	0.62904	0.58526	0.53761	0.41723	0.22227
%C.V.	0.01055	0.21191	0.23054	0.23169	0.22659	0.22117	0.20163	0.15351

I 55 SOUTH ; SECTION # 3 ; GRENADA COUNTY ; STA. 364+00 - 359+00 AVG. HMA THICKNESS = 4.4 IN. SURFACE TEMP. = 73 - 90 F Air temp. = 77 - 80 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.894	9328	2.65	2.3	2.22	2.11	1.98	1.71	1.27
6.889	9232	2.33	2.08	2.02	1.93	1.83	1.59	1.2
6.884	9161	2.62	2.33	2.26	2.14	2	1.72	1.28
6.88	9169	2.49	2.15	2.1	2	1.88	1.63	1.21
6.875	9173	2.29	2.06	2.02	1.94	1.86	1.63	1.2
6.87	9240	2.91	2.65	2.57	2.43	2.27	1.91	1.39
6.866	9208	3.02	2.69	2.63	2.5	2.35	2.02	1.44
6.856	9200	3.1	2.76	2.68	2.55	2.41	2.08	1.51
6.847	9145	3.69	3.37	3.27	3.04	2.81	2.36	1.64
6.837	9110	2.94	2.64	2.59	2.46	2.31	2.01	1.48
6.828	9229	3.58	3.21	3.09	2.85	2.6	2.16	1.56
6.818	9121	2.67	2.35	2.32	2.25	2.15	1.9	1.39
6.809	9166	2.88	2.58	2.54	2.42	2.27	1.88	1.29
6.799	9177	2.69	2.35	2.3	2.2	2.09	1.81	1.35

AVG.	9189.93	2.84714	2.53714	2.47214	2.34429	2.20071	1.88643	1.37214
ST. DEV.	55.991	0.41202	0.39226	0.3745	0.32966	0.28803	0.22438	0.13995
%C.V.	0.00609	0.14471	0.15461	0.15149	0.14062	0.13088	0.11895	0.102

I 55 SOUTH ; SECTION # 4 ; GRENADA COUNTY ; STA. 352+00 - 347+00 AVG. HMA THICKNESS = 2.9 IN. SURFACE TEMP. = 86 - 93 F Air temp. = 81 - 83 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.667	9097	3.25	3.05	3.01	2.91	2.79	2.48	1.9
6.662	9118	3.23	2.99	2.94	2.82	2.66	2.33	1.75
6.657	9137	3.54	3.29	3.22	3.04	2.85	2.44	1.76
6.652	9121	3.32	3.06	3.01	2.87	2.7	2.34	1.73
6.648	9065	3.06	2.79	2.74	2.61	2.48	2.17	1.6
6.643	8983	3.43	3.23	3.17	3	2.8	2.26	1.38
6.638	9046	3.36	3.04	2.96	2.7	2.44	1.96	1.26
6.629	9014	2.81	2.56	2.52	2.38	2.23	1.92	1.39
6.619	8991	3.05	2.83	2.79	2.67	2.52	2.18	1.57
6.61	8978	3.07	2.85	2.76	2.58	2.4	2.02	1.43
6.6	9038	3.43	3.16	3.08	2.85	2.58	2.04	1.31
6.591	9018	2.96	2.67	2.6	2.44	2.28	1.93	1.35
6.581	9002	2.93	2.8	2.76	2.63	2.49	2.11	1.39
6.572	9014	2.34	2.11	2.07	1.96	1.84	1.57	1.15

AVG.	9044.43	3.12714	2.88786	2.83071	2.67571	2.50429	2.125	1.49786
ST. DEV.	54.397	0.31277	0.3069	0.30001	0.28462	0.26886	0.24346	0.22189
%C.V.	0.00601	0.10002	0.10627	0.10598	0.10637	0.10736	0.11457	0.14814

I 55 SOUTH ; SECTION # 5 ; GRENADA COUNTY ; STA. 345+00 - 340+00 AVG. HMA THICKNESS = 1.4 IN. SURFACE TEMP. = 89 - 96 F Air temp. = 82 - 84 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.534	8994	3.87	3.66	3.6	3.43	3.22	2.75	1.88
6.529	8943	4.71	4.5	4.36	4.04	3.73	3	1.76
6.525	9010	4.15	3.96	3.83	3.59	3.31	2.72	1.74
6.52	8943	4.83	4.51	4.38	4.05	3.69	2.94	1.77
6.515	8768	7.6	7.2	6.8	6.05	5.37	4.06	2.3
6.51	9002	3.74	3.5	3.42	3.21	3	2.52	1.69
6.506	8891	5.37	4.97	4.81	4.47	4.13	3.4	2.19
6.496	8887	5.11	4.75	4.58	4.24	3.91	3.21	2.05
6.487	8808	5.73	5.5	5.38	5.1	4.8	4.07	2.67
6.477	8919	3.49	3.41	3.36	3.2	3.01	2.59	1.73
6.468	8922	4.48	4.18	4.09	3.86	3.6	3.04	2.02
6.458	8840	4.76	4.61	4.48	4.18	3.88	3.21	2.07
6.449	8883	3.8	3.6	3.53	3.34	3.13	2.68	1.85
6.439	8991	4.13	3.85	3.75	3.53	3.29	2.8	1.97

AVG.	8914.36	4.69786	4.44286	4.31214	4.02071	3.71929	3.07071	1.97786
ST. DEV.	74.0609	1.06225	1.00231	0.92419	0.79201	0.68544	0.49097	0.27186
%C.V.	0.00831	0.22611	0.2256	0.21432	0.19698	0.18429	0.15989	0.13745

I 55 SOUTH ; SECTION #6 ; GRENADA COUNTY ; STA. 312+00 - 307+00 AVG. HMA THICKNESS = 2.4 IN. SURFACE TEMP. = 93 - 100 F Air temp. = 85 - 86 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.909	8919	3.99	3.6	3.51	3.33	3.08	2.53	1.69
5.904	8919	3.69	3.35	3.26	3.03	2.81	2.35	1.58
5.9	8848	3.92	3.68	3.61	3.39	3.17	2.6	1.72
5.895	8835	4.42	3.87	3.7	3.38	3.07	2.43	1.45
5.89	8776	5.95	5.8	5.57	4.98	4.3	2.97	1.46
5.885	8872	2.98	2.71	2.66	2.5	2.31	1.89	1.21
5.881	8906	3.65	3.28	3.22	3.05	2.87	2.44	1.76
5.871	8951	2.79	2.44	2.39	2.22	2.05	1.7	1.17
5.862	8875	3.77	3.54	3.49	3.31	3.1	2.63	1.84
5.852	8911	3.06	2.89	2.85	2.68	2.5	2.1	1.45
5.843	8779	5.99	5.12	4.76	4.09	3.44	2.49	1.52
5.833	8859	4.25	3.65	3.48	3.15	2.83	2.22	1.3
5.824	8864	4.6	4.08	3.85	3.45	3.08	2.39	1.39
5.814	8840	4.74	4.21	4	3.64	3.26	2.57	1.42

AVG.	8868.14	4.12857	3.73	3.59643	3.3	2.99071	2.37929	1.49714
ST. DEV.	51.2938	0.97443	0.89479	0.81636	0.67646	0.53472	0.32145	0.20239
%C.V.	0.00578	0.23602	0.23989	0.22699	0.20499	0.17879	0.1351	0.13518

I 55 SOUTH ; SECTION # 7 ; GRENADA COUNTY ; STA. 304+00 - 299+00 AVG. HMA THICKNESS = 3.6 IN. SURFACE TEMP. = 96 - 113 F Air temp. = 89 - 92 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.757	9050	4.91	3.56	3.49	3.3	3.04	2.49	1.62
5.753	9089	4.41	3.18	3.13	3.02	2.82	2.42	1.72
5.748	9073	4.98	4.06	4.04	3.86	3.63	3.06	2.02
5.743	9161	4.5	3.67	3.65	3.47	3.26	2.78	1.94
5.739	8999	4.35	3.29	3.28	3.14	2.91	2.42	1.56
5.734	8975	3.3	2.37	2.34	2.26	2.14	1.83	1.3
5.729	8938	4.15	3.06	3.04	2.88	2.69	2.26	1.59
5.72	9026	3.7	2.47	2.46	2.39	2.23	1.92	1.47
5.71	8856	3.94	3.2	3.16	3.06	2.88	2.49	1.83
5.701	8819	3.35	2.53	2.47	2.33	2.14	1.74	1.12
5.691	8922	3.45	2.6	2.52	2.38	2.19	1.78	1.09
5.682	8975	3.66	2.86	2.78	2.61	2.37	1.88	1.09
5.672	9177	2.88	2	1.95	1.85	1.7	1.4	0.94
5.663	9073	3.19	2.43	2.31	2.08	1.87	1.47	0.91

AVG.	9009.5	3.91214	2.94857	2.90143	2.75929	2.56214	2.13857	1.44286
ST. DEV.	104.667	0.65505	0.58259	0.5946	0.57855	0.55643	0.49384	0.37054
%C.V.	0.01162	0.16744	0.19758	0.20493	0.20967	0.21718	0.23092	0.25681

I 55 SOUTH ; SECTION # 8 ; GRENADA COUNTY ; STA. 274+00 - 269+00
AVG. HMA THICKNESS = 5.0 IN. SURFACE TEMP. = 103 - 113 F Air temp. = 91 - 94 F

STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.189	8903	5.29	3.95	3.85	3.7	3.44	2.85	1.74
5.185	9002	4.82	3.52	3.43	3.25	2.97	2.42	1.44
5.18	8891	4.62	3.13	3	2.84	2.62	2.09	1.25
5.175	8840	3.64	2.35	2.26	2.15	1.97	1.59	1.06
5.17	8946	3.12	1.82	1.8	1.78	1.69	1.44	1
5.166	8891	3.84	2.61	2.6	2.58	2.47	2.15	1.45
5.161	8875	3.57	2.34	2.28	2.23	2.1	1.75	1.16
5.152	8720	4.13	2.86	2.82	2.76	2.62	2.24	1.46
5.142	8724	3.67	2.15	2.03	1.99	1.87	1.58	1.12
5.133	8887	3.24	2.02	1.96	1.92	1.81	1.53	1.05
5.123	8800	3.81	2.8	2.78	2.73	2.61	2.3	1.64
5.104	8867	4.37	3.37	3.29	3.19	3.01	2.52	1.61
5.095	8752	4.06	3.15	3.09	2.96	2.76	2.27	1.42
AVG.	8853.69	4.01385	2.77462	2.70692	2.62154	2.45692	2.05615	1.33846
ST. DEV.	84.4476	0.62669	0.63469	0.62265	0.58102	0.53384	0.43978	0.24711
%C.V.	0.00954	0.15613	0.22875	0.23002	0.22163	0.21728	0.21389	0.18462

1996 Deflection Data

I 55 NORTH ; SECTION # 1 ; MONTGOMERY COUNTY ; STA. 772+00 - 775+00
AVG. HMA THICKNESS = 6.9 IN. SURFACE TEMP. = 64 - 66 F. AIR TEMP. = 50 - 51 F

STA	LOAD	0"	8"	12"	18"	24"	36"	60"
14.621R	9619	4.46	3.85	3.47	2.98	2.59	2	1.27
14.631R	9646	4.74	4.01	3.61	3.11	2.7	2.07	1.28
14.640R	9598	4.57	3.86	3.51	3.03	2.61	2.01	1.21
14.650R	9646	4.25	3.54	3.21	2.79	2.43	1.91	1.22
14.659R	9651	3.9	3.36	3.04	2.67	2.37	1.85	1.18
14.669R	9614	4.37	3.86	3.53	3.06	2.65	2.04	1.27
14.678R	9646	3.84	3.39	3.08	2.67	2.3	1.75	1.09
AVG.	9631.43	4.30429	3.69571	3.35	2.90143	2.52143	1.94714	1.21714
ST. DEV.	20.7995	0.33441	0.26044	0.23402	0.18748	0.15345	0.11557	0.06726
%C.V.	0.00216	0.07769	0.07047	0.06986	0.06462	0.06086	0.05936	0.05526

I 55 NORTH ; SECTION # 2 ; MONTGOMERY COUNTY ; STA. 843+00 - 846+00
AVG. HMA THICKNESS = 6.9 IN. SURFACE TEMP. = 63 - 65 F. AIR TEMP. = 51 - 53 F.

STA	LOAD	0"	8"	12"	18"	24"	36"	60"
15.966	9686	4.48	3.85	3.49	3.01	2.61	2.01	1.31
15.975	9526	4.66	3.99	3.6	3.08	2.66	2.06	1.27
15.985	9598	3.62	3.15	2.91	2.59	2.31	1.87	1.28
15.994	9526	3.84	3.36	3.12	2.75	2.44	1.96	1.33
16.004	9526	4.27	3.69	3.39	2.96	2.59	2.07	1.4
16.013	9427	5.15	4.51	4.12	3.62	3.17	2.54	1.67
16.023	9534	3.32	2.95	2.8	2.57	2.35	2	1.44
AVG.	9546.14	4.19143	3.64286	3.34714	2.94	2.59	2.07286	1.38571
ST. DEV.	79.3818	0.63735	0.5355	0.45195	0.3612	0.28873	0.21662	0.13986
%C.V.	0.00832	0.15206	0.147	0.13503	0.12286	0.11148	0.1045	0.10093

I 55 NORTH ; SECTION # 3 ; CARROLL COUNTY ; STA. 985+00 - 988+00 AVG. HMA THICKNESS = 6.2 IN. SURFACE TEMP. = 66 - 68 F. AIR TEMP. = 51 - 53 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
18.655	9646	4.01	3.32	2.93	2.46	2.09	1.57	0.91
18.665	9622	4.54	3.8	3.31	2.67	2.11	1.4	0.73
18.674	9526	5.41	4.5	3.93	3.13	2.48	1.56	0.68
18.684	9574	5.37	4.57	4.02	3.31	2.67	1.78	0.85
18.693	9534	5.76	4.6	3.98	3.21	2.58	1.74	0.81
18.703	9566	4.77	3.93	3.4	2.74	2.21	1.44	0.62
18.712	9579	4.46	3.76	3.33	2.76	2.25	1.52	0.74
AVG.	9578.14	4.90286	4.06857	3.55714	2.89714	2.34143	1.57286	0.76286
ST. DEV.	43.5141	0.6262	0.49445	0.42086	0.31852	0.23327	0.14221	0.10029
%C.V.	0.00454	0.12772	0.12153	0.11831	0.10994	0.09963	0.09042	0.13146

I 55 NORTH ; SECTION # 4 ; GRENADA COUNTY ; STA. 48+00 - 51+00 AVG. HMA THICKNESS = 6.8 IN. SURFACE TEMP. = 66 - 68 F. AIR TEMP = 53 - 54 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
0.909R	9630	4.12	3.74	3.55	3.26	3.01	2.59	1.79
0.919R	9606	5.35	4.79	4.41	3.91	3.48	2.79	1.81
0.928R	9579	4.01	3.49	3.24	2.91	2.61	2.13	1.39
0.937R	9582	4.8	4.09	3.69	3.16	2.69	2.01	1.21
0.947R	9558	4.33	3.65	3.22	2.67	2.21	1.56	0.91
0.956R	9622	4.98	4.35	3.96	3.39	2.87	2.07	1.08
0.966R	9574	4.32	3.81	3.58	3.26	2.95	2.43	1.61
AVG.	9593	4.55857	3.98857	3.66429	3.22286	2.83143	2.22571	1.4
ST. DEV.	26.7145	0.49408	0.45462	0.41669	0.38952	0.39228	0.4115	0.3519
%C.V.	0.00278	0.10838	0.11398	0.11372	0.12086	0.13854	0.18488	0.25136

I 55 NORTH ; SECTION # 5 ; GRENADA COUNTY ; STA. 338+00 - 341+00 AVG. HMA THICKNESS = 5.2 IN. SURFACE TEMP. = 66 - 70 F. AIR TEMP. = 51 - 54 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.402	9587	6.65	5.76	5.19	4.48	3.87	2.98	1.81
6.411	9542	5.78	4.87	4.4	3.77	3.28	2.55	1.52
6.42	9486	4.87	4.26	3.93	3.51	3.12	2.4	1.44
6.43	9518	6.5	5.6	4.97	4.15	3.53	2.67	1.57
6.439	9438	7.69	6.43	5.65	4.73	3.98	2.91	1.69
6.449	9462	7.17	6.17	5.47	4.57	3.81	2.73	1.44
6.458	9534	4.33	3.79	3.56	3.24	2.97	2.53	1.81
AVG.	9509.57	6.14143	5.26857	4.73857	4.06429	3.50857	2.68143	1.61143
ST. DEV.	51.0812	1.21598	0.98954	0.79378	0.57043	0.39528	0.20948	0.16015
%C.V.	0.00537	0.198	0.18782	0.16751	0.14035	0.11266	0.07812	0.09938

I 55 NORTH ; SECTION # 6 ; GRENADA COUNTY ; STA. 380+00 - 383+00 AVG. HMA THICKNESS = 5.7 IN. SURFACE TEMP. = 67 - 69 F. AIR TEMP. = 51 - 53 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
7.197	9598	3.99	3.44	3.17	2.82	2.54	2.06	1.39
7.206	9538	4.13	3.46	3.11	2.72	2.39	1.94	1.31
7.216	9550	4.89	4.11	3.66	3.16	2.76	2.19	1.48
7.225	9494	5.89	4.96	4.43	3.71	3.15	2.26	1.31
7.235	9438	7.26	6.03	5.26	4.28	3.53	2.49	1.45
7.244	9435	5.46	4.43	3.89	3.29	2.8	2.11	1.27
7.254	9542	4.39	3.7	3.28	2.81	2.44	1.94	1.21
AVG.	9513.57	5.14429	4.30429	3.82857	3.25571	2.80143	2.14143	1.34571
ST. DEV.	60.7285	1.16381	0.93867	0.78463	0.56883	0.41277	0.19437	0.09796
%C.V.	0.00638	0.22623	0.21808	0.20494	0.17472	0.14734	0.09077	0.07279

I 55 NORTH ; SECTION # 7 ; GRENADA COUNTY ; STA. 216+00 - 219+00 SOIL CEMENT BASE ! AVG. HMA THICKNESS = 7.9 IN. SURFACE TEMP. = 69 - 70 F. AIR TEMP. = 51 - 53 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
4.091	9510	10.47	9.29	8.64	7.67	6.74	5.24	3
4.1	9491	9.42	8.52	7.91	7	6.14	4.72	2.69
4.11	9518	8.76	7.86	7.33	6.5	5.74	4.44	2.54
4.119	9547	8.17	7.42	6.98	6.3	5.64	4.51	2.69
4.129	9582	6.97	6.24	5.87	5.3	4.78	3.8	2.28
4.138	9563	6.05	5.48	5.22	4.79	4.34	3.55	2.22
4.148	9587	4.22	3.51	3.34	3.13	2.9	2.52	1.74
AVG.	9542.57	7.72286	6.90286	6.47	5.81286	5.18286	4.11143	2.45143
ST. DEV.	37.1701	2.13455	1.9779	1.80285	1.5316	1.2874	0.8996	0.41063
%C.V.	0.0039	0.27639	0.28653	0.27865	0.26348	0.2484	0.2188	0.16751

I 55 SOUTH ; SECTION # 1 ; GRENADA COUNTY ; STA.392+00 - 387+00 AVG. HMA THICKNESS = 6.4 IN. SURFACE TEMP. 93.5 - 97 F. AIR TEMP. 81.5 - 82.5 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
7.424	9261	3.31	2.54	2.4	2.29	2.16	1.83	1.37
7.415	9312	2.91	2.27	2.2	2.14	2.03	1.76	1.24
7.405	9237	3.22	2.39	2.3	2.2	2.07	1.76	1.24
7.396	9312	2.59	1.82	1.71	1.68	1.6	1.43	1.11
7.386	9232	2.61	1.89	1.8	1.78	1.7	1.54	1.2
7.377	9205	3.46	2.51	2.4	2.31	2.13	1.79	1.22
7.367	9216	2.74	2.18	2.1	2.02	1.89	1.6	1.07
7.358	9166	4.09	3.22	3.05	2.84	2.57	2.06	1.19
7.348	9213	3.21	2.55	2.47	2.42	2.26	1.99	1.35
7.339	9224	3.09	2.36	2.3	2.21	2.07	1.81	1.29
7.33	9169	3.53	2.39	2.29	2.23	2.11	1.85	1.37
AVG.	9231.55	3.16	2.37455	2.27455	2.19273	2.05364	1.76545	1.24091
ST. DEV.	48.3722	0.44627	0.3719	0.3539	0.31007	0.26235	0.1849	0.09934
%C.V.	0.00524	0.14123	0.15662	0.15559	0.14141	0.12775	0.10473	0.08006

I 55 SOUTH ; SECTION # 2 ; GRENADA COUNTY ; STA.377+00 - 372+00 AVG. HMA THICKNESS = 5.1 IN. SURFACE TEMP. = 50 - 54 F. AIR TEMP. = 46 - 47 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
7.14	9795	2.42	2.19	2.13	2.04	1.95	1.72	1.33
7.131	9755	3.59	3.28	3.13	2.84	2.55	2.08	1.45
7.121	9699	3.59	3.24	3.1	2.91	2.72	2.36	1.6
7.112	9707	3.16	2.79	2.69	2.56	2.39	2.07	1.47
7.102	9707	3.05	2.88	2.76	2.6	2.44	2.1	1.53
7.093	9662	3.05	2.82	2.74	2.59	2.46	2.16	1.6
7.083	9630	3.58	3.36	3.27	3.13	2.98	2.69	1.91
7.074	9699	4.23	3.9	3.72	3.45	3.19	2.68	1.73
7.064	9638	2.67	2.31	2.19	2.05	1.91	1.64	1.15
7.055	9594	2.91	2.53	2.39	2.22	2.05	1.71	1.17
7.045	9614	2.41	2.17	2.06	1.9	1.75	1.47	1
AVG.	9681.82	3.15091	2.86091	2.74364	2.57182	2.39909	2.06182	1.44909
ST. DEV.	61.1013	0.5592	0.54733	0.52776	0.48996	0.45588	0.4057	0.26965
%C.V.	0.00631	0.17747	0.19131	0.19236	0.19051	0.19002	0.19677	0.18608

I 55 SOUTH ; SECTION # 3 ; GRENADA COUNTY ; STA.364+00 - 359+00 AVG. HMA THICKNESS = 4.4 IN. SURFACE TEMP. = 41 - 56 F. AIR TEMP. = 44 - 47 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.894	9630	2.78	2.65	2.55	2.4	2.26	1.97	1.44
6.884	9594	2.75	2.56	2.47	2.33	2.2	1.89	1.35
6.875	9483	2.4	2.24	2.14	2.01	1.88	1.63	1.2
6.866	9515	3.03	2.79	2.68	2.51	2.35	2.03	1.48
6.856	9550	2.83	2.65	2.58	2.46	2.31	2.02	1.48
6.847	9531	3.28	3.17	3.05	2.84	2.63	2.22	1.61
6.837	9526	2.87	2.77	2.74	2.59	2.42	2.12	1.52
6.828	9510	2.74	2.56	2.5	2.38	2.26	2.01	1.49
6.818	9486	2.64	2.51	2.48	2.36	2.2	1.89	1.39
6.809	9483	2.72	2.57	2.49	2.33	2.17	1.88	1.36
6.799	9478	2.67	2.46	2.39	2.26	2.14	1.85	1.37
AVG.	9526	2.79182	2.63	2.55182	2.40636	2.25636	1.95545	1.42636
ST. DEV.	49.0102	0.22445	0.23375	0.22693	0.20699	0.18629	0.15533	0.10884
%C.V.	0.00514	0.08039	0.08888	0.08893	0.08602	0.08256	0.07943	0.0763

I 55 SOUTH ; SECTION # 4 ; GRENADA COUNTY ; STA. 352+00 - 347+00 AVG. HMA THICKNESS = 2.9 IN. SURFACE TEMP. = 51 - 56 F. AIR TEMP.= 45 - 48 F.								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.667	9483	3.14	3.04	2.96	2.83	2.69	2.39	1.77
6.657	9435	3.6	3.49	3.43	3.27	3.07	2.67	1.96
6.648	9483	3.15	2.93	2.85	2.71	2.56	2.26	1.67
6.638	9475	3.13	2.9	2.78	2.56	2.34	1.95	1.31
6.629	9442	3	2.91	2.83	2.65	2.47	2.12	1.48
6.619	9470	3.07	2.94	2.87	2.74	2.57	2.25	1.65
6.61	9451	3.31	3.19	3.06	2.82	2.59	2.17	1.5
6.6	9435	2.94	2.85	2.75	2.51	2.27	1.89	1.3
6.591	9446	2.87	2.73	2.66	2.54	2.35	2	1.38
6.581	9427	3.01	2.8	2.73	2.57	2.42	2.04	1.35
6.572	9486	2.78	2.58	2.5	2.35	2.18	1.86	1.3
AVG.	9457.55	3.09091	2.94182	2.85636	2.68636	2.50091	2.14545	1.51545
ST. DEV.	22.2097	0.22318	0.24062	0.24101	0.24064	0.24255	0.24031	0.22061
%C.V.	0.00235	0.07221	0.08179	0.08438	0.08958	0.09698	0.11201	0.14557

I 55 SOUTH ; SECTION # 5 ; GRENADA COUNTY ; STA.345+00 - 340+00 AVG. HMA THICKNESS = 1.4 IN. SURFACE TEMP. = 51 - 61 F. AIR TEMP. = 46 - 48 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
6.534	9446	4.95	4.82	4.78	4.48	4.34	3.74	2.63
6.525	9430	3.72	3.5	3.37	3.09	2.82	2.35	1.56
6.515	9390	5.41	5.04	4.72	4.29	3.88	3.18	2.05
6.506	9435	4.29	4.12	4.02	3.72	3.39	2.8	1.78
6.496	9467	4.13	3.91	3.77	3.54	3.29	2.76	1.74
6.487	9387	5.34	5.13	4.81	4.32	3.86	3.04	1.81
6.477	9427	3.95	3.9	3.86	3.57	3.2	2.53	1.52
6.468	9442	4.23	3.95	3.8	3.53	3.25	2.7	1.79
6.449	9483	3.96	3.71	3.57	3.34	3.1	2.65	1.82
6.439	9390	3.91	3.71	3.6	3.37	3.14	2.68	1.85
AVG.	9429.7	4.389	4.179	4.03	3.725	3.427	2.843	1.855
ST. DEV.	32.7619	0.61622	0.59289	0.54043	0.47341	0.45789	0.39314	0.30988
%C.V.	0.00347	0.1404	0.14187	0.1341	0.12709	0.13361	0.13828	0.16705

I 55 SOUTH ; SECTION # 6 ; GRENADA COUNTY ; STA. 312+00 - 307+00 AVG. HMA THICKNESS = 2.4 IN. SURFACE TEMP. = 55 - 58 F. AIR TEMP. = 47 - 48 F								
STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.909R	9571	3.82	3.58	3.43	3.19	2.94	2.43	1.64
5.900R	9542	4.56	4.4	4.28	4.06	3.83	3.34	2.41
5.890R	9555	3.93	3.81	3.66	3.37	3.07	2.5	1.46
5.881R	9531	3.92	3.78	3.67	3.44	3.24	2.84	2.07
5.871R	9555	2.81	2.67	2.53	2.33	2.13	1.76	1.2
5.862R	9483	4.75	4.52	4.35	4.06	3.75	3.15	2.09
5.852R	9538	3.37	3.17	3.07	2.9	2.67	2.26	1.48
5.843R	9475	5.22	4.9	4.69	4.12	3.56	2.58	1.56
5.833R	9499	3.61	3.42	3.26	3.05	2.82	2.31	1.44
5.824R	9459	4.68	4.43	4.27	4	3.69	3	1.76
5.814R	9422	4.97	4.36	4.09	3.66	3.25	2.54	1.38
AVG.	9511.82	4.14909	3.91273	3.75455	3.47091	3.17727	2.61	1.68091
ST. DEV.	47.3325	0.74378	0.67277	0.64947	0.57671	0.52175	0.44887	0.36632
%C.V.	0.00498	0.17926	0.17194	0.17298	0.16615	0.16421	0.17198	0.21793

I 55 SOUTH ; SECTION # 7 ; GRENADA COUNTY ; STA. 304+00 - 299+00
AVG. HMA THICKNESS = 3.6 IN. SURFACE TEMP. = 56 - 60 F. AIR TEMP. = 46 - 49 F

STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.758	9594	3.04	2.75	2.65	2.48	2.31	1.98	1.39
5.748	9563	3.07	2.97	2.95	2.92	2.86	2.5	1.76
5.739	9547	3.28	3.12	3.05	2.87	2.66	2.26	1.58
5.729	9582	2.82	2.69	2.66	2.52	2.31	1.94	1.33
5.72	9594	2.96	2.76	2.69	2.53	2.32	1.98	1.43
5.71	9594	2.93	2.7	2.62	2.46	2.29	1.95	1.37
5.701	9598	2.61	2.43	2.36	2.21	2.02	1.7	1.14
5.691	9563	2.54	2.32	2.22	2.05	1.88	1.55	0.98
5.682	9566	2.59	2.39	2.28	2.1	1.91	1.53	0.93
5.672	9555	2.52	2.37	2.25	2.07	1.89	1.57	1.06
5.663	9531	2.73	2.49	2.39	2.25	2.09	1.74	1.12
AVG.	9571.55	2.82636	2.63545	2.55636	2.40545	2.23091	1.88182	1.28091
ST. DEV.	22.4025	0.25045	0.26001	0.28101	0.30204	0.31788	0.30607	0.25917
%C.V.	0.00234	0.08861	0.09866	0.10992	0.12556	0.14249	0.16264	0.20233

I 55 SOUTH ; SECTION # 8 ; GRENADA COUNTY ; STA. 274+00 - 269+00
AVG. HMA THICKNESS = 5.0 IN. SURFACE TEMP. = 57 - 60 F. AIR TEMP = 47 - 49 F

STA	LOAD	0"	8"	12"	18"	24"	36"	60"
5.208	9510	2.63	2.43	2.34	2.22	2.08	1.82	1.34
5.199	9555	2.19	2.02	1.95	1.85	1.74	1.5	1.11
5.189	9502	2.65	2.45	2.31	2.11	1.94	1.61	1.07
5.18	9499	2.88	2.62	2.48	2.26	2.04	1.65	1.06
5.17	9526	2.09	1.92	1.86	1.75	1.64	1.42	1
5.161	9470	2.2	1.95	1.87	1.76	1.65	1.43	1.04
5.152	9486	2.64	2.42	2.34	2.21	2.06	1.78	1.24
5.142	9478	2.75	2.32	2.23	2.09	1.94	1.65	1.15
5.133	9459	2.8	2.58	2.5	2.37	2.22	1.89	1.27
5.123	9547	4.43	4.27	4.12	3.89	3.65	3.2	2.21
5.114	9467	2.53	2.35	2.29	2.2	2.1	1.86	1.37
AVG.	9499.91	2.70818	2.48455	2.39	2.24636	2.09636	1.80091	1.26
ST. DEV.	32.1946	0.62922	0.63946	0.61685	0.58346	0.5493	0.49243	0.33885
%C.V.	0.00339	0.23234	0.25737	0.25809	0.25974	0.26202	0.27344	0.26893

1997 Deflection Data

I 55 North; Section #1; Montgomery County; STA. 772+00 - 775+00								
Avg. HMA thickness = 6.9 in. Surface temp. = 102 - 106 F Air temp. = 78 - 80 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
14.631	9237	4.89	3.57	3.22	2.77	2.41	1.85	1.15
14.64	9218	4.74	3.47	3.16	2.73	2.35	1.86	1.16
14.65	9186	4.74	3.24	2.93	2.56	2.26	1.81	1.15
14.659	9245	4.31	3.21	2.94	2.58	2.25	1.8	1.16
14.669	9189	4.74	3.57	3.27	2.83	2.47	1.94	1.18
14.678	9229	4.33	3.01	2.81	2.57	2.34	1.82	1.09
AVG.	9217.333	4.625	3.345	3.055	2.673333	2.346667	1.846667	1.148333
Std. Dev:	24.79247	0.243372	0.22731	0.186199	0.117757	0.08501	0.051251	0.030605
%C.V.	0.00269	0.052621	0.067955	0.060949	0.044049	0.036226	0.027753	0.026652

I 55 North; Section #2; Montgomery County; STA. 843+00 -846+00								
Avg. HMA thickness = 6.9 in. Surface temp. = 102 - 107 F Air temp. = 78 - 80 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
15.966	9370	4.32	3.28	3.01	2.63	2.28	1.8	1.19
15.975	9293	4.83	3.58	3.28	2.84	2.47	1.86	1.14
15.985	9346	3.73	2.93	2.75	2.46	2.22	1.8	1.26
15.994	9301	3.8	3.06	2.89	2.59	2.32	1.93	1.3
16.004	9285	5.02	3.76	3.45	3.01	2.63	2.07	1.37
16.013	9197	6.01	4.44	4.05	3.47	2.98	2.27	1.53
16.023	9277	4.18	3.15	2.96	2.68	2.42	2.04	1.47
AVG.	9295.571	4.555714	3.457143	3.198571	2.811429	2.474286	1.967143	1.322857
Std. Dev:	55.2143	0.8016	0.521878	0.444163	0.340755	0.261142	0.171437	0.142795
%C.V.	0.00594	0.175955	0.150957	0.138863	0.121204	0.105542	0.08715	0.107945

I 55 North; Section #3; Carroll County; STA. 985+00 - 988+00								
Avg. HMA thickness = 6.2 in. Surface temp. = 104 - 105 F Air temp. = 78 - 80 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
18.655	9133	4.63	3.46	3.1	2.62	2.23	1.67	0.86
18.665	9173	4.75	3.55	2.97	2.3	1.82	1.22	0.62
18.674	9037	6.53	4.91	4.12	3.07	2.28	1.34	0.61
18.684	9058	5.91	4.3	3.69	2.84	2.28	1.44	0.69
18.693	9085	4.88	3.59	3.12	2.48	1.97	1.31	0.61
18.703	9058	5.72	4.12	3.48	2.68	2.06	1.28	0.59
AVG.	9090.667	5.403333	3.988333	3.413333	2.665	2.106667	1.376667	0.663333
Std. Dev:	52.18684	0.76487	0.564603	0.438437	0.269944	0.188856	0.16108	0.102307
%C.V.	0.005741	0.141555	0.141564	0.128448	0.101292	0.089647	0.117007	0.154231

I 55 North; Section #4; Grenada County; STA. 48+00 - 51+00								
Avg. HMA thickness = 6.8 in. Surface temp. = 103 - 105 F Air temp. = 78 - 82 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
0.909	9181	4.64	3.71	3.53	3.23	2.94	2.44	1.61
0.919	9093	5.43	4.25	3.94	3.5	3.1	2.48	1.58
0.928	9117	4.31	3.24	3.06	2.8	2.52	2.07	1.26
0.937	9045	5.19	3.72	3.31	2.83	2.4	1.8	1.07
0.947	9101	3.97	2.7	2.42	2.09	1.78	1.4	0.83
0.956	9093	4.99	3.74	3.44	2.91	2.44	1.78	0.93
0.966	9045	5.2	3.69	3.41	3.11	2.76	2.28	1.44
AVG.	9096	4.818571	3.578571	3.301429	2.924286	2.562857	2.035714	1.245714
Std. Dev:	46.38555	0.531866	0.485298	0.470157	0.443466	0.433194	0.397234	0.312456
%C.V.	0.005099	0.110378	0.135612	0.14241	0.151649	0.169028	0.195133	0.250825

I 55 North; Section #5; Grenada County; STA. 338+00 - 341+00								
Avg. HMA thickness = 5.0 in. Surface temp. = 100 - 102 F Air temp. = 78 - 82 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
6.402	9090	5.99	4.57	4.24	3.69	3.26	2.61	1.54
6.411	9074	5.37	4.03	3.68	3.21	2.82	2.27	1.4
6.42	9114	4.82	3.92	3.75	3.39	3.04	2.44	1.48
6.43	9034	6.15	4.6	4.06	3.46	3.02	2.39	1.43
6.439	9026	6.99	5.24	4.67	3.92	3.37	2.62	1.57
6.449	8970	6.58	5.08	4.54	3.78	3.27	2.35	1.3
6.458	9106	4.97	3.7	3.49	3.3	3.07	2.68	1.87
AVG.	9059	5.838571	4.448571	4.061429	3.535714	3.121429	2.48	1.512857
Std. Dev:	51.72823	0.817199	0.588456	0.447267	0.264503	0.188629	0.156631	0.181449
%C.V.	0.00571	0.139966	0.13228	0.110125	0.074809	0.06043	0.063158	0.119938

I 55 North; Section #6; Grenada County; STA. 380+00 - 383+00								
Avg. HMA thickness = 5.7 in. Surface temp. = 99 - 100 F Air temp. = 80 - 82 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
7.197	9098	4.8	3.61	3.34	3.05	2.78	2.31	1.48
7.206	9101	4.48	3.3	3.01	2.8	2.5	2.18	1.37
7.216	9058	5.04	3.8	3.44	3.18	2.85	2.37	1.55
7.225	8949	6.69	4.84	4.25	3.59	3.09	2.39	1.47
AVG.	9051.5	5.2525	3.8875	3.51	3.155	2.805	2.3125	1.4675
Std. Dev:	71.08915	0.985406	0.667601	0.526435	0.330101	0.242831	0.094648	0.074106
%C.V.	0.007854	0.187607	0.17173	0.149981	0.104628	0.086571	0.040929	0.050498

I 55 North; Section #7; Grenada County; STA. 216+00 -219+00								
Avg. HMA thickness = 7.9 in. Surface temp. = 102 - 104 F Air temp. = 80 - 82 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	-------	--------	--------	---------	--------	--------	-------	---------
4.091	8949	13.87	11.32	10.2	8.65	7.39	5.46	2.95
4.1	9029	11.97	9.72	8.86	7.64	6.52	4.88	2.72
4.11	8978	11.83	9.3	8.42	7.23	6.2	4.69	2.58
4.119	9026	10.06	8.27	7.64	6.74	5.91	4.63	2.63
4.129	9010	8.96	6.95	6.41	5.62	4.96	3.9	2.23
4.138	9029	8.2	6.46	6.02	5.36	4.72	3.7	2.2
4.148	9114	5.44	3.93	3.65	3.46	3.19	2.8	1.85
AVG.	9019.286	10.04714	7.992857	7.314286	6.385714	5.555714	4.294286	2.451429
Std. Dev:	51.53547	2.808023	2.442074	2.158903	1.71934	1.383532	0.886263	0.374852
%C.V.	0.005714	0.279485	0.305532	0.295163	0.269248	0.249029	0.206382	0.152912

I 55 South; Section #1; Grenada County; STA. 392+00 - 387+00								
Avg. HMA thickness = 6.4 in. Surface temp. = 89 - 95 F Air temp. = 64 - 66 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	--------	-------	--------	--------	---------	--------	--------	--------
7.424	9,301	3.19	2.55	2.41	2.31	2.19	1.91	1.4
7.415	9,282	2.52	2.04	2	1.93	1.83	1.61	1.13
7.405	9,317	2.81	2.37	2.31	2.19	2.04	1.77	1.23
7.396	9,274	2.19	1.76	1.73	1.68	1.59	1.44	1.07
7.386	9,282	2.23	1.8	1.77	1.74	1.67	1.54	1.13
7.377	9,229	3.02	2.52	2.44	2.25	2.08	1.74	1.24
7.367	9,269	2.83	2.36	2.27	2.11	1.93	1.59	0.99
7.358	9,221	3.25	2.54	2.41	2.34	2.09	1.76	1.09
7.348	9,317	2.99	2.55	2.51	2.43	2.3	1.92	1.23
7.339	9,133	3.04	2.5	2.38	2.32	2.11	1.89	1.26
AVG.	9,263	2.807	2.299	2.223	2.13	1.983	1.717	1.177
Std. Dev:	55.74994	0.376033	0.314235	0.285153	0.261534	0.22662	0.166403	0.117667
%C.V.	0.006019	0.133963	0.136683	0.128274	0.122786	0.114281	0.096915	0.099972

I 55 South; Section #2; Grenada County; STA. 377+00 - 372+00								
Avg. HMA thickness = 5.1 in. Surface temp. = 89 - 95 F Air temp. = 64 - 68 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	--------	-------	--------	--------	---------	--------	--------	--------
7.15	9,306	2.73	2.34	2.3	2.21	2.09	1.83	1.33
7.14	9,162	4.61	3.62	3.48	3.05	2.94	2.28	1.59
7.131	9,245	3.45	2.84	2.77	2.56	2.44	2.06	1.45
7.121	9,186	3.8	3.14	3.13	2.82	2.75	2.15	1.49
7.112	9,250	3.3	2.74	2.67	2.57	2.42	2.14	1.52
7.102	9,250	3.35	2.72	2.66	2.56	2.42	2.13	1.53
7.093	9,194	4.04	3.48	3.35	3.12	2.89	2.42	1.6
7.083	9,181	3.26	2.59	2.55	2.43	2.26	1.93	1.31
7.074	9,242	2.82	2.26	2.21	2.11	1.99	1.71	1.18
7.064	9,266	2.8	2.08	2.02	1.93	1.79	1.5	1.05
7.055	9,365	2.75	2.12	2.03	1.87	1.71	1.41	0.97
7.045	9,229	3.43	2.87	2.79	2.61	2.42	2.09	1.51
AVG.	9,240	3.361667	2.733333	2.663333	2.486667	2.343333	1.970833	1.3775
Std. Dev:	56.89118	0.573614	0.499242	0.481387	0.401618	0.398915	0.306192	0.211665
%C.V.	0.006157	0.170634	0.182649	0.180746	0.161509	0.170234	0.155362	0.153659

I 55 South; Section #3; Grenada County; STA. 364+00 - 359+00								
Avg. HMA thickness = 4.4 in. Surface temp. = 91 - 95 F Air temp. = 65 - 67 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
----------	--------	-------	--------	--------	---------	--------	--------	--------
6.894	9,394	2.68	2.28	2.25	2.14	2.01	1.73	1.28
6.884	9,325	3.02	2.53	2.48	2.33	2.2	1.89	1.31
6.875	9,346	2.69	2.43	2.39	2.22	2.06	1.72	1.22
6.866	9,410	3.33	3.01	2.95	2.79	2.6	2.24	1.6
6.856	9,381	3.76	3.14	3.08	2.93	2.75	2.38	1.69
6.847	9,405	3.8	3.39	3.31	3.09	2.87	2.46	1.69
6.837	9,381	3.26	2.91	2.89	2.75	2.58	2.26	1.63
6.827	9,397	3	2.61	2.59	2.5	2.34	2.04	1.43
6.818	9,266	3.22	2.74	2.67	2.5	2.29	1.92	1.28
6.809	9,349	3.1	2.75	2.73	2.63	2.52	2.21	1.55
6.799	9,317	3.39	3.07	3	2.83	2.63	2.24	1.52
AVG.	9,361	3.204545	2.805455	2.758182	2.61	2.440909	2.099091	1.472727
Std. Dev:	44.88652	0.366507	0.333897	0.320743	0.301529	0.28073	0.254223	0.176073
%C.V.	0.004795	0.114371	0.119017	0.116288	0.115529	0.11501	0.121111	0.119556

I 55 South; Section #4; Grenada County; STA. 352+00 - 347+00								
Avg. HMA thickness = 2.9 in. Surface temp. = 90 - 94 F Air temp. = 66 - 68 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
----------	--------	-------	--------	--------	---------	--------	--------	--------
6.667	9,314	3.47	3.16	3.15	3.02	2.86	2.56	1.9
6.657	9,338	3.78	3.5	3.43	3.24	2.98	2.57	1.81
6.648	9,362	3.44	3.25	3.22	3.07	2.89	2.53	1.8
6.638	9,290	4.11	3.81	3.69	3.34	3.03	2.47	1.57
6.629	9,325	3.43	3.09	3.06	2.89	2.68	2.31	1.61
6.619	9,317	3.72	3.43	3.4	3.23	3	2.61	1.78
6.61	9,325	3.4	3.17	3.1	2.88	2.64	2.23	1.54
6.6	9,202	3.99	3.8	3.72	3.43	3.11	2.5	1.49
6.591	9,293	3.19	3.05	3.01	2.83	2.62	2.18	1.46
6.581	9,258	3.74	3.62	3.6	3.42	3.19	2.69	1.65
AVG.	9,302	3.627	3.388	3.338	3.135	2.9	2.465	1.661
Std. Dev:	45.31666	0.288831	0.286271	0.266991	0.227511	0.199332	0.169197	0.152056
%C.V.	0.004872	0.079634	0.084496	0.079985	0.072571	0.068735	0.06864	0.091545

I 55 South; Section #5; Grenada County; STA. 345+00 - 340+00								
Avg. HMA thickness = 1.4 in. Surface temp. = 91 - 94 F Air temp. = 65 - 67 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	---------	-------	---------	---------	----------	---------	---------	---------
6.534	9,266	3.71	3.65	3.62	3.43	3.24	2.81	1.93
6.525	9,237	5.22	5.02	4.9	4.57	4.22	3.49	2.21
6.515	9,146	7.34	7.14	6.85	6.16	5.52	4.35	2.59
6.506	9,093	6.85	6.38	6.15	5.68	5.21	4.34	2.74
6.496	9,186	5.34	5.25	5.2	4.95	4.54	3.8	2.43
6.487	9,189	6.12	6.04	5.97	5.68	5.37	4.65	3.11
6.477	9,229	4.69	4.59	4.55	4.3	3.99	3.39	2.19
6.468	9,202	5.04	4.93	4.83	4.54	4.22	3.62	2.39
6.458	9,149	5.15	5.02	4.91	4.58	4.24	3.5	2.21
6.44	9,285	4	3.94	3.88	3.65	3.41	2.94	2.04
AVG.	9,198	5.346	5.196	5.086	4.754	4.396	3.689	2.384
Std. Dev:	58.73254	1.150055	1.073097	1.003341	0.883053	0.778534	0.605502	0.352931
%C.V.	0.006385	0.215124	0.206524	0.197275	0.185749	0.177101	0.164137	0.148041

I 55 South; Section #6; Grenada County; STA. 312+00 - 307+00								
Avg. HMA thickness = 2.4 in. Surface temp. = 92 - 99 F Air temp. = 66 - 71 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	---------	-------	---------	---------	----------	---------	---------	---------
5.909	9,178	4.7	4.66	4.63	4.36	3.96	3.15	1.69
5.9	9,261	3.26	3.17	3.13	2.95	2.77	2.4	1.72
5.89	9,250	3.65	3.33	3.17	2.85	2.55	2	1.31
5.881	9,226	3.51	3.42	3.41	3.31	3.13	2.69	1.86
5.871	9,250	2.63	2.41	2.37	2.22	2.05	1.74	1.22
5.862	9,053	6.21	5.87	5.65	5.19	4.74	3.82	2.08
5.852	9,282	3.06	2.95	2.92	2.76	2.57	2.19	1.45
5.843	9,301	3.08	2.96	2.93	2.76	2.59	2.2	1.48
5.833	9,338	3.26	3.22	3.22	3.1	2.91	2.42	1.41
5.824	9,269	4.6	4.57	4.52	4.26	3.89	3.15	1.92
5.814	9,245	3.9	3.62	3.54	3.24	2.92	2.33	1.31
AVG.	9,241	3.805455	3.652727	3.59	3.363636	3.098182	2.553636	1.586364
Std. Dev:	74.55846	1.019435	0.99348	0.955133	0.876987	0.785975	0.604223	0.283981
%C.V.	0.008068	0.267888	0.271983	0.266054	0.260726	0.253689	0.236613	0.179014

I 55 South; Section #7; Grenada County; STA. 304+00 - 299+00								
Avg. HMA thickness = 3.6 in. Surface temp. = 92 - 99 F Air temp. = 66 - 69 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	--------	-------	--------	--------	---------	--------	--------	--------
5.758	9,242	3.91	3.39	3.28	3.02	2.84	2.26	1.54
5.748	9,226	3.69	3.44	3.41	3.18	2.98	2.53	1.79
5.738	9,242	3.69	3.31	3.2	2.95	2.69	2.19	1.47
5.729	9,261	3.32	3	2.97	2.77	2.59	2.21	1.6
5.71	9,141	3.3	3.02	2.98	2.81	2.59	2.18	1.58
5.701	9,213	3.16	2.76	2.69	2.44	2.33	1.78	1.17
5.691	9,162	3.5	3	2.98	2.8	2.56	2.13	1.22
5.682	9,173	3.75	3.43	3.34	3.07	2.8	2.21	1.25
5.672	9,261	2.63	2.08	2.08	1.91	1.82	1.42	0.98
5.663	9,218	2.94	2.31	2.25	2.04	1.83	1.5	0.96
AVG.	9,214	3.389	2.974	2.918	2.699	2.503	2.041	1.356
Std. Dev:	41.98002	0.399735	0.471456	0.452347	0.432883	0.398889	0.355917	0.280365
%C.V.	0.004556	0.117951	0.158526	0.15502	0.160386	0.159364	0.174383	0.206759

I 55 South; Section #8; Grenada County; STA. 274+00 - 269+00								
Avg. HMA thickness = 5.0 in. Surface temp. = 96 - 99 F Air temp. = 66 - 69 F								
Station	LOAD	R1	R2	R3	R4	R5	R6	R7
-----------	--------	-------	--------	--------	---------	--------	--------	--------
5.189	9,178	3.98	3.49	3.43	3.23	3	2.51	1.51
5.18	8,989	4.51	3.61	3.43	3.11	2.76	2.14	1.14
5.17	9,274	2.3	1.85	1.84	1.77	1.66	1.44	1.01
5.161	9,258	2.96	2.5	2.46	2.35	2.18	1.83	1.12
5.152	9,282	3.39	2.78	2.73	2.6	2.44	2.1	1.43
5.142	9,250	3	2.13	2.06	1.98	1.87	1.59	1.13
5.133	9,346	2.73	2.1	2.1	2.02	1.9	1.63	1.07
5.114	9,242	3.11	2.48	2.47	2.37	2.25	1.98	1.44
5.104	9,242	3.49	2.96	2.92	2.8	2.62	2.26	1.47
5.095	9,173	3.73	3.23	3.16	2.95	2.7	2.17	1.32
AVG.	9,223	3.32	2.713	2.66	2.518	2.338	1.965	1.264
Std. Dev:	96.12862	0.642754	0.605641	0.570614	0.503031	0.439768	0.336955	0.188809
%C.V.	1.000545	0.193601	0.223237	0.214516	0.199774	0.188096	0.171479	0.149374

APPENDIX B

MDOT Special Provision No. 907-507-2, Rubblizing Continuously Reinforced Cement Concrete Pavement

MISSISSIPPI STATE HIGHWAY DEPARTMENT

SPECIAL PROVISION NO. 907-507-2 **CODE: (SP)**

DATE: 10/23/91

SUBJECT: Rubblizing Continuously Reinforced Cement Concrete Pavement

Section 907-507, Rubblizing Existing Continuously Reinforced Cement Concrete Pavement, is added to the 1990 Edition of the Mississippi Standard Specifications for Road and Bridge Construction as follows:

SECTION 907-507--RUBBLIZING EXISTING CONTINUOUSLY REINFORCED CEMENT CONCRETE PAVEMENT

907-507.01--Description. This work consists of crushing in place (rubblizing) an existing continuously reinforced cement concrete pavement using a resonant pavement breaker. After rubblizing, the crushed pavement shall be compacted and used as a base for an asphalt concrete pavement. Rubblization and compaction will be within the limits shown on the plans or as directed by the Engineer.

907-507.02--Materials. Filler aggregate shall conform to the requirements of 703.03, Coarse Aggregate for Portland Cement Concrete, for Size 57 or 67 coarse aggregate. The aggregate shall be 100 percent crushed.

907-507.03--Construction Requirements.

907-507.03.1--General. Rubblizing is to be limited to one lane at a time. Traffic is to be directed over the adjacent lane as crushing is being performed. Traffic control shall be in accordance with the Department's Traffic Control Plan. The use of flagpersons will be required when encroaching on the adjacent lane. Before the completion of each days construction, the Contractor shall make every effort to overlay the crushed pavement with the first course of asphalt binder material shown on the plans to help hold the rubble in place until further layer(s) are placed.

Asphalt overlays or patches shall be removed from the surface and the site prior to rubblizing.

All loose joint fillers, expansion material, raised pavement markers or other debris shall be removed from the site after rubblizing.

Reinforcement in rubblized pavement shall remain in place. However, any reinforcement exposed at the surface as a result of rubblizing and/or compaction operations shall be cut off below the surface and removed from the site.

When the area to be rubblized abuts concrete pavement which is to remain in place and unbroken, the longitudinal or transverse joint in between shall be saw cut full depth.

Prior to rubblizing the pavement, all edge drains and edge drain outlets shall be completely installed and functioning as shown on the plans.
The rubblizing operation shall not begin until any pavement widening or other shoulder work is completed up to the elevation of the existing pavement.

907-507.03.2--Test Strip. Initial construction requirements shall consist of the Contractor setting up a "test strip" in order to determine the proper speed and coverage required to rubblize the concrete pavement as specified. The "test strip" shall not exceed 1000 feet in one travel lane. This area shall also be used to determine the appropriate coverage of each roller in order to provide satisfactory compaction.

Prior to beginning the rubblizing process the Contractor shall saw 3'x 3' full depth cuts (8"±) through the pavement (at intervals determined by the Engineer but not to exceed 10 cuts) within the area designated as the "test strip". The Contractor shall remove the rubblized pavement for the full depth of the cut as directed by the Engineer. The Engineer will use these areas for observation to determine if the specified breakage is being obtained and to assist in the determination of the most suitable procedure for accomplishing the rubblization process.

Once a sequence of crushing has been established this procedure shall be used for the remainder of the project unless field conditions reflect the need for modification.

907-507.03.3--Equipment and Construction Procedure. The existing pavement shall be rubblized with a self-contained, self-propelled, resonant frequency pavement breaking unit capable of producing low amplitude, 2000 foot-pound blows at a rate of not less than 44 per second. The unit shall also be equipped with a water system to suppress dust generated by the rubblizing operation. The operating speed of the unit shall be such that the existing pavement is rubblized, full depth, into particles ranging from sand sized to pieces no larger than 6 inches in any dimension, the majority being a nominal 1 to 2 inches in size. The surface concrete to top of reinforcement shall be reduced to the 1 to 2 inch size. The breaking pattern shall proceed in a longitudinal direction, beginning at a free edge (shoulder or previously broken edge) and progressing toward the opposite shoulder. The pattern shall overlap or be line on line. Continuous coverage, overlapped if necessary, may be required to achieve this size. Additional passes may be required if larger sizes remain above the reinforcement. However, the speed and coverage of the machine (as determined during the initial "test strip") should be such that additional passes will be kept to an absolute minimum in order to avoid damage to the underlying base.

If in order to maintain traffic, only a portion of the total pavement width is being rubblized and overlaid, rubblizing shall continue to the width shown on the plans or as directed by the Engineer and shall be at least six inches beyond the anticipated overlay width.

At the appropriate time in construction phasing, rubblizing shall continue in the next unbroken lane, beginning at the edge of the broken pavement, and progressing toward the opposite shoulder. The rubblizing shall continue in this direction until all the concrete pavement is rubblized.

In areas of existing cement treated base, if the Contractor requests authorization to pre-break the pavement using a guillotine-designed hammer, pre-cracking at 12" to 18" intervals will be permitted subject to the approval of the Engineer. Justification will be required.

Prior to placing the initial asphalt pavement course, the rubblized pavement shall be compacted. Compaction shall consist of rolling with a pass of a steel wheel vibratory roller then with a pass of a pneumatic roller, then a pass of the vibratory roller. Immediately prior to paving, a fourth pass shall be made with the vibratory roller. As used herein, one pass is up and back in the same path. Rollers shall meet the requirements as set out in 401.03.5. In addition, the steel wheel vibratory roller shall have a nominal gross weight of not less than 10 tons when operated in the vibration mode, and the pneumatic roller shall be capable of producing a uniform ground contact pressure on a level unyielding surface of not less than 80 lbs./sq.in. on all wheels. All rollers shall be operated at a speed not to exceed six feet per second (approximately 4 miles per hour). If however, during construction this procedure is found to be unsatisfactory, the Engineer may decrease or increase the number of roller coverages required in order to achieve desired compaction.

907-507.03.4--Surface Irregularities. Any depressions, one inch or greater in depth from that of the immediate surrounding area, resulting from the rubblizing or compaction effort shall be filled with aggregrate as specified in 907-507.02. Filled depressions shall be compacted with the same roller and compaction effort described in 907-507.03.3.

907-507.03.5--Opening to Traffic. Except at restricted cross-over and ramp intersections, traffic will not be allowed on the rubblized pavement before the initial asphalt pavement course is in place. Though it is desirable that the asphalt pavement course be placed over the area on the same day rubblized (reference 907-507.03.1), in no instance shall more than forty-eight hours elapse between rubblizing the existing pavement and placement of the initial asphalt pavement course. However, in the event of rain, this time limitation may be waived by the Engineer to allow sufficient time for the rubblized pavement to dry to his satisfaction.

Crossovers and ramp intersections shall be maintained in the same compacted state as other areas until the initial asphalt pavement course is placed.

907-507.04--Method of Measurement. Rubblized existing continuously reinforced cement concrete pavement will be measured by the square yard. The quantity of filler aggregate shall be the number of cubic yards (LVM) of aggregate placed and compacted.

907-507.05--Basis of Payment. The quantity of rubblized pavement, complete in place, accepted and measured as prescribed, will be paid for at the contract unit price per square yard and shall be full compensation for furnishing all labor, materials, and equipment necessary to rubblize; suppress dust; remove exposed reinforcement, loose joint fillers, expansion material, raised pavement markers or other debris; compact; and maintain the compacted condition of the existing pavement until the initial asphalt pavement course is placed. Unless designated otherwise on the plans, removal of asphalt overlays and/or asphalt patches shall be paid for under appropriate pay items. Full depth saw cuts, including that necessary for the 3' x 3' cuts in the "test strip", will not be paid for separately, but shall be included in the unit price for rubblization.

Filler aggregate will be paid for at the contract until price per cubic yard (LVM) and shall be full compensation for furnishing, hauling, placing, leveling and compacting the aggregate to fill depressions in the rubblized pavement.

The unit price for each item of work shall include the cost of continuous maintenance of traffic and protective services as required by the Department's Traffic Control Plan. This shall include all required individual traffic control devices.

Payment will be made under:

907-507-A:	Rubblizing of Existing 8" Continuously Reinforced Cement Concrete Pavement	- per square yard
907-507-B:	Filler Aggregate (LVM) (Contractor Furnished)	- per cubic yard