SURFACE PAVEMENT SOLUTIONS FOR POOR SUBGRADE CONDITIONS PHASE II: PERFORMANCE ANALYSIS OF TEST SECTIONS AND IMPLEMENTATION GUIDELINES

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FINAL REPORT

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Disclaimer Page

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APPROXIMATE CONVERSIONS TO SI UNITS

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	Inches	25.4	millimeters	mm
ft	Feet	0.305	meters	m
yd	Yards	0.914	meters	m
mi	Miles	1.61	kilometers	km

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
AREA				
in^2	Squareinches	645.2	square millimeters	mm^2
ft^2	Squarefeet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	Acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	Gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
MASS				
oz	Ounces	28.35	grams	g
lb	Pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
ILLUMINATION				
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
FORCE and PRESSURE or STRESS				
lbf	Poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

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16. Abstract

Many regions throughout Florida have shallow layers of organic and plastic soils under existing roads. These roads often exhibit large amount of cracking and distortion in a short period of time. Traditional repairs are often not practical due to high costs and extended construction time. In an effort to develop rehabilitation strategies that could be strictly applied to the surface layer, a pilot test site was selected along the alignment of SR 15/US 98 in northwest Palm Beach county, where severe pavement distresses were observed due to the presence of thick organic layers. PaveTrac MT-1, GlasGrid 8501, PetroGrid 4582, and ARMI were used as promising asphalt reinforcing products in 24 experimental pavement sections, including eight control sections without any reinforcement. A comprehensive field testing and monitoring program involving FWD, rut and ride quality measurements was conducted at the pre-construction, 6-month post-construction, and 18-month post-construction stages. Due to large variability in the subsurface conditions, a statistics-based data analysis protocol was developed for performance evaluation and relative comparisons of the test sections and, in turn, reinforcing products. Post construction data from both 6 months and 18 months demonstrated that stiffness of reinforced sections were significantly higher than the control sections. Procedures were developed to identify and statistically quantify the benefits derived from the reinforcements only, so that the relative performance of various products could be monitored over time. Based on the field testing data available to date, a framework was developed in this study for the prediction of pavement life, which is essential for conducting a detailed Life Cycle Cost Analysis (LCCA), thus providing FDOT the necessary tools for selecting a site-specific rehabilitation strategy when organic soils are encountered.

17. Key Word		18. Distribution Statement	
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EXECUTIVE SUMMARY

Many regions throughout Florida have thick layers of organic and plastic soils at shallow depth under existing roads. Due to the secondary compression behavior of organic soils, these roads often exhibit large amount of cracking, distortion and differential settlement in a relatively short period of time. Traditional repairs are often not practical due to high costs and extended construction time. In an effort to develop rehabilitation strategies that could be strictly applied to the surface layer, a pilot test site was selected along the alignment of SR 15/US 98 in northwest Palm Beach County, where severe pavement distresses were observed due to the presence of organic layers. A total of 24 experimental pavement sections, each 500 feet in length, were constructed in September 2008, with a planned long-term monitoring and testing program. Four types of pavement reinforcing materials, each one distinctly different in geometry and stiffness properties, were selected as promising asphalt reinforcing products to be incorporated within the surface layer of 16 test sections; the remaining eight sections were controls with no reinforcements. Each reinforcing product was repeated at two locations along each lane (north and southbound lanes), resulting in four test sections incorporating each type of reinforcement. The reinforcements used were as follows: (i) GlasGrid 8511, which is a high-stiffness open-mesh glass fiber reinforced polymeric grid; (ii) PetroGrid 4582, which is a composite of non-woven paving fabric and a glass fiber; (iii) PaveTrac MT-1, which is a double-twist woven hexagonal steel wire netting; and (iv) Asphalt Rubber Membrane Interlayer (ARMI), which is composed of a separate application of asphalt rubber binder ARB-20 covered with a single application of aggregate constructed per FDOT specification.

A comprehensive field testing / monitoring program involving FWD, crack survey, rut and ride quality measurements was conducted at the pre-construction, 6-month post-construction, and 18-month post-construction stages. The pre-construction data provided the necessary base line information for calculation of gain in stiffness of reinforced sections. Impulse Stiffness Modulus (ISM), calculated from FWD load and deflection data was the primary metric used for pavement condition assessment. Due to large variation in the subsurface conditions, a statistics-based data analysis protocol coupled with a color-coded graphical representation method was developed for performance evaluation and relative comparisons of the test sections and reinforcing products.

In order to provide FDOT the necessary tools for selecting a site-specific rehabilitation strategy, it is necessary to correctly assess the effectiveness and long-term performance of the reinforcing products by conducting a detailed Life Cycle Cost Analysis (LCCA). In the current study, a two-prong approach was proposed for assessing the relative performance of reinforcing materials, and the prediction of pavement life, which is a necessary component for LCCA. The first method is based on the concept of *Gain in Stiffness*, G_R, which is the improvement in stiffness solely due to reinforcement. The second method embraces the concept of Condition Factor, *CF*, as defined in the AASHTO Remaining Life Method (1993), with *CF* calculated in terms of the *Impulse Stiffness Modulus, ISM.* Monitoring the variation of G_R and *CF* with time is a direct and fundamental way of quantifying damage accumulation, assessing the relative performance, and finally estimating the life span of each reinforced section.

Significant conclusions from this study are as follows:

1. All reinforcing products could be successfully incorporated into the test sections as planned, with minor construction related issues for which remedial measures were suggested and implemented.
2. Comparison of post-construction FWD test results with pre-construction results shows that PetroGrid, GlasGrid and PaveTrac embedded sections improved the pavement stiffness in 11 out of 12 test sections (95% confidence level), with ARMI layer stiffness remaining unchanged. In addition, there was statistically significant improvement in stiffness between the reinforced sections compared to the unreinforced control sections.
3. The concept of *Gain in Stiffness,* G_R, was developed and successfully employed to delineate the contribution of the individual reinforcing materials from the overall improvement in stiffness observed in each reinforced test section. This *Gain in Stiffness* solely due to reinforcing products was statistically significant.
4. The organic factor concept, F_{org}, introduced to characterize soft organic soils is shown to be a satisfactory metric for correlating site-specific soil conditions with probable pavement performance.
5. The spatial consistency of three time-series FWD test results suggests that it can be effectively employed for direct, reliable and fast characterization of the stiffness properties of reinforced asphalt pavement sections.

6. Gain in Stiffness, G_R, and Condition Factor, *CF*, both calculated directly from *ISM* data, can be used as performance-based parameters for long-term evaluation of reinforced test sections, and the estimation of pavement life, which is required for a Life Cycle Cost Analysis (LCCA).

In summary, this study has accomplished the construction of asphalt overlay with various types of embedded reinforcements, and developed a robust statistical methodology for the analysis of long-term performance data of those reinforced sections. This long-term data become useful for objective ranking of the reinforcing products, and also for estimating the life span of the test sections; the latter is a required input to Life Cycle Cost Analysis.

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CHAPTER 1

Introduction

1.1 INTRODUCTION AND PROBLEM STATEMENT

Highway engineers often encounter thick deposits of soft compressible natural soils underneath existing highway pavements causing pre-mature failures in terms of cracking, rutting, and distortional settlement. As a result, frequent and costly rehabilitation projects need to be undertaken which not only disrupt traffic flow, but can also affect nearby business community and the overall public life. Supporting the recently introduced concepts of "perpetual pavements," research is needed to develop new materials, methods and practices for building a more sustainable and durable infrastructure to withstand difficult soil and environmental conditions.

Many regions throughout Florida contain (have) problematic organic silts and peats at relatively shallow depth under existing roads. Traditional repair methods such as complete reconstruction, surcharging or removal of unsuitable material and replacing with select material, often become impractical due to the thickness of the layer (high costs) and prolonged construction time associated with these strategies. Accordingly, there is a strong motivation to identify rehabilitation strategies which could be applied to the surface or near-surface layers only, and develop design methodology based on some site-specific metric such that the identified techniques could be used elsewhere if similar soil conditions are encountered. During the first Phase of this investigation, a 6-mile long pilot test site was selected for a research study involving surface reinforcement strategies along the alignment of SR 15 / US 98 in northwest Palm Beach county, where severe pavement distresses were observed due to the existence of thick organic layers, and a reconstruction project was scheduled to begin in 2008 (Sobhan, 2007; Final Report, FDOT, BD546-4). Since it is well documented that certain geosynthetic products have been successfully used in the recent years as base and/or subgrade reinforcements (requiring full reconstruction or for new pavements), a comprehensive experimental program was designed for the construction and performance monitoring of in-service pavement test sections incorporating various reinforcing products directly into the asphalt surface layers. During the first phase of this investigation, a comprehensive field and laboratory geotechnical testing program was also undertaken to characterize the strength and compressibility behavior of the organic soils underneath the test sections (Sobhan et al. 2007). This included field Piezocone Penetration and pore water dissipation tests with concurrent laboratory consolidation tests (including secondary compression) to validate/calibrate the field test results. A comprehensive literature search and a state-of-the-practice survey were also conducted in order to identify promising techniques and products. An important objective was to correlate site-specific subgrade soil conditions (thickness, moisture, and organic content) with pertinent soil properties, mechanistic pavement response parameters, and probable pavement performance.

In the second Phase of this investigation (current study), 24 experimental pavement sections were constructed along the alignment of SR 15 / US 98 during the Fall of 2008. PetroGrid 4582, GlasGrid 8501, PaveTrac MT-1, and Asphalt Rubber Membrane

Interlayer (ARMI) were used as promising asphalt reinforcing products within sixteen test sections, while eight sections were used as controls having no reinforcements. A comprehensive field testing and monitoring program involving Falling Weight Deflectometer (FWD), rut and ride quality measurements was undertaken before construction, and at 6-month post-construction and 18-month post-construction stages. Due to widespread variability in the subsurface conditions, a statistics-based data analysis protocol was developed for performance evaluation and relative comparisons of the test sections and, in turn, the reinforcing products. Procedures were developed to identify and statistically quantify the benefits derived from the reinforcements only, so that the relative performance of various products could be monitored over time. Since construction variability can play a significant role in the ultimate performance of the reinforced sections, a forensic type investigation was also undertaken by retrieving asphalt cores from the test sections. Finally, based on the field testing data available to date, a framework was developed in this study for the prediction of pavement life, which is essential for conducting a detailed Life Cycle Cost Analysis (LCCA) in order to provide FDOT the necessary tools for selecting a site-specific rehabilitation strategy when organic soils are encountered. The current report documents the activities and findings of the second phase of this investigation.

1.2 BACKGROUND

1.2.1 Organic Soils in South Florida

Organic soils in Florida are commonly referred to as “muck”, but this term may cover soils with a wide variety of soil characteristics. Soil classification standards have been developed to differentiate the muck found in engineering practice. For road-related work, the classification system usually used is that of the American Association of State Highway and Transportation Officials (AASHTO) using procedures contained in AASHTO M 145 and American Society for Testing and Materials (ASTM) standard ASTM D 3282. The AASHTO system of soil classification organizes soil samples by proportions of granular, silt, clay and organic materials as well as the plasticity index, liquid limit and particle size. Organic materials are classified as A-8 in the AASHTO system and are labeled as unsuitable for use as road subgrade.

According to Florida Department of Transportation (FDOT) Design Standards Index 505 (FDOT, 2010), any soil which has an average organic content of greater than five percent, or any soil for which an individual organic content test result exceeds seven percent, should not be used as an embankment material for flexible pavements. Organic soils generally have low strength and high compressibility compared to other soils. It is known that several northern states in the US such as Wisconsin, Minnesota, Illinois, Ohio, Michigan, New York, and the New England region have organic soils. A significant amount of organic deposits are also found in the southeastern coastal states of Florida and Georgia. Organic soils are found throughout the coastal lowlands of the Florida peninsula, which includes the Everglades, known for its largest single body of organic soils in the world encompassing two million acres (Thomas, 1965). Organic deposits have accumulated in this region due to its close proximity to the ocean, a source for heavy rainfall and high relative humidity. The deposits occur in drowned valleys and lagoons, formed by the gradual emergence of the Coastal Plain, and by wave action on flat, imperfectly drained areas farther inland (McVay and Nugyen, 2004). Figures 1.1 and 1.2 show organic soils retrieved from the test site locations.

Figure 1.1: Silty "Muck" Soil Samples at SR15 Test Site

Figure 1.2: Organic Peat Soil Sample at SR15 Test Site

Palm Beach County is part of the larger Florida Platform, which is a low-lying landform along with the Atlantic Coastal Plain and the Gulf Coastal Plain. The surface consists of the Pamlico terrace, which contains sediments that were formed by the advancing and retreating seas during the Pleistocene epoch, over the shelly deposits of the Plio-Plestocene epochs during the Tertiary/Quaternary periods. Generally, the Pamlico terrace ranges from about 8 to 25 feet in thickness, while the shelly deposits are about 25 to 150 feet thick.

The USDA soil survey classifies the soil under the test area in SR 15/US 98 to be “Torry Muck”. It is deep organic soil from poorly drained areas that are or were broad, freshwater marshes. According to the USDA, “this soil formed in well-decomposed remains of hydrophytic plants mixed with fine textured mineral material” (McCollum et al. 1978). In most years, the water table is very near to the surface for 6 to 12 months. The soil is well suited to sugar cane but, in its natural state, not for cultivated crops or citrus. It is also, in agreement with the AASHTO classification, unsuited as an engineering material. Figures 1.3 and 1.4 show the location of the SR 15 / US 98 test site in western Palm Beach County, Florida. The project site spans a distance of approximately six miles starting at Canal Point (MP 19.674) and ending at Palm Beach / Martin County line (MP 26.519). Properties along the east side of SR 15 / US 98 roadway include a mixture of residential lots, commercial properties, retail stores, churches and farmland. The FEC railroad, levee and Lake Okeechobee exist to the west of the roadway alignment.

Figure 1.3: Palm Beach County located within Southeastern Florida

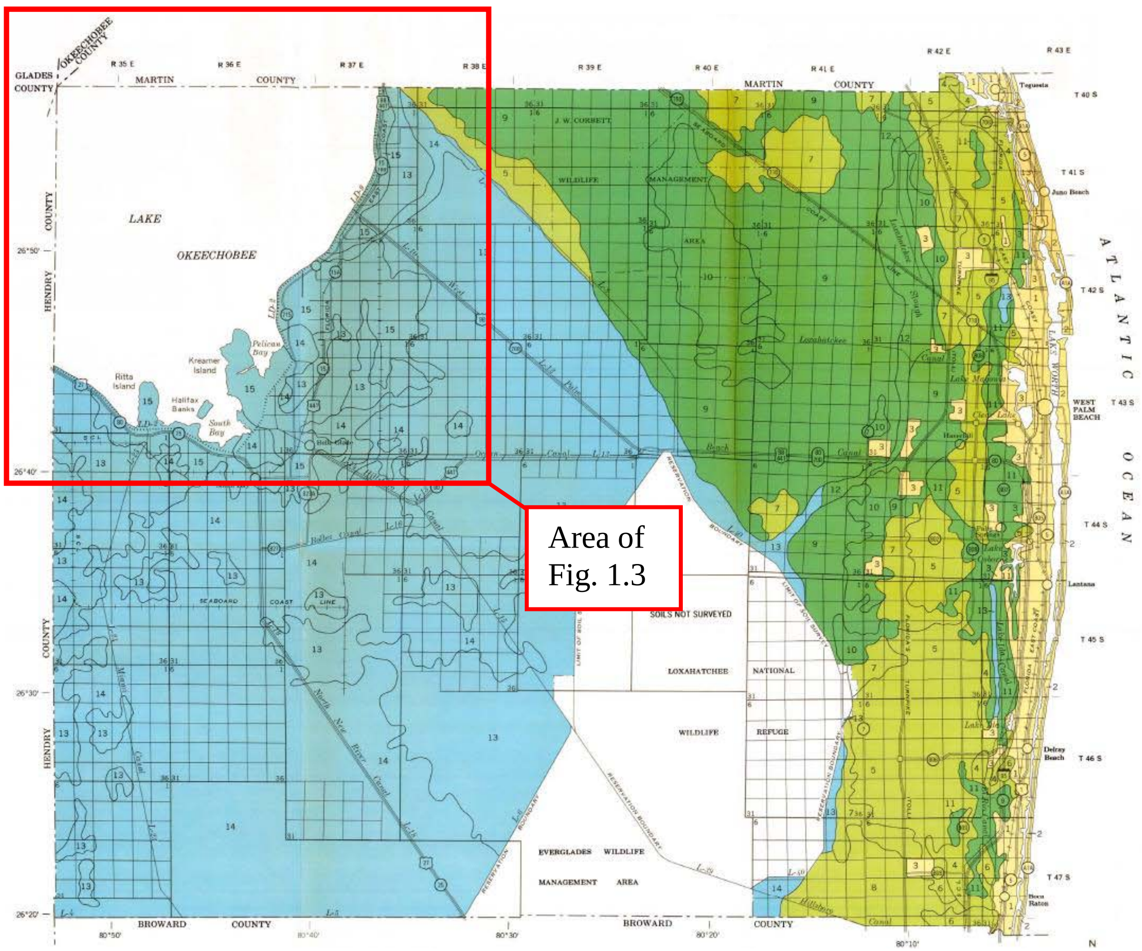


Figure 1.4: USDA Soils Survey Map of Palm Beach County

1.2.2 Mechanistic Considerations

The pavement structure of SR 15 / US 98 consists of nearly 305 mm of asphalt, 305 mm of limerock base, and 915 mm of silty sand subgrade, underlain by organic silts and peat with thicknesses ranging from 3 to 5.5 meters (Sobhan et al. 2007). Generally, the primary consolidation process in organic layers is quite rapid, followed by significant secondary compression stages under sustained effective overburden pressure due to the dead weight of the pavement structure. Although the passage of traffic may initiate short pulses of primary consolidation processes in the organic layer, the major component of the deformation in the organic layer is due to the long-term continuing secondary and tertiary compression phases under the constant pavement dead weight leading to premature distress and failures. Accordingly, one of the root causes of the premature pavement failure is the soft compressible nature of the underlying organic soils. Since complete removal of the organic layer is expensive and impractical, strengthening of surface layers by reinforcements was explored as an alternative rehabilitation strategy.

From a mechanistic standpoint, the asphalt surface layer is expected to crack due to differential settlement in the organic soils. It could be that the cracks are caused by tensile stresses at certain locations exceeding the tensile strength of the material. Once the crack has initiated, the reinforcing materials inhibit the rate of crack propagation by a “crack bridging” action, thereby extending the life of the pavement structure and the time between successive rehabilitation projects.

1.3 SITE GEOTECHNICAL CHARACTERISTICS

The existing roadway consists of a thick AC layer averaging almost 330 mm (13 in), a base layer averaging 305mm (12 in), and a sand fill subgrade averaging almost 1 m (40 in), overlying organic soils (silty muck and peat) ranging from 3 to 5m (9 to 16 ft) in thickness. The organic-rich soil at the test sites, mainly comprised of decomposed vegetation native to South Florida, was formed hundreds of years ago. These organic-rich soils, typically referred to as muck, is defined as a soil that is primarily comprised of humus from drained swampland. When muck contains more than 75 percent organics it is referred to as peat. Previous geotechnical characterization revealed that the organic soils at SR 15 had the following properties (Sobhan et al. 2007): the organic contents range from 25% – 92%, moisture content ranges from 160% - 650%, void ratio ranges from 3.2 – 13.9, undrained shear strength ranges between 17 – 40kPa (2 – 6psi), and the C_α/C_c ratio ranges between 0.028 and 0.051. Figure 1.5 shows the distressed conditions of the roadway primarily caused by organic deposits (pictures taken prior to reconstruction).

1.3.1 Organic Factor (F_{org})

A site-specific geotechnical parameter termed the Organic Factor (F_{org}) was introduced during the first phase of this investigation to determine the experimental test section locations (Sobhan, 2007). The Organic Factor, F_{org} is the theoretical weight of the pure organic material per unit area of the organic layer, and is expressed in terms of the Organic Content (OC), Moisture Content (MC), total unit weight (γ_T), and organic layer height (h_m), as in Eq. 1:

Figure 1.5: Alligator cracking and rutting along SR 15/US 98

$$F_{org} = \frac{h_m \gamma_T * OC}{(1 + MC)} \tag{1}$$

Note that the product of $\{\gamma_T / (1+MC)\}$ (which is the dry unit weight of solids including organics) and OC gives the weight of the organic solids per unit volume of the soil. Multiplying this weight by the volume of a column of the organic soil per unit area results in the weight of organic solids in that column of the foundation. With this interpretation, it is reasonable to expect that larger the $F_{org,}$, the poorer will be the pavement foundation.

The Organic Factor was determined at 35 boring locations along SR 15/US 98 as shown in Figure 1.6, with the most heavily distressed areas indicated by yellow color. Boring B-33 through B-41 (Station 155+00.75 – Station 170+98.01) within test section Location 1 has an average F_{org} (theoretical organic weight) of 86.3kg (≈ 190lb), and B-54 through B-70 (Station 227+02.48 – Station 258+97.75) within test Location 2 has an average F_{org} of 61.3kg (≈135lb). Pre-construction visual distress survey indicated that a higher F_{org} corresponds to higher level of pavement deterioration.

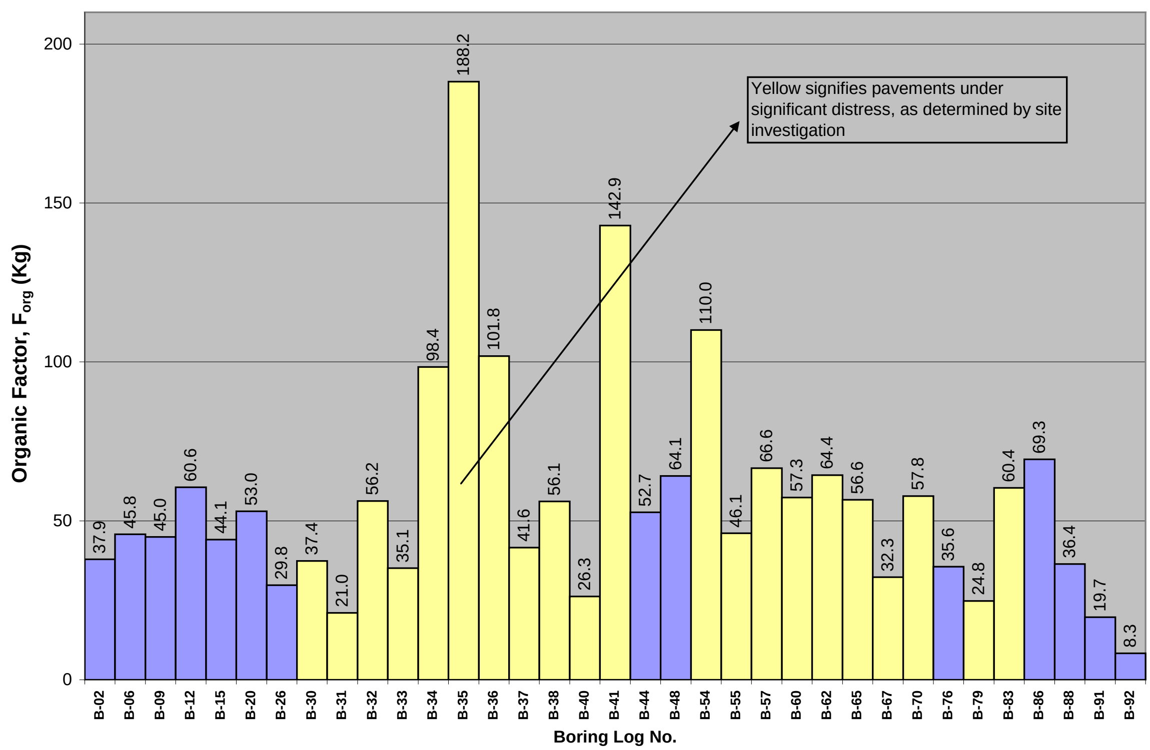


Figure 1.6. Organic Factor at various borehole locations

To confirm the above observation, a series of field Peizocone Penetration Tests (CPTu) and laboratory consolidation test program on undisturbed samples were conducted. Although based on limited data, reasonable correlations were found between the Organic Factor and in-situ Elastic Modulus, E, and the Organic Factor and Secondary Compression Index, C_α, as shown in Figure 1.7. These preliminary relationships involving both stiffness and compressibility behavior show some expected trends such as decreasing moduli and increasing C_α values with increasing F_{org}. Since F_{org} is related to both the modulus (and, in turn the strength) and the compressibility of the organic soils, and since the strength and deformation (settlement) properties of the foundation layer can be assumed to have a strong influence on the performance of the pavement structure (cracking, rutting and ride quality), it is reasonable to hypothesize that F_{org} will also be related to pavement performance. This hypothesis will be verified by careful monitoring, testing and analysis of the experimental pavement sections for several years.

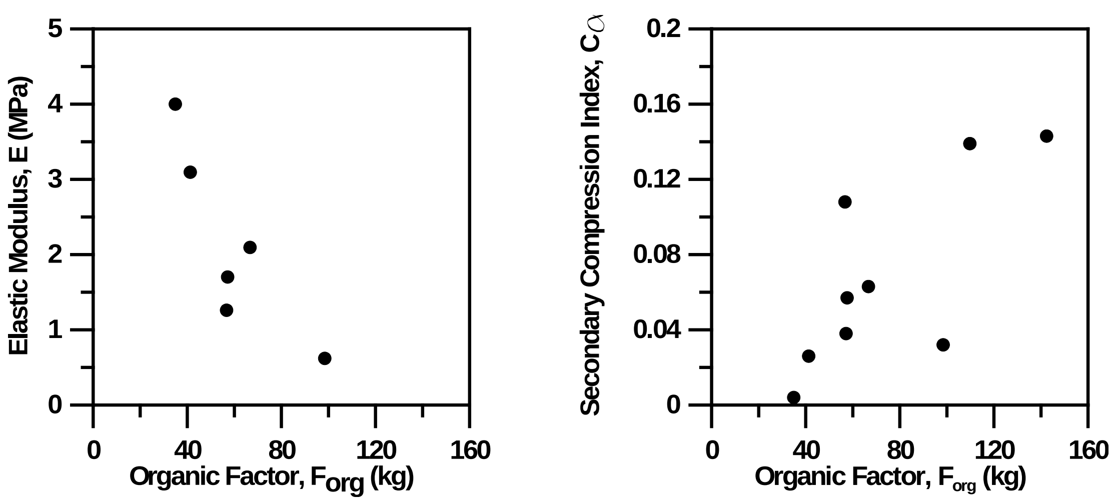


Figure 1.7: Variation of (a) Elastic Modulus and (b) C_α with Organic Factor

(1psi = 6.894kPa; 1lb = 4.44 N)

1.4 RESEARCH OBJECTIVES AND SCOPE

Based on the foregoing discussions, it is surmised that the usual milling and resurfacing is hardly a viable solution when encountering peat/muck subgrade soil. The broad motivation for this investigation is to develop cost-effective near-surface strategies which could be employed in rehabilitation projects with underlying organic soils. In order to provide FDOT the necessary tools for selecting site-specific rehabilitation strategy (such as the type of reinforcing products for a particular subsurface condition), it is necessary to correctly assess the effectiveness and long-term performance of the reinforcing products by conducting a detailed Life Cycle Cost Analysis (LCCA) for each of these alternative strategies. Besides various cost associated factors, the LCCA requires an estimation of the pavement life. With the 6-month and 18-month field testing data acquired during this study, a general framework related to life span estimation has been developed such that long-term performance data can be easily incorporated into this protocol as they become available.

Figure 1.8 shows the sequential phases of this investigation with various tasks numbered I through V. These tasks result in essential inputs for comparing relative performance of test sections with the four reinforcing materials, and also conducting Life Cycle Cost Analysis. Sought from this study would be relevant design and material selection guidelines for reinforced asphalt design and material selection in rehabilitating flexible pavements in Florida.

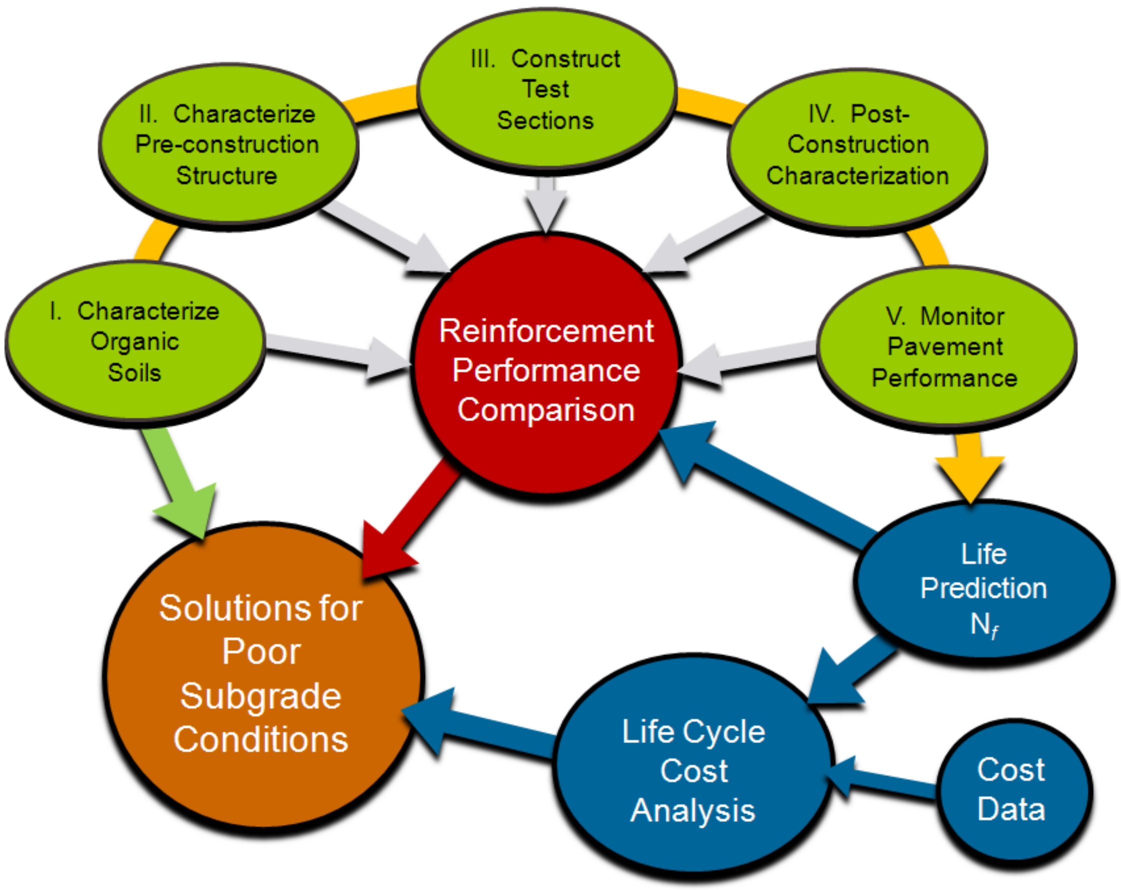


Figure 1.8: Various phases of the investigation

Task I was completed during the first phase of this investigation involving geotechnical characterization, and the selection of test section locations and reinforcing products (Sobhan, 2007; Final Report, FDOT BD546-4). Tasks II through V, the focus of the current investigation, are briefly outlined below:

Task II: Characterization of the pavement structure before reconstruction was a critically important step that established a statistical baseline by which the performance of the various pavement reinforcement products may be compared in a meaningful manner.

Task III: Construction of the reinforced test sections and unreinforced control sections.

Task IV: Post-Construction characterization involving coordinated field testing for performance evaluation of test sections.

Task V: Monitoring Pavement Performance, an ongoing effort, with the 6-month and 18-month data collected and reported as part of the current study; developing a methodology for life prediction of test sections

Specific objectives of the current research were as follows:

1. To develop a statistically sound and practical plan for a field testing / monitoring program;
2. To develop a data collection program geared to measuring critical performance indicators of the test sections;
3. To develop a statistical-based data analysis protocol for quantifying the individual contribution of the reinforcing product, and for delineating the best performing reinforcing material when long term performance data become available;
4. To evaluate the suitability of FWD tests for directly characterizing the stiffness properties of the reinforced asphalt overlays;
5. To quantify the benefits of using reinforcing products in asphalt overlays based on FWD test data by comparing the performance of reinforced and control test sections.
6. To develop a framework for the prediction of pavement life, which is essential for conducting a detailed Life Cycle Cost Analysis (LCCA) in the future.

CHAPTER 2

Literature Review

2.1 INTRODUCTION

Numerous chemical and mechanical stabilization, and ground modification techniques have been developed and implemented during the last several decades to alleviate problems associated with difficult soil conditions, and this trend will continue into the foreseeable future. Excellent summaries of two decades of such developments are available in two Geotechnical Special Publications (GSP), published by the American Society of Civil Engineers (ASCE, 1987; ASCE 1997). In addition, the state-of-the-practice in the stabilization of soil and base for pavement applications has been elaborately documented in a two-volume publication by the Federal Highway Administration (FHWA, 1992a; 1992b).

2.2. "SURFACE" SOLUTIONS

"Surface Solutions" refer to near-surface ground modifications strategies as opposed to "deep solutions" which refer to deep underground soil stabilization techniques. In the recent years, several new-generation reinforcing products and composites have been used to directly reinforce the asphalt concrete overlays in an effort to primarily mitigate reflection cracks originating from the existing cracks and joints of the underlying pavement. These include Asphalt Rubber Membrane Interlayer (ARMI), Geogrids, Fiberglass Grid, Petrogrid, Base-isolating Interlayer / Glass Fiber Reinforcement, and Interlayer Stress Absorbing Composite (ISAC). Techniques other than reinforcement include Resin-modified Asphalts and Ultra-Thin Whitetopping (UTW).

2.3 RELATED PROJECTS IN FLORIDA

Several experimental projects previously conducted by the Florida Department of Transportation are noteworthy in this context, and were described in the Final Report for the first phase of this investigation (BD 546-4, 2007). A summary is provided below:

Two experimental roadway sections each 1000 ft. long were constructed in 1994 along the east and west bound traffic lanes of SR 80 in Palm Beach County (FDOT Project No. 93110-3543). The west bound section served as the control, while the east bound section was reinforced with a geogrid mat placed in the base layer. Improved performance was reported for the geogrid reinforced sections during 1994-2003. Another study undertaken in 1999 included five test sections along the northbound and southbound lanes of SR 15 in Palm Beach County, with four sections containing a combination of geotextile and geogrid reinforcements incorporated in the base and subgrade, and one section serving as a control section with no reinforcement (FDOT Project No. 93130-3508). Most recent data acquired in 2005 indicate that reinforced sections had lower FWD deflections and rutting compared to the control section. In another project, Bayex 8501 GlasGrid was used for the rehabilitation of SR 820 (Hollywood Blvd.) in South Florida. Personal communications with FDOT Pavement Evaluation Engineers in 2006 revealed that there were a number of construction related issues in the project, and that the effects of GlasGrid reinforcement could not be determined conclusively at that time.

Five test sections were constructed in 1998 along the eastbound lane of SR 2 in Baker County containing Asphalt Rubber Membrane Interlayer (FDOT Project No. 27020-3509). Most recent data acquired in 2004 suggest that various modifications of ARMI reinforcement design contributed to moderate improvements in rutting and cracking performance compared to control sections.

Very similar to the current study, PaveTrac MT-1 steel mesh manufactured by Bekaert Corporation, Netherlands was used in the rehabilitation of southbound I-95bridge approach to Tillman Canal Overpass near Melbourne, Florida in June 2003. Existing asphalt pavement was heavily distressed due to wet organic subgrade. PaveTrac design specified four inches of milling, followed by the placement of mechanically fastened PaveTrac MT-1, and 4 inches of asphalt overlay in two lifts. Visual surveys conducted after 15 months showed minimal to no sign of distress in the reinforced sections. (ACF Environmental, 2004).

2.4 CASE HISTORIES OUTSIDE FLORIDA

Recently, high stiffness Fiberglass Grids (E = 10,000,000 psi) were sandwiched between the AC binder course and wearing course to reduce premature cracking of the AC overlay in the rehabilitation of US Highway 190 in Louisiana, and US Highway 96 in Texas

(Darling and Woolstencroft, 2000). In addition, GlasGrids have been used in field test sections in Wisconsin (Bischoff and Toepel, 2003) and Iowa (Marks, 1990) to evaluate its effectiveness in resisting reflective cracking in AC overlays placed over PCC joints and cracks. Kim and Buttlar (2002) recently developed a composite system with rut resistant base-isolating interlayer and high-stiffness glass-fiber reinforcement. Interlayer Stress Absorbing Composite (ISAC), which effectively isolates the AC overlay from the movements in the underlying layers, was used in six test sections in Illinois (Dempsey, 2001). This three-layer composite system consists of a low stiffness geotextile at the bottom, a viscoelastic membrane layer at the core, and a high stiffness geotextile at the upper layer.

In 1983, PaveTrac steel mesh was installed within asphalt surface layer of a flexible pavement built over soft organic subgrade in Netherlands (ACF Environmental, 2004). Reinforced pavement showed no structural cracking when investigated two years later in 1985, compared to control sections which showed extensive longitudinal cracking. It was reported that no structural cracking was observed in the reinforced sections even after 19 years of service.

Cafiso and Di Graziano (2007) reported work accomplished in Italy that had a number of similarities to the present study. Their study involved construction of four reinforced and five unreinforced asphalt pavement test sections each 73.2 to 98.4ft (22.3 to 30m) long. The reinforcement included two different meshes, a heavy mesh and a light mesh, placed at two different depths of 3.15 in and 5.91in (8cm and 15cm). Ground penetrating radar was used to establish the depths of the pavement layers and Falling Weight Deflectometer (FWD) tests were conducted on the completed pavement. The comparisons used t-tests to judge statistical significance at a confidence level of 90%. The authors could not draw statistically significant conclusions regarding an effective increase in pavement structural capacity due to reinforcement alone. After five years of traffic on the test sections, the authors showed that the unreinforced sections had used 33% of their design life while the reinforced sections had used only 15%. Based on visual and video inspection of the pavement surface, the unreinforced sections showed greater surface distress than the reinforced sections. Unlike these findings, the current study did demonstrate statistically significant improvement in pavement stiffness due to inclusion of reinforcing products (described later).

Brown, Thom and Sanders (2001) focused on developing an improved understanding of reflection cracking in grid-reinforced asphalt due to both traffic and thermal loading. The authors developed a simplified theoretical model for the transient loading situation, forming a basis for designing reinforced overlays, and studied three grid types: polypropylene, glass fiber and steel. They found that the differing stiffness, geometry and other characteristics of the various grids helped in understanding the key properties influencing performance of grid reinforcement. Additional parameters of significance were found to be the shear strength and stiffness of the interface at the grid location. One of their conclusions was that although the stiffness of the reinforcement grid was not by itself one of the most significant factors, it did appear to be related to the degree of improvement in the asphalt fatigue resistance. Additionally they found that, in both theoretical models and laboratory tests, the bond strength between a reinforcing strand and the surrounding asphalt is a key factor affecting the performance of reinforced asphalt. They found that reinforcement grids extended asphalt life 2.5 times for steel and 1.2 to 1.8 times for the other grids.

Thom (2003) performed a follow up research based on numerical modeling and laboratory validation studies and concluded that grid reinforcement of asphalt overlays proved to be a viable option, with good interlock and adhesion to the asphalt playing a significant role compared to grid stiffness. The model had been validated by laboratory tests demonstrating crack propagation rates and life expectancy of reinforced and unreinforced asphalt. He further identified under which circumstances grid reinforcement is likely to be economically beneficial and at which level it should be introduced. It was reported that benefits of grid reinforcements are best realized for overlays on existing cracked asphalt pavements, resulting in a life extension of as much as 6 to 60 times.

Sobhan and Tandon (2008) conducted extensive laboratory fatigue crack propagation studies and ABAQUS finite element based numerical investigations for evaluating the performance of reinforced asphalt overlays. Significant improvement in fatigue life was reported due to GlassGrid and PetroGrid reinforcement, with placement location of the grid within the overlay playing an important role. Both the laboratory tests and numerical study showed improved resistance to reflection cracking when a stiff geosynthetic layer was imbedded in the AC overlay. Some indication was additionally seen that the embedded geosythetics may reduce permanent deformation of the pavement but this was not conclusive. The results also indicated that the reinforcement should be placed deep in the overlay, at the bottom of the AC or immediately above a thin 0.75in (19mm) leveling course. The AC overlay should then be at least 4-inch (102mm) thick.

Ling and Liu (2001) provided further confirmation of the benefits of a polymeric grid located at the bottom of the AC layer. Their tests simulated new construction, wherein the reinforcement would be placed at the interface of the AC layer with the granular base layer. The life of the pavement was shown to be prolonged when subjected to dynamic, cyclic and monotonic loading. Significantly, and somewhat in conflict with Cafiso and Di Graziano (2007) study, Ling and Liu (2001) found that the geosythetic reinforcements did contribute to an improvement in the stiffness as well as the strength of asphalt pavement immediately after construction.

Several other related studies are available in the literature (e.g. Al-Qadi et al. 1998). However, the current study with four different reinforcing products in 16 test sections, eight control sections, and each section repeated along both northbound and southbound directions appear to be a truly comprehensive effort for characterizing the performance of reinforced asphalt pavements built of soft organic soils.

CHAPTER 3

Design and Layout of Test Sections

3.1 INTRODUCTION

As discussed in Chapter 1, the first phase of this investigation involved extensive characterization of the organic soils under the SR 15/US 98 roadway. Coordinated series of laboratory and field geotechnical investigations were conducted for characterization of the organic layers. The results of this work had direct bearing on the selection of the test site locations, design of the pavement rehabilitation strategy, as well as the field performance evaluation programs in the current study.

3.2 SELECTION OF TEST SECTION LOCATIONS

Two test section locations were selected with significantly different subsoil characteristics as defined by the Organic Factor, F_{org} (Equation 1) described briefly in Chapter 1. The Organic Factor was determined at 35 boring locations along SR15/US 98 as previously shown in Figure 1.6, and repeated here in Figure 3.1 for discussions. Test Location 1, with an average F_{org} of about 86 Kg (190 lb), and test Location 2, with an average F_{org} of about 61 Kg (135 lb), clearly represent two sites with different geotechnical properties related to organic content, moisture content, and organic layer thickness. Consequently, it is expected that long-term performance of test sections built at these two sites will also be quite different.

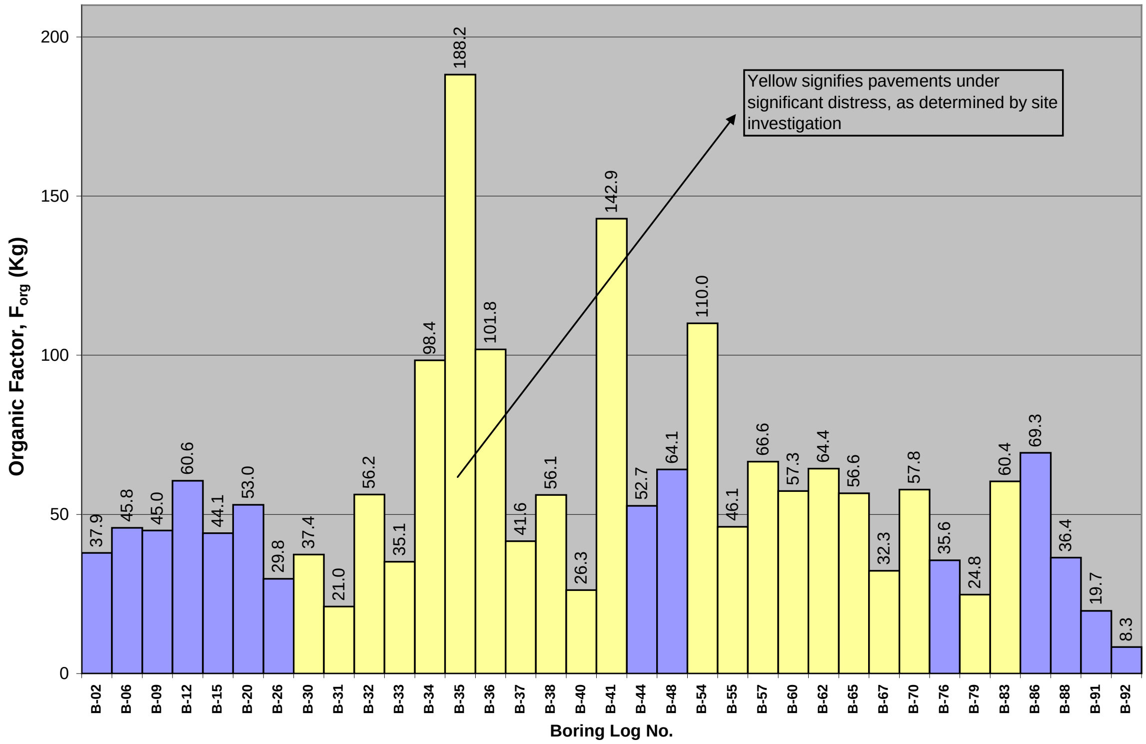


Figure 3.1: Organic Factor at Various Bore Hole Locations

An apparent correlation between the relatively high F_{org} values and visual observations of pavement distress, and measurably different average F_{org} values, were the primary reasons for the selection of two test locations. Test Location 1 would be placed in the road from station 155+00.75 to station 170+98.01 (boring B-33 to B-44) and test Location 2 would be placed in the road from station 227+02.48 to station 258+97.75 (boring B-54 to B-70). The choice of two test locations and their specific placement along SR15/US 98 were expected to provide several benefits:

- Two test locations would provide the space needed to have two test sections for each reinforcement material in each lane, northbound and southbound, for a total of four test sections per material.

- Separation of the two test locations allowed for control sections to be placed at both the north and south ends of both test locations. The relatively large number of control sections (eight), with each pair at least 3000 ft. apart, would provide a wealth of baseline data for performance comparison with the reinforced sections.
- The measurably different average F_{org} values of the two test locations would provide the opportunity to try to isolate the affects of the varying organic soil contents on pavement performance in both the control and reinforced sections.
- There were no major turnoffs along or between the two test locations. Only scattered residential driveways and unpaved agricultural roads exist along and between the test locations. This assures that the traffic, particularly the truck traffic, may be taken to be identical in the same lane of each test location. This would allow direct comparison of the results between the two test locations and eliminate a major potential variable.

3.3 REINFORCING PRODUCTS AND MECHANISMS

Four pavement reinforcing materials were selected for the test sections. These were PetroGrid 4582, GlasGrid 8511, and PaveTrac MT-1. These products are distinctly different in geometry and stiffness properties.

PetroGrid 4582, manufactured by Propex Fabrics, Inc., is a composite of non-woven paving fabric and a glass fiber structural grid (Figure 3.2; Table 3.1). According to the manufacturer, it is recommended for use where cracking may be induced by lateral pavement movement or fatigue cracking and in pavement installed over expansive soils such as swelling clays or expansion caused by frost. It is further recommended by its manufacturer for pavements subject to lateral shear stressing, such as on slopes, curves, intersections and bus stops. Of the reinforcements tested, only PetroGrid does not have an open mesh. In addition to stress absorption, the fabric also provides a moisture barrier.

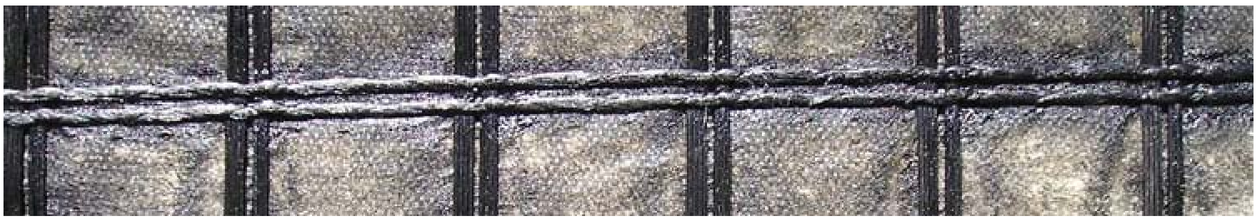


Figure 3.2: PetroGrid 4582 Fabric

Table 3.1: PetroGrid 4582 Material Data

Unit weight	16 oz/yd^2
Tensile strength	560 lb/in
Ultimate elongation	<5%
Strength at 2% strain	280 lb/in
Grid junction strength	18 lb
Aperture size	0.8 X 0.8 in

Note: in Table 3.1, the tensile strength is measured by the single strand method.

GlasGrid 8511, manufactured by Tensar International, comprise an open-mesh fiberglass grid intended to reduce or slow fatigue and reflective cracking (Figure 3.3; Table 3.2). Its construction, according to Tensar, is a custom-knitted fiberglass mesh with elastomeric polymer coating and pressure sensitive adhesive backing. The manufacturer of this product claims that it can be milled using normal milling equipment and procedures without adverse affect.

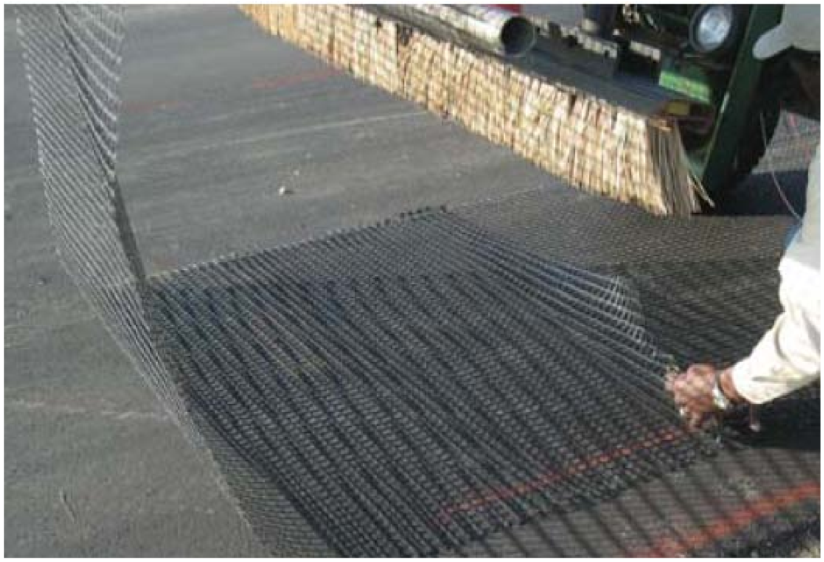


Figure 3.3: GlasGrid 8511 Material

Table 3.2: GlasGrid 8511 Material Data

Unit weight	11 oz/yd^2
Tensile strength	560 lb/in
Ultimate elongation	<3%
Aperture size	1 X 1 in

PaveTrac MT-1 is unique among the products tested for being constructed of steel rather than glass fiber. The first application of steel reinforcement netting in the United States was done on the Virginia Smart Road in 1999. Since then, steel reinforcement netting has been used in many test sections in the United States (Baek and Al-Qadi, 2006). PaveTrac is a double twist woven hexagonal wire netting of steel wire coated with 95% zinc and

5% aluminum (Figure 3.4; Table 3.3). It is reinforced in the transverse direction at regular intervals by flat alternately torsioned reinforcing bars. The manufacturer, Bekaert Corporation, recommends PaveTrac MT-1 for reinforcement of HMA overlay that is placed over jointed and distressed asphalt or concrete pavements exhibiting rutting, shoving, or severe cracking as well as other high stress applications.

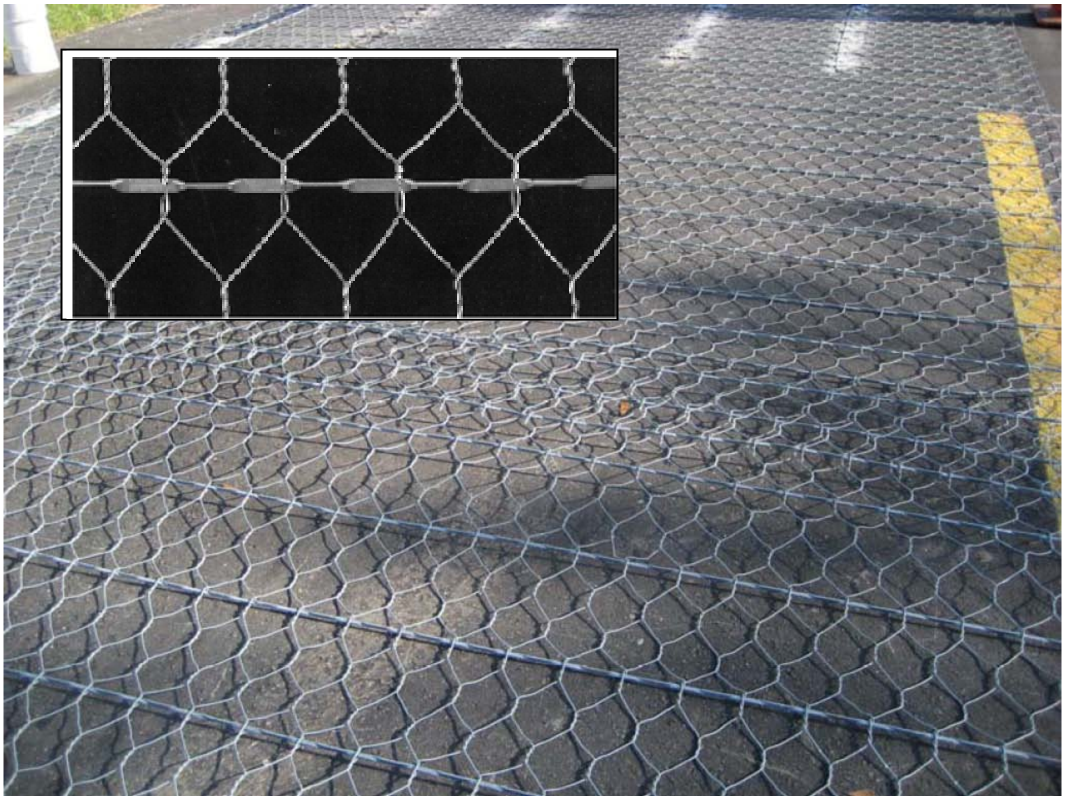


Figure 3.4: PaveTrac MT-1 Material

Table 3.3: PaveTrac MT-1 Material Data

Unit weight	3.2 lb/yd^2
Tensile strength Weaving wire Transverse bar	 405 lb minimum 2,700 lb minimum
Aperture size	Hexagonal, 3.15 wide X 4.65 in long

In order to better understand the motivation behind reinforcement of asphalt pavements, it is good to briefly review the various types of cracking distresses commonly observed in flexible overlays. It is generally expected that the reinforcing products help resist and delay reflective cracks in the pavement. Reflection cracking is a well-documented phenomenon that particularly occurs in flexible overlays placed over PCC pavements in poor conditions. Reflection cracks occur over joints in the PCC pavement and are caused mainly by the movement of the concrete slab beneath the asphalt surface due to thermal or moisture changes. Reflection cracks can also occur in asphalt over PCC pavement with cracks in the PCC other than joints. Due to the presence of deep seated cracks in some locations along SR 15/US 98, it is conceivable that the new overlay proposed would be susceptible to potential reflection cracking due to similar reasons.

Fatigue or alligator cracking, by contrast, is a series of interconnected cracks caused by fatigue failure of an asphalt surface or stabilized base due to repeated traffic loading. The tensile stress and strain under a wheel load is greatest at the bottom of the asphalt layer, and it is in this high-stress interface with the granular base that fatigue cracks initiate in the asphalt. The cracks propagate from this initiation site, progressing toward the surface of the AC layer and being seen on the surface initially as parallel cracks, usually longitudinal. With sufficient repeated loading, the cracks interconnect and form what is called alligator cracking. Because of the bottom-up crack process, fatigue crack propagation is expected to be retarded by the pavement reinforcement materials as shown schematically in Figure 3.5. Pavement interlayer systems are intended to mitigate crack propagation by reducing the stress concentration at the crack tips. Baek and Al-Qadi (2006) confirmed through finite element modeling that improved resistance to cracking in reinforced pavement resulted from the ability of the reinforcement to resist tensile stress caused by bending moment and stress concentration at the crack tip.

Figure 3.5: Resistance to Bottom-up Cracks (from Tensar Corp.)

The fourth type of treatment used in the test sections is known as Asphalt Rubber Membrane Interlayer (ARMI). ARMI is composed of a separate application of asphalt rubber binder ARB-20 covered with a single application of aggregate constructed per FDOT specification 341. The design intent behind ARMI has two components: (i) it is to provide a barrier to crack propagation and (ii) be a moisture barrier to help prevent failure of the subgrade. The first design goal can be thought of as similar to the difference between welded steel construction of ship's hulls and riveted construction. When plates are welded together, a crack in one plate can propagate through the welded interface and continue into the next plate whereas cracks cannot propagate across riveted joints. The ARMI intent is analogous: because the pavement layers above and below the asphalt rubber layer are marginally bonded together, the ARMI is a barrier to vertical crack propagation.

3.4 PAVEMENT REHABILITATION DESIGN

The construction of the test sections on SR 15 / US 98 was accomplished as a part of a larger rehabilitation of 6.8 miles of the roadway beginning 140 ft north of the Palm Beach Canal bridge in the town of Canal Point north to the Martin County line. The rehabilitation was designed by C3TS Engineers of Boca Raton, Florida, for a 14 year design life. Figure 3.6 shows the typical section for general rehabilitation of the road and Figure 3.7 shows a longitudinal view of the construction in the test sections.

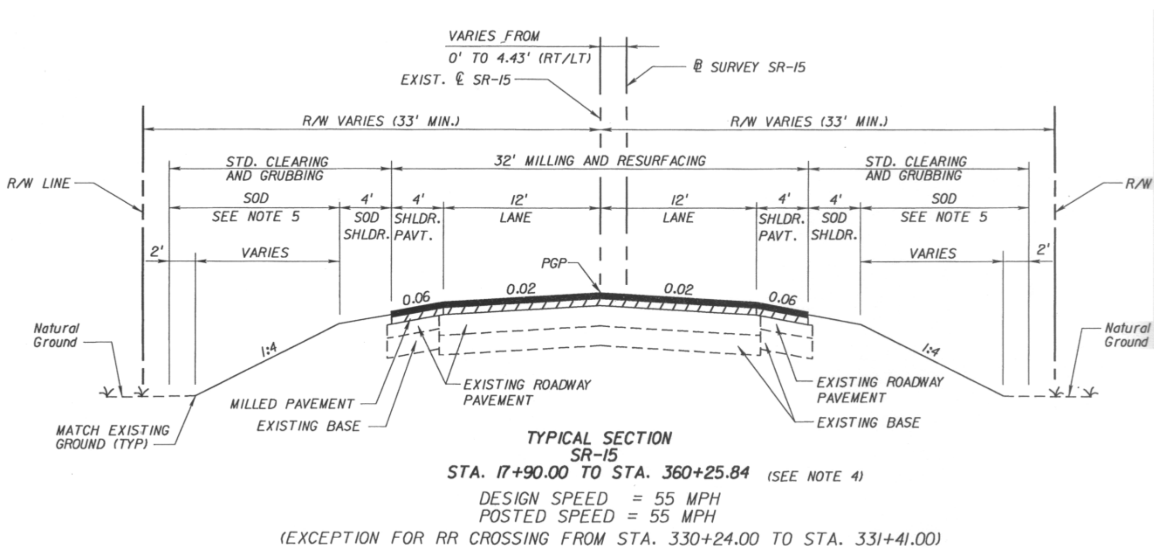


Figure 3.6: Typical Cross-section of SR 15/US 98 (from C3TS Engineering)

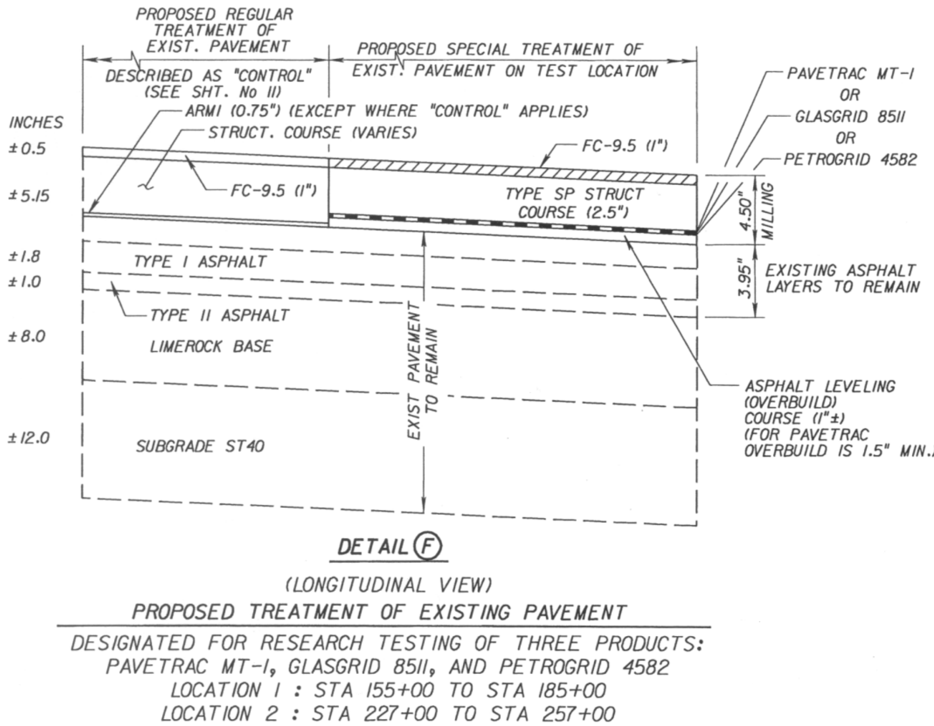


Figure 3.7: Typical Longitudinal View of Test Section (from C3TS Engineering)

The reconstruction of the pavement in the test locations will be covered in detail later in the report; a brief summary is presented here. The rehabilitation in the test and control sections began with milling off the top 4.5 inches of the existing pavement. In all sections, milling was followed by a leveling course overbuild of type SP asphalt 1 in. thick nominally. In the test sections, the reinforcement materials were then placed. A 2.5 in. (approximately 1.75 in. for the ARMI sections) type SP structural course was then placed in multiple lifts. Finally an FC-9.5 friction course 1 in. thick was placed to finish the asphalt pavement. The PetroGrid, GlasGrid and PaveTrac provided no appreciable thickness themselves; the ARMI layer however was about 0.75 in. thick. Therefore the structural course thickness was reduced above the ARMI layer in those test sections.

The control and test sections were arranged as shown in Figure 3.8. Each test location begins and ends with a 500 ft. control section; the reinforcements are arranged as follows: PetroGrid, GlasGrid, PaveTrac and ARMI from south to north. Each test and control section was given an identifying number, increasing sequentially south to north, from 1.0 to 1.5 for Location 1, and 2.0 to 2.5 for Location 2. As the test and control sections existed in both traffic lanes, a given test or control section was fully identified by a number and a letter, "N" for the Northbound Travel Lane (NTL), and "S" for the Southbound Travel Lane (STL). For example, the south control section in the STL of test Location 1 was identified as 1.0S and is referred to by this designator throughout this research.

Station 0+00 for the project was the bridge over the Palm Beach Canal in Canal Point. This is at mile post 19.674 on SR15/US 98. The construction project ended at the Palm Beach County – Martin County line, mile post 26.519. The stations at the beginning and end of each control and test section are shown in Figure 3.8. On the actual roadway, the beginning and end points of both test locations are marked with signs alongside the road (Figure 3.9) and a bronze marker on both shoulders marks the dividing lines between test sections. An example is shown in Figure 3.10; this marker was placed at the north end of test Location 2, station 227+00, and notes the end of the control section (2.5) located immediately south (to the left in the figure) of the marker.

Test Location 1

Stn:	155+00	160+00	165+00	170+00	175+00	180+00	185+00
← STL	Control	Petrogrid	GlasGrid	PaveTrac	ARMI	Control	← STL
→ NTL	Control	Petrogrid	GlasGrid	PaveTrac	ARMI	Control	→ NTL
Section:	1.0	1.1	1.2	1.3	1.4	1.5	

Test Location 2

Stn:	227+00	232+00	237+00	242+00	247+00	252+00	257+00
← STL	Control	Petrogrid	GlasGrid	PaveTrac	ARMI	Control	← STL
→ NTL	Control	Petrogrid	GlasGrid	PaveTrac	ARMI	Control	→ NTL
Section:	2.0	2.1	2.2	2.3	2.4	2.5	

Figure 3.8: Layout of Test and Control Sections in Each Test Location

Figure 3.9: Signage on SR15 / US 98 Test Locations

Figure 3.10: Bronze Permanent Marker Identifying the Test Section and Location

CHAPTER 4

Experimental Methods

4.1 INTRODUCTION

In-situ testing of existing roadways is generally conducted using Non-destructive Test (NDT) methods, because roadways may remain partially in service during the testing and evaluation, and immediately return to full service after testing. The current research employed a number of NDT methods, including Falling Weight Deflectometer (FWD), rut measurements, ride quality tests, and crack surveys. Of these, the FWD and rut measurements are considered critically important for this project because it is hypothesized that the presence of organic soils is primarily responsible for cracking (causing reduced stiffness and high deflection in FWD tests) and rutting (permanent deformation) related distresses as observed in SR 15/US 98 roadway. All four methods will be briefly discussed in this chapter, followed by a description of the statistical analysis methods used on the NDT data.

4.2 FALLING WEIGHT DEFLECTOMETER

The most widely used FWD device in the United States is the Dynatest Model 8000 (Huang, 2004) which was also used in the current study. The Dynatest device, shown in Figures 4.1 and 4.2, is mounted on a trailer behind a vehicle that carries a computer for automatic data acquisition. The Dynatest creates an impulse force by dropping a weight from a specific height that impacts on the road surface. The weight and drop height may both be varied to generate a range of peak forces. For the current study, a 9000lb nominal peak force was used. The half sine wave load pulse, which is 25 to 30 ms in duration, is transmitted to the pavement through a steel loading plate, 11.8 inches in diameter with a rubber pad under it ensuring satisfactory seating of the plate, and to prevent pavement damage. A load cell measures the actual magnitude of the load each time the weight is dropped. For each FWD measurement, the weight is dropped two times and the data for the test point is recorded on the second drop.

Figure 4.1: Dynatest Deflectometer and Tow Vehicle on SR15/US98

Sensors arrayed linearly along the travel axis of the trailer are automatically lowered to the pavement surface before the weight is dropped. The sensors measure the deflection of the pavement due to the impact of the falling weight. The sensors may be placed a variety of distances from the center of the load impact plate; the sensor distances used for the current study were the FDOT standard 8, 12, 18, 24, 36 and 60 inches from the load center. A seventh sensor is located at the center of the load plate. The sensors and their data are labeled D0 (at the load center), D8, D12, D18, D24, D36 and D60. Figure 4.2 shows the sensors on the sensor bar lowered to the pavement surface during a test. The Dynatest is highly automated; the operators need only position the trailer, record the location, and initiate the test sequence. A computer and custom software in the tow vehicle record the data. In addition to the loads and deflections, the software records the pavement surface temperature at each point tested.

Figure 4.2: Dynatest Deflectometer with Sensor Bar Deployed During a Test

4.3 RUT MEASUREMENTS

Rutting refers to the permanent deflection of a pavement structure. The AASHO road tests of the early 1960s showed that rutting is principally due to the decrease in thickness of the layers of the road structure. Rut depth is frequently used by highway and transportation authorities as a failure criterion for pavements. The Asphalt Institute uses a rut depth of 0.5 in. as a design failure criterion. Measurement of rut depth is straightforward, requiring that a 6 ft. long straight edge be placed across the wheel path and the rut depth be measured at the deepest point from the bottom surface of the straight edge. Figure 4.3 shows a rut depth measurement on SR 15/ US 98.

Figure 4.3: Rut Depth Measurement on SR15 / US 98

4.4 RIDE TESTS

Ride measurement may involve any one of several methods to define in an objective way the ride comfort experienced by humans travelling in a vehicle on a given road (ASTM E 950 with Ride No. determined by ASTM E 1489). Ride testing as accomplished by FDOT employs a vehicle equipped with road profiling instruments as shown in Figure 4.4 and is reported in terms of either a Ride Number (RN) or International Roughness Index (IRI). For the current research it was decided to use the IRI due to its wide scale use and acceptance.

Pavement roughness may be defined in general as a measurement of irregularities in a pavement surface that adversely affects the ride quality experienced by humans on the road (Pavement Interactive.org). In the 1980s, the World Bank worked with the University of Michigan Transportation Research Institute to develop the IRI as a standardized measure of ride quality. “IRI is used to define a characteristic of the longitudinal profile of a traveled wheel track and constitutes a standardized roughness measurement. The commonly recommended units are meters per kilometer (m/km) or millimeters per meter (mm/m). The IRI is based on the Average Rectified Slope (ARS), which is a filtered ratio of a standard vehicle's accumulated suspension motion (in mm, inches, etc.) divided by the distance traveled by the vehicle during the measurement (km, mi, etc.). IRI is then equal to ARS multiplied by 1,000.” (Milla, 2002). The IRI scale and range of values are shown in Figure 4.5.

The FDOT van was equipped with inertial-reference type profiling instruments. It used accelerometers in the box mounted at the front bumper location on the van to create an inertial reference by measuring the vehicle body motion. In addition, the relative displacement between the accelerometer box and the pavement surface profile was measured simultaneously using non-contact distance sensors. The van contained a computer that processed data from the instruments in real time as the van was driven over the road. The output of the computer was a mathematical measurement of the pavement roughness. While ride measurements made by different types of sensor systems can be difficult to compare with one another, measurements on SR15 / US 98 using the same type profiling equipment should be repeatable and comparable.

Figure 4.4: FDOT Instrumented Van for Ride Measurement

4.5 CRACK SURVEY

Concurrent to the FWD, rut and ride tests, the FDOT personnel also conducted a crack survey in accordance with the FDOT Flexible Pavement Condition Survey Handbook (FDOT, 2009). This survey was visual, accomplished by visually judging the percentage of area that was cracked in each 50 ft. section of each lane of the road.

4.6 TEMPERATURE AND OTHER CORRECTIONS TO DATA

The FWD data was corrected per recognized standards for both the temperature at the time of testing, and variability of the actual applied load. These corrections help assure comparability of data taken under different conditions. Temperature corrections were accomplished according to the procedures described in the United States Department of Transportation (USDOT) publication number FHWA-RD-98-085, “Temperature Prediction and Adjustment Factors for Asphalt Pavement” (2000). The USDOT procedure calls for use of a Temperature Adjustment Factor (TAF) to be calculated and used to correct D0, the deflection measured under the center of load plate of the deflectometer. The deflections were corrected to a temperature of 68°F, the preferred standard reference temperature.

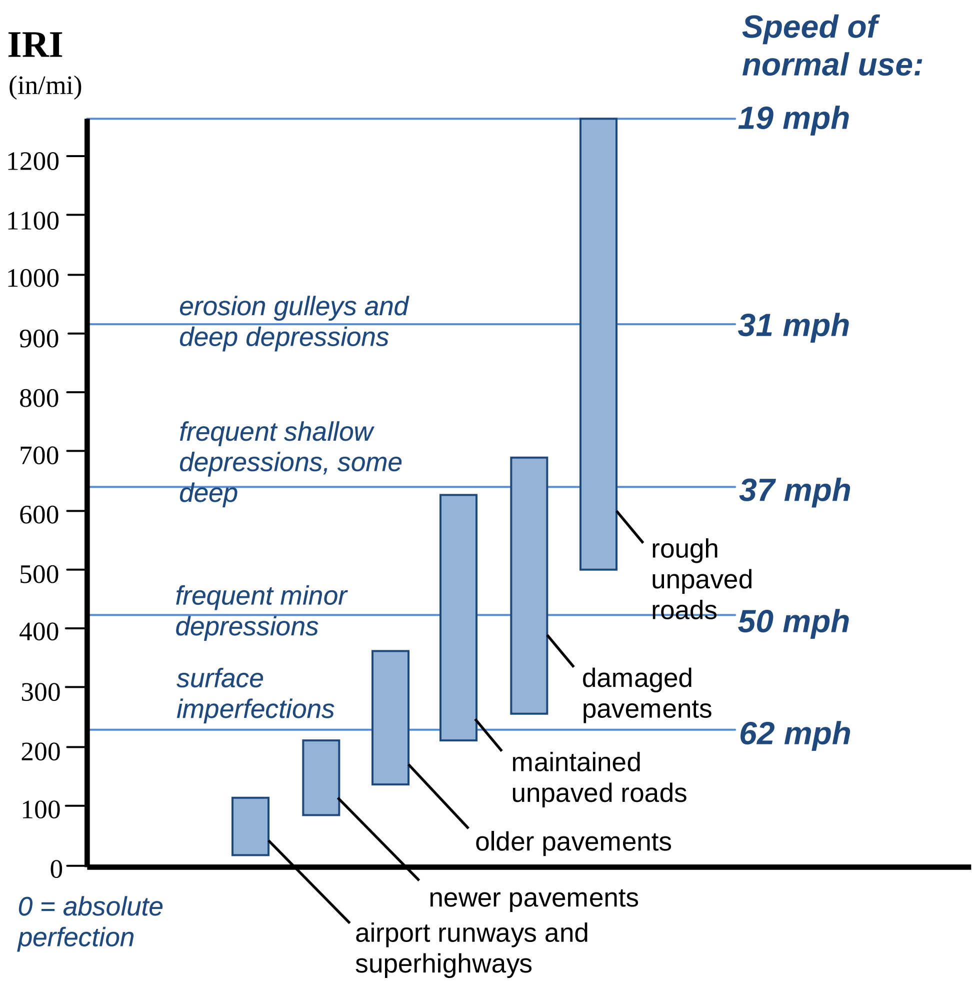


Figure 4.5: International Roughness Index Scale (Milla, 2002)

In general, warmer pavement is expected to deflect more and colder pavement is expected to deflect less. The TAF is used to adjust all deflections to a single reference temperature so that they may be directly compared regardless of the actual temperatures at the times various test were accomplished.

The TAF is defined as:

$$TAF = \frac{Defl36 + Delta36_{Ref.Temp}}{Defl36 + Delta36_{Meas.Temp}} \tag{4.1}$$

Where,

Defl36 = deflection at 36in (D36), normalized to 40.5kN (9104.76lbf)

Delta36 is defined by the following equation:

$$log(Delta36) = 3.05 - 1.13log(ac) + 0.502log(\theta)log(Defl36) - 0.00487Tlog(\theta)log(Defl36) + 0.00677Tlog(ac)log(\theta) \tag{4.2}$$

Where,

ac = total thickness of the HMA

θ = latitude of the pavement section

T = temperature at mid-depth of the HMA, calculated per BELLS method

The BELLS method estimates the temperature at mid-depth of the asphalt layer based on several parameters using the equation

$$T = 0.95 + 0.892*IR + \{log(d) - 1.25\}\{-0.448*IR + 0.621*(1\text{-}day) + 1.83*sin(hr_{18} - 15.5)\} + 0.042*IR*sin(hr_{18} - 13.5) \tag{4.3}$$

Where,

IR = infrared surface temperature measured by deflectometer

d = depth at which temperature is predicted

1-day = average air temperature for 24 hours before testing

hr_{18} = Time of day on a 24-hour clock system, adjusted so 24 hours = 2π radians

The deflections at 36 in from the center of the load plate, D36, were normalized to 40.5kN (9104.76lbf) using the following equation:

$$D36_N = D36(9104.76/F_a) \tag{4.4}$$

Where,

$D36$ = Actual measured deflection at 36in

$D36_N$ = Normalized deflection at 36in

F_a = Actual load applied and measured by the deflectometer

In this study, the *Impulse Stiffness Modulus* (ISM) was used as a direct quantitative measurement of pavement response when subjected to FWD loading. ISM is defined by:

$$ISM = \frac{F}{D_0} \tag{4.5}$$

where, F = vertical dynamic load≈40,000N (9,000lb)); and D_0 = deflection at the center sensor. Because of the direct, fundamental nature of ISM it was used as the primary index derived from the FWD data for all analysis and comparisons in this project. ISM is a direct measure of the stiffness of the total pavement structure.

4.7 STATISTICAL ANALYSIS

The FWD tests, rut measurements and ride measurements yielded large quantities of data. Due to inherent variability of the subsurface conditions, emphasis was placed on rigorous statistical methods using recognized protocols to assure that meaningful conclusions could be drawn when performing comparative analysis of reinforcing materials and test section performance.

In many cases, data from one population had to be compared with data from a second population and a determination made whether the two sets of data were the same or different to a statistically significant degree. For example, in the analysis of the pre-construction data, each test section was to be compared to every other section in the same lane and same test location to determine if the characteristics of the section were the same or significantly different. The statistical method chosen for these comparisons was the t-test.

The t-test is a widely used statistical method used for comparing the similarity of two data samples. The t-test method involves two steps. First, the variances of the two data sets are compared using the F-test. The F-test determines if the two data samples are from the same population. Then, a comparison is made of the means of the two data sets using the t-test, which determines if the two data sets are significantly similar or different. A different calculation is used for the t-test depending on the outcome of the F-test. Critical values of test variables, F_{crit} and t_{crit}, are found from statistical tables dependent on sample sizes n_1 and n_2 and chosen confidence level α. In all calculations herein, two-tailed tests were used to test for similarity within a range of values both greater and less than the mean of the first data set.

The F-test is accomplished using the following steps:

1. variance is computed for each data set = v_1, v_2; variance is the square of the standard deviation
2. Data is assumed to follow an F-distribution: F_{crit} is found from a table based on the sizes of the data samples and desired confidence level. In the present case, both data sets have ten data points; for 10 data points and confidence α = 98.9%, F_{crit} = 6.540
3. Find: $F = \max(v_1/v_2, v_2/v_1)$, such that $F > 1.0$
4. Test: if $F < F_{crit}$, variances are not significantly different and data sets are taken to be from the same population (to the confidence level selected); if $F \geq F_{crit}$, variances are significantly different and the data sets are taken to be from different populations.

The t-test is then accomplished using the following steps, noting that t is found differently depending on outcome of the F-test:

5. t_{crit} is found from a table: For sample sizes n_1 & n_2 = 10 and confidence α = 99%, t_{crit} = 2.878
6. If variances are not significantly different ($F < F_{crit}$), then find the variance of the data sets pooled together = v_p, and:

$$t = \frac{|mean_1 - mean_2|}{\sqrt{v_p/n_1 + v_p/n_2}} \tag{4.6}$$

If variances are significantly different ($F \geq F_{crit}$), then use the variances of the data sets individually and:

$$t = \frac{|mean_1 - mean_2|}{\sqrt{v_1/n_1 + v_2/n_2}} \tag{4.7}$$

7. Test: if $t < t_{crit}$, the data sets are not significantly different (or similar, to the confidence level selected); if $t \geq t_{crit}$, the data sets are significantly different.

CHAPTER 5

Pre-construction Tests

5.1 INTRODUCTION

Prior to reconstruction of the SR15/US98 roadway, it was essential to establish the pre-existing conditions at the site. Once reconstruction was completed, conditions at the site would be completely altered (improved). Therefore a complete battery of tests was conducted at the site on September 18 2007. FWD and rut measurements were made every 50ft in each lane of each test section, a visual crack survey was done and ride tests were conducted using the FDOT survey van. The purposes of the pre-construction tests were to:

1. Determine the structural integrity of the existing pavement for comparison with post-construction data;
2. Determine the uniformity and consistency of the existing pavement in each test and control section.

The first of these goals was important to determine the changes in the pavement structure that would occur due to the reconstruction. These conditions at the site immediately after reconstruction will be compared with the pre-construction conditions to isolate the changes due to reconstruction. This comparison will also allow a determination of whether there were distinguishable differences in the initial conditions of the reinforced sections versus one another and versus the control sections.

The second goal was perhaps even more vital to the overall research project. Natural variability in the site conditions have the obvious potential to affect the test results and potentially lead to incorrect conclusions. Variability in the existing site conditions could be due to the natural soil conditions as well as differences in how the existing pavement has been damaged along the length of the roadway. It was therefore essential to characterize the existing conditions to determine if significant differences existed among the test sections and if so, to record the differences in a way that could be used to fairly and accurately interpret the long-term pavement performance results.

The tests began at approximately 9:00 am on September 18, 2007, starting at the south end of test Location 1 in the north travel lane and proceeding north. FWD and rut measurements were made at the same locations every 50ft beginning at station 155+25. Starting at this station caused all measurements to be at least 25ft from the borderlines between sections. The construction survey markers were used as reference, so that the same locations could be found after reconstruction of the road. The Dynatest system acquired the FWD data including deflections, actual applied load and pavement temperature. Representatives from the FDOT State Materials Office made the rut measurements and conducted the crack survey. The FWD tests, rut measurements and crack survey were completed at about 4:00 pm. Afterward, the FDOT van was used to conduct the ride test.

5.2 ANALYSIS OF FWD DATA

The Dynatest FWD was used to take measurements every 50 ft in both lanes of both test locations. The deflectometer was set to apply a 9000 lb nominal load; it also took infrared temperature readings at each test point. The FWD tests were conducted after the construction survey was complete and used the survey markers as way points to assure that post-construction tests could be accomplished at exactly the same points, as nearly as possible. The Dynatest trailer was carefully towed so that the right hand wheel stayed on the right hand lane line, placing the test load in the right hand (outside) wheel path. The raw test data, as well as temperature-adjusted ISM values, are given in Appendix 2. Figure 5.1 summarizes the FWD data for both test locations, expressed as ISM values adjusted for temperature.

The data in Figure 5.1 reveals that the structural stiffness as measured by the deflectometer was more consistent in test Location 2 than Location 1. Location 2 exhibited more consistency both section to section and between the northbound and southbound lanes. Location 1 exhibited more uniform stiffness in the southbound lane but the southbound lane was generally less stiff than the northbound lane; this held true for all sections except 1.3 and 1.5. It can also be seen that the northbound lane of Location 1 had relatively high average stiffness in sections 1.0, 1.1, the southern part of 1.2 and all of 1.4.

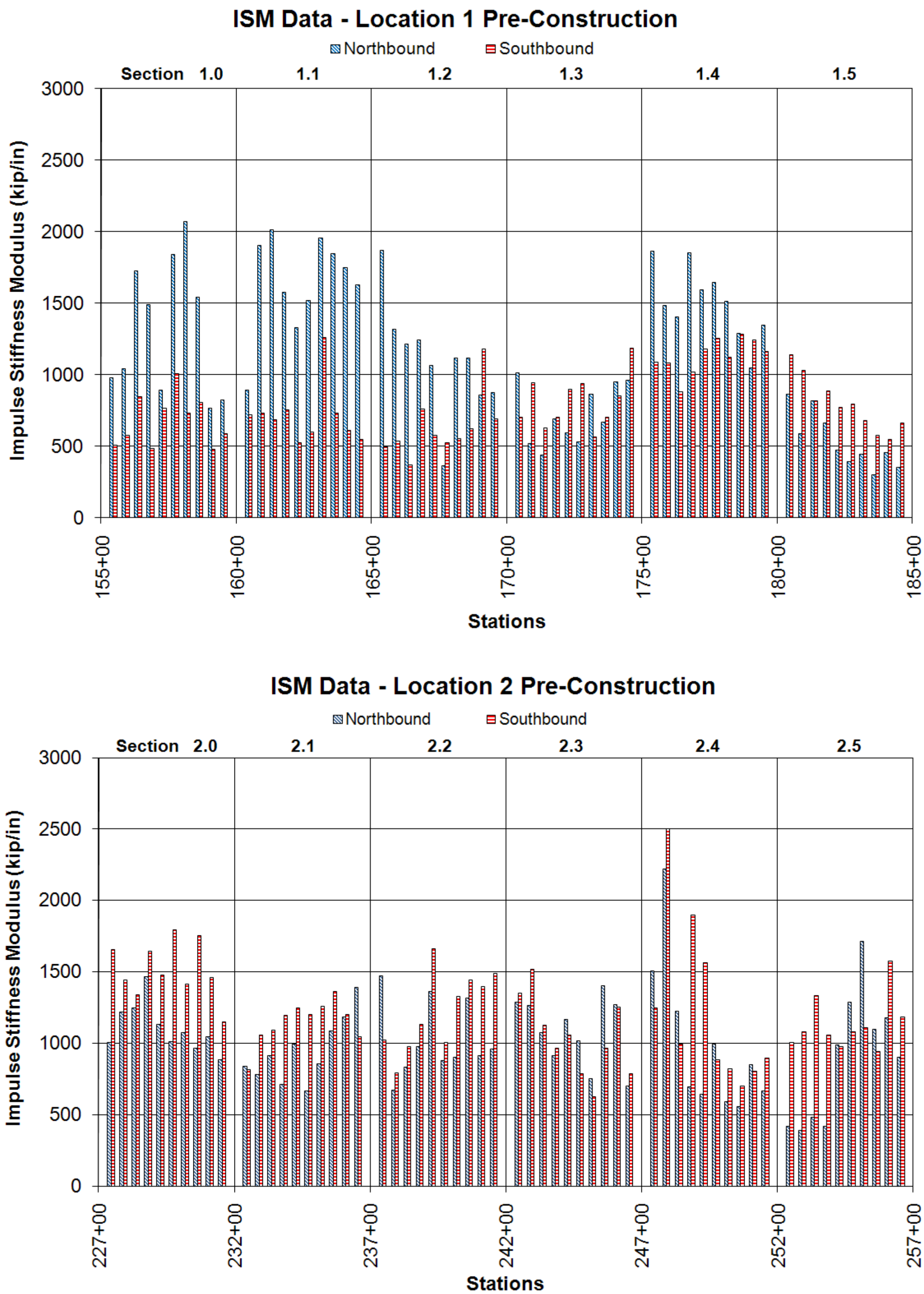


Figure 5.1 – FWD Data for Locations 1 and 2 Pre-construction

5.3 RUT MEASUREMENT DATA

As stated, the rut measurements were made at the same locations as the FWD tests. The methodology followed was FDOT standard, using a 6 ft straight edge and depth gauge. The rut depth was measured at the deepest point, but avoiding cracks and other irregularities. Figure 5.2 shows a typical rut measurement, and Figure 5.3 shows the variation of the rut data.

Figure 5.2: Rut Depth Measurement

Figure 5.3 shows that the southbound lane is generally more consistent than the northbound lane similar to the FWD data trends. This held true in both test locations. The greatest rut depths were found in test section 2.1N, which was the northbound lane of Location 2 between stations 232+00 and 237+00. Visual observations confirmed that the northbound lane in this section exhibited significant permanent deformation. Relatively greater rutting was also seen in the northbound lane in sections 1.5, 2.2, 2.4 and 2.5, although none of these were as severe as section 2.1.

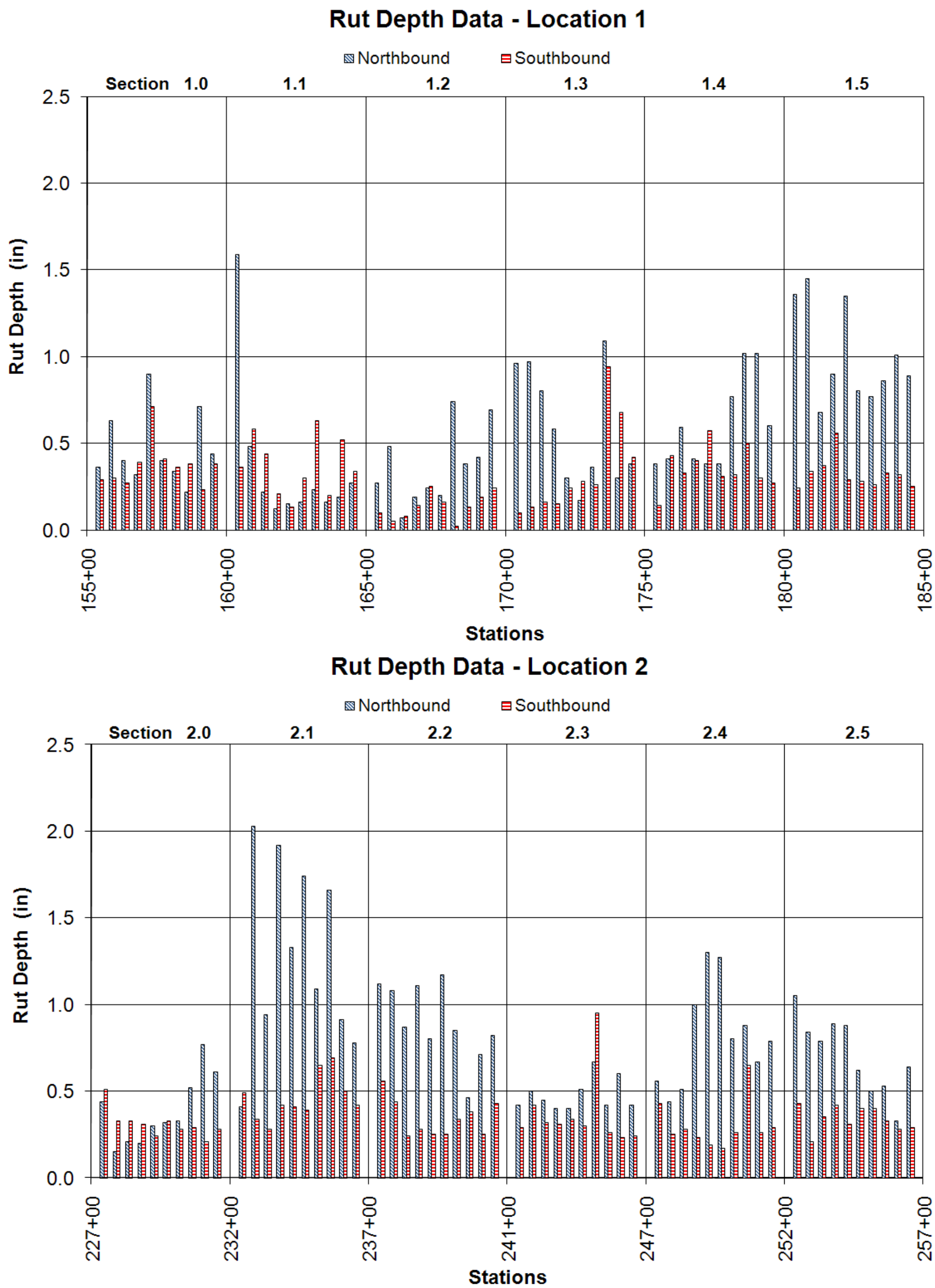


Figure 5.3: Rut Depth Data for Locations 1 and 2

5.4 RIDE DATA

Following the FWD tests and rut measurements, the FDOT instrumented van drove the lengths of both test locations in both lanes to obtain ride data. The data collection system in the van provided both International Roughness Index (IRI) and ride numbers as output; the IRI values are reported in Figure 5.4, and in Appendix 4. Data are reported per test section. The closest correlation of the IRI should be with the rut data, and this can generally be seen from the charts. For example, where the rut depths in the northbound lane were greater on average than the southbound lane, such as sections 1.5, 2.1, 2.2 and 2.4, the IRI was also seen to be greater. An exception was section 1.0, for which the IRI was significantly higher in the northbound lane but a similar disparity did not show in the rut data. Also sections 1.2 and 2.5 showed the IRI lower in the northbound lane than southbound but this was not reflected in the rut data for the two sections. Otherwise, based on visual inspection, the ride and rut data seemed to show some correlation.

5.5 CRACK SURVEY

Crack survey was conducted by FDOT personnel using visual techniques. For completeness, the results are reported in Figure 5.5. However, it was felt by the research team that the crack survey was somewhat subjective, as the technician scanned the area and made a judgment as to the percentage of area that was cracked in each 50 ft segment. Therefore the data may be useful as a reference, but it is not used herein for any rigorous data analysis. Interestingly, the technician who performed the survey consistently indicated greater cracking in the southbound lane. This was true for every section except 2.1, which was the section with the worst rutting.

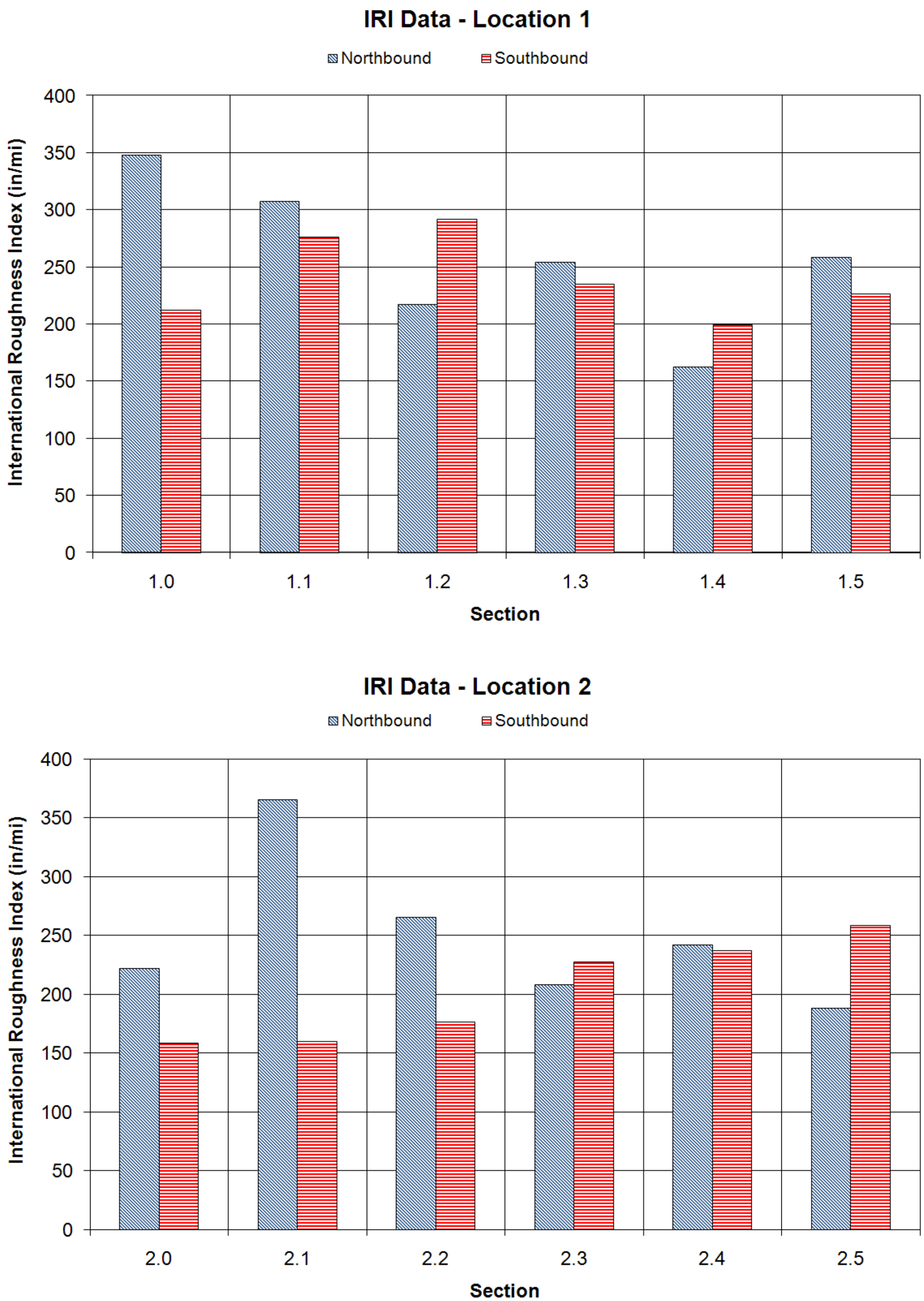
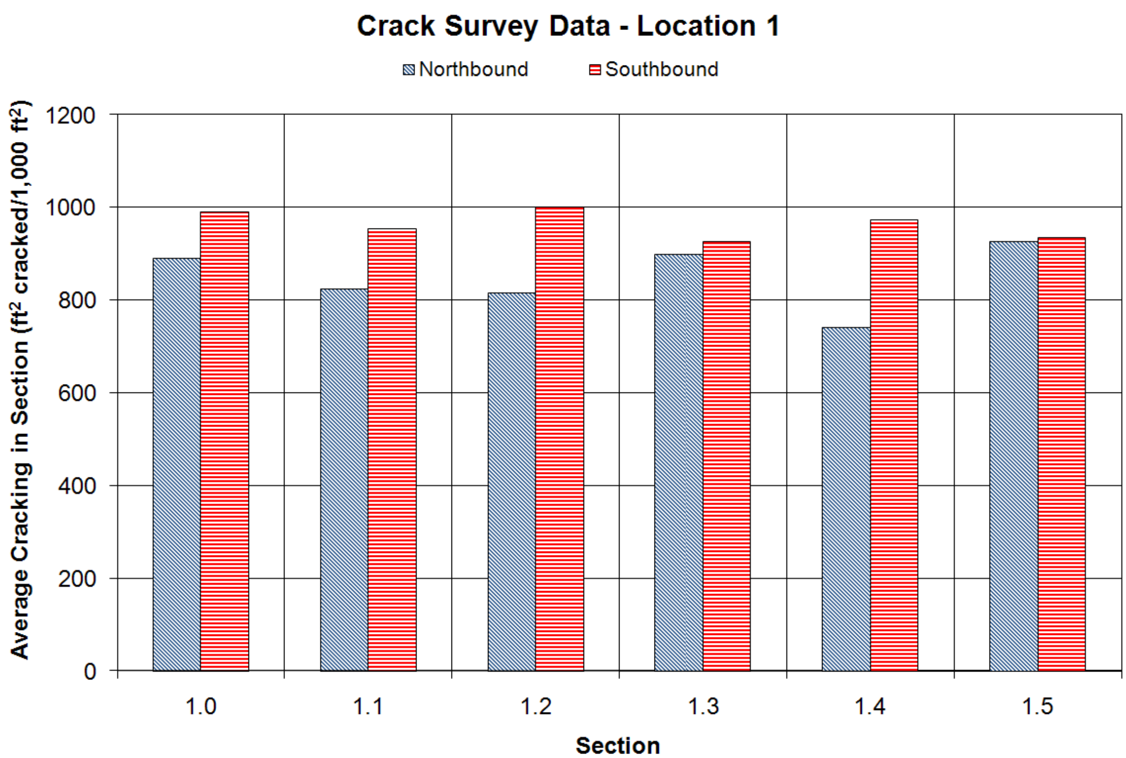


Figure 5.4: Ride Data for Locations 1 and 2



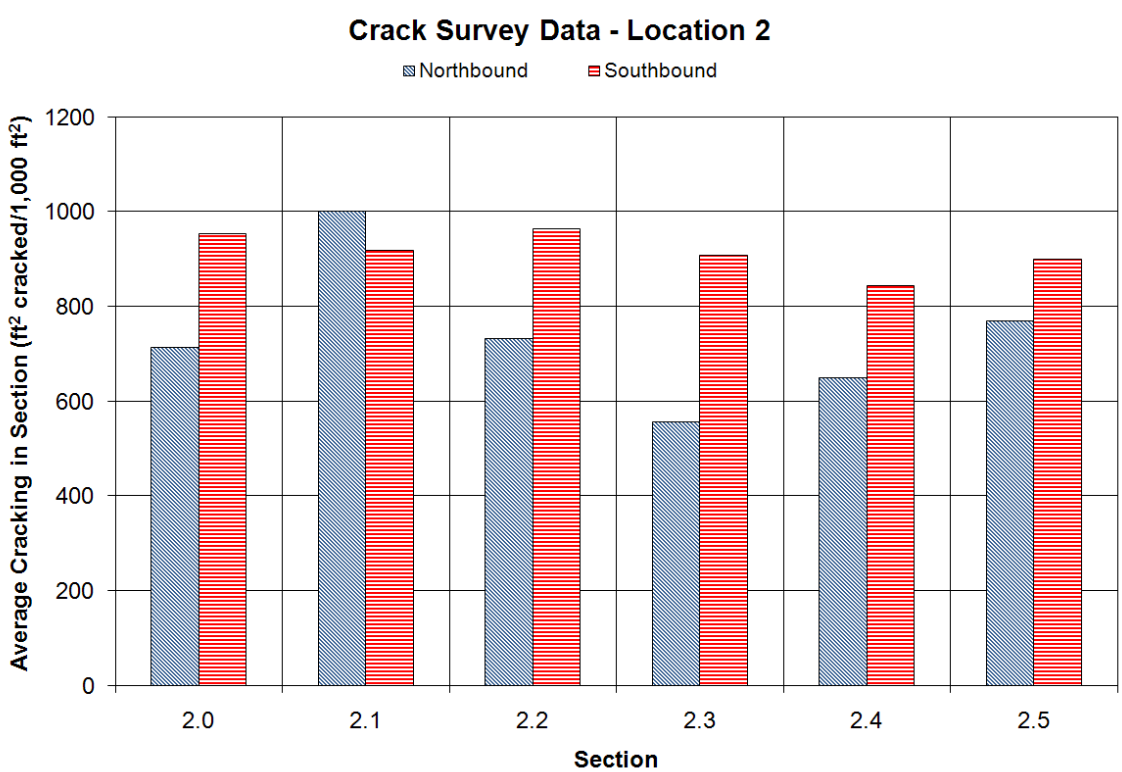


Figure 5.5: Crack Survey Data for Locations 1 and 2

5.6 DATA ANALYSIS

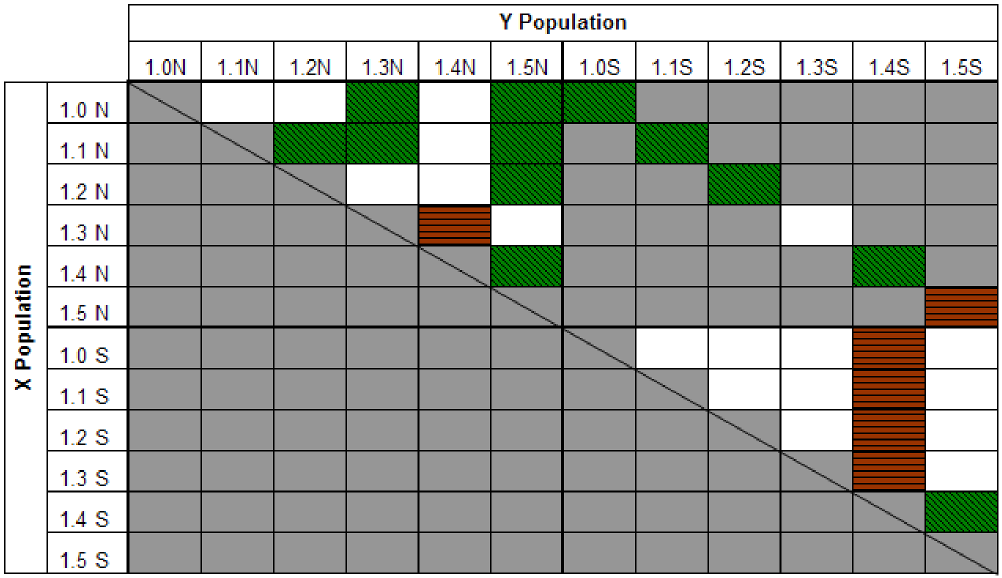
The statistical methods described in Chapter 4 were used to analyze the pre-construction data to determine the consistency of the properties of each test and control section. This comparison was absolutely essential to assure that valid conclusions could be drawn from the long-term performance results of each reinforcement material tested. A material placed over a test section that was intrinsically weak would be at an obvious disadvantage versus another material placed over a relatively strong test section.

Therefore, the primary focus of the analysis of the pre-construction data was to establish whether the existing conditions in each test and control section were statistically similar to one another. The analysis focused on comparisons between sections in the same lane of the same test location, because these should provide the most valid long term performance comparisons, keeping in mind that the two test locations have differing geotechnical characteristics as identified during the first phase of this investigation. This allowed four sets of comparisons, given two lanes and two locations.

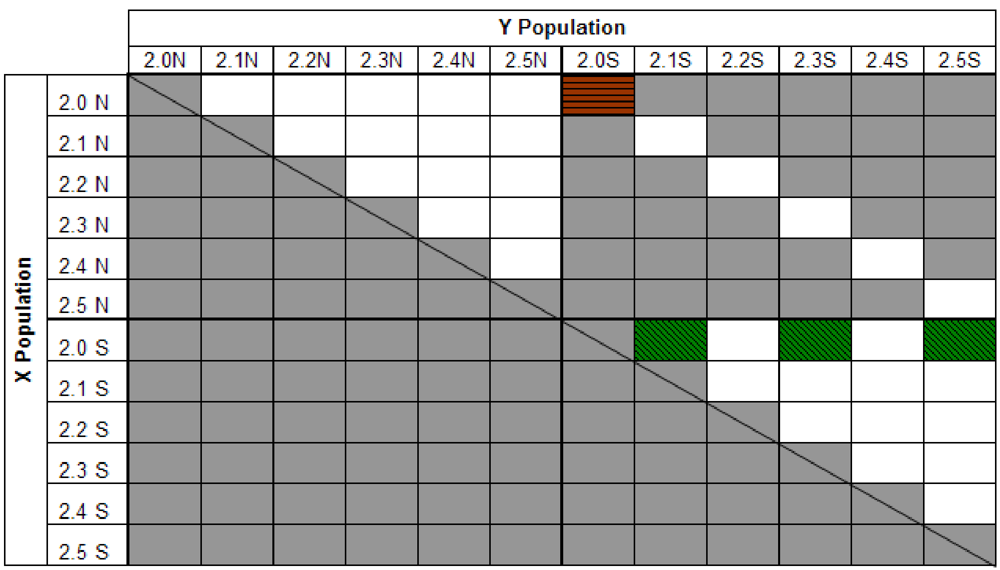
Using the F-test and t-test, the data for each section was compared with that of every other section in the same lane and same test location. In addition, comparisons were made across the lane, comparing each section with the section directly across the road. The tests determined the statistical similarity or dissimilarity of the sections. There were ten data points in each section for comparisons of FWD and rut data, meeting the recommended minimum number of data points for the statistical tests. A 99% confidence level was used.

Summary matrices presented in Figures 5.6 and 5.7 were developed as a way of visually presenting the statistical comparison results. The x-populations are shown in the rows of each matrix and the y-populations are listed in the columns. F-test and t-test comparisons were made of the y-populations against the x-populations; however the results would be mathematically identical if the comparisons were made the opposite way. Each colored cell in each matrix represents the results of a t-test comparison. If the two sections compared were found to be statistically similar; the cell was left uncolored. If the t-test showed the x-population was stiffer (had greater ISM values) or less rutted than the y-population to a statistically significant degree, the cell was colored green with diagonal hatching. Conversely, if the t-test showed the x-population was weaker (had lower ISM values) or more rutted than the y-population to a statistically significant degree, the cell was colored red with horizontal hatching. Grey cells indicate comparisons that were not made because they would be invalid (such as a section compared against itself), redundant or otherwise was not desired for the analysis. F-test and t-test comparisons were not made section-by-section for the ride data because there were not enough data points for valid comparison. The ride data was reported as a single average value per section.

Location 1 Summary Matrix for ISM Data



Location 2 Summary Matrix for ISM Data



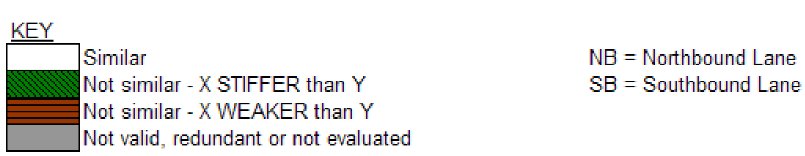
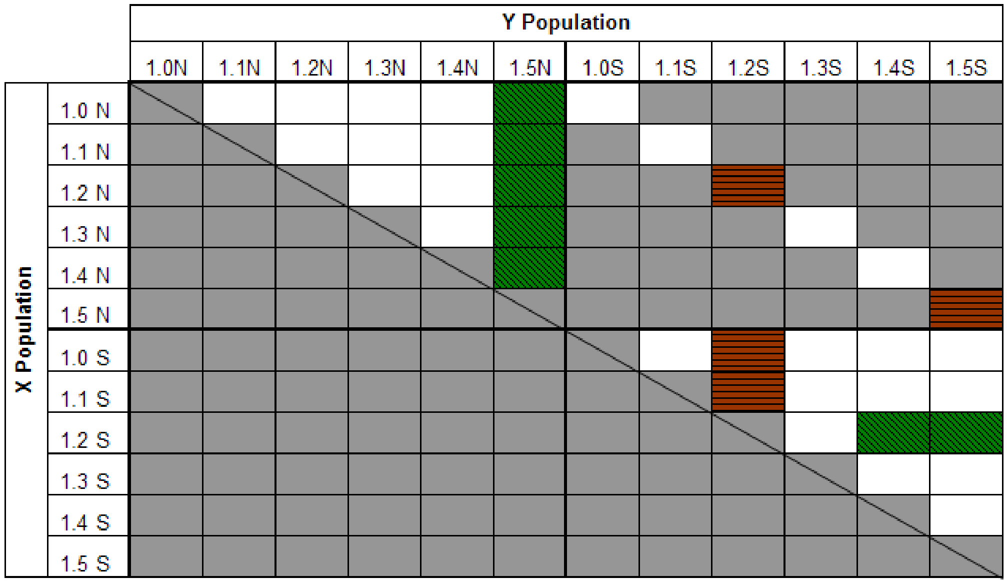


Figure 5.6: Summary Matrices for t-test Comparisons of FWD Data

Location 1 Summary Matrix for Rut Data



Location 2 Summary Matrix for Rut Data

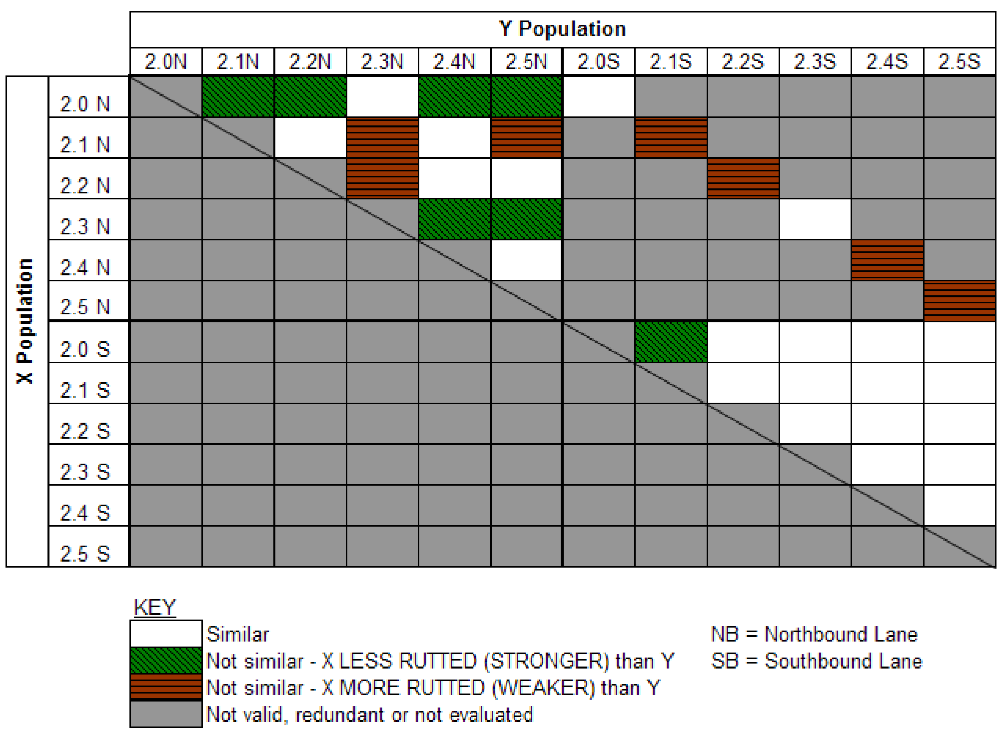


Figure 5.7: Summary Matrices for t-test Comparisons of Rut Data

Based on the summary matrices, following observations are made.

5.6.1 <u>Test Location 1: Northbound Lane</u>

Control section (CS) 1.0 N was significantly stiffer in the ISM comparison than Test Section (TS) 1.3N and CS 1.5 N, but it had ISM values similar to the other NTL test sections in Location 1. CS 1.0N was similar in rut data to all other sections except CS 1.5N.

Control Section 1.5N was significantly weaker than all other NTL test sections in test Location 1 except TS 1.3N to which it was found to be similar in the ISM analysis. The rut data showed CS 1.5N to be significantly more rutted than all other NTL sections in Location 1. Therefore CS 1.0N was found to be a better control section for the NTL in Location 1 than was CS 1.5N. The consistency of both the ISM and rut data analyses supports that CS 1.5N was a relatively weak region in the pavement.

Test Section 1.1N was found to be stiffer in the ISM analysis than three other sections, including 1.2N, 1.3N and 1.5N. While 1.5N was shown to be particularly weak, and 1.3N may be somewhat weak, still the comparisons indicate that 1.1N is a relatively stiff section in the ISM data. The rut data for TS 1.1N was similar to all other sections except 1.5N.

Test Section 1.3N was weaker than CS 1.0N and test sections1.1N and 1.4N in the ISM analysis, indicating that test results in TS 1.3N must be viewed with some additional care. The rut data did not show 1.3N to be relatively weak, however. Other comparisons indicated statistical similarity between the test sections.

5.6.2 Test Location 1: Southbound Lane

Both control sections were similar in both the ISM and rut data, therefore both may be retained and an average used for performance comparison with the four test sections. Section 1.4S was the stiffest of all of the southbound sections in the ISM data. The rut analysis however did not show particular strength in 1.4S as it was favorably dissimilar to only one other section, 1.2S. Employing the average of the two control sections and circumventing 1.4 S, comparisons between the remaining sections in the southbound lane of test Location 1 appear reasonable.

5.6.3 Test Location 1: Comparisons across the road between NTL and STL

All the northbound sections of Location 1 were found to be stiffer in the ISM analysis than their southbound partners except for sections 1.3 and 1.5. Test section 1.5N was the sole occasion for which the NTL section tested weaker than the STL section, further underscoring the northbound lane result that found CS 1.5N to be weaker than most other NTL sections in Location 1.

5.6.4 Summary for Test Location 1

From the ISM data for Location 1, overall the sections appear to be consistent (similar) except (i) CS 1.5N is relatively weak; and (ii) section 1.4S is a particular outlier in the STL in all comparisons made. Also, there were some indications that 1.1N was somewhat strong and 1.3N was somewhat weak in comparison with other sections in Location 1. The rut data strongly supported the conclusion that 1.5N was relatively weak; in addition the rut data showed section 1.2S to be somewhat strong.

5.6.5 Test Location 2: Northbound Lane

All comparisons in the northbound lane of Location 2 indicated similarity in terms of ISM data. The rut data, however, did not show similar consistency. CS 2.0N was less rutted than four other sections, including three test sections and CS 2.5N. TS 2.3N also exhibited significantly less rutting than four other sections. CS 2.5N had more mixed results, being more rutted than 2.0N and 2.3N but less rutted than 2.1N. The indications of the rut data comparisons were that 2.0N and 2.3N were relatively strong (less rutted) sections; 2.5N was similar in the rut data to most sections other than these two.

5.6.6 Test Location 2: Southbound Lane

Test Section 2.0 southbound (TS 2.0S) was found to be stiffer in the ISM analysis than three other sections: 2.1S, 2.3S and 2.5S. The rut analysis showed dissimilarity only between 2.0S and 2.1S, with 2.0S being less rutted. All other comparisons in the southbound lane of Location 2 indicated similarity in terms of both ISM and rut data.

5.6.7 Test Location 2: Comparisons across the road between NTL and STL

CS 2.0N was found to be weaker than CS 2.0S. All other comparisons across the road indicated similarity in the ISM data. Again the rut data did not support the similarity of sections as the ISM data did. The rut analysis showed the NTL sections to be significantly more rutted than the STL sections in all comparisons except in sections 2.0 and 2.3.

5.6.8 <u>Summary for Test Location 2</u>

Overall, test Location 2 exhibited greater consistency in ISM values than test Location 1. CS 2.0S, being stiffer than CS2.0N, and also stiffer than TS 2.1S, 2.3S and CS 2.5S, was shown to be on the high end of the stiffness scale. The rut data supported the conclusion that CS 2.0N was relatively strong. Together, the data indicated that CS 2.0S was an outlier and CS 2.5S would be the better control section to use when making comparisons for pavement performance in the STL test sections of Location 2. Additionally, CS 2.0N and TS 2.3N were shown to be relatively strong in the rut data, although the ISM data did not support these conclusions.

The charts shown in Figure 5.8 were created to help show at a glance the relative consistency of the sections. Each chart, one for each test location, graphically shows the conclusions drawn from the above analyses. It was seen in the analyses that certain sections were notable for being stiffer or less rutted than most (three or more) of the other sections in the same lane and test location. These sections are highlighted most boldly in green in the pre-construction summary charts of Figure 5.8. The sections that were relatively weak or more rutted compared to three or more other sections are highlighted most boldly in red. Sections that were statistically dissimilar to two other sections are highlighted less boldly using the same colors; these were the sections that show only minor indication of relative strength or weakness. Sections that are not colored in the summary charts compared similarly to most other sections in the same lane and location, being dissimilar to not more than one other section.

Direct comparisons of the performance of reinforcing materials in the sections that are not shaded may be made with good confidence, noting that the comparisons may be valid only in the same lane and test location.

SR-15 Summary Charts: Pre-Construction Conditions

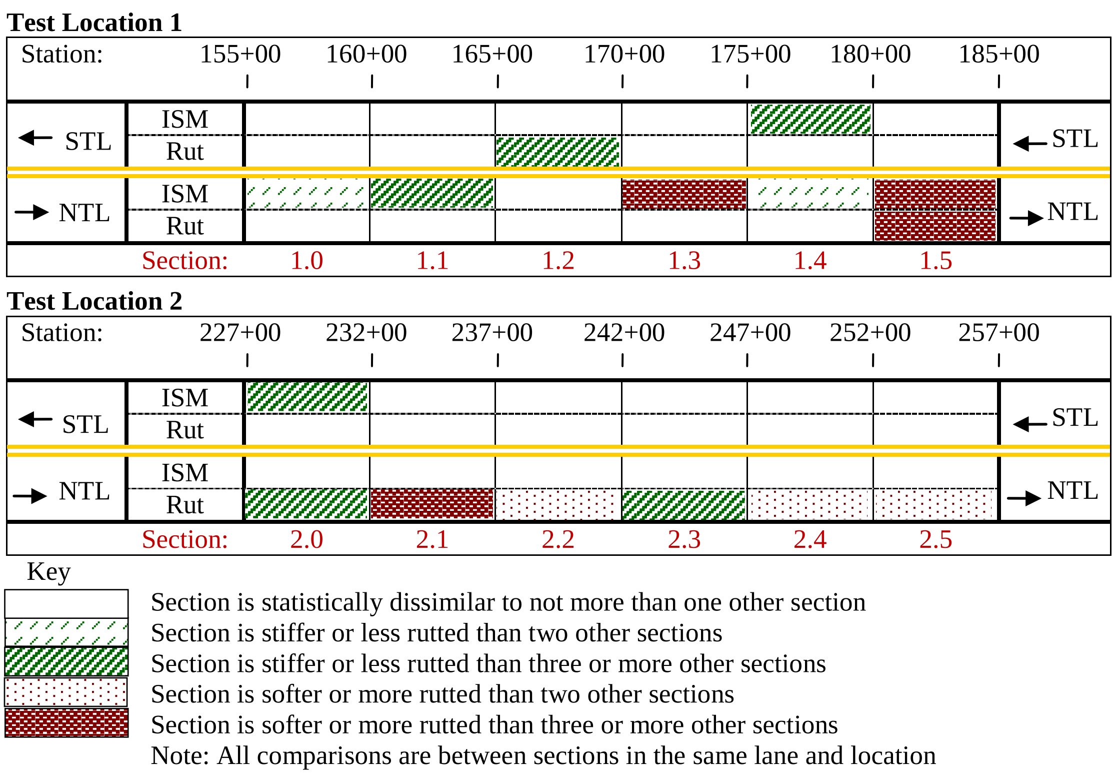


Figure 5.8: Pre-construction Summary Charts

CHAPTER 6

Construction of Test Sections

6.1 INTRODUCTION

The construction of all 24 test sections took place over four days from August 12 to 15, 2008. Several days prior to this time period, the top 4.5 in. of the existing pavement had been milled off, and a leveling course of 1 in. nominal thickness had been placed.

Installation of the reinforcing materials began toward the north end of the southbound lane in test Location 2 and proceeded to the south. The materials were installed one after the other, PaveTrac, GlasGrid and PetroGrid in that order from north to south. After placing a 1.5 in. HMA layer on the reinforcement materials, the construction operation reversed direction onto the northbound lane and proceeded north to complete test Location 2. The order was different for Location 1, where work started at the south end for both lanes and proceeded north, beginning with the southbound lane and ending with the northbound.

After all the reinforcing materials were placed and covered with the 1.5 in HMA, an additional layer of HMA 1 in. thick was placed to complete the 2.5 in. structural course above the reinforcements. Traffic was permitted on the road until the final 1 in. friction course was placed over the entire 6.8 miles of the SR15 / US98 rehabilitation project in

November of 2008. This final layer brought the road surface up to approximately its pre-construction elevation. The following discussion of the construction focuses on placement of the three reinforcement materials and the 1.5 in HMA layer atop the reinforcements. It is organized by material rather than chronology.

6.2 PAVETRAC MT-1

The PaveTrac reinforcing material was installed first, beginning on August 12 at station 247+00 at the north end of test section 2.3S. The PaveTrac steel mesh was 13 ft. wide and was secured in place using 2 in. long Hilti fasteners at the edges and in the overlaps as it was placed in the southbound lane. A forklift suspended the roll of material on an improvised device and moved forward to unroll the mesh while one end was held to the road surface. Figure 6.1 shows the PavTrac installation at work. The PaveTrac was overlapped 6 in. at the longitudinal edges and at transverse joints. A view of the reinforcement in place and overlap can be seen in Figure 6.2.

The installation contractor placed asphalt impregnated tape, known as Qwick Seal, to try to ensure adhesion between the mesh and the asphalt. The Qwick Seal tape was placed in five rows glued to the PaveTrac mesh, after which the backing of the tape was removed. A rubber tire roller was then driven over the mesh in an attempt to secure it to the road surface; however, the tape adhered to the tires of the roller. After two passes to flatten the mesh with the roller, a trackless tack NTSS-1HM anionic asphalt emulsion was applied to the PaveTrac and the road surface at a rate of 0.06 gal/sq. yd. For the later installations of PaveTrac in other test sections, the trackless tack coat was applied before placing the PaveTrac material.

After the GlasGrid and PetroGrid materials were placed in test sections 2.2S and 2.1S as described below, a hot mix asphalt concrete overlay 1.5 in. thick was placed over all three test sections. The overlay work began at 12:30 pm starting at the north end and proceeding south. The front tires of the paving machine immediately began to pick up the Qwick Seal tape, on occasion pulling out some of the Hilti fasteners as well. In addition, the PaveTrac mat curled up in front of and behind the tires of the paver as shown in Figure 6.3. The tires of the asphalt delivery truck also caused wrinkles in the mesh. The curling and wrinkling of the mesh were considered to be due to (i) the mesh not being properly adhered to the pavement, and (ii) the mesh not being flat on the surface following placement and rolling. The placement could have been improved by turning down the curvature shape of the mesh.

Some success was found by spreading HMA on the mesh in front of the paver wheel paths. The HMA was then compacted first by a steel wheel roller and then by a rubber tire roller. The PaveTrac again curled in front of the tires, and as the wrinkles accumulated in front of the tires it tended to protrude from the top surface of the overlay. This prevented finishing the overlay to a smooth surface. Due to these problems, a 40 ft. section of the PaveTrac had to be removed and reconstructed twice in the area beginning at station 243+60.

Better success was achieved by applying the tack coat to the pavement before placing the PaveTrac, and also by leaving the paper backing on the Qwick Seal tape so it did not stick to the tires of the roller. In addition, more Hilti fasteners were used to help prevent and alleviate wrinkles in the mesh. Because of these difficulties, 1 hour and 45 minutes was needed to place the HMA layer. Despite the extra time and effort, when section 2.3S was inspected the next day, the surface was rough due to the curling of the PaveTrac (Figure 6.7). This probably indicated inadequate compaction that could affect the strength and future performance of the test section.

The following day, August 13, PaveTrac was placed in the northbound lane on test section 2.3. This work began at the south end of the section, at station 242+00, and continued north. After the learning experience the previous day, the procedure was modified. First, the trackless tack emulsion coat was applied prior to unrolling the mesh on the road. Second, more Hilti fasteners were used, being placed every 6 to 8 ft in the two wheel paths of the paver. Third, the paper backing of the Qwick Seal tape was left in place until after rolling with the rubber tire roller. The installation, thus modified, went relatively smoothly. It was felt that the tack coat helped the netting to lay flat while being rolled; the Hilti fasteners were also considered helpful in keeping the mesh on the road while the HMA was placed. In addition, the manufacturer’s representatives assisted by stepping on the edges of the mesh to hold it in place, and also cut the edges of the mesh with snips to help alleviate curling.

The placement of the HMA in section 2.3N went better; this was attributed partially to lower pavement surface temperatures. The surface temperature was 109^0 F on August 13 while it had been 133^0 F the day before. As the temperature rose near midday, the steel mesh began to wrinkle more. This became pronounced near station 244+00. Workers pushed the mesh down flat with shovels behind both tires of the paver to alleviate the problem. Placement of the HMA was accomplished in half the time for test sections 2.1N, 2.2N and 2.3N compared with the southbound section done the previous day.

The next day, August 14, PaveTrac was placed in test section 1.3S beginning at the south end and proceeding north. After reasonable success having been achieved in section 2.3N, essentially the same procedure was repeated: (i) trackless tack was applied at a rate of 0.06 gal/sq. yd.; (ii) the mesh was placed with a tractor equipped with a device to hold the roll; (iii) the mesh was rolled with the rubber tire roller; (iv) Qwick Seal tape was placed in four rows with the paper backing left on and then rolled again with the rubber tire roller; (v) paper backing was not peeled off the tape; and (vi) numerous Hilti fasteners were driven at random. Figure 6.4 shows more efficient and successful installation of PaveTrac following this protocol.

HMA overlay began with the PaveTrac section and proceeded south. The pavement temperature was 122 to 133^0 F and the HMA was 316^0 F. In the first 40 ft, the PaveTrac began to wrinkle and this short length was abandoned. The north 40 ft of test section 1.3S was reconstructed with no reinforcement, using a 1.5 in. HMA overlay only. The work in the remainder of the test section proceeded satisfactorily, with workers having to push down wrinkles with shovels. While compacting the pavement with the steel wheel roller, the mesh protruded at station 173+64. The laying process was improved significantly by adding more Hilti fasteners along the edges of the PaveTrac mesh.

The pavement temperature was 143^0 F when the section was completed at 1:00 pm. One hour was required to place the HMA layer in this section. A nuclear density measuring device was used to analyze the spongy areas of the section. The relative density was found to be 91.6 as compared to 96 at an adjacent section.

The following day, August 15, the PaveTrac section 1.3S was inspected. Transverse cracks were observed in the area where the reinforcement had protruded to the surface (Figure 6.5). The spongy HMA area exhibited a network of hairline cracks at Station 172+70 (Figure 6.6). On August 15, 2008, the PaveTrac was placed in the last of its four test sections, section 1.3N, installing from south to north. For this final effort, a few more changes were made to the procedure: in addition to the tack coat, five rows of Qwick Seal tape and many more Hilti fasteners were used. The fasteners were placed at a rate of about one per square yard to secure the mesh to the road. The contractor stopped placement of the material 25ft short of the north end of the section, with the end of the material at station 174+75, to provide an area of transition to the ARMI section.

The 1.5 in. asphalt overlay work began at 10:00 am at the south end of section 1.1N and proceeded north. The pavement temperature was 115 to 120^0 F. The additional fasteners performed as desired, holding the PaveTrac to the road surface with virtually no wrinkles arising during installation (Figure 6.8).

As a postscript on the PaveTrac installation, it was realized during the installation that the material had been unrolled incorrectly. The manufacturer's instructions stated to unroll the material from the top of the roll so that the natural curvature would be toward the road surface. As can be seen in Figure 6.1, the PaveTrac was instead unrolled from the bottom of the roll so the curvature would face up. This practice was corrected as shown in Figure 6.9 and this may have contributed to the better success with the later sections.

Figure 6.1: PaveTrac Installation, Section 2.3S

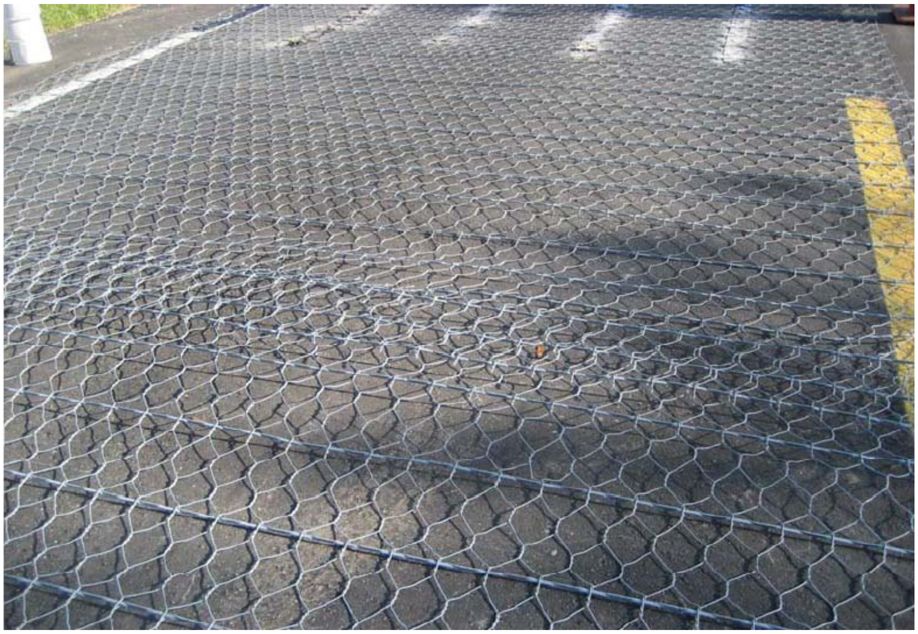


Figure 6.2: PaveTrac in Place, Showing a Transverse Overlap

Figure 6.3: PaveTrac Mesh Curling under the Paver Tires

Figure 6.4: PaveTrac being Rolled with Qwick Seal Tape in Place

Figure 6.5: Transverse Cracks in PaveTrac Section 1.3S

Figure 6.6: Hairline Cracks in PaveTrac Section 1.3S, ST 172+70

Figure 6.7: Rough Surface of 2.3S after 24 hours due to PaveTrac Curling

Figure 6.8: Additional Fasteners Resolve Wrinkles under Wheels

Figure 6.9: PaveTrac Mesh being Unrolled Correctly

Figure 6.10: Six Inch Overlap of Material at Center of Road

6.3 FIBERGLASS MESH: GLASGRID 8511

The first section of GlasGrid, 2.2S, was placed after the PaveTrac on August 12. The GlasGrid material incorporated a self-adhesive backing feature, and this greatly improved the ease of installation as compared to the PaveTrac. Before placing the reinforcement material, a coating of trackless tack NTSS-1HM was applied to the broom-swept pavement surface at a rate of 0.06 gal/sq. yd., same as for the PaveTrac. The tack coat was allowed to cure for about one hour, with the color changing from brown to black. A special fixture attached to a tractor, shown in Figure 6.11, was used to simultaneously unroll the material and press it to the tack-coated pavement surface. The GlasGrid mesh was narrower, requiring two passes to cover one lane with overlap near the center of the lane. Two passes of a rubber tire roller were then used to help secure the mesh to the road. The GlasGrid installation was successful; the self-adhesive backing together with the other steps taken kept the material in place during the placement of the 1.5 in HMA overlay. Placement of the overlay was completed without reported issues. On August 14 and 15, placement of the material in section 1.2S and 1.2N had a minor additional challenge because of the road curvature. This necessitated that mesh be cut and jointed with overlapping joints periodically. There was no issue in placing the HMA.

Figure 6.11: Special Fixture used to Place GlasGrid

6.4 PETROGRID 4582

In terms of ease of installation, the PetroGrid reinforcement was in between the difficult PaveTrac and the relatively easy GlasGrid. For the PetroGrid material, a different tack coat was used: a bituminous tack PG 22-64 applied at a rate of 0.25gal/sq.yd. The emulsion trackless tack was sprayed on the shoulders. The reason for the difference in the tack coat was that the bituminous tack was intended to impregnate the non-woven fabric backing of the PaveTrac and provide a good bond to the road surface. Therefore the fabric was placed immediately after the tack coat, before the tack could cure. This necessitated a stop-and-go installation procedure.

The same fixture shown in Figure 6.11 was used to unroll and press down the PetroGrid as the GlasGrid. This placed the material with minimum wrinkles. When occasional wrinkles occurred with sufficient severity, the material was slit and laid flat by hand. The installation report noted that the fiberglass mesh of the PetroGrid had separated from the fabric in a number of places, totaling approximately 10% of the total area (Figure 6.12).

For the first section on which PetroGrid was placed, 2.1S, the surface temperature was about 130^0 F when the work began on the HMA overlay. The high temperature and relatively soft bitumen tack coat combined to cause the material to slip and wrinkle under the wheels of the paver. The PetroGrid was occasionally cut and re-laid to repair the wrinkles. Also, workers pressed down the mat with their feet and shovels with partial success (Figure 6.13). Some success also was found by spreading HMA in front of the two wheel paths as shown in Figure 6.14. The overlapped joints of the material also presented problems in keeping the material flat. The tractive force applied by the paver tires tended to peel the fiberglass mesh off of the nonwoven fabric layer. At station 232+70, a tear appeared in the PetroGrid and this was buried in the HMA.

The extra work required by both the PaveTrac and PetroGrid sections caused the HMA overlay work on August 12 to consume three hours total for the 1500 ft of pavement. On August 13, the PetroGrid section was the first installation of the day because work started at the south end, station 232+00, of test section 2.1N. The same procedures were used as on the previous day, and the cooler morning temperatures allowed the material to stay in place better under the wheels of the construction vehicles. The fiberglass mesh however continued to separate from the fabric layer (Figure 6.14).

During the placement of the HMA on test section 2.1N, the cooler 109^0 F surface temperature was again beneficial. The bitumen tack coat impregnated the fabric as intended and kept it bonded to the road surface. The material remained more stable with fewer wrinkles and less separation of the fiberglass mesh. On occasion, the material rolled up behind the wheels of the paver due to adhesion to the wheels, but it was pressed back down using a shovel. Placing HMA in front of the paver wheels again helped. The lower temperature turned out to be the key to success for installing the PetroGrid and placing the HMA overlay. For use in Florida, that may be a significant consideration.

PetroGrid was again the first reinforcement placed on August 14, as work started at the south end of section 1.1S (station 160+00). The same procedures were again used, and the primary problem reported continued to be separation of the fiberglass mesh from the fabric. Two transverse overlaps were required in the section, placed at stations 162+20 and 164+40. During placement of the HMA, the PetroGrid wrinkled at several locations, notably severe at stations 163+20 and 161+50. The construction traffic continued to separate the mesh from the fabric. Both separations and wrinkles in the PetroGrid can be seen in the fabric extending from under the HMA layer in Figure 6.16.

The final section of PetroGrid was 1.1N, placed from south to north on August 15. The same procedures were used and the same issues persisted. Temperatures were somewhat higher, 115 to 120^0 F on the pavement surface, when the HMA was placed on the section beginning at 10:00 am. The overlay was completed satisfactorily however with only occasional wrinkles appearing and extending for three to four inches.

Figure 6.12: PetroGrid Mesh Separating from the Fabric

Figure 6.13: Pressing Down Wrinkles in the PetroGrid Mesh by Walking on it

Figure 6.14: HMA Spread before the Paver Wheels

Figure 6.15: PetroGrid Mesh Separating due to Construction Traffic

Figure 6.16: Wrinkles and Separations in the PetroGrid Material

6.5 CONSTRUCTION PROCESS SUMMARY

Primary issues encountered during the installation of the pavement reinforcements and resolutions for each are summarized as follows:

	Issues	Resolutions
PaveTrac:		
	i) keeping the mesh flat on the pavement	place numerous fasteners
		unroll the material from the top
GlasGrid:	no serious issues encountered	
PetroGrid:		
	i) Keeping the mesh flat on the pavement	lower surface temperatures
	ii) Separation of the fiberglass mesh from the nonwoven fabric	no resolution found during construction; materials issue suspected

The research team recommended the use of longer or threaded fasteners to better secure the PaveTrac. Also a different bituminous tack coat should be used for the PetroGrid that provides better adhesion at the pavement temperatures actually encountered in the field. Finally, it was noted that keeping the reinforcement material flat on the pavement during installation and subsequent overlaying with asphalt was the critical issue for successful installation. Table 6.1 summarizes specific instances of issues noted in the construction report that are identified by a particular location. This may be useful for reference while interpreting the long term performance results.

Table 6.1: Specific Instances of Issues with Reinforcement

Station	Section	Material	Issues Noted
161+50	1.1S	PetroGrid	Severe wrinkle
162+20	1.1S	PetroGrid	Transverse overlap
163+20	1.1S	PetroGrid	Severe wrinkle
164+40	1.1S	PetroGrid	Transverse overlap
172+70	1.3S	PaveTrac	Spongy HMA area; lower density indicated less compaction; hairline cracks
173+64	1.3S	PaveTrac	Wrinkle in mesh protruded above 1.5in structural HMA course; transverse cracks
174+60 – 175+00	1.3S	PaveTrac	No reinforcement material placed
174+75 – 175+00	1.3N	PaveTrac	No reinforcement material placed
232+70	2.1S	PetroGrid	Tear in the reinforcement material
243+60 - 243+20	2.3S	PaveTrac	40ft had to be removed and reinstalled twice

CHAPTER 7

Post-construction Tests and Data Analysis

7.1 INTRODUCTION

Following the reconstruction of SR15/US98 in the Fall of 2008, two series of Post-construction tests were conducted, the first two of a long-term performance evaluation and monitoring program. The first series was conducted six month after the reconstruction project in March 2009, while the second series was conducted in April, 2010, approximately eighteen months after the reconstruction project. Similar to the pre-construction tests, the post-construction tests (beginning with the 6-month series) included the FWD tests, rutting measurement, ride quality and the crack survey, following the same experimental protocols in all 24 test sections. The primary goals of the post-construction tests were to:

i. Establish the conditions of the pavement after reconstruction to form a baseline against which future performance will be measured.
ii. Compare the pre-construction and post-construction data to determine if there is any benefit derived from pavement reinforcement, and to quantify the benefit; and
iii. Set up the framework for a life cycle analysis as more performance data become available in the future.

7.2 SIX-MONTH POST-CONSTRUCTION TESTS

For the newly paved road, the surface looked very smooth and intact, and, therefore, rut and crack surveys were carried out sparingly. What collected in six months was a full set of FWD measurements. No cracks were visible, and a few rut measurements revealed either no rut or a depression of less than 0.06 in, and were considered negligible. Thus the six months of traffic on the road had not caused any measurable damage anywhere in the test locations including the controls sections. Figure 7.1 shows the vastly improved road surface at station 155+00, the south end of test Location 1.

7.2.1 FWD Test Data

Every effort was made to conduct each FWD measurement as was practical at the same spots as for the pre-construction tests. The bronze permanent markers and signage had been placed to mark the test sections, and the locations of these were verified as matching the pre-construction survey datum. The measurements were made every 50ft beginning at station 155+25. As in the pre-construction tests, the Dynatest deflectometer applied a 9000 lb nominal load, and acquired deflections, actual applied load and pavement temperature at each test location. The FWD tests and visual survey of the road were completed in about five working hours. The raw test data, as well as normalized and temperature-adjusted values, are given in Appendix 3. Figure 7.2 summarizes the FWD data for both test locations, expressed as ISM values adjusted for temperature.

7.2.2 <u>Preliminary Observations</u>

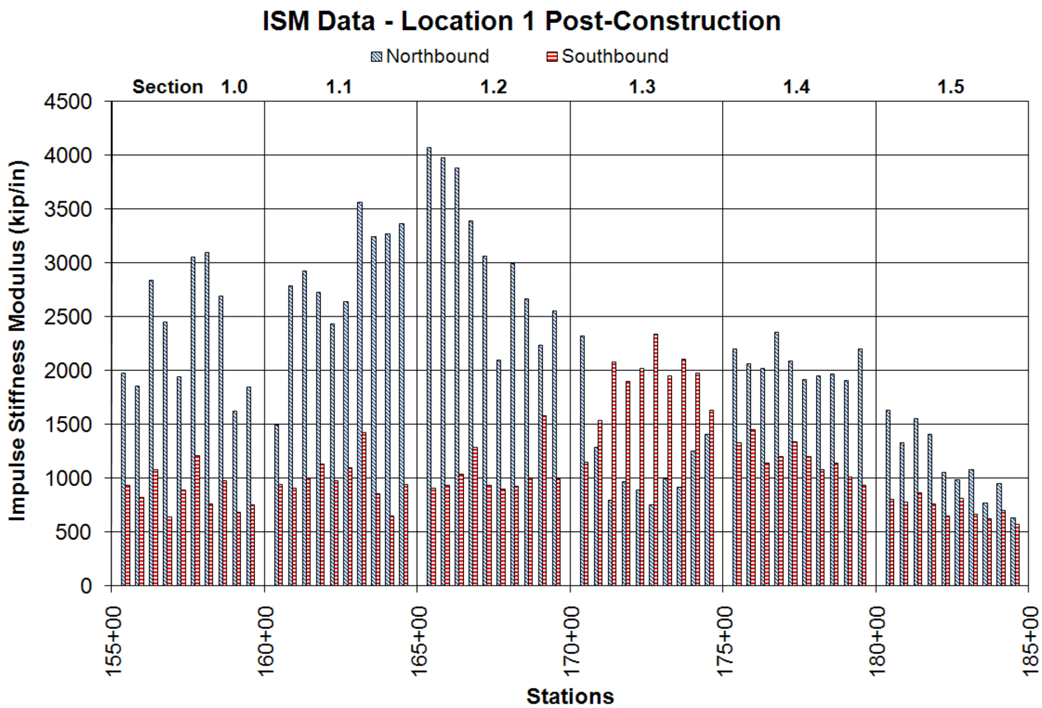
The data in Figure 7.2 show more consistent stiffness values at test Location 2 than Location 1, similar to the trends observed in pre-construction tests. Location 2 again

Figure 7.1: Smooth Road Surface on the Day of the 6-month Post-construction Tests

exhibited more consistency both from section to section and between the northbound and southbound lanes. Location 1 exhibited more uniform stiffness in the southbound lane, with section 1.3S a relative outlier with greater stiffness. The southbound lane of Location 1 was again shown to be generally less stiff than the northbound lane, holding true for all sections except 1.3. The data also showed that that the northbound lane of Location 1 had relatively high average stiffness in sections 1.0, 1.1, 1.2, and to a lesser degree, in 1.4. The relative weakness of control section 1.5, in both lanes but more notably in the STL, as well as the relative weakness of both lanes of section 2.5 can also be readily seen. All these results were consistent with the pre-construction tests; the observable trends were perhaps even more pronounced in the post-construction data. The post-construction tests and visual inspection established the baseline conditions of the rehabilitated pavement. The visual inspection indicated no cracks of any kind in the travel lanes and no reportable rutting. Thus the baseline condition at the beginning of the long term performance test period was excellent, as expected. The FWD tests indicated that the structural stiffness of the roadway had clearly increased due to the rehabilitation. Interestingly, the spatial trend in the pre-construction data was carried over to the post-construction data, with their relative scales perhaps magnified. These benefits are quantified in the following sections.

7.2.3 <u>Data Analysis: General</u>

The analysis presented here uses the same methods employed in the analysis of pre-construction data described earlier. While the methods are the same, the following distinction between the two analyses is emphasized: the pre-construction analysis compared the test sections to one another using data taken at the same point in time. The purpose of the pre-construction data analysis was to establish relative consistency of the test sections and recognize sections in which the conditions were significantly different. By contrast, the analysis of this chapter compares each section only with itself using two sets of data taken at different points in time, before and after reconstruction. The purposes of the post-construction data analysis are to (i) quantify the changes that occurred during the reconstruction; (ii) determine whether the changes are statistically significant; and (iii) compare the changes in the test sections to those of the control sections to determine if there are discernable differences



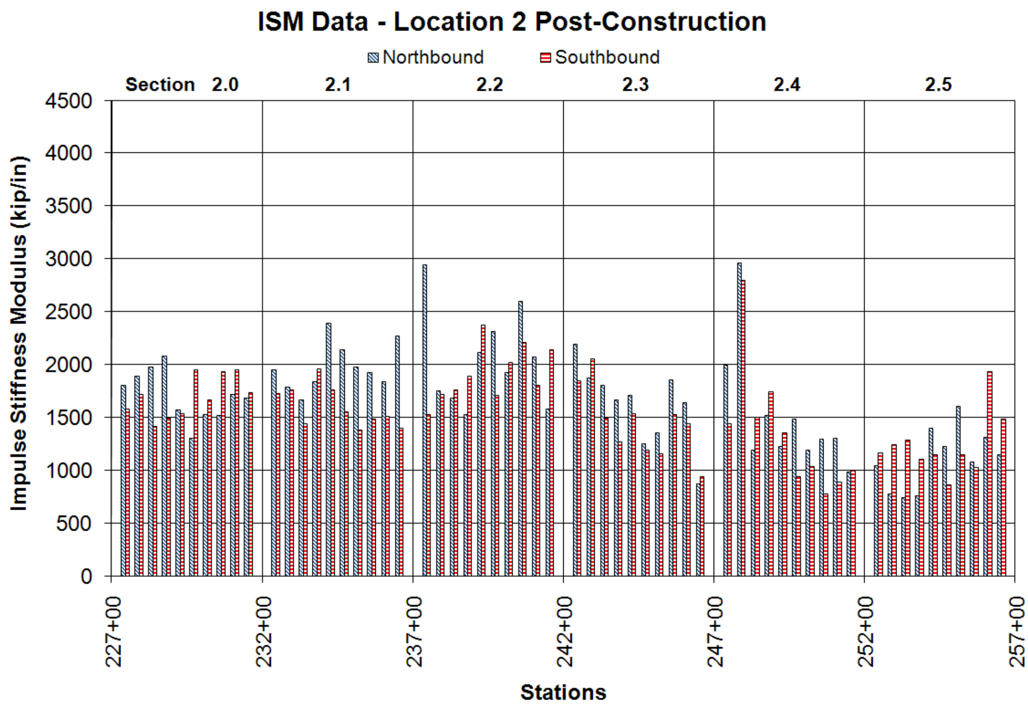
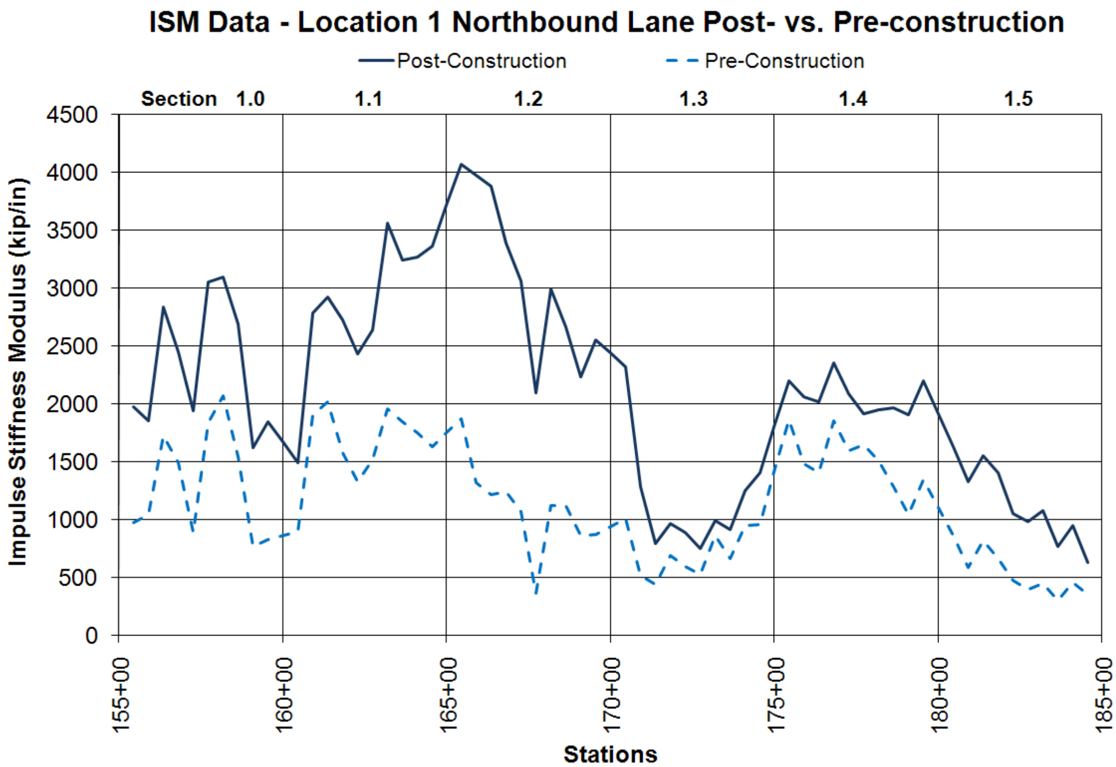


Figure 7.2: 6-month Post-construction FWD Data for Locations 1 and 2

Prior to the analyses, the post-construction FWD data was adjusted for actual temperatures at each data point using the same methods as for the pre-construction data. This removed a major environmental variable and made the data sets directly comparable. Figures 7.3 and 7.4 plot the post-construction and pre-construction FWD data, displayed as temperature-adjusted ISM values, for each lane in each test location to clearly show the changes due to the rehabilitation. Reviewing the data displayed in these figures, several characteristics immediately stand out. Notable first is the clear matching of peaks, valleys and trends in the two plots of each of the charts. The matching of the data for each lane in each location is despite the data being separated by 17 months of continuous traffic, as well as the significant reconstruction work done on the roadway. Local maxima and minima occur at virtually the same locations along the abscissa in all of the test sections, and in many instances the increasing and decreasing trends seen in the pre-construction and post-construction data also match. This provides a degree of confidence that the post- and pre-construction FWD data sets can be readily compared to one another, and that FWD measurements are reliable and repeatable. Second, for the majority of stations, the post-construction stiffness is clearly greater than the pre-construction. Only in a few areas were the post construction ISM values lower than the pre-construction values, most prominently around station 180+00 of Location 1, southbound lane. Third, it appeared to the research team that there was an apparently greater separation between the two plots in the test sections employing geogrid reinforcements as compared to the control and ARMI sections. This observation initiated the “delta mean” analysis described in the next section.



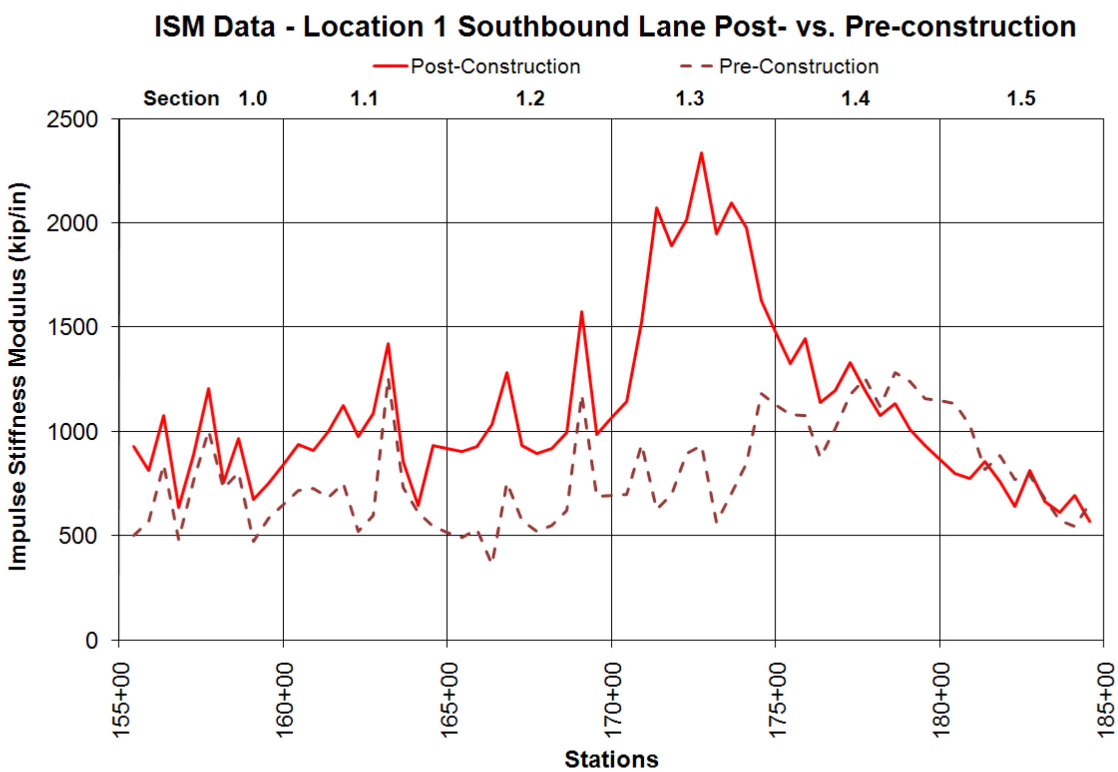
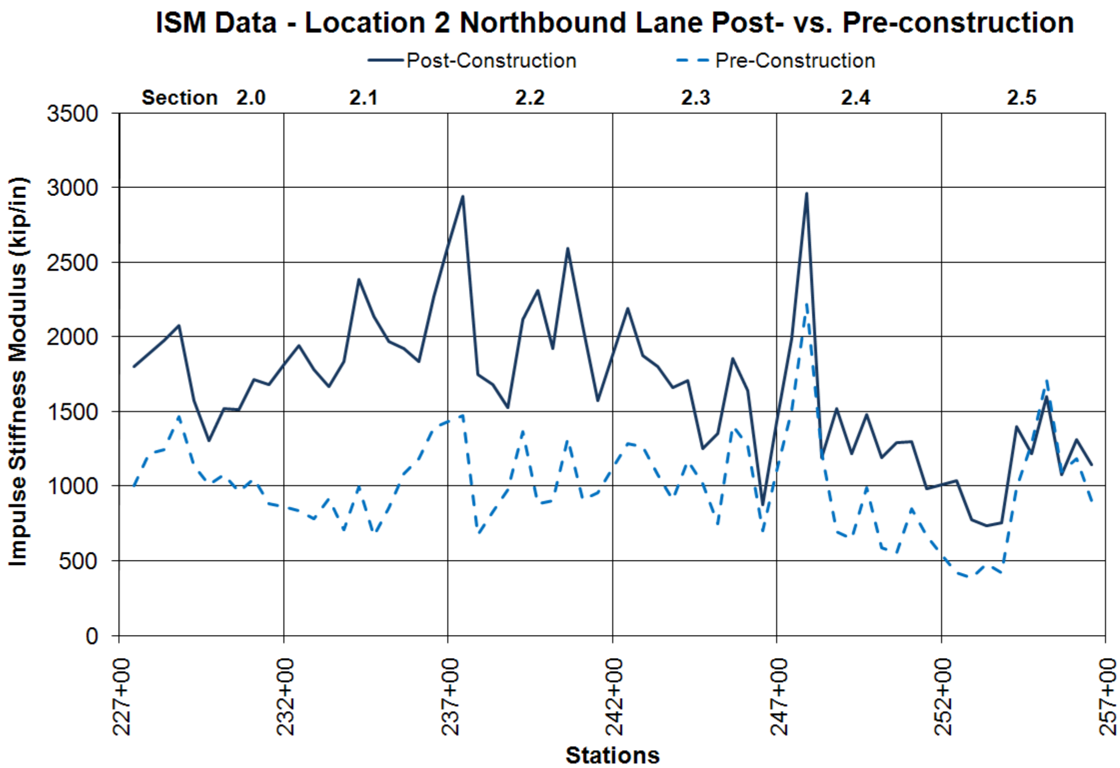


Figure 7.3: ISM Data for 6-month Post- versus Pre-construction, Location 1



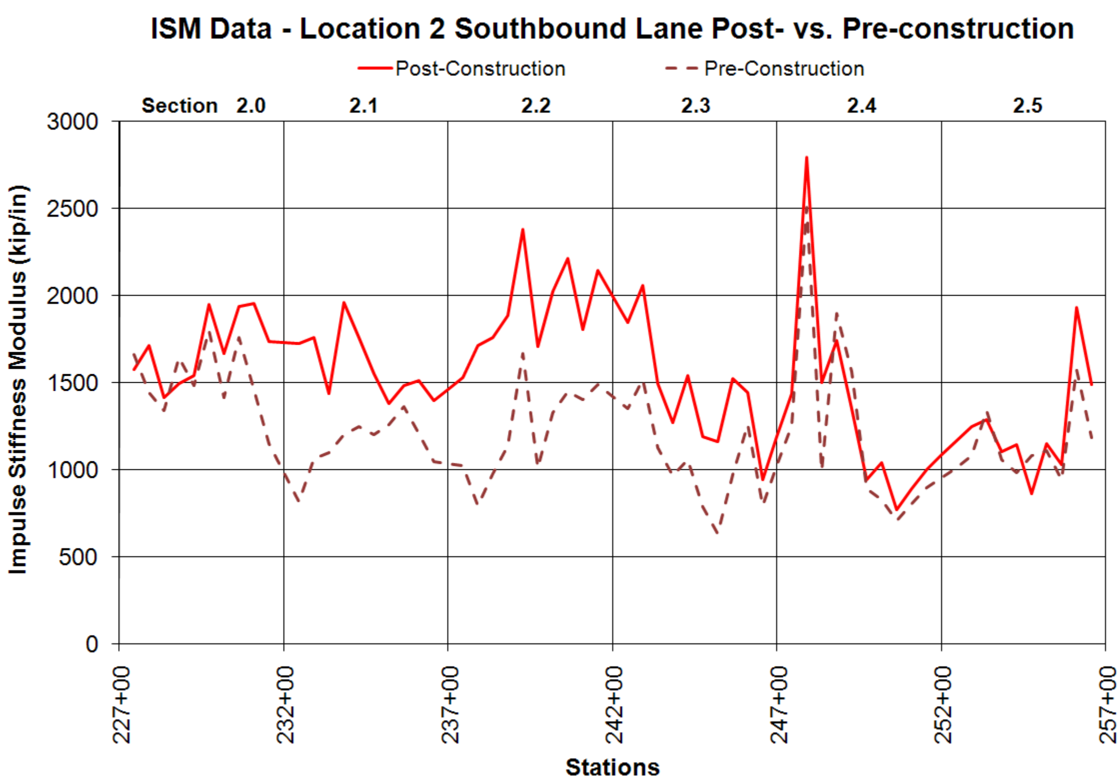


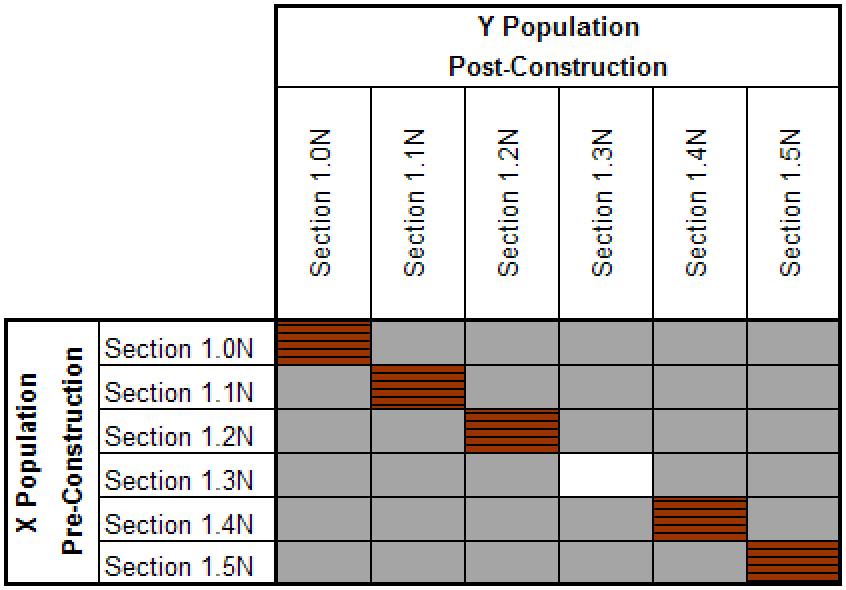
Figure 7.4: ISM Data for 6-monthPost- versus Pre-construction, Location 2

7.2.4 Data Analysis: Statistical

To determine if the changes in ISM values in each section were statistically significant, F-tests and t-tests were used to compare each section against itself, post-construction versus pre-construction. The procedures used were identical to those of the pre-construction analysis, only the x and y population sets were selected differently. In all the F- and t-tests, the x population was the pre-construction data and the y population was the post-construction data.

Figures 7.5 and 7.6 present the results of the statistical analysis graphically in matrix format. The red, horizontally hatched cells on the diagonals indicate that the post-construction ISM values in that test section were greater than the pre-construction values to a statistically significant degree. White cells indicate no statistical difference (the post-construction data sets were similar to the pre-construction data). Had any of the post-construction data sets been significantly weaker than the pre-construction data then the cells would have been green. No such cases occurred. Comparison of post-construction FWD test results with pre-construction results shows that PetroGrid, GlasGrid and PaveTrac reinforcement improved the pavement stiffness in 11 out of 12 test sections (95% confidence level). By contrast, only three of eight control sections showed statistically significant improvement in stiffness.

Location 1 Northbound Lane



Location 1 Southbound Lane

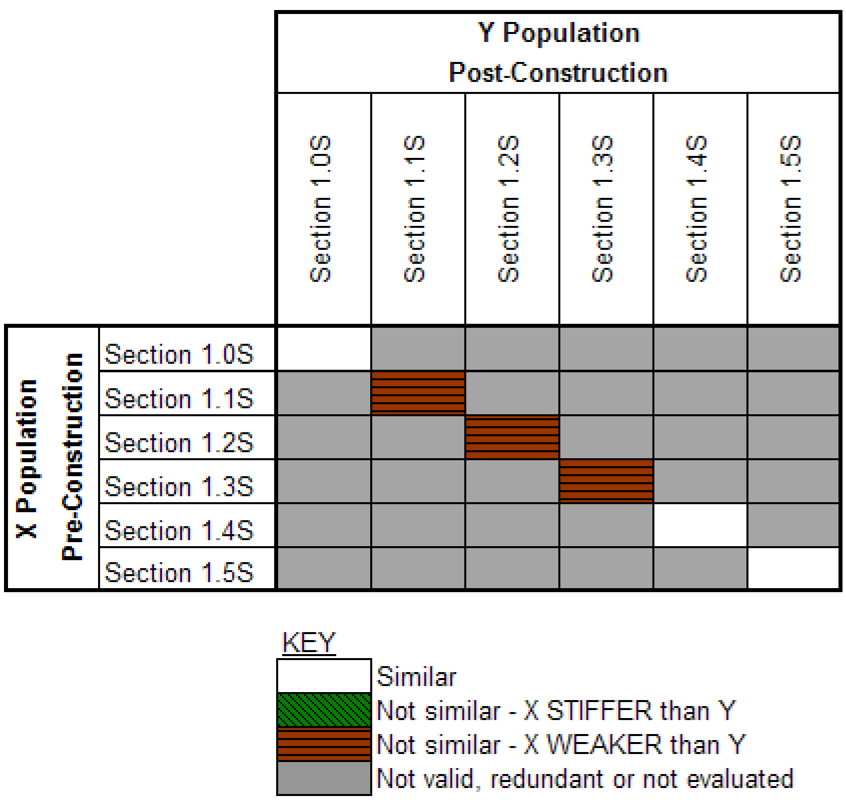
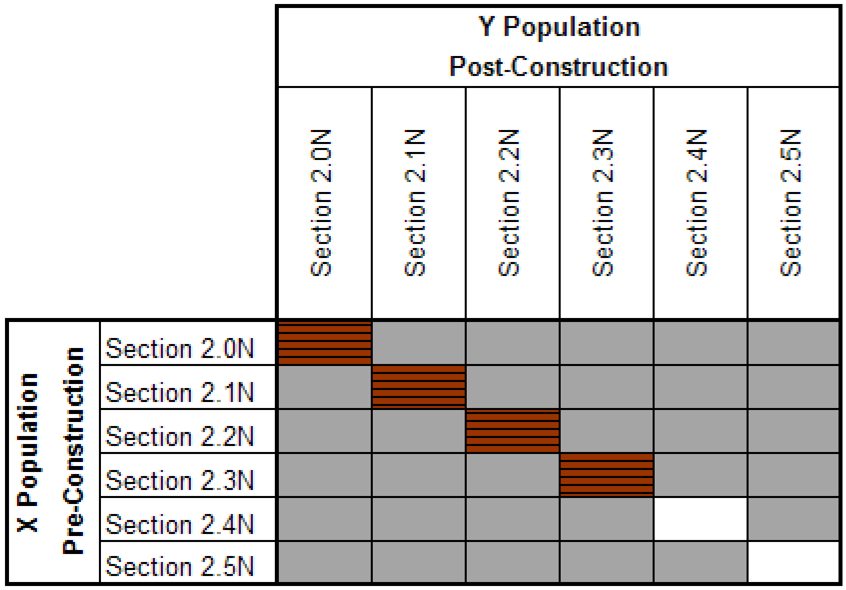


Figure 7.5: t-test Summary Matrices, Post- versus Pre-construction, Location 1

Location 2 Northbound Lane



Location 2 Southbound Lane

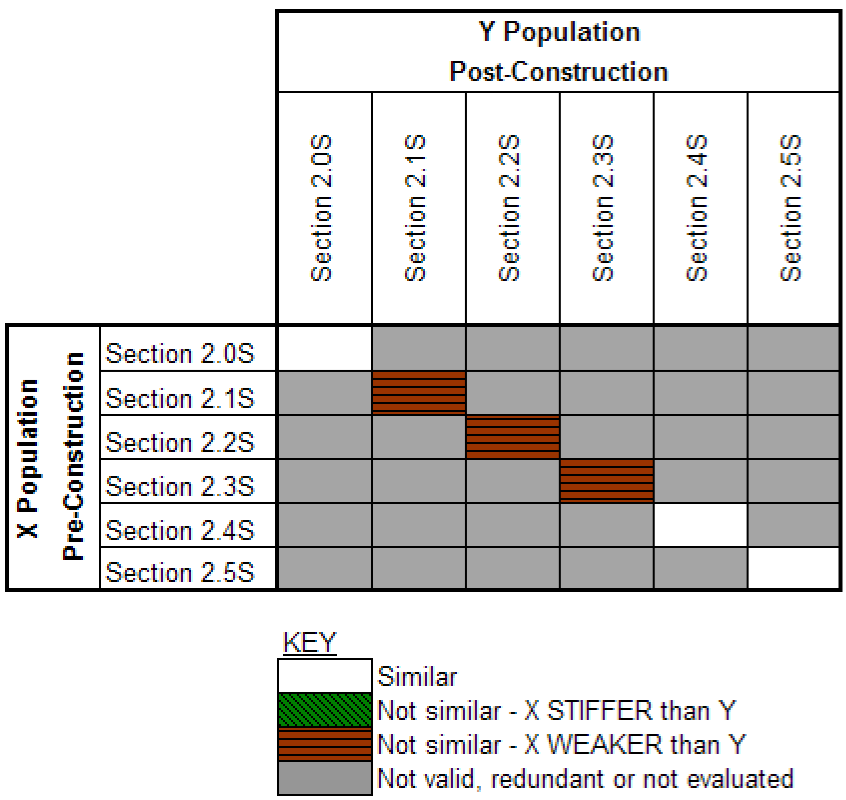


Figure 7.6: t-test Summary Matrices, Post- versus Pre-construction, Location 2

7.2.5 Contribution of Reinforcing Products

In order to isolate and quantify the contribution of the reinforcement materials alone in the overall improvement of pavement stiffness, the following methodology was developed:

1. The mean of the ten ISM values in each section was found for both the post- and pre-construction measurements and designated as follows:

   $ISM_{M\text{-}POST}$ = the mean ISM value for a section (post-construction)

   $ISM_{M\text{-}PRE}$ = the mean ISM value for a section (pre-construction)

2. The difference in the mean ISM value post-versus pre-construction was found and designated as ΔISM_M:

   $$\Delta ISM_M = ISM_{M-POST} - ISM_{M-PRE} \qquad (7.1)$$

   Thus ΔISM_M is the increase in mean ISM due to reconstruction.

3. The ΔISM_M values for the two control sections in each lane of each test location were averaged and designated $\Delta ISM_{M\text{-}C}$. Therefore,

   $\Delta ISM_{M\text{-}C}$ = average increase in mean ISM for two control sections

   $\Delta ISM_{M\text{-}R}$ = increase in mean ISM for one reinforced test section

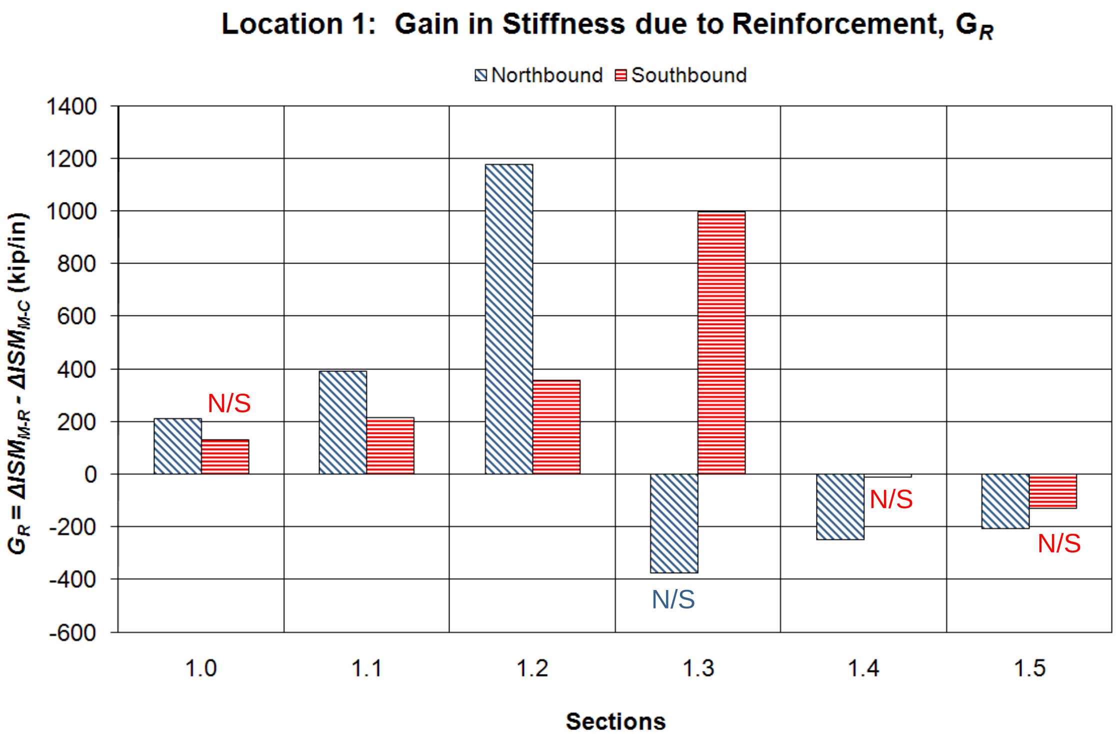
4. The difference between the Δ ISM_M for each section and the average of the two ΔISM_M values for the two control sections in the same lane and test location is calculated. This is a direct comparison of the change in stiffness of each test section compared with the average change in stiffness of the corresponding control sections. For example, if $\Delta ISM_{M\text{-}R}$ and $\Delta ISM_{M\text{-}C}$ represent the ΔISM_M according to equation 7.1 for a reinforced and the control section, respectively, then the actual "gain" in stiffness due to reinforcement alone = ($\Delta ISM_{M\text{-}R}$ -

$\Delta ISM_{M\text{-}C}$). So the actual gain in stiffness due to reinforcement alone, $G_{R,}$ would be found as:

$$G_R = \Delta ISM_{M-R} - \Delta ISM_{M-C} \qquad (7.2)$$

The results of this analysis are presented in Figure 7.7. Note that all G_R data is relative to a baseline, that is the average change in ISM values in the control sections in that lane and location, $\Delta ISM_{M\text{-}C}$. The values shown for the control sections 1.0, 1.5, 2.0 and 2.5 are shown for reference; by definition the G_R values in the two control sections in the same lane of a test location will be equal and opposite. The values for the control sections are presented in the graph only to show which control section had the greater change in stiffness, as well as their relative magnitudes. Note also that the charts for Location 1 and Location 2 have different scales on the ordinate for clarity. The "N/S" markings for certain columns indicate that the change in stiffness in that section was not statistically significant.

Figure 7.7 shows that in case of all three reinforcing materials used in test sections 1, 2 and 3, the increase in pavement stiffness was both statistically significant and greater than the average change in the two related control sections (true for 11 out of 12 sets of data). The ARMI sections showed either a nonsignificant increase in ISM or had a "negative" change (or decline in stiffness values) compared to that of control sections. The increase in stiffness observed with three reinforcing grids, however, was more pronounced and statistically significant than that observed by the other researchers (Cafiso and Di Graziano, 2007).



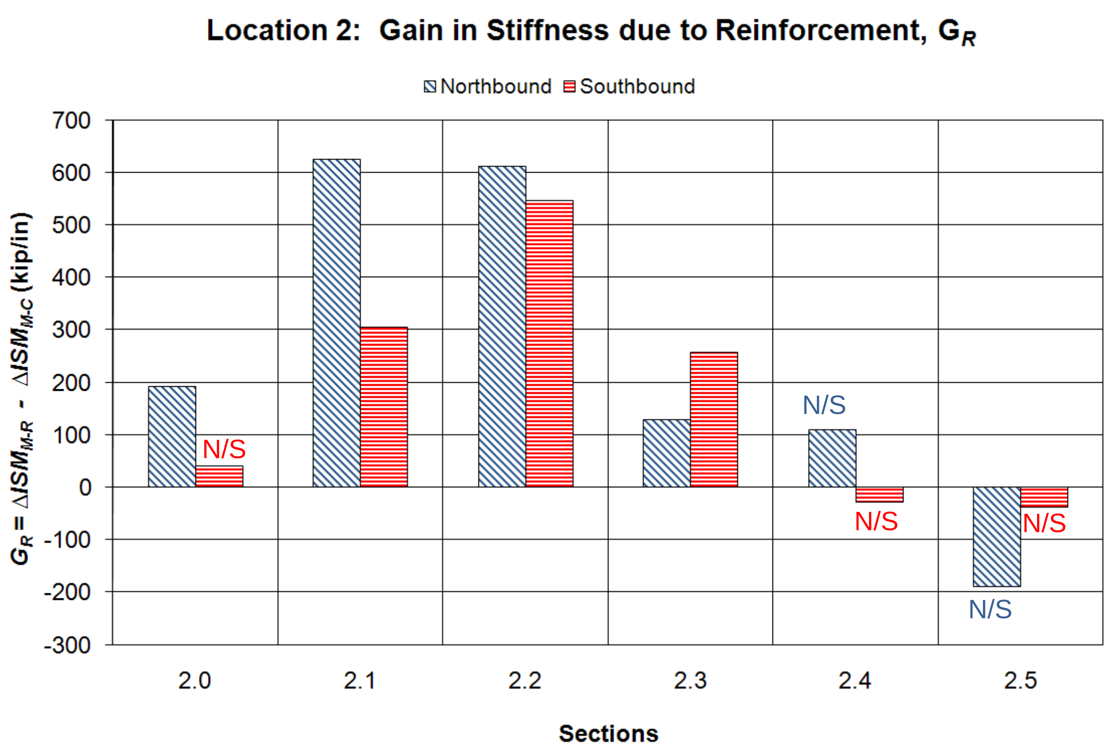


Figure 7.7: Gain in Stiffness due to Reinforcement

7.2.6 Comparison of Deflection Basins

Figures 7.8 and 7.9 show the average deflection basins in each test section for both pre-construction and post construction stages along northbound and southbound travel lanes at Location 1 and 2, respectively. Results indicate (i) noticeable improvement in pavement stiffness due to new overlay construction (compare solid and dotted curves), but only marginal increase in ARMI sections; (ii) the curvature of the deflection basins in two sites conform to the F_{org} values of the respective locations (elaborated later); and (iii) all reinforced sections outperform the corresponding control sections.

7.2.7 Relationship Between F_{org} and ISM

Figure 7.10 shows the mean values of the ISM for all test sections, both for pre and post construction stages. It was expected that Location 2 (with lower F_{org}) would be stiffer than Location 1 (with higher F_{org}), and the following observations are made: (i) at the pre-construction stage, the two-lane average at Location 2 (= 1110kN/mm) is higher than the two-lane average at Location 1 (= 942kN/mm). Similar comparison at post-construction stage shows that the mean ISM at Location 1 (1604kN/mm) is nearly equal to mean ISM at Location 2 (1598kN/mm); and (ii) though the comparison of the overall ISM between the two sites agrees with their respective F_{org} values, a lane-wise comparison between the two sites showed a mixed result in that southbound lanes showing an inverse relation while the northbound lanes practically showing no difference. Three other observations confirm that the pavement foundation behaves in a manner inversely proportional to the F_{org} values. They are: (i) the concavity (upward) of the deflection basins in Figures 7.8 and 7.9 tend to show larger curvature in sections of Location 1 as compared to those of

Location 2; (ii) the test sections in Location 2 show consistent deflection basins suggesting a relatively uniform and, therefore, a robust pavement foundation; and (iii) based on the FWD data presented in Appendix 5, the average subgrade M_r (36-inch) of test Location 1 (17,634 psi) was lower than the average M_r at Location 2 (21,794 psi).

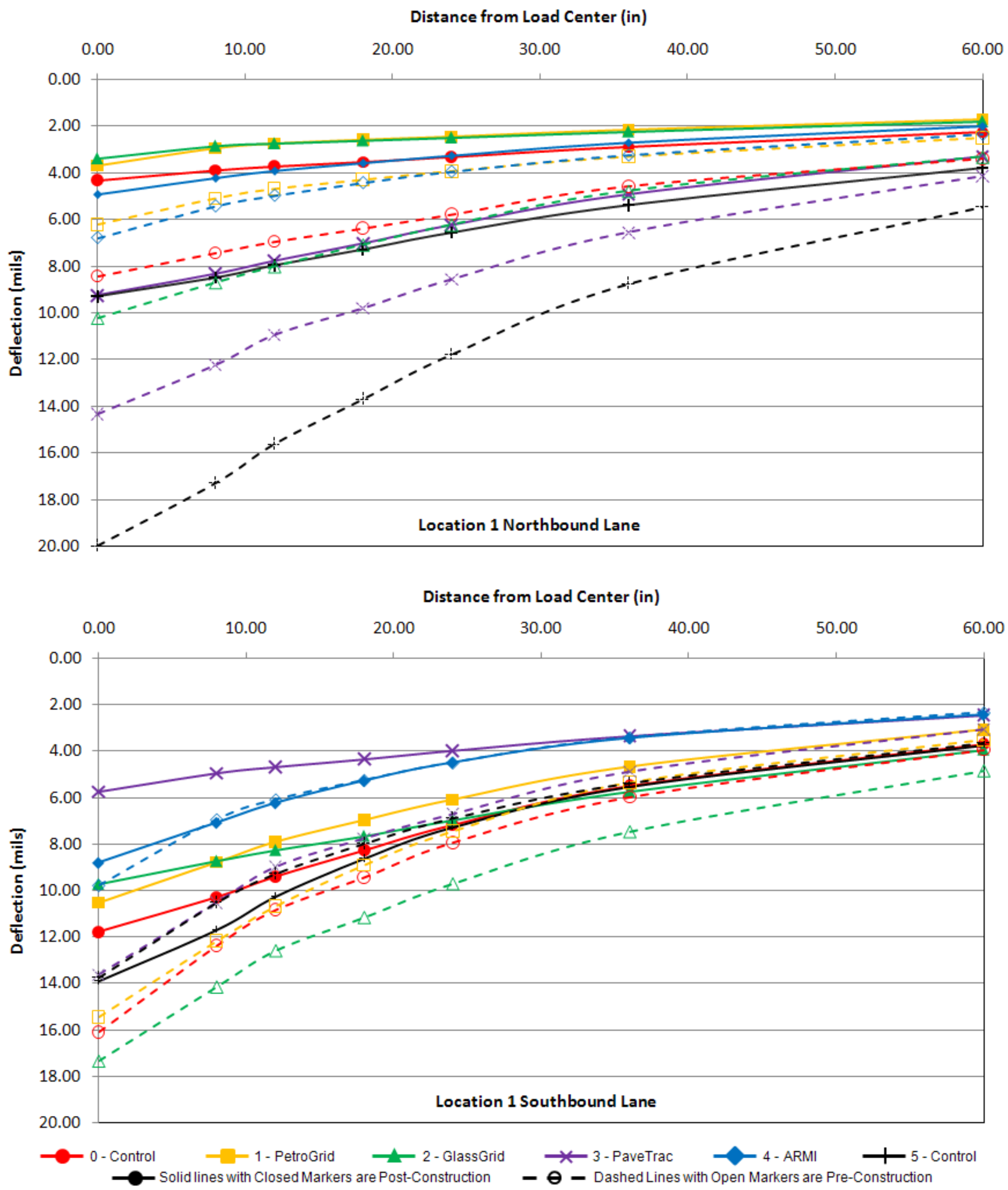


Figure 7.8: Analysis of average deflection basins at Location 1

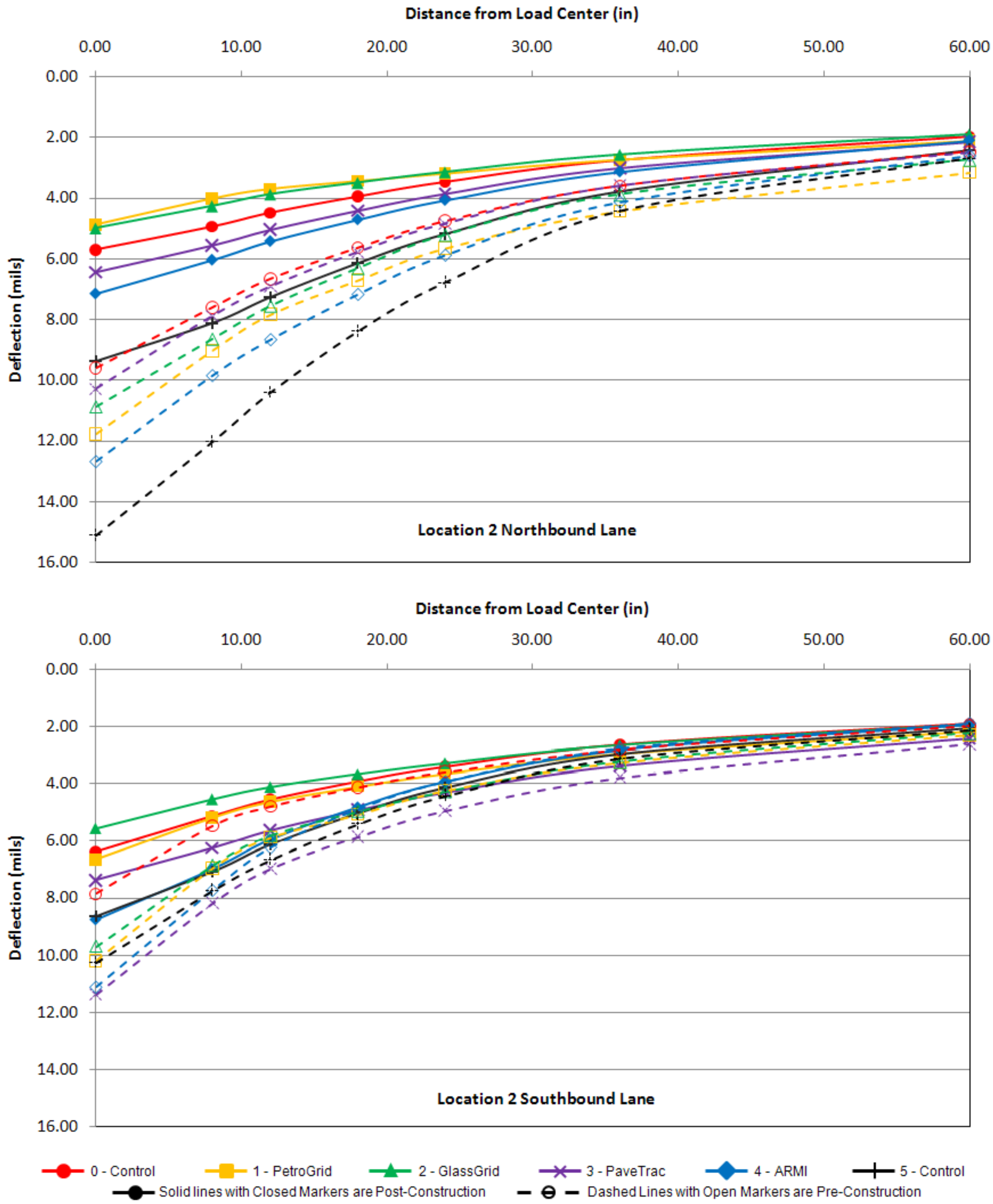


Figure 7.9: Analysis of average deflection basins at Location 2

Test Location 1

Pre-construction

Station: 155+00 160+00 165+00 170+00 175+00 180+00 185+00

← STL	Lane Avg.	775						← STL
	Section Avg.	664	700	618	793	1102	773	
→ NTL	Lane Avg.	1110						→ NTL
	Section Avg.	1286	1600	1079	707	1465	525	
	Section:	1.0	1.1	1.2	1.3	1.4	1.5	

Post-construction

Station: 155+00 160+00 165+00 170+00 175+00 180+00 185+00

← STL	Lane Avg.	1109						← STL
	Section Avg.	868	987	1043	1862	1177	716	
→ NTL	Lane Avg.	2100						→ NTL
	Section Avg.	2331	2839	3086	1152	2060	1133	
	Section:	1.0	1.1	1.2	1.3	1.4	1.5	

Test Location 2

Pre-construction

Station: 227+00 232+00 237+00 242+00 247+00 252+00 257+00

← STL	Lane Avg.	1215						← STL
	Section Avg.	1513	1147	1224	1043	1231	1134	
→ NTL	Lane Avg.	1006						→ NTL
	Section Avg.	1104	941	1028	1084	994	887	
	Section:	2.0	2.1	2.2	2.3	2.4	2.5	

Post-construction

Station: 227+00 232+00 237+00 242+00 247+00 252+00 257+00

← STL	Lane Avg.	1537						← STL
	Section Avg.	1695	1593	1912	1443	1345	1237	
→ NTL	Lane Avg.	1660						→ NTL
	Section Avg.	1703	1974	2048	1620	1512	1105	
	Section:	2.0	2.1	2.2	2.3	2.4	2.5	

Figure 7.10: The mean ISM values in all test sections

7.3 EIGHTEEN-MONTH POST-CONSTRUCTION TESTS

The second series (18-month) of nondestructive tests using the FWD, and pavement rut measurements were conducted at the SR15 test locations in April 2010. As with the previous 6-month tests, FWD tests and rut measurements were conducted at every 15.2m

(50 ft) in each lane, compiling ten deflection- and ten rut-measurements per test section. In-depth statistical analysis of the FWD data was accomplished using t-tests at a 99% confidence level. The *Impulse Stiffness Modulus* (ISM) was again used as a direct quantitative measurement of pavement response when subjected to FWD loading. The deflections under the center of the load plate were adjusted to a reference asphalt temperature of 20^0 C (68^0 F), as described previously.

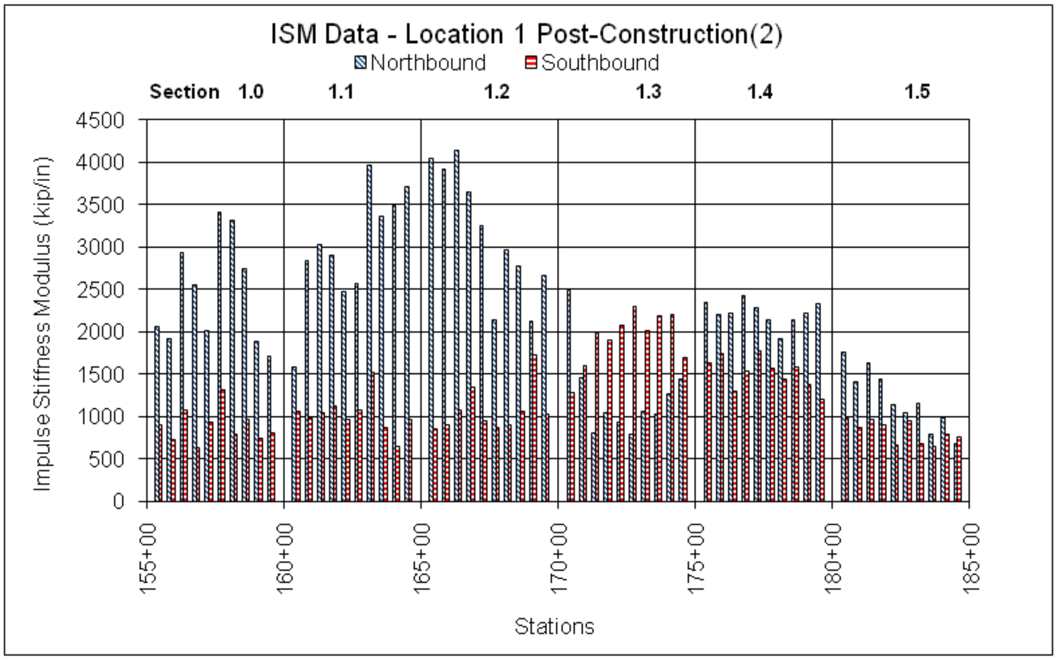
7.3.1 FWD Test Data: General

Figure 7.11 shows the post construction histogram for ISM for Northbound and Southbound directions. Figures 7.12 and 7.13 show comparisons among pre-construction, 6-month post-construction, and 18-month post-construction data. Some general conclusions from the test data are as follows:

1. 18-month ISM is practically the same as 6-month ISM. The difference, if any, is slight increase in 18-month ISM, but not statistically significant (discussed later). The slight improvement may be attributed to the new 4.5 in AC layer undergoing slight compaction under heavy wheels. This is pretty much supported by the fact that minor rutting was measured during the 18-month tests compared to no measurable rutting observed during the 6-month tests.
2. One observation recorded after the 6-month test was that PaveTrac section NB in Test Location 1 was relatively weaker than that of the other NB sections, especially PetroGrid and GlasGrid. However, the same PaveTrac in the SB lane had comparable or better ISM value. In view of the fact the same trend had been

observed in PaveTrac NB and SB sections during 18-month tests, it can be concluded that the NB PaveTrac section encountered some construction issues. If an average value of PaveTrac NB and SB sections is compared with PetroGrid and GlasGrid, all three reinforcements show ISM improvement during 6 and 18 month tests.

3. ARMI section during 6-month tests showed practically no change in ISM compared to pre-construction test results. A small increase, though statistically not significant, in ISM value was observed during 18-month tests. This slight increasing trend could be attributed to the ARMI layer (in addition to AC layer) undergoing slight compaction under heavy traffic load. The uniform size aggregate of ARMI could be the reason for this additional compaction. Note that improvement is not observed in test Location 2.



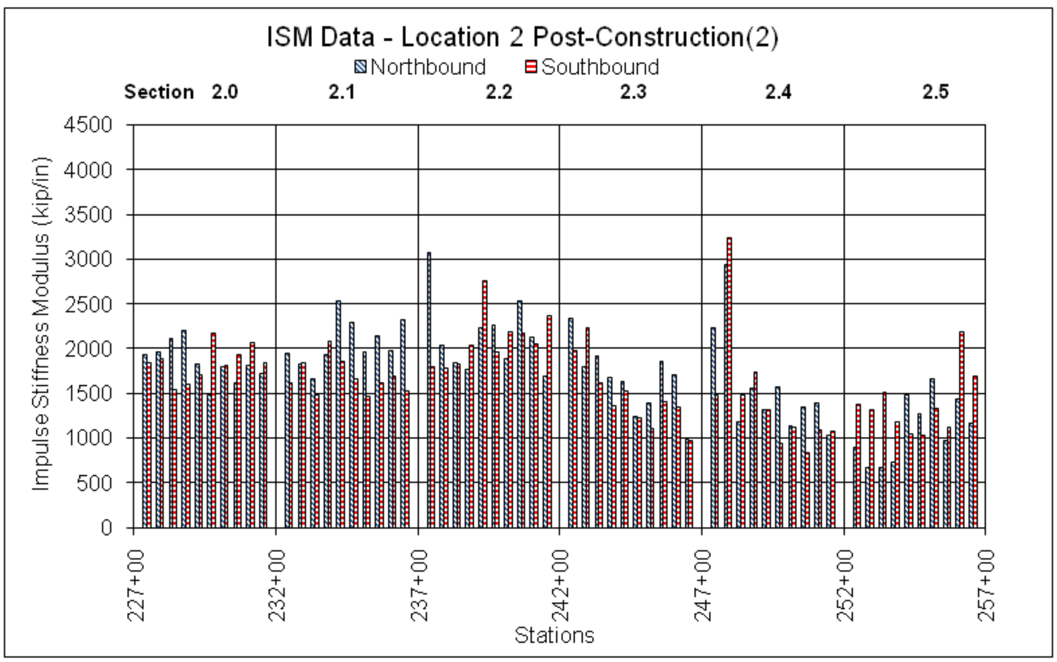
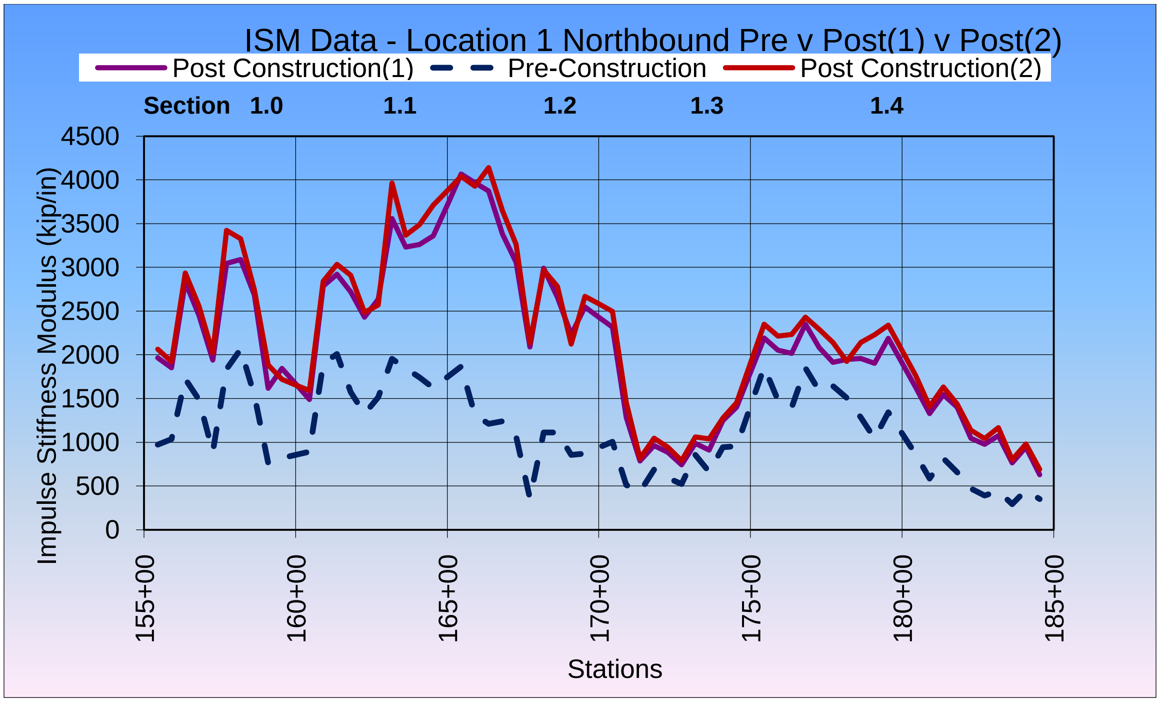


Figure 7.11: ISM Values for 18-Month Post-construction Tests



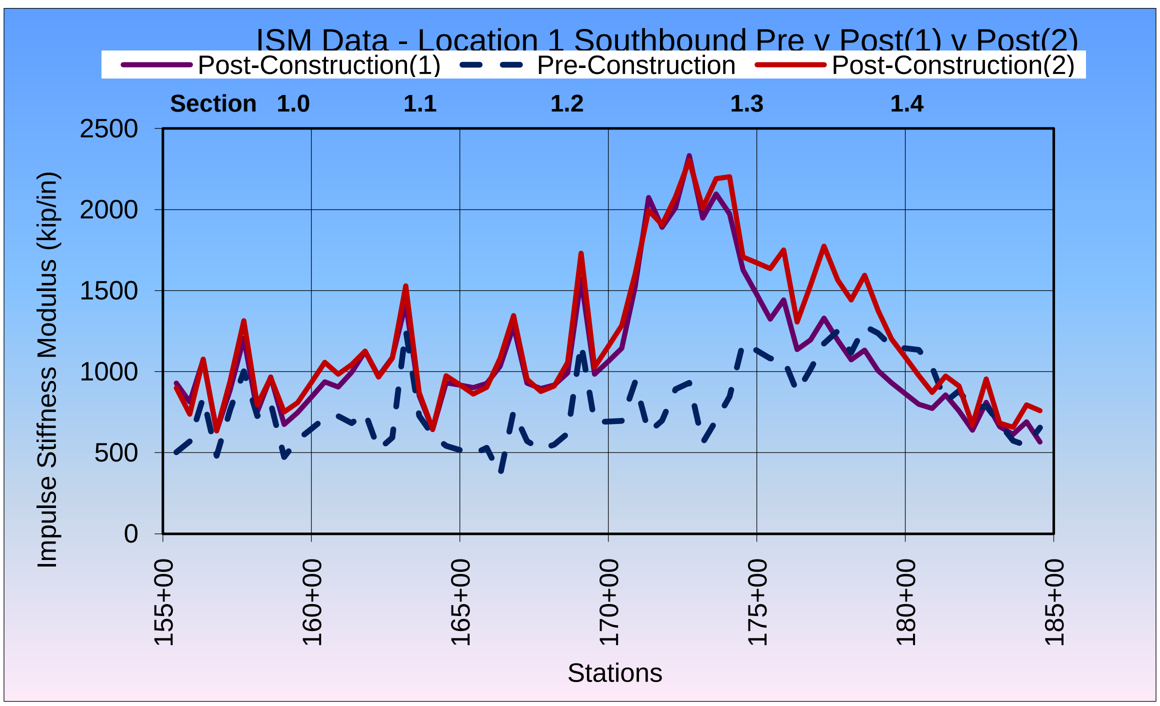
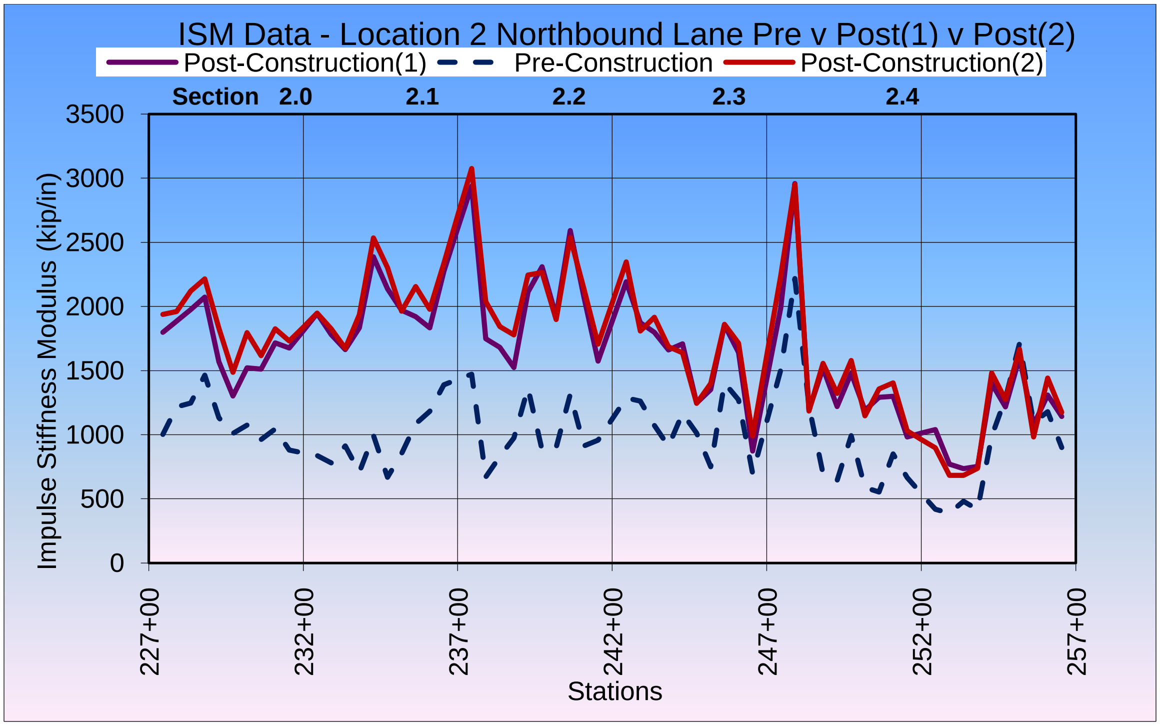


Figure 7.12: Comparison of Pre-construction and Post-construction (6-month and 18-month) ISM data for Location 1



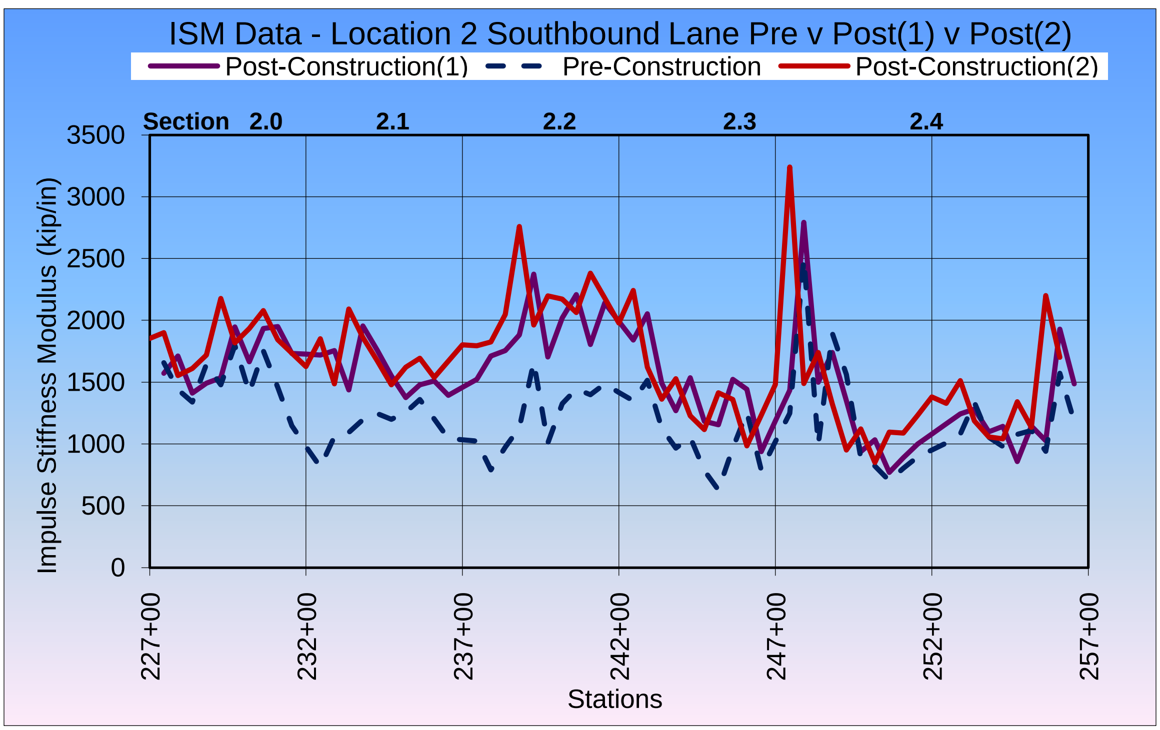


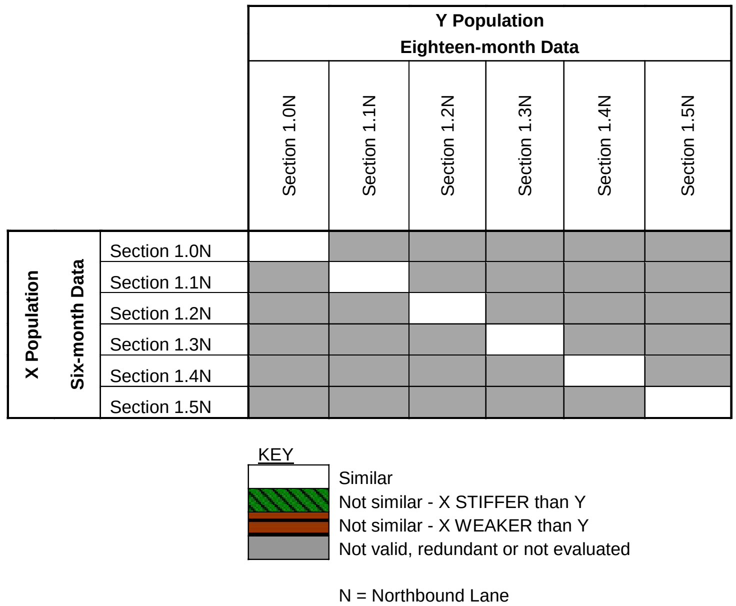
Figure 7.13: Comparison of Pre-construction and Post-construction (6-month and 18-month) ISM data for Location 2

7.3.2 Data Analysis: Statistical

Using the post-construction data, two types of statistical analysis were carried out:

1. To determine if the changes in ISM values in each section were statistically significant, F-tests and t-tests were used to compare each section against itself for the 6-month and 18-month post-construction data. The procedures used were identical to those of the pre-construction analysis, except that the x population represented 6-month post-construction data, and the y population represented the 18-month post-construction data. These results, presented in Figures 7.14 and 7.15, show that statistically there was no difference between the stiffness data obtained six month and 18 month after the reconstruction. In other words, there was no measurable deterioration due to 12 months of traffic.
2. To evaluate how each section is performing relative to the other sections 18 months after construction, both the ISM and rut measurements of each section was statistically compared to every other section in the same lane. Results are presented graphically in Figure 7.16. As expected (based on previous data trends and F_{org}), most sections in Location 2 are performing in a statistically similar way to each other, while in Location 1, performance of several sections are found to be statistically dissimilar, most likely as a consequence of highly variable underlying organic layers.

ISM Data t-Test Comparisons Summary
Location 1: Northbound



ISM Data t-Test Comparisons Summary
Location 1: Southbound

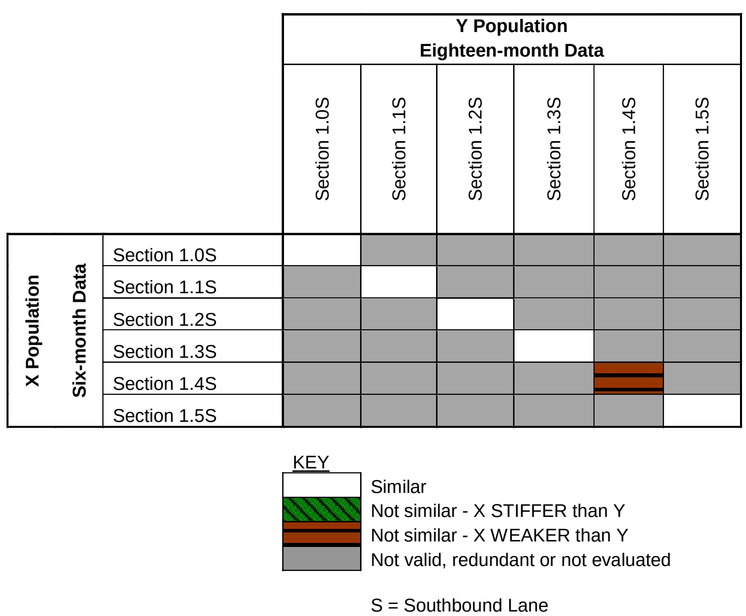
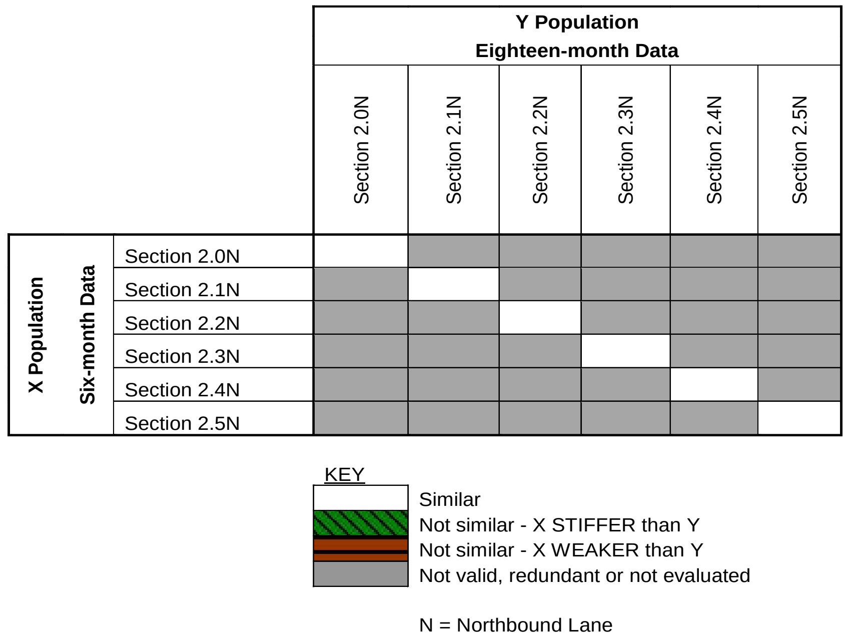


Figure 7.14: Statistical Comparisons of 6-month and 18-month Data for Location 1

ISM Data t-Test Comparisons Summary
Location 2: Northbound



ISM Data t-Test Comparisons Summary
Location 2: Southbound

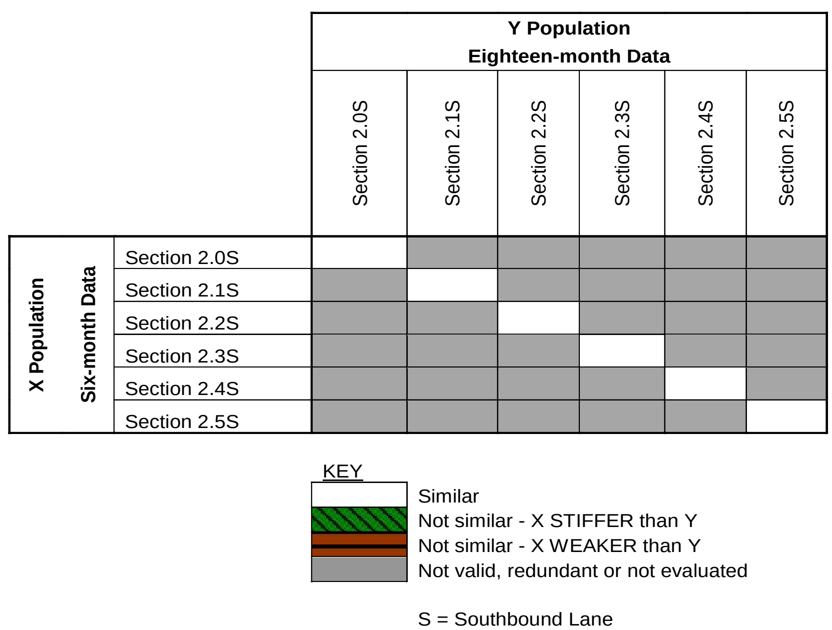


Figure 7.15: Statistical Comparisons of 6-month and 18-month Data for Location 2

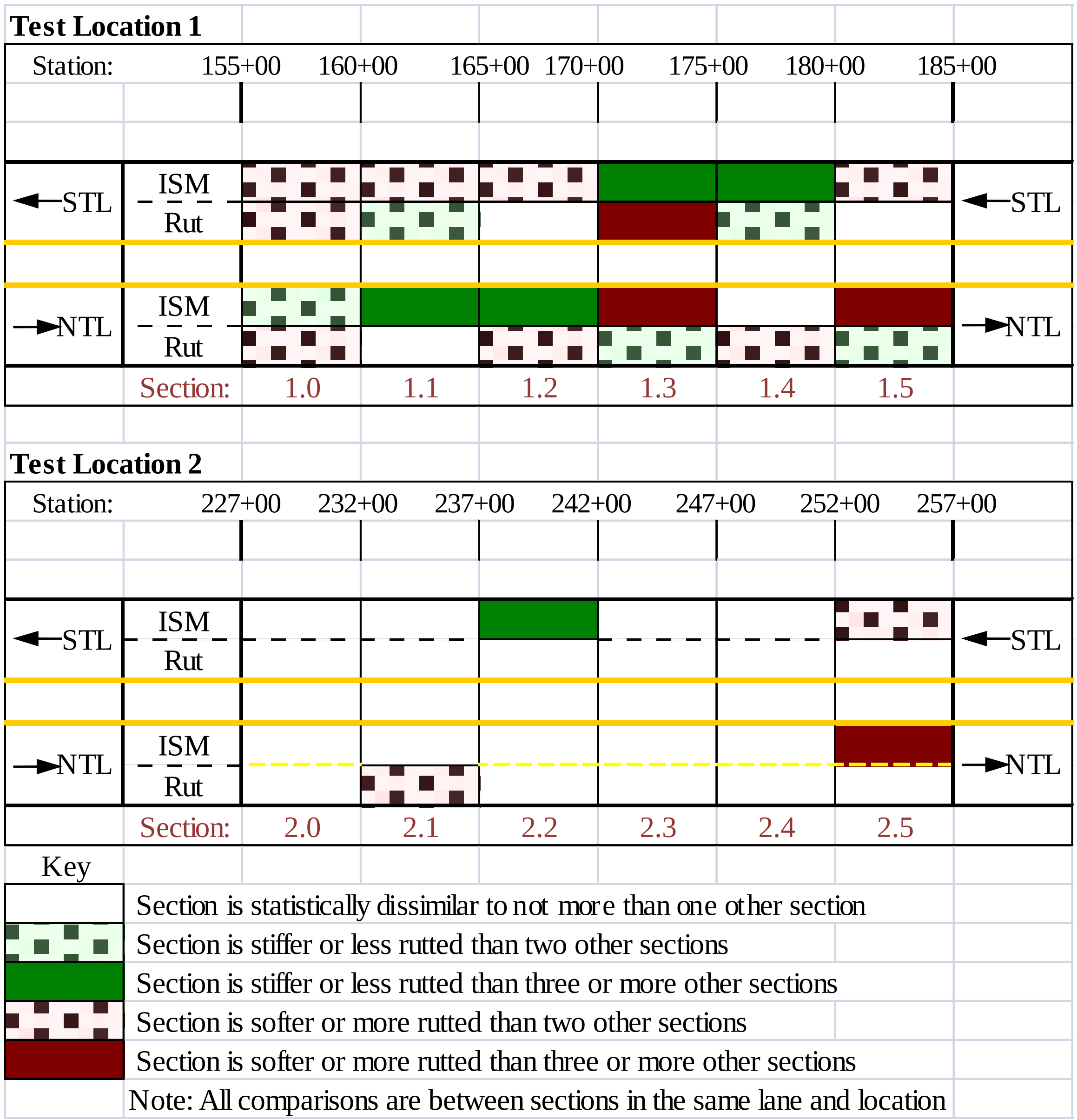


Figure 7.16: Relative Performance Comparison based on 18-month Data

7.3.3 Analysis of Deflection Basins

Figures 7.17 and 7.18 show the average deflection basins in each test section for both pre-construction and post construction (18-month) stages along northbound and southbound travel lanes at Location 1 and 2, respectively. Results indicate the following:

1. Noticeable improvement in pavement stiffness due to the construction of reinforced overlays (compare solid and dotted curves)
2. The curvature of the deflection basins in two sites conform to the F_{org} values of the respective locations (elaborated previously); and
3. All reinforced sections outperformed the corresponding control sections.

7.3.4 Relative Performance of Reinforcing Products

Based on the data analysis protocol described in Section 7.2.5, the individual contributions of the reinforcing materials, also termed the *Gain in Stiffness due to Reinforcement*, G_R (Equation 7.2), was calculated with the 18-month FWD data. Figure 7.19 shows the variations of G_R for all reinforced test sections to date (incorporating both six and eighteen month test data) in order to evaluate the relative performance of reinforcing products, and also to determine any changes (loss or gain) over time. Keeping in mind that the pavement structure is still in its early life cycle, only limited conclusions/observations are valid, as listed below:

1. In case of all test sections, the increase in stiffness due to reinforcement (G_R), from introducing the three reinforcing materials, was statistically significant. The ARMI sections showed either a non-significant increase in ISM or had a "negative" change (or decline in stiffness values) compared to that of control sections.
2. Noting that the vertical scales are different for Locations 1 and 2 in Figure 7.19 (needed for clarity), the reinforcements were significantly more effective in Location 1, which has a weaker and more variable subsurface condition (higher F_{org}). This confirms the well-known fact that certain amount of displacement

(movement) is needed to fully realize the reinforcing effects owing to geosynthetic inclusions. And, since Location 1 is in general “softer,” and tended to deform more, the contributions from the reinforcements to the pavement structural capacity is more pronounced.

3. Determining the relationship between performance and reinforcement type (a desired goal of this study) is complicated due to the presence of and interaction with highly variable subsoil conditions. It is too early to make any reasonable predictions about future trends from the limited available data, however, continued evaluation of the test sections for a few more years along with a Life Cycle Cost Analysis would indeed lead to the selection of promising reinforcement. With the long-term data analyzed, design and construction guidelines could be developed for the promising reinforcement.

7.3.5 Rut, Ride and Crack Data

Crack, Rut and Ride measurements were conducted for both 6-month and 18-month tests. As expected, no rutting or cracking were observed at 6 months, while some measurable cracking and insignificant rutting were observed at certain spots after 18 months. Appendix 6 presents these data to establish a baseline for all 24 test sections.

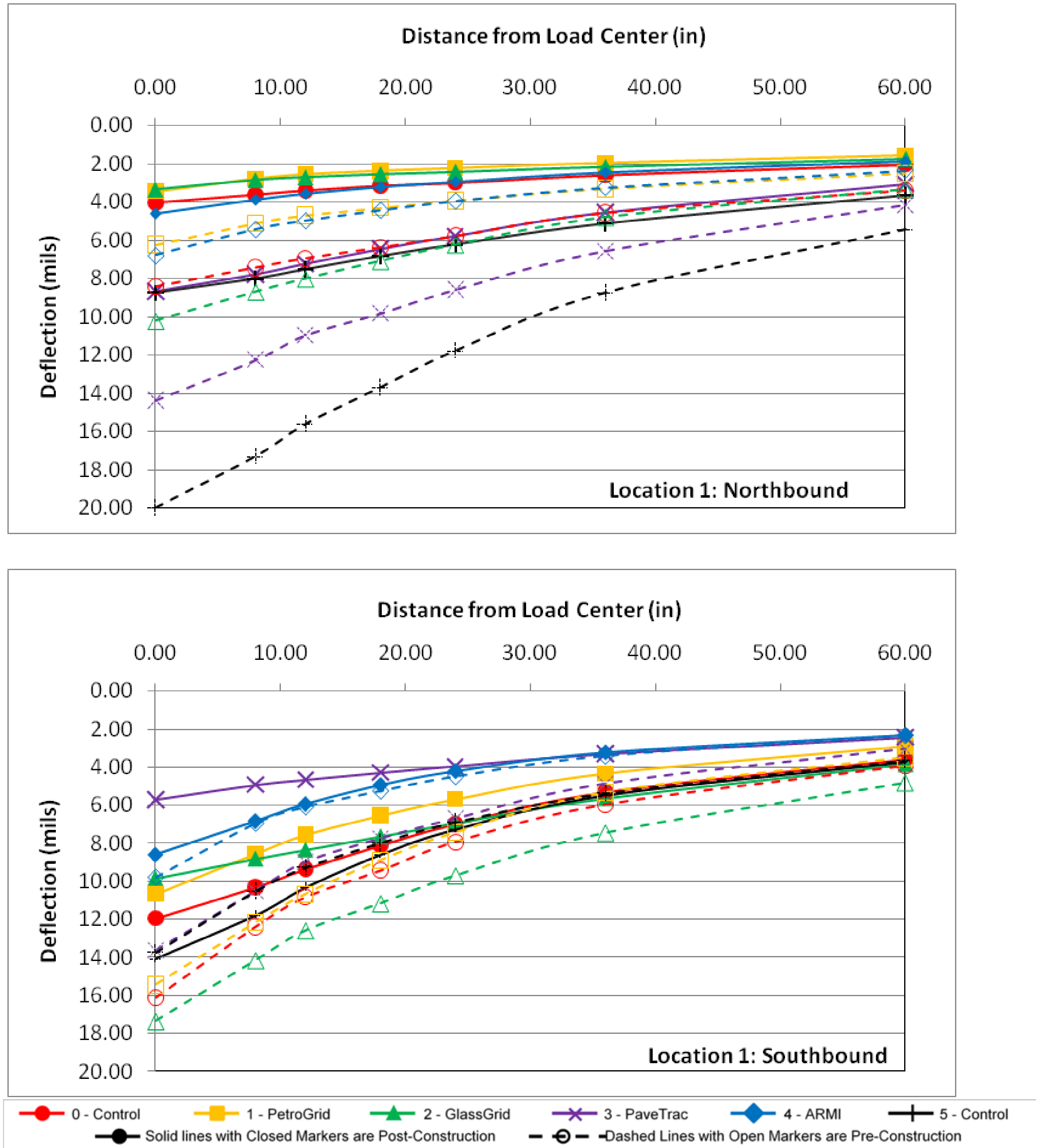


Figure 7.17: Pre-construction and 18-month Deflection Data (Location 1)

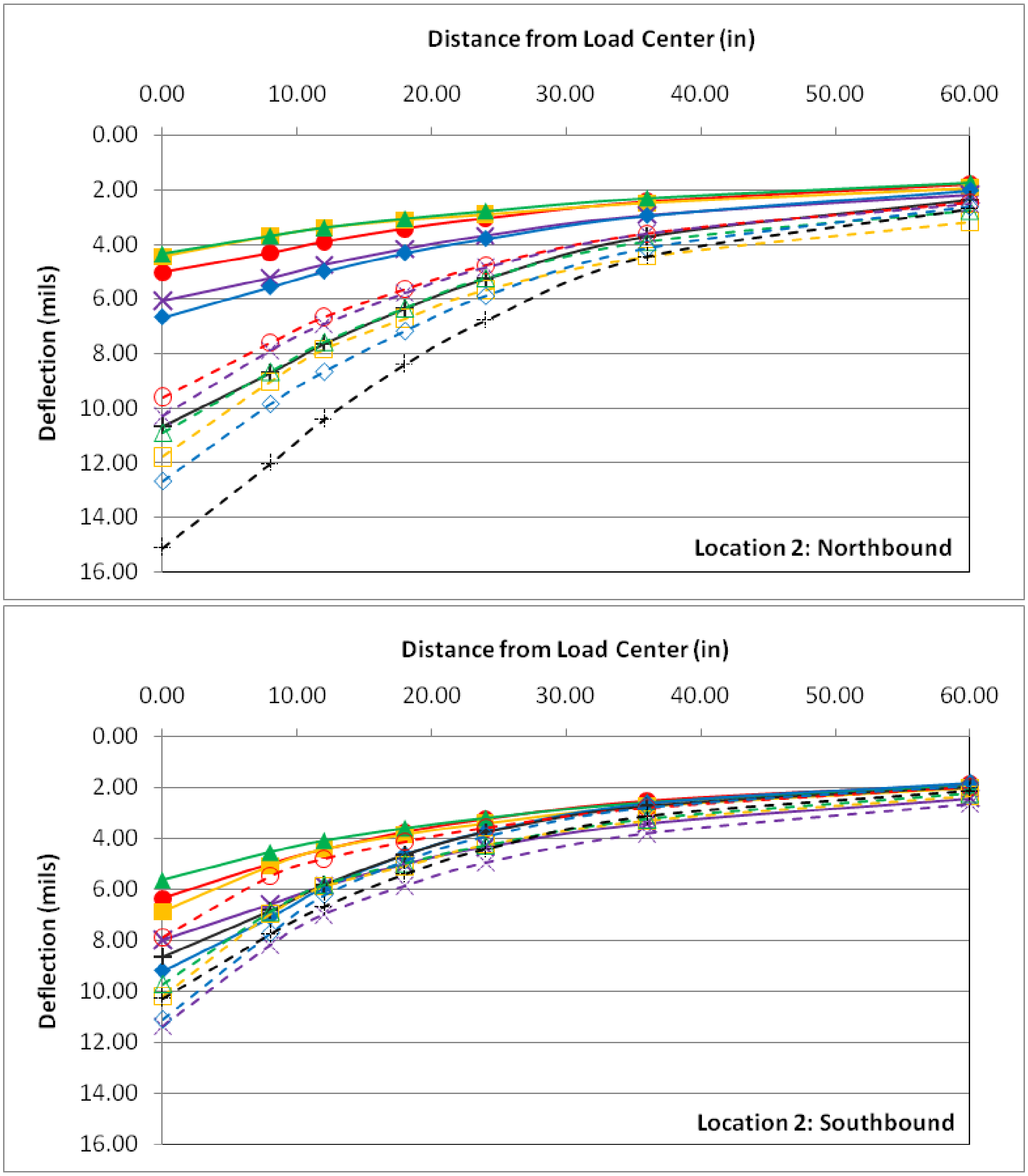
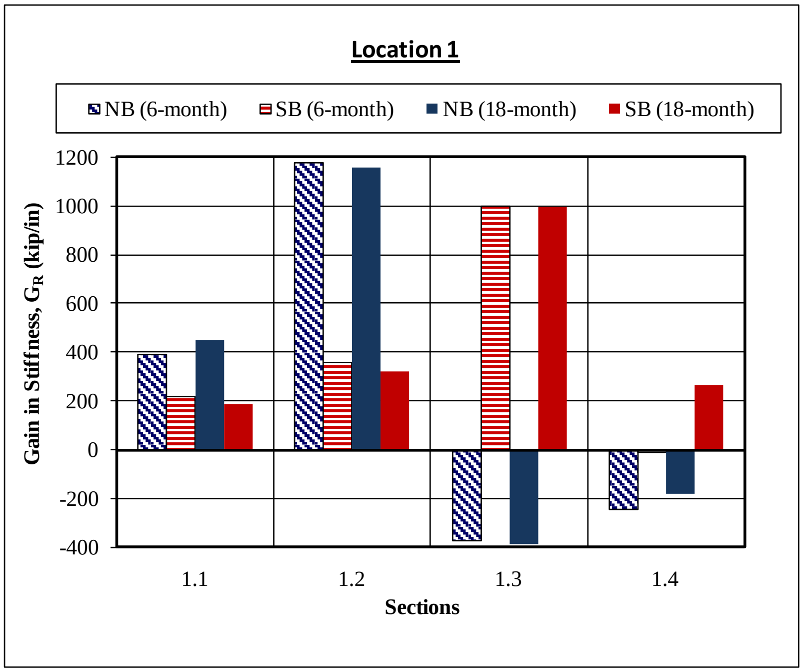


Figure 7.18: Pre-construction and 18-month Deflection Data (Location 2)



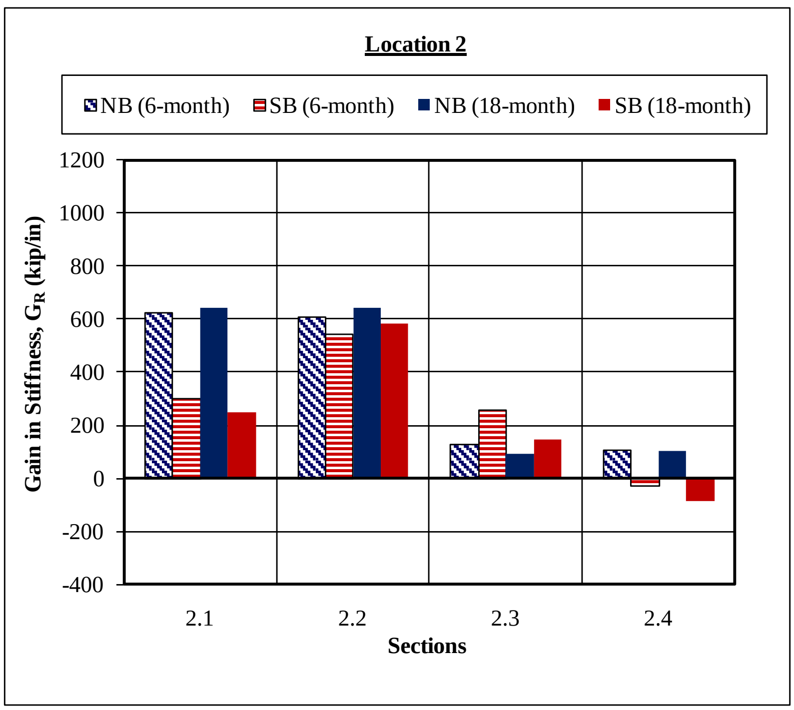


Figure 7.19: Gain in Stiffness due to Reinforcement based on 6 and 18 Month Data

CHAPTER 8

Framework for Life Cycle Cost Analysis

8.1 INTRODUCTION

To facilitate selection of economical overlay reinforcement, it is essential to correctly assess the effectiveness of the reinforcing products in mitigating pavement distress, and extending the time interval between successive rehabilitations. A detailed Life Cycle Cost Analysis (LCCA) for each of these alternative strategies is needed. Besides various items of costs, such as initial cost, maintenance cost, user costs, etc., LCCA requires an estimation of the pavement life through a combination of long-term performance monitoring and/or accelerated testing and modeling. With the 6-month and 18-month field testing data acquired during this study, a general framework related to life span estimation have been developed such that long-term performance data can be easily incorporated into this protocol as they become available.

It is to be noted that the AASHTO (1993) Design Guide provides a mechanistic-empirical procedure based on FWD deflection data to estimate Remaining Life (RL) of existing pavements. This involves backcalculation of subgrade resilient modulus (M_R), determination of an Effective Modulus (E_P) for the pavement structure above the subgrade, calculation of an effective Structural Number (SN_{eff}) for the existing pavement using E_P, calculation of a Condition Factor (CF) from SN_{eff}, and finally estimation of remaining life employing an assumed relationship between CF and RL (Figure 8.1)

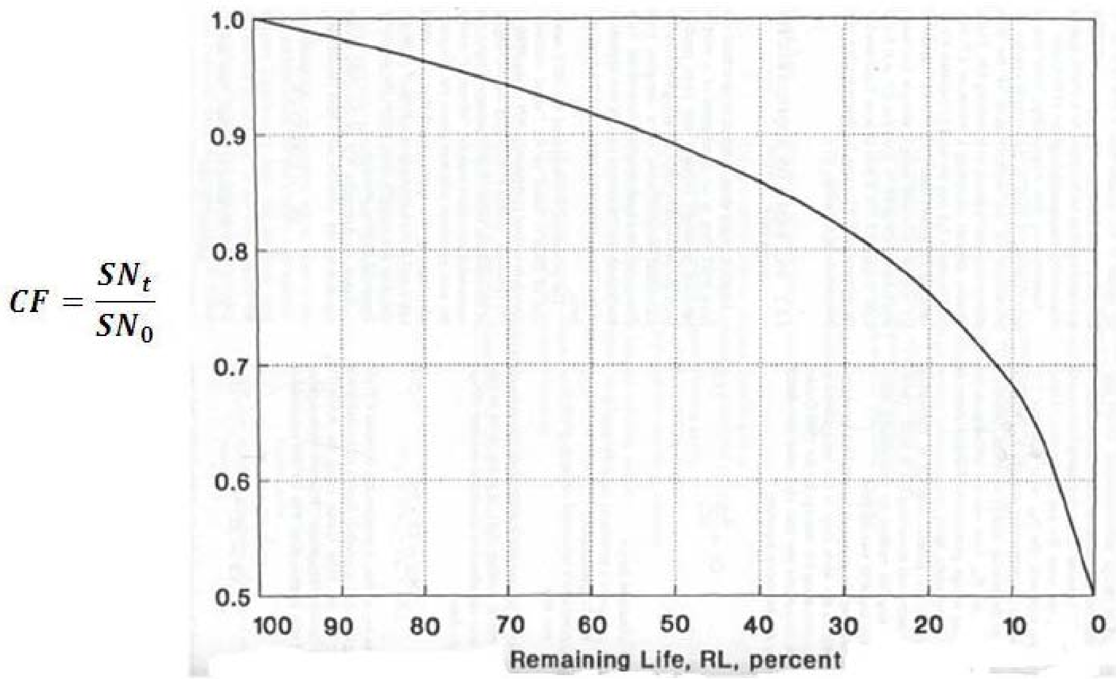


Figure 8.1: AASHTO (1993) Remaining Life Concept

Here, SN_t refers to the Effective Structural Number after any time t, and SN_0 is the initial Structural Number right after construction. These methods may not apply to the atypical conditions of SR15 / US 98 roadways for the following reasons:

1. After having undergone numerous resurfacing operations, the asphalt layer in the test locations is not only thick but composed of several layers with unknown properties. In addition, reinforcement in the overlay is another major component of the pavement controlling its behavior. With these exceptions, traditional linear elastic analysis for estimating composite modulus of the pavement resilient modulus may be questionable.

2. The thick organic layers at the site are considered to be responsible for large permanent deformations occurring rather quickly than would occur on a typical road; so subgrade modulus determination by elastic theory may not apply.
3. The presence of reinforcement and thick organic layers complicates the pavement response, and therefore, the remaining life trend shown in Figure 8.1 may not be appropriate.

Based on the foregoing discussions, and also due to the geotechnical challenges such as poor site conditions in the SR15/US 98 roadway, the mechanics and long-term performance of the reinforced asphalt test sections cannot be reliably predicted using traditional methods and models. The current study, therefore, developed a two-prong approach for assessing the life span and relative performance of reinforced asphalt test sections, both based on fundamental parameters obtained by direct field measurements. These methods are discussed in the following sections.

8.2 METHOD BASED ON G_R

Since reinforced sections demonstrated statistically significant improvement in stiffness (reported in Chapter 7) compared to control sections, it is interesting to delineate the contribution of each reinforcing product from the overall performance of the composite section. A procedure was developed to determine the *Gain in Stiffness*, G_R, which is the improvement in stiffness solely due to reinforcement (described in Section 7.2.5 and given by Equation 7.2). G_R can be monitored with time as a performance-based indicator for each reinforced pavement structure, and its variations with time may provide valuable insights into the relative performance of the reinforcing products during their life spans.

As defined previously, G_R is a mechanistic parameter based on the *Impulse Stiffness Modulus* (ISM), which is strictly derived from the fundamental load-deflection response of the pavement structure. From a mechanistic standpoint, it is inevitable that the pavement sections will eventually develop cracks due to the differential movements of the organic layers. Once the crack is formed, the life of a pavement is directly related to the ability of the reinforcement in "bridging the cracks" (absorbing and/or redistributing the stresses), thus delaying the propagation of the cracks to the pavement surface. As the pavements undergo cracking-related distresses over time, the *ISM* values will change (probably at a different rate for the control and the reinforced sections), and so will G_R. Thus, it is reasonable to state that G_R has a direct relevance to the service life of a reinforced pavement, and can be used as an indicator of the relative performance of the reinforcing products.

Figure 8.2 shows possible scenarios with the long-term variations of G_R with time. Here, the baseline value G_{Ro} is the value calculated for the test section at the beginning of the service life. For the present case, the 6-month data (shown previously in Figure 7.19) can be regarded as the baseline value. Following three scenarios are possible for each reinforcing product:

1. G_R remains constant with time, implying that the reinforced section uniformly maintains the same gain in stiffness compared to the controls (possible, but not likely); or
2. G_R increases with time, suggesting that the control sections deteriorate at a faster rate compared to the reinforced sections (possible and expected); or

3. G_R decreases with time, implying that the reinforced sections deteriorate at a faster rate than the control sections (possible, but not expected)

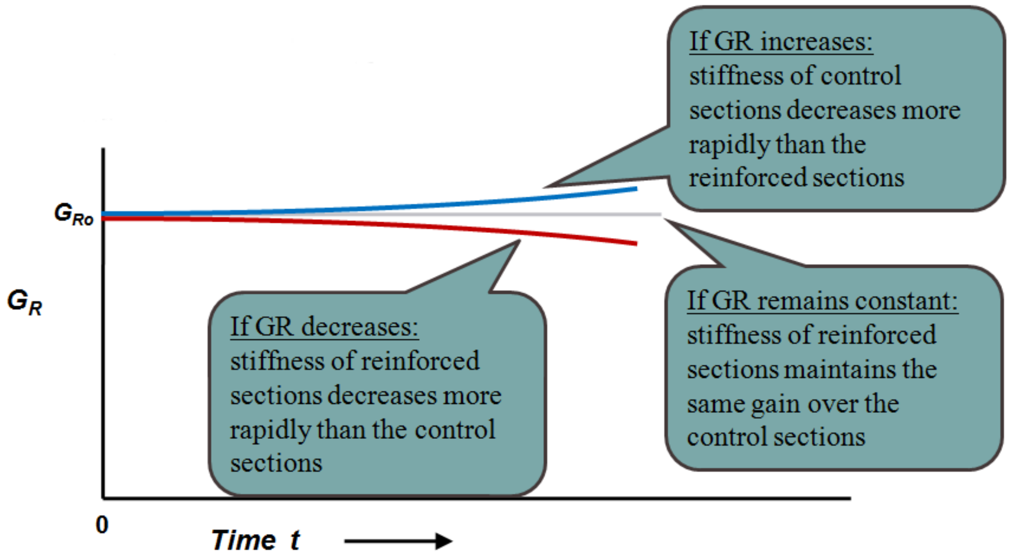


Figure 8.2: G_R verses Time as a Relative Performance Indicator

8.3 METHOD BASED ON *CONDITION FACTOR*

Similar to the AASHTO (1993) approach to Remaining Life calculations, a *Condition Factor, CF,* is defined in terms of the *Impulse Stiffness Modulus, ISM,* as follows:

$$CF = \frac{ISM_t}{ISM_0} \qquad (8.1)$$

Where ISM_0 refers to the initial *ISM* right after construction (in this case the 6-month *ISM*), and ISM_t refers to the *ISM* at any time during the pavement's life (e.g. the 18-month ISM).

Monitoring the variation of *CF* with time is a direct and fundamental way of quantifying the gradual degradation of the pavement. It is possible that *CF* defined by Equation 8.1

may not follow a similar path as the AASHTO Remaining Life curve (Figure 8.1). Several years of field testing, monitoring, and data analysis will establish a full characterization of this relationship.

Based on the available data to date, Figures 8.3 and 8.4 show the initial trends of CF versus time curve, facilitating a relative comparison among the various reinforcing strategies as time progresses. In both test sections, all trends show a slightly stiffening behavior up to 18 months, possibly due to initial compaction of the newly constructed pavement overlay. Note that increase in stiffness of reinforced sections exceeds that of the control sections.

It is to be noted that FDOT rehabilitation model is based on three factors: Ride, Rut, and Crack. Any one or more of these factors can trigger a need for rehabilitation. Accordingly, the CF will be calculated in terms of all four factors, namely, Stiffness, Ride, Rut and Crack, and monitored over time. The baseline Ride, Rut and Crack data for the 18-month tests are presented in Appendix 6.

8.4 DISCUSSION

The G_R and the *CF* methods discussed above establish a two-prong framework for the prediction of pavement life, which is an essential input to a Life Cycle Cost Analysis. This is further explained as follows.

In all likelihood, both the control sections and the reinforced sections will continue to deteriorate with time. However, the G_R curve (Figure 8.2) is expected to continue its upward trend with time, implying that the control sections are deteriorating at a faster rate than the reinforced sections. This trend will continue as long as the reinforcement remains effective in retarding crack propagation (or rutting). With the passage of time, the reinforcement effectiveness decreases somewhat abruptly relative to the control section and the G_R curve will assume a precipitous downward trend signifying severe damage accumulation. One of the reasons for this abrupt change could be, for example, the reinforcement becoming disengaged from the asphalt matrix. Put differently, the reinforcement is no longer effective and failure is imminent. The same abrupt slope change should be seen in the CF curve as well , attributable to the sudden decrease in the ISM value. A similar trend is present in the AASHTO remaining life curve, as shown in Figure 8.1 . In all likelihood, the timing of those abrupt slope changes in the Gr curve and CF curve should be close that a reasonable estimate of the life span of the roadway could be derived there from. The explanation for this coincident slope change could be that both parameters are derived from the same ISM data. By comparing the simultaneous downward trend in G_R and *CF curves*, it is plausible to develop a failure criterion such as a critical (minimum) value for *CF*, which marks the pavement life span. This analysis need to be carried out for each reinforcing product obtaining the life span of each reinforced section which becomes an input in Life Cycle Cost Analysis. The methods presented above are based on direct field measurements of mechanistic pavement response and, therefore, considered more relevant compared to the AASHTO *Remaining Life* method that relies heavily on empirical concepts involving *Structural Numbers* (SN). As more performance data become available in the future, they can be easily incorporated into the Life Cycle plots presented in Figures 8.2, 8.3 or 8.4.

The proposed task of Life Cycle Cost Analysis of the experimental sections will result in a tentative ranking of the relative performance of various reinforcing materials. The entire test program can be divided into two groups of test sections: (i) milling and resurfacing only, as represented by the control sections; and (ii) milling and resurfacing with the inclusion of reinforcement. The comparison of the LCCA of the two groups of test sections is expected to address the issue of the high initial cost of the reinforcements. LCCA incorporates both direct costs and indirect costs. In this context, the only direct costs include the initial cost and the salvage value. The indirect costs could be derived from discounted future agency costs including user and maintenance costs over the life of the pavement. Derived from those various costs are Equivalent Uniform Annual Costs (EUAC) for each test section. Assuming that lower EUAC represents a more cost-effective solution, the ranking of reinforcing products could be accomplished by comparing EUAC of different reinforced sections. The LCCA results, and therefore, the effectiveness of each section, are likely to be different. A refined LCCA analysis would involve employing the FHWA Real Cost software.

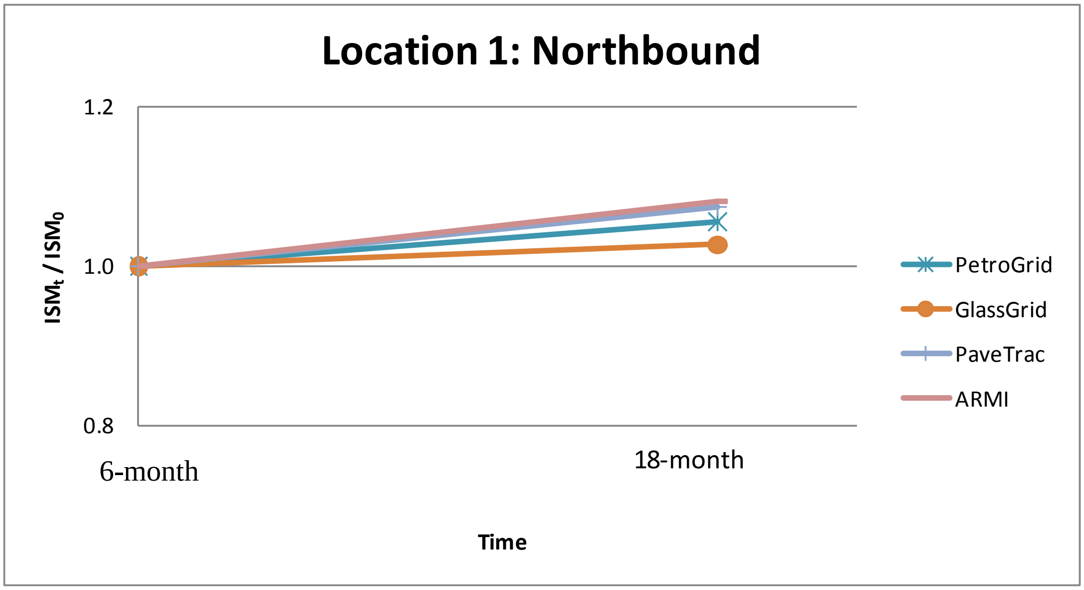
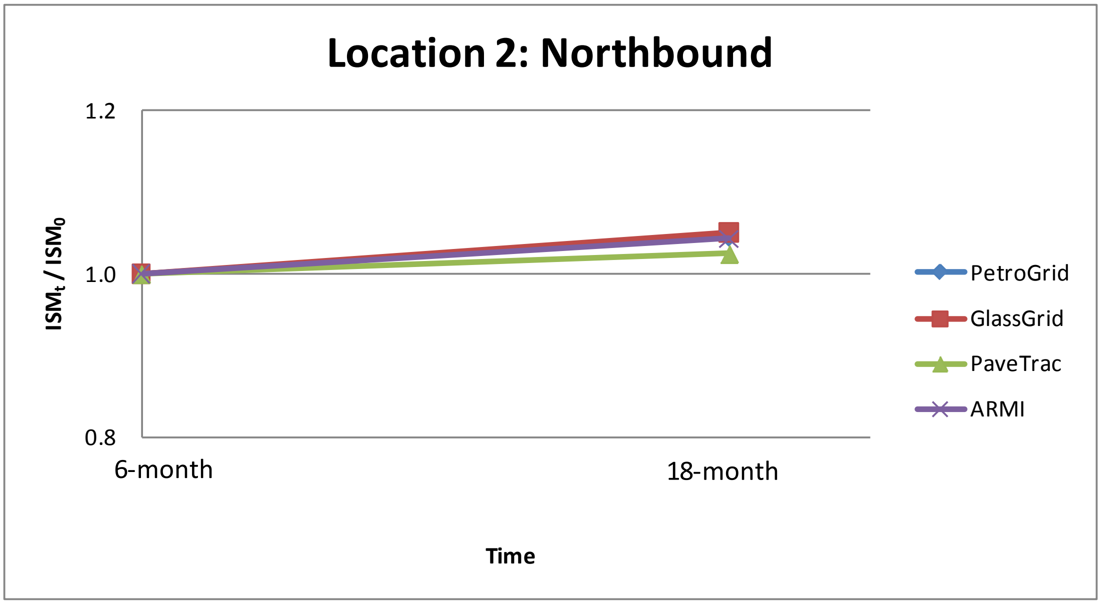


Figure 8.3: ISM based Condition Factor versus Time for Location1



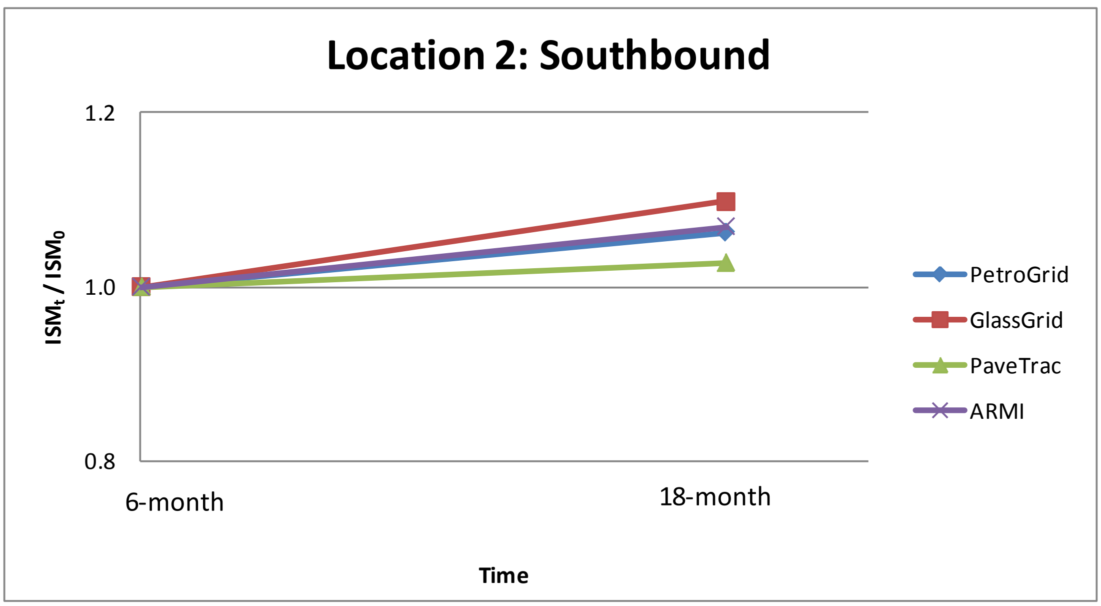


Figure 8.4: ISM based Condition Factor versus Time for Location 2

CHAPTER 9

Summary and Conclusions

9.1 SUMMARY

The objective of this study was to investigate near-surface strategies for rehabilitating flexible pavements underlain by thick organic/plastic soil deposits. Of specific interests herein were grid reinforcements (geosynthetics and steel mesh) embedded within the asphalt overlay. A total of 24 test sections, each 500 ft long, were constructed along the alignment of SR 15/US 98, and evaluated for a period of two years. Sixteen test sections had embedded reinforcements, while eight were control sections without any reinforcement. Each reinforcing product was repeated at two locations along each lane direction, resulting in four test sections incorporating each type of reinforcement. Four types of reinforcements, each distinctly different in geometry and stiffness properties were used:

(i) GlasGrid 8511, which is a high-stiffness open-mesh glass fiber reinforced polymeric grid

(ii) PetroGrid 4582, which is a composite of non-woven paving fabric and a glass fiber

(iii) PaveTrac MT-1, which is a double-twist woven hexagonal steel wire netting

(iv) Asphalt Rubber Membrane Interlayer (ARMI), which is composed of a separate application of asphalt rubber binder ARB-20 covered with a single application of aggregate constructed per FDOT specification.

Various non-destructive test methods, including FWD tests, ride quality, and rut- and crack-survey, were employed to establish the condition/stiffness of the roadway prior to overlay construction. This data provided valuable documentation of existing pavement and subsurface conditions, before placement of the reinforced overlay sections. Impulse Stiffness Modulus (ISM), calculated from FWD load and deflection data was the primary metric used for pavement condition assessment. A statistical data analysis protocol coupled with a color-coded graphical representation method was developed to determine the similarities or dissimilarities among the test sections in terms of performance, and hence facilitate the relative evaluation of each of the test sections. The same set of field tests were employed in 6-month and 18-month post-construction periods followed by the same series of statistical comparison studies. With the 6-month post-construction condition as the base line information, the 18-month data showed practically no (statistically significant) change, since this is still considered a very early age for the pavement structure.

From a mechanistic standpoint, it is inevitable that the pavement sections will eventually develop cracks due to the differential movements of the organic layers. Once the crack is formed, the life span of a pavement is directly related to the ability of the reinforcement in “bridging the cracks” (absorbing and transferring tensile stresses), thus delaying the propagation of the cracks to the pavement surface, leading to longer time intervals between costly rehabilitation effort. In order to provide FDOT the necessary tools for selecting site-specific rehabilitation strategy such as the type of reinforcing products for a particular subsurface condition, it is necessary to correctly assess the effectiveness and long-term performance of the reinforcing products by conducting a detailed Life Cycle Cost Analysis for each of these alternative strategies. Besides various cost associated factors, the LCCA requires an estimation of the pavement life. With the 6-month and 18-month field testing data acquired during this study, a general framework related to life span estimation has been developed. This protocol is amenable to accepting more long-term data (as they become available) enabling the calculation of life cycle of each of these reinforcements.

In the current study, a two-prong approach, based on fundamental parameters obtained by direct field measurements, was proposed for assessing the life span and relative performance of reinforced asphalt test sections. The first method is based on the concept of *Gain in Stiffness*, G_R, which is the improvement in stiffness solely due to reinforcement. G_R can be monitored over time as a performance-based indicator for each reinforced pavement structure. The second method embraces the concept of Condition Factor, *CF* as defined in the AASHTO Remaining Life Method (1993), and is defined in terms of the *Impulse Stiffness Modulus, ISM.* Monitoring the variation of *CF* with time is a direct and fundamental way of quantifying the gradual degradation of the pavement, and assessing the relative performances of each reinforced section. These two methods, presented in a graphical format, can easily incorporate future performance data for life cycle estimation, and tentative ranking of various reinforcing materials.

9.2 Conclusions

The specific conclusions of this study are as follows:

1. The pre-construction FWD tests and rut survey revealed that the southbound travel lines of both test locations exhibit more consistent (uniform) pavement condition compared to northbound travel lanes.
2. All reinforcing products could be successfully incorporated into the test sections as planned, with a few construction related issues commonly encountered in field installation (such as curling of reinforcements ahead of the paver, grids separating from underlying membranes, etc.). These issues were documented, and remedial measures were suggested and implemented.
3. Comparison of 6-month post-construction FWD test results with pre-construction results shows that PetroGrid, GlasGrid and PaveTrac embedded sections improved the pavement stiffness in 11 out of 12 test sections (95% confidence level), with ARMI layer stiffness remaining unchanged. Similar trends were observed with the 18-month data. In addition, there were measurable and statistically significant differences between the reinforced sections compared to the unreinforced control sections.
4. The concept of *Gain in Stiffness, G_R*, was developed and successfully employed to delineate the contribution of the individual reinforcing materials from the overall improvement in stiffness observed in each reinforced test section. This Gain in Stiffness solely due to reinforcing products was statistically significant.

5. The organic factor concept, F_{org}, introduced to characterize soft organic pavement foundations in Florida is shown to be a satisfactory metric for correlating site-specific soil conditions with probable pavement performance.

6. The spatial consistency of three time-series FWD test results suggests that it (FWD) can be effectively employed for direct, reliable and fast characterization of the stiffness properties (such as *ISM*) of reinforced asphalt pavement sections.

7. Gain in Stiffness, G_R, and Condition Factor, *CF*, both calculated directly from *ISM* data, can be used as performance-based parameters for long-term evaluation of reinforced test sections, and the estimation of pavement life, which is required for a Life Cycle Cost Analysis (LCCA).

Evaluation of four reinforcing materials for their effectiveness and longevity in asphalt overlay was the primary objective of this study. Considering the complexity of the pavement system, especially the thick organic subgrade and several layers of overlay placed on the roadway, no reasonable estimate of their effectiveness could be predicted with short-term data collected during this study. Continued evaluation of test sections accompanied by rigorous analysis proposed in this investigation could provide the desired results, namely, the relative ranking and effectiveness of the reinforcements, the life cycle of each test section, and associated design and construction guidelines when organic soils are encountered.

CHAPTER 10

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APPENDIX 1

SOIL LAYER THICKNESS DATA

Table A1.1 – Summary of SPT Boring Locations and Water Table in Test Sections

Location & Section	Boring No.	Station (feet)	Offset (feet)	Eleva-tion (feet)	Depth to H2O Table (feet)	H2O Table Elevation (feet)
1.0	B-33	155+00.75	9.04 RT	16.86	7.1	9.76
1.0	B-34	156+98.16	6.64 LT	16.92	6.5	10.42
1.0	B-35	158+97.76	10.49 RT	16.72	6.7	10.02
1.1	B-36	161+04.26	6.70 LT	17.05	6.9	10.15
1.1	B-37	162+98.37	8.67 RT	17.44	6.8	10.64
1.1	B-38	164+94.94	5.11 LT	17.20	6.6	10.60
1.2	B-39	166+96.37	9.93 RT	17.24	6.9	10.34
1.2	B-40	168+99.03	8.82 LT	17.21	7.0	10.21
1.3	B-41	170+98.01	8.17 RT	17.01	8.9	8.11
1.3	B-42	172+99.96	6.03 LT	17.89	6.9	10.99
1.3	B-43	174+90.58	10.57 RT	17.95	9.2	8.75
1.4	B-44	179+96.18	6.42 LT	18.81	8.8	10.01
1.5	B-45	184+97.39	12.03 RT	16.93	8.9	8.03
2.0	B-54	227+02.48	8.43 LT	18.70	9.0	9.70
2.0	B-55	229+06.75	9.81 RT	18.19	8.7	9.49
2.0	B-56	230+97.59	7.85 LT	17.69	8.9	8.79
2.1	B-57	233+01.07	10.78 RT	17.09	9.0	8.09
2.1	B-58	235+00.81	5.38 LT	17.82	8.7	9.12
2.1	B-59	236+99.46	9.96 RT	17.12	8.5	8.62
2.2	B-60	238+96.90	7.51 LT	17.93	9.0	8.93
2.2	B-61	241+04.83	9.93 RT	17.71	8.9	8.81
2.3	B-62	242+94.80	8.30 LT	18.31	8.8	9.51
2.3	B-63	245+05.37	8.92 RT	17.86	8.1	9.76
2.3	B-64	246+99.42	8.21 LT	18.36	8.1	10.26
2.4	B-65	249+02.02	13.06 RT	17.69	8.2	9.49
2.4	B-66	250+88.39	5.40 LT	18.28	8.0	10.28
2.5	B-67	252+98.94	10.46 RT	18.04	8.3	9.74
2.5	B-68	254+99.55	7.03 LT	18.61	8.3	10.31
2.5	B-69	256+97.06	10.73 RT	17.93	8.7	9.23

Source: Geosol, 2004

Table A1.2 – Summary of Muck Layer in Test Sections

Boring Locations			Summary of Muck Layer Data		
Location & Section	Boring No.	Station (feet)	From (feet)	To (feet)	Thick-ness (feet)
1.0	B-33	155+00.75	6.0	17.0	11.0
1.0	B-34	156+98.16	2.0	16.0	14.0
1.0	B-35	158+97.76	3.0	15.5	12.5
1.1	B-36	161+04.26	6.0	15.5	9.5
1.1	B-37	162+98.37	6.0	16.0	10.0
1.1	B-38	164+94.94	6.0	17.5	11.5
1.2	B-39	166+96.37	4.0	17.5	13.5
1.2	B-40	168+99.03	6.0	17.0	11.0
1.3	B-41	170+98.01	6.0	16.0	10.0
1.3	B-42	172+99.96	6.0	16.5	10.5
1.3	B-43	174+90.58	6.0	17.0	11.0
1.4	B-44	179+96.18	4.0	15.5	11.5
1.5	B-45	184+97.39	6.0	15.8	9.8
2.0	B-54	227+02.48	7.0	17.0	10.0
2.0	B-55	229+06.75	6.0	16.5	10.5
2.0	B-56	230+97.59	6.0	16.0	10.0
2.1	B-57	233+01.07	5.0	16.5	11.5
2.1	B-58	235+00.81	5.5	17.0	11.5
2.1	B-59	236+99.46	6.0	17.0	11.0
2.2	B-60	238+96.90	6.0	17.5	11.5
2.2	B-61	241+04.83	6.0	17.0	11.0
2.3	B-62	242+94.80	6.0	17.5	11.5
2.3	B-63	245+05.37	6.0	16.0	10.0
2.3	B-64	246+99.42	6.0	16.5	10.5
2.4	B-65	249+02.02	6.0	17.0	11.0
2.4	B-66	250+88.39	6.0	17.5	11.5
2.5	B-67	252+98.94	6.0	17.0	11.0
2.5	B-68	254+99.55	6.0	17.0	11.0
2.5	B-69	256+97.06	6.0	17.5	11.5

Table A1.3 – Summary of Pavement Layers in Test Sections

SPT Boring Loc.		Pavement Layer Thicknesses from Boring Logs								
		Asphalt Pavement Layer			Improved Fill Layer			Sand Fill Layer		
Loc'n & Sect'n	Station (feet)	From (feet)	To (feet)	Thick-ness (feet)	From (feet)	To (feet)	Thick-ness (feet)	From (feet)	To (feet)	Thick-ness (feet)
1.0	155+00.75	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
1.0	156+98.16	0.0	1.2	1.2	1.2	2.0	0.8	None	0	0.0
1.0	158+97.76	0.0	1.4	1.4	1.4	2.0	0.6	2.0	3.0	1.0
1.1	161+04.26	0.0	1.3	1.3	1.3	2.0	0.7	2.0	6.0	4.0
1.1	162+98.37	0.0	1.4	1.4	1.4	2.0	0.6	2.0	4.0	2.0
1.1	164+94.94	0.0	1.3	1.3	1.3	2.0	0.7	2.0	6.0	4.0
1.2	166+96.37	0.0	1.4	1.4	1.4	2.5	1.1	2.5	4.0	1.5
1.2	168+99.03	0.0	1.2	1.2	1.2	2.0	0.8	2.0	6.0	4.0
1.3	170+98.01	0.0	1.4	1.4	1.4	4.0	2.6	4.0	6.0	2.0
1.3	172+99.96	0.0	1.3	1.3	1.3	2.0	0.7	2.0	6.0	4.0
1.3	174+90.58	0.0	1.3	1.3	1.3	2.0	0.7	2.0	6.0	4.0
1.4	179+96.18	0.0	1.0	1.0	1.0	2.0	1.0	2.0	4.0	2.0
1.5	184+97.39	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.0	227+02.48	0.0	1.0	1.0	1.0	2.0	1.0	2.0	7.0	5.0
2.0	229+06.75	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.0	230+97.59	0.0	1.0	1.0	1.0	2.5	1.5	2.5	6.0	3.5
2.1	233+01.07	0.0	0.9	0.9	0.9	2.0	1.1	2.0	5.0	3.0
2.1	235+00.81	0.0	1.0	1.0	1.0	2.0	1.0	2.0	5.5	3.5
2.1	236+99.46	0.0	1.2	1.2	1.2	2.0	0.8	2.0	6.0	4.0
2.2	238+96.90	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.2	241+04.83	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.3	242+94.80	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.3	245+05.37	0.0	0.7	0.7	0.7	2.0	1.3	2.0	6.0	4.0
2.3	246+99.42	0.0	0.6	0.6	0.6	2.0	1.4	2.0	6.0	4.0
2.4	249+02.02	0.0	0.9	0.9	0.9	2.0	1.1	2.0	6.0	4.0
2.4	250+88.39	0.0	0.7	0.7	0.7	2.0	1.3	2.0	6.0	4.0
2.5	252+98.94	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.5	254+99.55	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0
2.5	256+97.06	0.0	1.0	1.0	1.0	2.0	1.0	2.0	6.0	4.0

APPENDIX 2

PRE-CONSTRUCTION FWD DATA

Table A2.1 – Pre-Construction FWD Data for Test Location 1, Northbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
1.0N	155+25	9728	10.36	9.21	8.68	8.07	7.45	6.35	4.61	79.7	0.9654	973
	155+75	9673	9.78	8.92	7.91	7.56	7.44	5.67	4.37	82.4	0.9557	1,035
	156+25	9881	6.07	5.17	4.91	4.60	4.27	3.65	2.76	80.8	0.9453	1,722
	156+75	9585	6.79	5.76	5.45	5.04	4.64	3.94	3.04	80.6	0.9493	1,487
	157+25	9530	11.16	9.81	9.09	8.28	7.58	6.23	4.50	80.8	0.9629	887
	157+75	8873	5.13	4.28	4.09	3.89	3.66	3.18	2.52	81.3	0.9425	1,835
	158+25	8807	4.67	4.06	3.88	3.73	3.53	3.14	2.48	89.7	0.9137	2,064
	158+75	8895	6.09	5.28	5.03	4.60	4.19	3.59	2.70	79.9	0.9509	1,536
	159+25	8950	12.52	10.78	9.94	8.60	6.96	5.10	3.43	89.5	0.9366	763
	159+75	9092	11.57	10.90	10.37	9.27	7.99	4.74	3.38	79.6	0.9593	819
1.1N	160+25	8917	10.83	8.74	7.83	6.70	5.64	4.35	3.10	91.1	0.9249	890
	160+75	9026	5.01	4.12	3.89	3.63	3.40	2.91	2.22	78.7	0.9483	1,900
	161+25	9005	4.87	4.44	4.24	4.02	3.80	3.37	2.76	88.3	0.9205	2,009
	161+75	9136	6.25	5.21	4.95	4.72	4.34	3.72	2.71	86.7	0.9294	1,573
	162+25	8698	7.25	5.89	5.53	5.07	4.51	3.68	2.67	95.0	0.9057	1,325
	162+75	8796	6.43	5.44	4.72	4.40	4.12	3.40	2.42	94.1	0.9032	1,515
	163+25	8796	4.89	3.96	3.66	3.45	3.26	2.85	2.29	86.3	0.9208	1,954
	163+75	9092	5.24	4.13	3.81	3.49	3.21	2.79	2.19	80.3	0.9407	1,845
	164+25	8796	5.56	4.38	3.97	3.56	3.22	2.77	2.20	89.4	0.9082	1,742
	164+75	8917	5.80	4.58	4.22	3.89	3.68	3.12	2.35	79.5	0.9476	1,622
1.2N	165+25	8742	4.92	4.09	3.81	3.51	3.18	2.75	2.21	77.5	0.9518	1,867
	165+75	8785	7.04	5.99	5.30	4.78	4.13	3.46	2.52	79.8	0.9501	1,313
	166+25	8862	8.05	6.69	6.09	5.46	4.96	4.17	3.22	95.3	0.9107	1,209
	166+75	8840	7.93	6.52	5.97	5.30	4.84	4.00	2.82	98.7	0.8985	1,241
	167+25	8709	8.77	7.59	7.17	6.43	5.80	4.69	3.38	89.3	0.9341	1,063
	167+75	8884	26.14	22.72	20.99	17.54	14.94	9.37	5.73	96.3	0.9528	357
	168+25	8720	8.19	7.17	6.76	6.25	5.73	4.83	3.50	80.9	0.9572	1,112
	168+75	8873	8.68	7.48	7.02	6.26	5.50	4.43	3.13	93.7	0.9184	1,113
	169+25	8829	11.27	9.32	8.19	7.38	6.49	4.84	3.26	96.1	0.9172	854
	169+75	8829	11.05	9.23	8.63	7.74	6.53	5.13	3.28	96.7	0.9191	869

Note: In all FWD tables, the ISM values shown are temperature-adjusted.

Table A2.1, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
1.3N	170+25	8774	9.04	7.97	7.57	7.07	6.48	5.43	3.87	79.3	0.9644	1,006
	170+75	8851	18.33	14.04	11.88	10.87	8.70	6.19	3.42	90.9	0.9423	512
	171+25	8774	21.18	18.57	17.14	15.11	12.94	9.31	5.20	96.5	0.9527	435
	171+75	8961	13.87	12.18	11.42	10.32	9.12	7.07	4.45	93.4	0.9429	685
	172+25	8829	15.85	14.00	13.10	11.77	10.34	7.97	4.87	98.3	0.9410	592
	172+75	8939	18.11	15.57	14.38	12.94	11.61	9.01	5.39	100.6	0.9436	523
	173+25	8939	11.32	9.60	8.84	8.01	7.24	5.91	4.03	98.7	0.9218	857
	173+75	8862	14.81	13.32	9.50	8.21	7.02	5.29	4.01	103.4	0.9041	662
	174+25	8796	10.41	8.03	7.31	6.42	5.59	4.33	2.95	101.5	0.8956	943
	174+75	9114	10.48	9.04	8.28	7.28	6.59	4.91	3.19	98.1	0.9106	955
1.4N	175+25	8840	5.45	4.25	3.91	3.64	3.37	2.86	2.13	99.7	0.8722	1,860
	175+75	8687	6.44	5.30	5.02	4.54	4.19	3.53	2.52	92.4	0.9104	1,482
	176+25	8665	6.76	5.70	5.39	4.96	4.44	3.82	2.72	91.4	0.9178	1,397
	176+75	8906	5.38	4.38	4.09	3.80	3.54	2.98	2.25	93.4	0.8962	1,847
	177+25	9092	6.43	5.24	4.85	4.41	3.96	3.24	2.33	96.3	0.8900	1,589
	177+75	8895	6.15	4.76	4.38	3.76	3.25	2.67	1.87	95.7	0.8813	1,641
	178+25	8807	6.63	5.19	4.72	4.20	3.70	2.93	2.18	97.3	0.8821	1,506
	178+75	8785	7.77	5.85	5.13	4.30	3.67	2.93	2.19	97.7	0.8808	1,284
	179+25	8818	9.46	7.48	6.51	5.40	4.61	3.63	2.52	97.7	0.8944	1,042
	179+75	8829	7.33	6.01	5.63	5.15	4.65	3.72	2.65	97.2	0.8973	1,342
1.5N	180+25	8796	11.27	8.99	7.94	6.83	6.03	4.63	3.19	98.1	0.9087	859
	180+75	8862	16.27	14.04	12.54	10.50	8.21	6.00	3.69	95.1	0.9308	585
	181+25	8785	11.69	10.07	9.29	8.45	7.30	5.78	3.99	97.7	0.9233	814
	181+75	8917	14.56	12.91	12.14	10.97	9.68	7.23	4.28	100.0	0.9311	658
	182+25	9990	22.48	19.50	16.64	14.11	11.69	9.18	5.36	96.9	0.9439	471
	182+75	8807	23.71	21.26	18.70	16.10	13.54	9.66	5.83	95.4	0.9555	389
	183+25	8796	20.87	16.75	15.41	13.77	12.89	9.46	6.53	95.3	0.9546	441
	183+75	8807	31.14	27.57	25.06	21.78	18.26	11.88	6.76	96.2	0.9646	293
	184+25	8906	20.45	18.97	17.72	16.06	14.31	11.43	7.43	95.7	0.9628	452
	184+75	9246	27.43	22.87	20.72	18.37	15.92	12.23	7.41	96.3	0.9635	350

Table A2.2 – Pre-Construction FWD Data for Test Location 1, Southbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp °F	TAF	ISM kip/in
1.0S	155+25	8862	19.56	15.63	13.74	11.96	9.97	6.87	4.65	113.5	0.9014	503
	155+75	9136	17.65	13.75	12.46	11.35	9.99	8.15	5.54	115.9	0.9088	570
	156+25	8906	12.06	9.68	8.73	7.67	6.96	5.36	3.65	114.0	0.8783	841
	156+75	8873	20.53	15.37	13.11	11.09	9.28	6.83	4.34	114.2	0.8993	481
	157+25	9059	13.47	10.29	9.34	8.52	7.43	5.74	3.82	115.2	0.8800	764
	157+75	9048	10.51	7.26	6.47	6.27	5.53	4.50	3.08	114.8	0.8590	1,002
	158+25	8818	13.83	11.66	9.92	7.96	6.62	5.13	3.21	113.1	0.8773	727
	158+75	8829	12.56	9.67	8.65	7.58	6.61	5.25	3.66	115.1	0.8744	804
	159+25	8939	21.74	15.38	12.75	10.67	7.31	5.05	3.17	115.2	0.8694	473
	159+75	9782	19.04	15.03	13.10	11.17	9.52	6.76	4.18	116.4	0.8849	581
1.1S	160+25	10001	16.20	13.04	11.31	9.32	7.77	5.65	3.70	117.1	0.8646	714
	160+75	8917	14.14	10.93	9.91	8.16	6.87	5.17	3.45	116.1	0.8694	725
	161+25	9059	15.07	11.72	10.64	9.60	8.28	6.05	3.65	117.0	0.8803	683
	161+75	8873	13.61	10.49	9.42	8.26	7.31	5.51	3.73	117.5	0.8724	747
	162+25	8906	19.41	15.76	13.78	11.09	9.18	6.26	4.10	117.3	0.8843	519
	162+75	8851	17.17	13.44	11.63	10.14	8.32	5.69	4.06	120.9	0.8678	594
	163+25	8939	8.60	6.95	6.28	5.49	4.75	3.67	2.56	119.3	0.8270	1,257
	163+75	8939	14.54	11.98	10.39	7.62	5.71	4.17	2.88	117.7	0.8442	728
	164+25	8906	16.80	12.98	11.29	9.56	8.02	5.66	3.02	119.0	0.8708	609
	164+75	8862	18.83	14.39	12.05	9.73	8.19	5.56	3.82	119.9	0.8675	543
1.2S	165+25	8873	20.17	16.15	14.15	12.01	9.81	7.22	4.53	118.8	0.8945	492
	165+75	8884	18.41	15.56	14.23	12.85	11.40	8.95	5.72	121.7	0.9093	531
	166+25	8884	27.09	21.10	17.57	14.30	11.63	8.11	4.79	119.6	0.9036	363
	166+75	8906	13.36	11.27	10.42	9.35	8.49	6.76	4.54	121.0	0.8835	755
	167+25	8917	17.17	15.16	14.24	13.00	11.46	8.77	5.59	120.0	0.9097	571
	167+75	8818	18.77	15.78	13.74	12.47	11.08	8.79	5.70	124.2	0.9042	520
	168+25	8807	17.76	15.26	13.85	12.67	11.13	8.85	5.89	125.5	0.9030	549
	168+75	8829	16.02	12.78	11.48	10.77	9.87	7.90	5.25	125.8	0.8907	619
	169+25	8829	9.11	6.44	5.88	5.52	5.15	4.39	3.30	126.6	0.8259	1,174
	169+75	8994	15.63	11.99	10.31	8.63	7.00	4.83	2.98	126.2	0.8353	689

Table A2.2, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp °F	TAF	ISM kip/in
1.3S	170+25	8851	15.07	11.46	9.45	7.96	6.76	4.87	2.97	123.6	0.8444	696
	170+75	8917	11.24	8.82	8.07	7.25	6.41	5.06	3.37	124.0	0.8466	937
	171+25	8862	17.01	11.11	8.87	8.18	7.68	4.64	2.95	125.7	0.8336	625
	171+75	8829	14.75	11.83	10.21	9.33	7.70	6.00	3.59	127.4	0.8581	698
	172+25	8764	11.48	9.71	8.41	7.93	7.03	5.30	3.43	122.7	0.8562	892
	172+75	8818	11.41	8.55	7.53	6.46	5.60	4.34	3.05	124.5	0.8297	931
	173+25	8928	18.50	13.83	11.84	9.68	7.87	5.37	3.38	121.8	0.8576	563
	173+75	8720	14.67	11.93	10.43	8.44	7.60	5.37	2.98	126.2	0.8497	700
	174+25	9081	13.08	10.72	9.10	7.31	5.80	4.15	2.42	125.2	0.8195	847
	174+75	8807	9.05	7.07	5.88	4.96	4.56	3.60	2.30	118.9	0.8258	1,178
1.4S	175+25	8764	9.82	8.34	7.58	6.48	5.44	3.72	2.49	120.2	0.8257	1,081
	175+75	8873	10.00	7.64	6.80	6.11	5.28	4.17	2.79	124.7	0.8237	1,077
	176+25	8753	12.02	9.12	8.04	6.98	5.93	4.15	2.52	121.7	0.8328	874
	176+75	8774	10.34	7.17	6.43	5.71	5.06	4.07	2.90	119.7	0.8360	1,015
	177+25	9005	9.47	6.26	5.52	4.93	4.18	3.25	2.21	119.9	0.8094	1,175
	177+75	8895	8.83	5.84	5.09	4.44	3.89	3.15	2.26	120.4	0.8058	1,250
	178+25	8796	9.89	6.12	5.09	4.16	3.50	2.78	1.99	119.7	0.7961	1,117
	178+75	8939	8.80	6.26	5.42	4.56	3.89	2.96	2.06	121.9	0.7935	1,280
	179+25	8972	9.08	6.24	5.34	4.42	3.77	2.87	2.03	119.3	0.7985	1,237
	179+75	8939	9.63	6.49	5.55	4.70	3.95	2.97	2.07	119.2	0.8026	1,156
1.5S	180+25	8928	9.84	6.71	5.63	4.60	3.83	2.90	2.08	119.2	0.8002	1,134
	180+75	8917	10.49	7.32	6.32	5.33	4.70	3.60	2.59	117.1	0.8289	1,026
	181+25	8983	12.94	10.02	8.50	7.24	6.04	4.56	3.00	116.7	0.8523	814
	181+75	8829	11.81	9.20	8.34	6.83	5.74	4.57	3.19	119.1	0.8478	882
	182+25	8851	13.42	10.54	9.43	8.04	6.77	5.30	3.58	119.8	0.8606	766
	182+75	8917	13.18	9.63	8.30	7.35	6.30	5.00	3.50	118.7	0.8566	790
	183+25	8873	14.90	11.76	10.46	9.12	7.94	6.18	4.11	118.5	0.8782	678
	183+75	8884	17.62	13.15	11.33	9.44	8.35	6.18	4.07	117.9	0.8793	573
	184+25	8972	18.09	15.20	14.05	12.48	10.90	8.58	5.58	115.7	0.9125	544
	184+75	8851	15.20	11.65	10.36	9.31	8.25	6.79	4.65	117.9	0.8884	655

Table A2.3 – Pre-Construction FWD Data for Test Location 2, Northbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.0N	227+25	9026	10.26	8.66	7.39	6.11	5.02	3.54	2.19	98.9	0.8766	1,004
	227+75	8939	8.34	7.09	6.43	5.65	4.93	3.66	2.37	98.7	0.8803	1,218
	228+25	8873	8.00	6.67	6.11	5.50	4.69	3.76	2.75	96.3	0.8902	1,246
	228+75	8928	7.22	5.19	4.64	4.05	3.50	2.73	1.93	102.4	0.8450	1,463
	229+25	9048	9.39	7.45	6.65	5.56	4.56	3.33	2.25	105.2	0.8503	1,133
	229+75	8818	10.48	7.96	6.58	5.03	3.96	2.78	1.81	106.1	0.8338	1,009
	230+25	8994	9.82	7.13	6.10	5.14	4.37	3.33	2.30	104.7	0.8522	1,075
	230+75	9037	10.95	8.57	7.31	5.71	4.80	3.75	2.67	106	0.8575	962
	231+25	9026	9.76	8.04	7.24	6.51	5.69	4.44	3.12	101.7	0.8840	1,046
	231+75	8983	11.67	9.18	8.07	7.10	6.07	4.66	3.32	106.9	0.8736	881
2.1N	232+25	8917	12.01	9.78	8.62	7.23	6.18	4.76	3.29	102.8	0.8870	837
	232+75	10461	15.22	10.78	9.98	8.07	6.71	4.99	3.50	102.3	0.8796	781
	233+25	8906	11.11	8.58	7.50	6.48	5.68	4.46	3.02	104	0.8784	913
	233+75	10089	15.81	11.80	10.34	8.65	7.25	5.43	3.71	97.9	0.9006	709
	234+25	8829	10.07	7.68	6.80	6.08	5.02	4.15	2.99	101.4	0.8808	995
	234+75	8895	15.17	11.28	8.17	7.46	6.33	5.08	3.64	108	0.8782	668
	235+25	9005	12.30	10.03	8.37	6.73	5.15	3.88	3.04	106.6	0.8578	853
	235+75	9969	10.38	8.15	7.39	6.22	5.16	3.96	2.86	96	0.8851	1,085
	236+25	8917	8.60	6.81	6.30	5.70	5.05	4.24	3.12	103.1	0.8762	1,183
	236+75	8961	7.17	5.37	4.93	4.48	4.03	3.33	2.39	90.5	0.8992	1,390
2.2N	237+25	10144	7.88	6.90	6.24	5.39	4.76	3.85	3.22	98	0.8749	1,471
	237+75	9881	16.68	12.89	10.82	8.66	6.84	5.04	3.68	102.8	0.8823	671
	238+25	8785	11.96	9.94	8.96	7.71	6.48	4.96	3.37	105.2	0.8838	831
	238+75	8818	10.60	8.59	7.63	6.33	5.02	3.65	2.39	106.9	0.8525	976
	239+25	8928	7.87	6.04	5.16	4.39	3.73	2.87	1.99	106.5	0.8315	1,364
	239+75	8818	11.96	8.54	7.19	5.71	4.55	3.22	2.34	108	0.8375	880
	240+25	8950	11.61	9.61	8.49	7.11	5.77	3.88	2.48	106.7	0.8568	900
	240+75	8972	7.80	6.78	6.37	5.86	5.36	4.31	3.04	103.4	0.8752	1,314
	241+25	8983	11.55	8.56	7.17	5.66	4.56	3.38	2.42	104	0.8531	912
	241+75	8906	10.95	8.61	7.55	6.32	5.07	3.62	2.40	107.4	0.8486	958

Table A2.3, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.3N	242+25	8972	8.24	6.44	5.78	5.05	4.37	3.45	2.47	106.6	0.8461	1,287
	242+75	8895	8.50	6.63	5.96	5.13	4.44	3.34	2.34	110.9	0.8297	1,261
	243+25	8972	9.73	7.74	7.08	6.10	5.21	3.85	2.36	105.5	0.8589	1,074
	243+75	8862	11.49	9.12	8.04	6.86	5.69	3.71	2.43	108.8	0.8463	911
	244+25	8939	9.21	6.93	5.99	5.06	4.27	3.25	2.39	109.3	0.8316	1,167
	244+75	8895	10.33	8.00	6.85	5.78	4.84	3.55	2.43	106.4	0.8494	1,014
	245+25	8796	13.89	9.92	9.04	6.91	5.25	3.36	2.65	106.9	0.8438	751
	245+75	8917	7.45	5.93	5.56	5.19	4.65	3.95	2.76	108.4	0.8522	1,404
	246+25	9048	8.28	6.54	6.07	5.56	4.95	4.07	2.84	106.5	0.8592	1,272
	246+75	9125	15.75	11.60	8.76	6.15	4.74	3.42	2.35	110.6	0.8294	699
2.4N	247+25	8873	8.17	4.63	3.13	1.99	1.46	1.05	0.84	110.1	0.7205	1,507
	247+75	8939	5.70	3.16	2.22	1.43	1.06	0.83	0.71	108.3	0.7072	2,217
	248+25	8994	8.63	6.56	6.09	5.57	5.06	4.15	2.86	109.7	0.8514	1,224
	248+75	8796	14.32	11.88	11.11	9.94	8.22	6.02	3.59	112.0	0.8819	697
	249+25	8862	15.91	12.50	10.74	8.70	7.22	5.07	3.21	112.0	0.8650	644
	249+75	8895	10.70	8.21	7.22	6.13	5.13	3.79	2.56	111.5	0.8381	992
	250+25	8983	17.47	13.98	12.48	10.69	8.53	5.54	3.42	110.7	0.8751	588
	250+75	8796	18.17	14.26	12.61	10.26	8.30	5.56	3.29	111.5	0.8753	553
	251+25	8950	12.29	10.44	9.40	7.26	5.98	4.27	2.70	109.0	0.8559	851
	251+75	8972	15.31	12.79	11.59	9.74	7.88	5.16	2.98	105.6	0.8816	665
2.5N	252+25	8906	24.81	18.96	15.65	11.10	8.19	4.55	2.76	111.1	0.8560	419
	252+75	8983	25.92	20.58	18.08	13.98	11.20	6.67	3.84	109.7	0.8936	388
	253+25	8764	20.17	17.10	14.14	11.89	9.93	7.06	3.96	109.5	0.9011	482
	253+75	8840	23.65	18.67	16.24	12.97	10.47	6.79	3.49	109.0	0.8979	416
	254+25	8862	10.46	8.83	7.99	7.04	5.91	3.91	2.37	105.4	0.8589	986
	254+75	8906	8.59	6.61	5.77	4.63	3.68	2.37	1.64	107.3	0.8067	1,285
	255+25	8873	6.46	4.94	4.38	3.77	3.20	2.41	1.69	108.9	0.8023	1,712
	255+75	9081	10.23	8.41	7.37	6.09	4.76	2.79	1.89	109.9	0.8102	1,096
	256+25	8774	8.86	7.15	6.46	5.67	4.83	3.59	2.38	109.4	0.8391	1,180
	256+75	9147	11.93	8.98	7.90	6.76	5.61	4.15	2.89	108.4	0.8517	900

Table A2.4 – Pre-Construction FWD Data for Test Location 2, Southbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.0S	227+25	8851	7.41	4.75	4.03	3.34	2.81	2.19	1.62	127.4	0.7209	1,657
	227+75	8818	8.13	5.26	4.60	3.97	3.47	2.72	1.91	125.9	0.7531	1,440
	228+25	8851	8.58	5.96	5.18	4.41	3.76	2.88	1.98	122.5	0.7710	1,338
	228+75	8950	7.37	5.02	4.26	3.49	2.96	2.24	1.63	122.8	0.7392	1,643
	229+25	8742	7.65	5.58	4.88	4.09	3.43	2.57	1.81	118.5	0.7733	1,478
	229+75	8961	6.71	4.46	3.94	3.48	3.09	2.46	1.72	124.5	0.7434	1,796
	230+25	8829	8.24	5.73	4.96	4.20	3.63	2.83	2.02	125.6	0.7580	1,414
	230+75	8939	6.66	4.76	4.35	3.94	3.56	2.97	2.18	124.6	0.7655	1,753
	231+25	8851	7.81	5.78	5.11	4.51	3.98	3.17	2.24	123.9	0.7767	1,459
	231+75	9147	10.00	7.38	6.57	5.77	5.07	3.95	2.66	124.4	0.7972	1,147
2.1S	232+25	8950	13.67	8.99	7.67	6.74	4.96	3.93	2.77	122.2	0.8056	813
	232+75	8796	10.20	7.76	6.63	5.79	5.01	3.91	2.75	119.6	0.8146	1,059
	233+25	8994	10.36	7.34	6.43	5.49	4.73	3.64	2.63	122.9	0.7937	1,094
	233+75	8906	9.43	6.26	5.34	4.73	4.09	3.30	2.39	121.2	0.7887	1,197
	234+25	8939	9.31	6.34	5.30	4.78	4.12	3.30	2.33	126.6	0.7707	1,246
	234+75	9103	10.06	6.55	5.00	4.44	3.85	3.01	2.19	127.1	0.7552	1,198
	235+25	9005	9.45	6.18	5.31	4.55	3.78	2.85	1.93	124.6	0.7583	1,257
	235+75	9026	8.64	5.90	5.22	4.36	3.64	2.79	1.82	120.8	0.7686	1,359
	236+25	8895	9.61	6.93	5.83	4.75	3.90	2.83	1.96	121.2	0.7704	1,201
	236+75	8928	11.08	7.22	5.93	4.97	4.19	3.12	2.23	123.9	0.7721	1,044
2.2S	237+25	8807	10.64	8.15	6.98	5.94	5.00	3.87	2.70	120.5	0.8094	1,023
	237+75	8840	13.43	9.80	8.31	7.34	6.30	4.82	3.25	120.9	0.8326	791
	238+25	9015	11.46	7.95	6.58	5.63	5.02	3.78	2.63	119.5	0.8069	975
	238+75	8862	10.15	6.64	5.89	5.01	4.18	3.02	1.98	123.3	0.7705	1,133
	239+25	8818	6.79	5.32	4.80	4.15	3.62	2.84	1.93	118.3	0.7810	1,663
	239+75	8862	11.50	7.80	6.01	4.79	4.20	2.96	2.05	124	0.7654	1,007
	240+25	8983	8.92	6.35	5.44	4.59	3.79	2.77	2.04	122.9	0.7595	1,326
	240+75	8884	7.85	5.59	4.95	4.36	3.84	3.06	2.20	119.6	0.7836	1,444
	241+25	8840	8.30	5.91	4.74	4.17	3.55	2.76	1.87	122.5	0.7621	1,398
	241+75	8829	7.95	5.02	4.24	3.58	3.09	2.37	1.62	121.6	0.7474	1,486

Table A2.4, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.3S	242+25	8906	8.54	5.63	4.92	4.22	3.68	2.85	2.06	120.2	0.7727	1,350
	242+75	8939	7.58	5.13	4.45	3.92	3.39	2.80	2.02	117.8	0.7786	1,515
	243+25	8829	10.11	6.72	5.51	4.47	3.74	2.83	2.06	119.4	0.7754	1,126
	243+75	8917	11.88	8.49	7.07	5.58	4.18	3.07	2.26	121.1	0.7776	965
	244+25	9180	10.72	8.14	7.37	6.43	5.54	4.24	2.77	121.0	0.8118	1,055
	244+75	8818	13.73	9.45	8.23	7.14	6.06	4.53	2.90	123.3	0.8176	786
	245+25	8972	17.23	12.45	10.45	8.95	7.26	5.09	3.30	122.7	0.8307	627
	245+75	8994	11.24	8.91	7.80	6.83	6.00	4.70	3.11	120.2	0.8278	967
	246+25	8851	8.46	7.03	6.59	6.01	5.41	4.47	3.24	116.7	0.8336	1,255
	246+75	8796	14.20	9.75	7.20	4.84	4.02	3.22	2.48	120.4	0.7862	788
2.4S	247+25	9169	10.91	6.36	4.48	2.76	1.83	1.22	1.00	119.6	0.6738	1,247
	247+75	8961	5.56	3.04	2.28	1.48	1.24	0.93	0.78	120.0	0.6445	2,501
	248+25	9005	12.28	7.74	5.91	4.28	3.24	2.38	1.81	122.7	0.7393	992
	248+75	8906	6.18	4.66	4.12	3.64	3.28	2.57	1.96	119.7	0.7606	1,895
	249+25	8939	7.31	5.69	4.99	4.35	3.77	3.00	2.04	118.2	0.7830	1,562
	249+75	8764	12.50	8.60	7.30	6.06	4.92	3.38	2.08	120.4	0.7914	886
	250+25	8851	13.91	9.35	6.78	5.69	4.40	3.05	2.15	121.6	0.7741	822
	250+75	8807	15.68	12.00	10.12	7.94	6.32	4.06	2.71	124.2	0.8005	702
	251+25	8796	13.83	10.09	8.23	6.24	5.11	3.50	2.11	121.3	0.7917	803
	251+75	9114	12.89	9.58	7.93	6.19	4.87	3.46	2.27	120.5	0.7887	897
2.5S	252+25	8961	11.82	8.70	7.16	5.25	4.15	2.56	1.81	121.3	0.7524	1,008
	252+75	8895	10.44	7.61	6.56	5.54	4.68	3.43	2.42	121.0	0.7886	1,080
	253+25	8753	8.52	5.97	5.11	4.27	3.73	2.97	2.15	122.2	0.7693	1,335
	253+75	8829	10.89	8.00	6.77	5.06	4.00	2.87	1.75	121.0	0.7682	1,055
	254+25	8796	11.39	8.32	7.11	5.74	4.64	3.30	2.26	119.6	0.7895	978
	254+75	8851	10.69	8.45	7.30	5.82	4.26	2.67	1.89	118.5	0.7682	1,078
	255+25	8994	10.54	8.17	6.90	5.58	4.31	2.63	1.83	117.0	0.7700	1,108
	255+75	9026	11.86	9.41	8.27	6.95	5.95	4.09	2.45	120.2	0.8090	941
	256+25	8796	7.17	5.43	5.00	4.43	3.94	3.18	2.35	121.0	0.7800	1,573
	256+75	8687	9.20	7.24	6.35	5.29	4.46	3.53	2.45	119.2	0.7993	1,181

APPENDIX 3

POST-CONSTRUCTION FWD DATA

(6-month)

Table A3.1 – Post-Construction FWD Data for Test Location 1, Northbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 Mils	D36 mils	D60 mils	Temp °F	TAF	ISM kip/in
1.0N	155+25	8873	4.84	4.25	4.08	3.83	3.61	3.15	2.47	91.1	0.9322	1,967
	155+75	8873	5.21	4.63	4.41	4.15	3.91	3.41	2.59	95.8	0.9199	1,851
	156+25	8840	3.34	3.01	2.86	2.74	2.62	2.35	1.94	87.6	0.9346	2,832
	156+75	8895	3.94	3.52	3.37	3.20	3.03	2.65	2.09	91.8	0.9225	2,447
	157+25	8873	4.83	4.34	4.13	3.91	3.64	3.15	2.44	86.7	0.9472	1,939
	157+75	8807	3.11	2.79	2.68	2.57	2.45	2.21	1.79	88.2	0.9301	3,045
	158+25	8873	3.08	2.74	2.65	2.56	2.47	2.24	1.87	87.5	0.9331	3,087
	158+75	8851	3.57	3.30	3.18	3.07	2.93	2.60	2.09	91.3	0.9237	2,684
	159+25	8873	6.00	5.50	5.24	4.90	4.48	3.81	2.93	99.2	0.9147	1,617
	159+75	8862	5.26	4.81	4.63	4.37	4.03	3.31	2.35	97.3	0.9134	1,845
1.1N	160+25	8840	6.56	5.40	4.91	4.44	4.00	3.26	2.34	99.6	0.9051	1,489
	160+75	8873	3.54	2.94	2.76	2.63	2.50	2.23	1.77	95.4	0.9004	2,784
	161+25	8851	3.36	2.80	2.60	2.46	2.39	2.22	1.87	95.0	0.9019	2,921
	161+75	8764	3.59	2.93	2.80	2.65	2.61	2.32	1.84	96.6	0.8982	2,718
	162+25	8818	4.07	3.28	3.03	2.87	2.70	2.34	1.84	98.2	0.8920	2,429
	162+75	8862	3.80	2.99	2.74	2.57	2.39	2.10	1.67	98.3	0.8854	2,634
	163+25	8862	2.83	2.12	2.01	1.90	1.84	1.68	1.40	96.8	0.8798	3,559
	163+75	8807	2.99	2.27	2.12	2.01	1.98	1.74	1.46	90.4	0.9109	3,233
	164+25	8796	3.07	2.28	2.19	2.10	2.00	1.78	1.42	97.8	0.8787	3,261
	164+75	8840	2.98	2.37	2.24	2.13	2.03	1.87	1.49	97.4	0.8828	3,360
1.2N	165+25	8840	2.44	2.05	1.94	1.86	1.80	1.68	1.42	94.3	0.8911	4,066
	165+75	8807	2.51	2.15	2.07	1.98	1.93	1.73	1.46	96.2	0.8841	3,969
	166+25	8862	2.62	2.02	1.96	1.91	1.82	1.64	1.33	97.8	0.8736	3,872
	166+75	8818	2.93	2.33	2.26	2.22	2.12	1.92	1.58	96.1	0.8897	3,382
	167+25	8862	3.24	2.74	2.63	2.52	2.40	2.22	1.83	96.6	0.8948	3,057
	167+75	8884	4.66	4.06	3.97	3.82	3.62	3.20	2.52	97.0	0.9119	2,091
	168+25	8873	3.31	2.72	2.69	2.59	2.53	2.28	1.87	96.5	0.8965	2,990
	168+75	8829	3.69	3.26	3.15	2.96	2.81	2.56	2.03	97.0	0.9007	2,656
	169+25	8851	4.42	3.81	3.52	3.25	3.02	2.62	1.98	98.2	0.8973	2,232
	169+75	8873	3.89	3.28	3.13	2.97	2.80	2.45	1.89	97.5	0.8961	2,545

Note: In all FWD tables, the ISM values shown are temperature-adjusted.

Table A3.1, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp °F	TAF	ISM kip/in
1.3N	170+25	8840	4.20	3.70	3.57	3.39	3.22	2.88	2.25	96.6	0.9080	2,318
	170+75	8818	7.36	6.77	6.33	5.72	5.10	4.08	2.89	93.6	0.9341	1,283
	171+25	8939	12.18	11.00	10.21	9.04	7.85	5.94	3.77	99.8	0.9351	785
	171+75	8873	9.89	9.07	8.56	7.79	6.91	5.43	3.56	99.0	0.9328	962
	172+25	8939	10.82	9.89	9.26	8.40	7.50	5.87	3.80	100.1	0.9338	885
	172+75	8873	12.73	11.70	11.04	10.02	8.96	7.05	4.48	102.8	0.9382	743
	173+25	8851	9.73	8.94	8.44	7.77	6.95	5.56	3.68	103.8	0.9227	986
	173+75	8807	10.54	9.11	8.20	7.18	6.20	4.80	3.32	102.9	0.9166	912
	174+25	8884	7.91	6.91	6.39	5.72	5.01	3.87	2.57	104.0	0.8999	1,248
	174+75	8895	7.03	6.12	5.69	5.19	4.64	3.71	2.63	102.3	0.9024	1,402
1.4N	175+25	8862	4.59	3.93	3.69	3.46	3.23	2.74	2.08	103.1	0.8813	2,191
	175+75	8862	4.85	4.20	3.98	3.72	3.41	2.92	2.16	101.7	0.8901	2,053
	176+25	8785	4.85	4.27	4.02	3.77	3.47	2.95	2.20	99.7	0.8981	2,017
	176+75	8807	4.28	3.72	3.48	3.23	3.00	2.56	1.96	103.4	0.8761	2,349
	177+25	8906	4.88	4.24	3.94	3.60	3.27	2.70	1.96	104.0	0.8765	2,082
	177+75	8895	5.34	4.44	3.96	3.50	3.13	2.51	1.76	104.2	0.8710	1,912
	178+25	8840	5.20	4.35	3.98	3.50	3.13	2.50	1.81	103.7	0.8730	1,947
	178+75	8895	5.21	4.31	3.90	3.46	3.07	2.47	1.84	103.8	0.8714	1,959
	179+25	8873	5.33	4.65	4.35	3.96	3.56	2.86	2.12	105.3	0.8757	1,901
	179+75	8851	4.63	4.03	3.80	3.56	3.30	2.80	2.07	105.7	0.8729	2,190
1.5N	180+25	8939	6.22	5.41	5.02	4.52	4.07	3.30	2.33	105.5	0.8839	1,626
	180+75	8884	7.48	6.67	6.21	5.58	4.91	3.70	2.54	104.5	0.8949	1,327
	181+25	8873	6.41	5.85	5.52	5.12	4.67	3.88	2.76	105.0	0.8965	1,544
	181+75	8862	7.00	6.42	6.11	5.72	5.27	4.41	3.07	105.2	0.9042	1,400
	182+25	8895	9.31	8.45	7.87	7.06	6.24	5.06	3.49	104.5	0.9143	1,045
	182+75	8895	9.94	8.89	8.20	7.37	6.63	5.47	3.80	105.9	0.9157	977
	183+25	8785	8.86	8.37	7.98	7.41	6.81	5.83	4.34	105.2	0.9220	1,075
	183+75	8884	12.43	11.50	10.80	9.91	8.89	7.28	5.05	105.5	0.9340	765
	184+25	8884	10.12	9.51	9.11	8.57	7.92	6.72	4.95	104.6	0.9310	943
	184+75	8939	15.13	13.82	12.80	11.56	10.22	8.17	5.57	106.1	0.9393	629

Table A3.2 – Post-Construction FWD Data for Test Location 1, Southbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
1.0S	155+25	8873	10.55	9.46	8.94	8.27	7.52	6.01	3.98	112.9	0.9061	928
	155+75	8785	11.81	10.76	10.03	9.09	8.23	6.67	4.53	111.9	0.9164	812
	156+25	8851	9.25	8.09	7.48	6.75	6.03	4.84	3.36	112.4	0.8912	1,074
	156+75	8862	15.36	13.32	12.07	10.38	8.67	6.22	4.15	112.6	0.9092	635
	157+25	8873	11.17	9.42	8.54	7.54	6.63	5.26	3.61	112.8	0.8962	886
	157+75	8862	8.37	7.37	6.79	6.02	5.30	4.17	2.90	112.8	0.8784	1,205
	158+25	8851	13.04	11.20	10.06	8.66	7.39	5.62	3.73	112.4	0.9021	752
	158+75	8873	10.31	9.13	8.43	7.48	6.46	4.89	3.37	113.0	0.8899	967
	159+25	8939	14.81	12.65	11.17	9.22	7.52	5.30	3.56	112.9	0.8957	674
	159+75	8862	13.11	11.40	10.46	9.25	7.96	5.87	3.66	113.0	0.9038	748
1.1S	160+25	8862	10.70	8.65	7.65	6.75	5.83	4.41	3.01	112.4	0.8835	937
	160+75	8818	11.04	8.71	7.56	6.50	5.63	4.39	2.99	112.8	0.8824	905
	161+25	8862	10.00	8.32	7.57	6.77	6.02	4.76	3.15	112.3	0.8895	996
	161+75	8906	8.91	7.53	6.93	6.36	5.74	4.70	3.28	111.8	0.8894	1,124
	162+25	8873	10.22	8.87	8.15	7.39	6.60	5.04	3.13	112.9	0.8921	973
	162+75	8950	9.26	8.02	7.49	6.87	6.20	4.83	3.26	112.5	0.8892	1,087
	163+25	8895	7.25	5.82	5.27	4.76	4.29	3.46	2.42	112.7	0.8630	1,422
	163+75	8873	11.81	9.79	8.47	6.93	5.70	4.27	2.96	112.2	0.8811	853
	164+25	8873	15.21	13.19	11.94	10.34	8.77	6.20	3.40	112.7	0.9079	643
	164+75	8917	10.74	8.83	7.93	6.95	6.06	4.65	3.16	110.5	0.8916	931
1.2S	165+25	8906	10.86	9.69	9.10	8.33	7.44	5.89	3.91	110.3	0.9092	902
	165+75	8884	10.47	9.43	8.98	8.39	7.72	6.44	4.38	110.3	0.9155	927
	166+25	8906	9.54	8.61	8.16	7.50	6.81	5.56	3.73	110.8	0.9038	1,033
	166+75	8961	7.80	7.02	6.74	6.37	5.94	5.08	3.57	110.6	0.8972	1,280
	167+25	8906	10.46	9.54	9.12	8.57	7.88	6.55	4.42	110.3	0.9164	929
	167+75	8961	10.94	9.83	9.28	8.61	7.85	6.52	4.54	110.7	0.9147	895
	168+25	8939	10.66	9.81	9.36	8.71	7.93	6.52	4.51	110.9	0.9144	917
	168+75	8862	9.81	8.99	8.57	8.05	7.41	6.23	4.33	111.3	0.9109	992
	169+25	8917	6.46	5.64	5.40	5.14	4.83	4.22	3.22	112.7	0.8776	1,573
	169+75	8862	10.25	8.75	7.96	6.93	5.91	4.39	2.82	113.6	0.8786	984

Table A3.2, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
1.3S	170+25	8917	8.87	7.70	7.13	6.35	5.57	4.33	2.87	113.1	0.8783	1,145
	170+75	8873	6.67	5.68	5.35	4.95	4.50	3.77	2.68	111.8	0.8715	1,526
	171+25	8906	5.02	4.34	4.13	3.87	3.57	3.03	2.18	111.3	0.8556	2,073
	171+75	8939	5.48	4.80	4.61	4.40	4.11	3.63	2.73	113.4	0.8629	1,890
	172+25	8873	5.15	4.45	4.28	4.04	3.79	3.30	2.53	113.2	0.8563	2,012
	172+75	8884	4.48	3.81	3.66	3.45	3.26	2.87	2.24	111.7	0.8499	2,333
	173+25	8884	5.29	4.67	4.44	4.15	3.80	3.19	2.35	110.4	0.8625	1,947
	173+75	8906	4.94	4.32	4.10	3.88	3.60	3.10	2.34	110.4	0.8600	2,096
	174+25	8851	5.22	4.39	4.17	3.90	3.56	3.01	2.21	110.1	0.8591	1,974
	174+75	8862	6.29	5.26	4.86	4.41	3.93	3.18	2.28	109.3	0.8658	1,627
1.4S	175+25	8807	7.61	6.41	5.89	5.29	4.67	3.69	2.50	110.5	0.8737	1,325
	175+75	8862	6.98	5.95	5.56	5.09	4.58	3.75	2.60	108.6	0.8801	1,443
	176+25	8884	8.82	7.41	6.77	5.98	5.23	3.97	2.61	107.8	0.8864	1,136
	176+75	8829	8.35	7.04	6.44	5.68	4.96	3.87	2.76	108.1	0.8840	1,196
	177+25	8862	7.69	6.41	5.85	5.13	4.47	3.40	2.33	110.4	0.8669	1,329
	177+75	8873	8.57	6.95	6.14	5.16	4.36	3.30	2.32	109.5	0.8673	1,194
	178+25	8884	9.69	7.28	6.05	4.72	3.83	2.81	2.06	109.9	0.8534	1,074
	178+75	8796	9.00	7.09	6.12	5.06	4.17	3.07	2.20	109.3	0.8630	1,133
	179+25	8906	10.25	7.74	6.39	4.98	4.03	3.05	2.27	108.6	0.8638	1,006
	179+75	8917	10.99	8.38	6.97	5.49	4.43	3.26	2.36	107.5	0.8723	930
1.5S	180+25	8873	12.78	9.52	7.60	5.61	4.42	3.27	2.45	108.6	0.8691	799
	180+75	8862	12.94	10.46	8.71	6.87	5.57	4.10	2.86	108.8	0.8852	774
	181+25	8884	11.63	9.95	8.78	7.37	6.14	4.49	2.99	108.3	0.8929	856
	181+75	8851	13.02	10.77	9.48	8.00	6.73	5.01	3.34	109.8	0.8970	758
	182+25	8873	15.20	13.04	11.37	9.51	7.95	5.98	4.10	108.0	0.9136	639
	182+75	8851	12.22	10.32	9.11	7.70	6.49	4.91	3.37	110.3	0.8941	810
	183+25	8862	14.67	12.22	10.83	9.26	7.89	6.05	4.04	108.2	0.9139	661
	183+75	8950	15.93	13.69	12.03	9.97	8.26	6.18	4.05	107.2	0.9168	613
	184+25	8829	13.76	12.29	11.39	10.28	9.13	7.31	4.92	106.9	0.9292	691
	184+75	8884	16.76	14.55	13.14	11.55	10.07	7.87	5.20	104.8	0.9372	566

Table A3.3 – Post-Construction FWD Data for Test Location 2, Northbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.0N	227+25	8878	5.31	4.62	4.15	3.56	3.10	2.37	1.61	85.5	0.9297	1,798
	227+75	8841	5.06	4.41	4.07	3.68	3.30	2.62	1.83	87.2	0.9266	1,886
	228+25	8886	4.82	4.19	3.83	3.50	3.11	2.51	1.81	85.1	0.9331	1,976
	228+75	8846	4.64	4.04	3.76	3.38	3.04	2.44	1.78	88.2	0.9194	2,074
	229+25	8849	6.11	5.27	4.73	4.09	3.52	2.68	1.84	88.3	0.9227	1,570
	229+75	8878	7.39	6.21	5.36	4.46	3.66	2.76	1.92	88.6	0.9225	1,302
	230+25	8881	6.30	5.40	4.80	4.13	3.56	2.78	2.01	87.6	0.9266	1,521
	230+75	8905	6.30	5.45	4.94	4.29	3.73	2.97	2.19	86.1	0.9346	1,512
	231+25	8878	5.52	4.84	4.52	4.10	3.72	3.06	2.22	85.6	0.9375	1,715
	231+75	8814	5.59	4.99	4.67	4.30	3.94	3.30	2.49	85.6	0.9404	1,677
2.1N	232+25	8778	4.81	4.04	3.81	3.58	3.36	2.91	2.25	84.9	0.9386	1,944
	232+75	8802	5.28	4.40	4.00	3.72	3.43	2.92	2.24	85.6	0.9358	1,781
	233+25	8862	5.72	4.70	4.28	3.90	3.56	2.95	2.20	86.7	0.9317	1,663
	233+75	8841	5.12	4.27	3.94	3.66	3.40	2.91	2.28	84	0.9414	1,834
	234+25	8830	3.98	3.26	3.05	2.90	2.74	2.42	1.94	85.3	0.9297	2,386
	234+75	8802	4.46	3.79	3.56	3.30	3.07	2.63	2.03	87.8	0.9228	2,139
	235+25	8810	4.83	4.00	3.68	3.41	3.14	2.68	2.07	87.2	0.9258	1,970
	235+75	8862	4.96	4.12	3.85	3.62	3.37	2.92	2.28	86.8	0.9303	1,920
	236+25	8865	5.24	4.18	3.76	3.44	3.17	2.67	2.05	87.9	0.9223	1,834
	236+75	8862	4.32	3.35	3.01	2.82	2.63	2.28	1.74	90.8	0.9032	2,271
2.2N	237+25	8854	3.25	2.76	2.56	2.46	2.30	2.11	1.77	84.6	0.9269	2,939
	237+75	8818	5.52	4.78	4.43	4.06	3.70	3.10	2.37	92.1	0.9132	1,749
	238+25	8870	5.75	5.07	4.69	4.31	3.91	3.26	2.37	91.4	0.9177	1,681
	238+75	8873	6.43	5.60	4.78	4.01	3.51	2.76	1.95	92.3	0.9060	1,523
	239+25	8862	4.69	3.87	3.54	3.19	2.86	2.28	1.66	92.8	0.8941	2,113
	239+75	8794	4.29	3.59	3.30	3.01	2.74	2.22	1.65	94.1	0.8874	2,310
	240+25	8846	5.13	4.38	4.00	3.59	3.17	2.44	1.70	93.1	0.8962	1,924
	240+75	8889	3.81	3.35	3.13	2.95	2.80	2.47	1.96	92.2	0.9001	2,592
	241+25	8810	4.75	4.07	3.69	3.32	2.95	2.37	1.75	92.9	0.8954	2,071
	241+75	8857	6.22	5.08	4.57	3.98	3.46	2.67	1.86	92.1	0.9044	1,574

Table A3.3, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.3N	242+25	8857	4.47	3.91	3.64	3.36	3.05	2.54	1.91	91.6	0.9038	2,192
	242+75	8886	5.22	4.59	4.22	3.77	3.33	2.62	1.85	90.6	0.9090	1,873
	243+25	8865	5.43	4.62	4.24	3.73	3.33	2.63	1.86	91.0	0.9076	1,799
	243+75	8865	5.91	5.14	4.78	4.32	3.85	3.00	2.13	93.9	0.9032	1,661
	244+25	8897	5.78	5.02	4.56	4.03	3.55	2.84	2.09	93.6	0.9010	1,708
	244+75	8838	7.78	6.62	5.89	5.01	4.26	3.20	2.21	92.8	0.9105	1,248
	245+25	8889	7.24	6.25	5.68	4.94	4.26	3.11	2.12	93.0	0.9078	1,352
	245+75	8775	5.19	4.61	4.36	4.09	3.81	3.28	2.46	93.0	0.9112	1,856
	246+25	8865	5.93	5.35	5.08	4.74	4.38	3.69	2.69	94.6	0.9113	1,640
	246+75	8897	11.40	9.41	7.90	6.09	4.67	3.08	2.10	96.2	0.8953	872
2.4N	247+25	8881	5.40	3.98	3.11	2.18	1.57	1.05	0.81	96.8	0.8261	1,991
	247+75	8838	3.63	2.49	1.89	1.35	1.02	0.77	0.65	94.1	0.8234	2,957
	248+25	8881	8.25	6.56	5.89	5.33	4.83	3.98	2.74	98.1	0.9039	1,191
	248+75	8865	6.47	5.84	5.47	5.02	4.57	3.74	2.59	97.5	0.9021	1,519
	249+25	8825	8.00	7.04	6.50	5.74	4.98	3.78	2.54	96.9	0.9048	1,219
	249+75	8865	6.64	5.52	4.99	4.42	3.89	3.09	2.15	94.0	0.9029	1,479
	250+25	8825	8.16	7.44	6.89	6.10	5.28	4.00	2.51	96.7	0.9085	1,190
	250+75	8833	7.59	6.61	6.05	5.31	4.61	3.52	2.32	96.8	0.9005	1,292
	251+25	8849	7.57	6.25	5.66	4.96	4.32	3.32	2.26	95.8	0.9002	1,298
	251+75	8870	9.83	8.67	7.81	6.69	5.65	4.09	2.53	94.0	0.9175	983
2.5N	252+25	8849	9.38	8.20	7.39	6.26	5.24	3.65	2.29	95.1	0.9078	1,039
	252+75	8894	12.33	11.21	10.04	8.63	7.36	5.35	3.20	92.7	0.9346	772
	253+25	8862	12.86	11.21	10.23	9.07	7.83	5.81	3.46	93.2	0.9374	735
	253+75	8881	12.67	11.31	10.28	8.86	7.46	5.41	3.17	94.9	0.9294	754
	254+25	8818	6.97	5.97	5.46	4.91	4.36	3.38	2.21	94.7	0.9045	1,399
	254+75	8810	8.15	6.57	5.57	4.37	3.44	2.37	1.68	93.9	0.8874	1,218
	255+25	8862	6.20	5.19	4.58	3.86	3.26	2.42	1.71	92.9	0.8922	1,602
	255+75	8849	9.19	7.85	6.83	5.04	3.90	2.70	1.87	94.2	0.8931	1,078
	256+25	8894	7.52	6.35	5.72	4.99	4.39	3.36	2.20	94.6	0.9036	1,309
	256+75	8814	8.59	7.36	6.53	5.43	4.54	3.26	2.28	95.6	0.8987	1,142

Table A3.4 – Post-Construction FWD Data for Test Location 2, Southbound Lane

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.0S	227+25	8884	6.82	5.28	4.50	3.70	3.11	2.32	1.68	107.6	0.8286	1,572
	227+75	8862	6.17	5.00	4.48	3.88	3.36	2.60	1.82	107.3	0.8392	1,712
	228+25	8884	7.54	6.18	5.40	4.49	3.74	2.76	1.97	109.5	0.8355	1,410
	228+75	8906	7.30	5.71	4.87	3.96	3.21	2.31	1.69	110.0	0.8179	1,492
	229+25	8862	7.02	5.60	4.81	3.92	3.31	2.48	1.75	110.7	0.8216	1,537
	229+75	8862	5.59	4.41	3.92	3.39	2.96	2.31	1.69	110.8	0.8148	1,946
	230+25	8796	6.38	5.15	4.58	3.97	3.43	2.67	1.91	110.7	0.8284	1,664
	230+75	8807	5.45	4.23	3.92	3.58	3.28	2.74	2.06	109.3	0.8356	1,934
	231+25	8873	5.46	4.55	4.19	3.82	3.46	2.83	2.09	110.3	0.8339	1,949
	231+75	8873	6.04	5.16	4.80	4.40	3.99	3.31	2.41	110.1	0.8480	1,732
2.1S	232+25	8917	6.10	4.96	4.57	4.20	3.85	3.27	2.37	109.0	0.8502	1,719
	232+75	8884	5.95	4.84	4.43	4.02	3.68	3.19	2.42	108.4	0.8504	1,756
	233+25	8862	7.26	5.50	4.86	4.32	3.85	3.12	2.26	108.0	0.8500	1,436
	233+75	8884	5.36	4.26	4.00	3.58	3.35	2.86	2.24	106.6	0.8476	1,956
	234+25	8884	5.99	4.63	4.16	3.72	3.37	2.75	2.02	106.6	0.8442	1,757
	234+75	8906	6.78	5.24	4.63	4.08	3.58	2.82	2.05	106.2	0.8474	1,550
	235+25	8917	7.58	5.90	5.17	4.49	3.89	3.04	2.20	105.6	0.8554	1,375
	235+75	8862	7.08	5.33	4.65	4.06	3.54	2.85	2.14	106.6	0.8469	1,478
	236+25	8895	7.00	5.53	4.83	4.17	3.61	2.78	1.93	107.5	0.8411	1,511
	236+75	8862	7.50	5.65	4.93	4.29	3.73	2.90	2.08	106.5	0.8484	1,393
2.2S	237+25	8884	6.75	5.70	5.22	4.61	4.11	3.36	2.41	105.3	0.8640	1,523
	237+75	8939	6.04	5.06	4.67	4.20	3.88	3.26	2.48	104.3	0.8645	1,712
	238+25	8818	5.88	4.94	4.53	4.07	3.65	2.95	2.16	105.1	0.8548	1,754
	238+75	8873	5.60	4.49	4.06	3.60	3.17	2.51	1.78	105.1	0.8414	1,883
	239+25	8917	4.51	3.53	3.23	2.93	2.66	2.22	1.68	104.7	0.8327	2,374
	239+75	8840	6.19	4.84	4.11	3.54	3.07	2.38	1.74	104.9	0.8380	1,704
	240+25	8851	5.19	4.14	3.74	3.30	2.96	2.40	1.76	103.4	0.8444	2,020
	240+75	8829	4.70	3.87	3.58	3.24	2.96	2.51	1.89	102.8	0.8503	2,209
	241+25	8862	5.78	4.65	4.14	3.62	3.17	2.49	1.81	102.7	0.8497	1,805
	241+75	8829	4.91	4.02	3.63	3.19	2.80	2.20	1.55	102.7	0.8404	2,140

Table A3.4, continued

Sect.	Station ft	Load lbf	D0 mils	D8 mils	D12 mils	D18 mils	D24 mils	D36 mils	D60 mils	Temp ºF	TAF	ISM kip/in
2.3S	242+25	8895	5.65	4.79	4.30	3.83	3.39	2.72	1.95	102.8	0.8554	1,841
	242+75	8840	5.08	4.18	3.80	3.41	3.04	2.47	1.89	103	0.8476	2,053
	243+25	8840	6.88	5.67	4.93	4.21	3.57	2.79	2.08	101.8	0.8612	1,492
	243+75	8774	8.02	6.54	5.69	4.75	4.01	2.95	2.04	102.6	0.8628	1,268
	244+25	8818	6.55	5.74	5.32	4.83	4.34	3.46	2.38	101.7	0.8772	1,535
	244+75	8840	8.37	7.33	6.78	6.04	5.37	4.28	2.92	101.7	0.8921	1,184
	245+25	8862	8.62	7.37	6.74	5.97	5.25	4.11	2.78	101.5	0.8895	1,156
	245+75	8917	6.64	5.86	5.52	5.06	4.59	3.80	2.76	101.9	0.8821	1,522
	246+25	8862	6.91	6.19	5.86	5.41	4.97	4.13	3.04	101.6	0.8893	1,442
	246+75	8829	10.94	8.68	7.21	5.54	4.32	2.94	2.23	102.7	0.8609	937
2.4S	247+25	8774	7.93	5.37	3.63	2.18	1.44	0.96	0.81	103.4	0.7709	1,435
	247+75	8829	4.13	2.82	2.15	1.51	1.14	0.86	0.69	102.7	0.7657	2,792
	248+25	8807	6.90	5.54	4.94	4.17	3.30	2.43	1.79	101.5	0.8510	1,500
	248+75	8873	5.92	4.73	4.24	3.73	3.31	2.67	1.95	100.4	0.8616	1,740
	249+25	8862	7.52	6.25	5.60	4.85	4.21	3.24	2.20	100.8	0.8740	1,348
	249+75	8906	10.78	8.87	7.71	6.34	5.18	3.56	2.25	100.9	0.8799	939
	250+25	8884	9.84	7.85	6.70	5.41	4.39	3.17	2.22	100.6	0.8727	1,035
	250+75	8961	13.18	10.95	9.42	7.49	5.93	3.81	2.43	101.1	0.8833	770
	251+25	8862	11.22	9.00	7.78	6.46	5.42	3.98	2.85	100.4	0.8893	888
	251+75	8895	10.16	8.34	7.17	5.86	4.79	3.43	2.24	101	0.8764	999
2.5S	252+25	8884	8.91	7.28	6.20	5.00	4.03	2.85	1.94	102.6	0.8569	1,164
	252+75	8851	8.20	6.81	6.09	5.18	4.34	3.18	2.30	101.6	0.8689	1,242
	253+25	8862	7.94	6.40	5.56	4.66	3.94	3.01	2.16	100	0.8705	1,282
	253+75	8895	9.39	7.52	6.26	4.90	3.93	2.79	2.07	100.6	0.8624	1,098
	254+25	8851	8.86	7.47	6.52	5.41	4.51	3.28	2.27	100.6	0.8743	1,143
	254+75	8884	12.11	9.34	7.41	5.37	4.00	2.57	1.78	101	0.8546	858
	255+25	8873	9.13	7.11	6.07	4.83	3.77	2.51	1.74	102	0.8488	1,145
	255+75	8796	9.70	8.36	7.51	6.38	5.28	3.70	2.19	100.5	0.8834	1,027
	256+25	8895	5.34	4.64	4.31	3.92	3.51	2.85	2.08	100.4	0.8640	1,928
	256+75	8851	6.84	5.83	5.25	4.57	3.93	3.04	2.17	99.8	0.8711	1,485

APPENDIX 4

RIDE, RUT AND CRACKING DATA

(Pre-construction)

Table A4.1 - Ride Data for Northbound Lane, both Test Locations

Section	Miles From	Miles To	Rough Dist.	Average Rut in	Rut Std.	IRI 1 in/mi	IRI 2 in/mi	Avg. IRI in/mi
1.0	22.609	22.639	0.030	0.71	0.250	339	358	348
1.1	22.639	22.799	0.160	0.46	0.450	274	341	307
1.2	22.799	22.893	0.094	0.30	0.351	207	227	217
1.3	22.893	22.988	0.095	0.71	0.253	243	266	254
1.4	22.988	23.083	0.095	0.41	0.256	175	149	162
1.5	23.083	23.177	0.094	0.67	0.173	205	311	258
2.0	23.973	24.067	0.094	0.31	0.130	178	266	222
2.1	24.067	24.162	0.095	0.49	0.261	246	485	365
2.2	24.162	24.257	0.095	0.40	0.149	175	355	265
2.3	24.257	24.352	0.095	0.38	0.152	186	230	208
2.4	24.352	24.446	0.094	0.58	0.259	225	260	242
2.5	24.446	24.541	0.095	0.41	0.157	194	182	188
Totals	22.609	24.728	1.136	0.47	0.298	217	285	251

Table A4.2 - Ride Data for Southbound Lane, both Test Locations

Section	Miles From	Miles To	Rough Dist.	Average Rut in	Rut Std.	IRI 1 in/mi	IRI 2 in/mi	Avg. IRI in/mi
1.0	22.639	22.609	0.019	0.20	0.142	249	174	212
1.1	22.799	22.639	0.160	0.42	0.211	327	225	276
1.2	22.893	22.799	0.094	0.56	0.261	442	142	292
1.3	22.988	22.893	0.095	0.28	0.227	270	199	235
1.4	23.083	22.988	0.095	0.41	0.169	215	184	199
1.5	23.177	23.083	0.094	0.36	0.199	244	208	226
2.0	24.067	23.973	0.094	0.35	0.188	169	147	158
2.1	24.162	24.067	0.095	0.21	0.165	166	154	160
2.2	24.257	24.162	0.095	0.35	0.126	171	182	176
2.3	24.352	24.257	0.095	0.32	0.226	228	227	227
2.4	24.446	24.352	0.094	0.16	0.153	238	236	237
2.5	24.541	24.446	0.095	0.48	0.149	338	179	258
Totals	24.541	22.609	1.124	0.35	0.221	259	191	225

Table A4.3 - Rut and Cracking Data for Test Location 1

Section 1.0	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
155+25	0.36	0.38		
155+75	0.63	0.23	500	600
156+25	0.40	0.38	550	600
156+75	0.32	0.36	500	600
157+25	0.90	0.41	600	550
157+75	0.40	0.71	500	600
158+25	0.34	0.39	500	600
158+75	0.22	0.27	550	600
159+25	0.71	0.30	550	600
159+75	0.44	0.29	550	600
Total Rut	4.72	3.72		
Average Rut	0.47	0.37		
	Total Cracking:		4800	5350
	sq. ft./ 1000 sq. ft.		888.9	990.7

Section 1.1	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
160+25	1.59	0.36		
160+75	0.48	0.58	550	600
161+25	0.22	0.44	600	550
161+75	0.12	0.21	500	550
162+25	0.15	0.13	500	550
162+75	0.16	0.30	450	550
163+25	0.23	0.63	450	550
163+75	0.16	0.20	450	600
164+25	0.19	0.52	450	600
164+75	0.27	0.34	500	600
Total Rut	3.57	3.71		
Average Rut	0.36	0.37		
	Total Cracking:		4450	5150
	sq. ft./ 1000 sq. ft.		824.1	953.7

Table A4.3, continued

Section 1.2	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
165+25	0.27	0.10		
165+75	0.48	0.05	500	600
166+25	0.07	0.08	500	600
166+75	0.19	0.14	250	600
167+25	0.24	0.25	400	600
167+75	0.20	0.16	500	600
168+25	0.74	0.02	600	600
168+75	0.38	0.13	500	600
169+25	0.42	0.19	600	600
169+75	0.69	0.24	550	600
Total Rut	3.68	1.36		
Average Rut	0.37	0.14		
	Total Cracking:		4400	6000
	sq. ft./ 1000 sq. ft.		814.8	1000.0

Section 1.3	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
170+25	0.96	0.10		
170+75	0.97	0.13	550	550
171+25	0.80	0.16	550	500
171+75	0.58	0.15	500	500
172+25	0.30	0.24	550	550
172+75	0.17	0.28	550	600
173+25	0.36	0.26	550	600
173+75	1.09	0.94	550	600
174+25	0.30	0.68	550	600
174+75	0.38	0.42	500	600
Total Rut	5.91	3.36		
Average Rut	0.59	0.34		
	Total Cracking:		4850	5000
	sq. ft./ 1000 sq. ft.		898.1	925.9

Table A4.3, continued

Section 1.4	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
175+25	0.38	0.14		
175+75	0.41	0.43	350	550
176+25	0.59	0.33	500	50
176+75	0.41	0.40	450	550
177+25	0.38	0.57	350	600
177+75	0.38	0.31	300	600
178+25	0.77	0.32	500	600
178+75	1.02	0.50	500	600
179+25	1.02	0.30	550	600
179+75	0.60	0.27	500	600
Total Rut	5.96	3.57		
Average Rut	0.60	0.36		
	Total Cracking:		4000	5250
	sq. ft./ 1000 sq. ft.		740.7	972.2

Section 1.5	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
180+25	1.36	0.25		
180+75	1.45	0.34	600	600
181+25	0.68	0.37	550	550
181+75	0.90	0.56	500	600
182+25	1.35	0.29	550	500
182+75	0.80	0.28	600	500
183+25	0.77	0.26	550	550
183+75	0.86	0.33	550	600
184+25	1.01	0.32	550	550
184+75	0.89	0.25	550	600
Total Rut	10.07			
Average Rut	1.01	0.34		
	Total Cracking:		5000	5050
	sq. ft./ 1000 sq. ft.		925.9	935.2

Table A4.4 - Rut and Cracking Data for Test Location 2

Section 2.0	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
227+25	0.44	0.51		
227+75	0.15	0.33	550	550
228+25	0.21	0.33	550	550
228+75	0.20	0.31	300	600
229+25	0.30	0.24	300	600
229+75	0.32	0.33	350	600
230+25	0.33	0.28	400	550
230+75	0.52	0.29	400	600
231+25	0.77	0.21	400	550
231+75	0.61	0.28	600	550
Total Rut	3.85	3.11		
Average Rut	0.39	0.31		
	Total Cracking:		3850	5150
	sq. ft./ 1000 sq. ft.		713.0	953.7

Section 2.1	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
232+25	0.41	0.49		
232+75	2.03	0.34	600	600
233+25	0.94	0.28	600	600
233+75	1.92	0.42	600	500
234+25	1.33	0.41	600	550
234+75	1.74	0.39	600	500
235+25	1.09	0.65	600	500
235+75	1.66	0.69	600	550
236+25	0.91	0.50	600	550
236+75	0.78	0.42	600	600
Total Rut	12.81	4.59		
Average Rut	1.28	0.46		
	Total Cracking:		5400	4950
	sq. ft./ 1000 sq. ft.		1000.0	916.7

Table A4.4, continued

Section 2.2	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
237+25	1.12	0.56		
237+75	1.08	0.44	600	600
238+25	0.87	0.24	500	600
238+75	1.11	0.28	250	600
239+25	0.80	0.25	400	600
239+75	1.17	0.25	400	550
240+25	0.85	0.34	400	550
240+75	0.46	0.38	800	550
241+25	0.71	0.25	300	550
241+75	0.82	0.43	300	600
Total Rut	8.99	3.42		
Average Rut	0.90	0.34		
	Total Cracking:		3950	5200
	sq. ft./ 1000 sq. ft.		731.5	963.0

Section 2.3	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
242+25	0.42	0.29		
242+75	0.50	0.42	400	550
243+25	0.45	0.32	350	550
243+75	0.40	0.31	350	550
244+25	0.40	0.34	300	550
244+75	0.51	0.30	350	500
245+25	0.67	0.95	300	550
245+75	0.42	0.26	250	500
246+25	0.60	0.23	350	550
246+75	0.42	0.24	350	600
Total Rut	4.79	3.66		
Average Rut	0.48	0.37		
	Total Cracking:		3000	4900
	sq. ft./ 1000 sq. ft.		555.6	907.4

Table A4.3, continued

Section 2.4	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
247+25	0.56	0.43		
247+75	0.44	0.25	200	500
248+25	0.51	0.28	150	600
248+75	1.00	0.23	350	500
249+25	1.30	0.19	300	450
249+75	1.27	0.17	500	500
250+25	0.80	0.26	550	500
250+75	0.88	0.65	550	500
251+25	0.67	0.26	500	500
251+75	0.79	0.29	400	500
Total Rut	8.22	3.01		
Average Rut	0.82	0.30		
	Total Cracking:		3500	4550
	sq. ft./ 1000 sq. ft.		648.1	842.6

Section 2.5	Rut Depth (in)		Cracking (sq. ft.)	
Station	NTL	STL	NTL	STL
252+25	1.05	0.43		
252+75	0.84	0.21	550	500
253+25	0.79	0.35	550	550
253+75	0.89	0.42	500	550
254+25	0.88	0.31	550	550
254+75	0.62	0.40	550	550
255+25	0.50	0.40	300	550
255+75	0.53	0.33	250	550
256+25	0.33	0.28	450	550
256+75	0.64	0.29	450	500
Total Rut	7.07	3.42		
Average Rut	0.71	0.34		
	Total Cracking:		4150	4850
	sq. ft./ 1000 sq. ft.		768.5	898.1

APPENDIX 5

POST-CONSTRUCTION FWD DATA

(18-month)

LOCATION 1: NORTHBOUND

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
155+25	8829	4.51	3.94	3.67	3.32	3.31	2.88	2.35	82.0		
155+75	8851	4.76	4.24	4.01	3.76	3.55	3.11	2.46	77.0		
156+25	8928	3.22	2.84	2.72	2.61	2.46	2.21	1.80	81.0		
156+75	8939	3.65	3.30	3.09	2.89	2.78	2.42	1.96	78.0		
157+25	8851	4.53	4.04	3.80	3.53	3.33	2.89	2.23	77.0		
157+75	8928	2.80	2.57	2.35	2.20	2.19	1.94	1.59	83.0		
158+25	8884	2.86	2.59	2.48	2.35	2.26	2.05	1.70	83.0		
158+75	8884	3.41	3.07	2.97	2.81	2.68	2.39	1.93	80.0		
159+25	8840	5.06	4.57	4.26	3.87	3.54	2.93	2.20	88.0		
159+75	8829	5.29	4.77	4.45	4.06	3.76	3.00	2.17	76.0		
Average	8876	4.01	3.59	3.38	3.14	2.99	2.58	2.04	80.50		
High	8939	5.29	4.77	4.45	4.06	3.76	3.11	2.46			
Low	8829	2.80	2.57	2.35	2.20	2.19	1.94	1.59			
S. D.	43	0.93	0.82	0.76	0.66	0.58	0.43	0.29			
L. C. L	8794	2.23	2.02	1.93	1.87	1.87	1.76	1.49			
H. C. L	8958	5.79	5.17	4.83	4.41	4.10	3.41	2.59			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						22918		19654		17290
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						158		136		119

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
160+25	8884	6.04	4.92	4.44	3.98	3.57	2.93	2.16	89		
160+75	8840	3.35	2.74	2.56	2.39	2.28	2.02	1.61	84		
160+75	8840	3.35	2.74	2.56	2.39	2.28	2.02	1.61	84.0		
161+25	8862	3.17	2.64	2.45	2.32	2.26	2.05	1.72	86.0		
161+75	8829	3.29	2.78	2.59	2.44	2.35	2.09	1.70	86.0		
162+25	8873	3.98	3.28	3.03	2.81	2.65	2.31	1.82	93.0		
162+75	8829	3.78	2.74	2.50	2.31	2.19	1.91	1.53	88.0		
163+25	8818	2.45	1.97	1.80	1.70	1.62	1.47	1.22	86.0		
163+75	8851	2.78	2.17	1.98	1.86	1.76	1.60	1.31	79.0		
164+25	8895	2.83	2.24	2.04	1.90	1.78	1.58	1.30	88.0		
164+75	8895	2.67	2.19	2.02	1.90	1.81	1.64	1.36	89.0		
Average	8856	3.43	2.76	2.54	2.36	2.23	1.97	1.58	86.55		
High	8895	6.04	4.92	4.44	3.98	3.57	2.93	2.16			
Low	8818	2.45	1.97	1.80	1.70	1.62	1.47	1.22			
S. D.	28	0.98	0.81	0.72	0.63	0.54	0.41	0.28			
L. C. L	8803	1.54	1.21	1.15	1.16	1.19	1.17	1.05			
H. C. L	8909	5.31	4.31	3.93	3.57	3.28	2.76	2.11			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						30039		24812		21261
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						207		171		147

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
165+25	8840	2.45	1.97	1.87	1.82	1.74	1.63	1.39	90.0		
165+75	8906	2.54	2.11	2.00	1.89	1.81	1.64	1.35	90.0		
166+25	8785	2.41	1.94	1.84	1.72	1.67	1.52	1.27	92.0		
166+75	8851	2.81	2.35	2.22	2.10	2.02	1.82	1.51	98.0		
167+25	8884	3.11	2.68	2.59	2.48	2.34	2.12	1.72	97.0		
167+75	8851	4.54	4.10	3.94	3.73	3.54	3.13	2.45	93.0		
168+25	8862	3.31	2.79	2.67	2.51	2.41	2.19	1.80	91.0		
168+75	8873	3.58	3.17	3.00	2.82	2.72	2.41	1.94	95.0		
169+25	8862	4.67	3.99	3.70	3.46	3.20	2.73	2.01	96.0		
169+75	8862	3.76	3.15	2.96	2.74	2.59	2.23	1.76	96.0		
Average	8858	3.32	2.83	2.68	2.53	2.40	2.14	1.72	93.80		
High	8906	4.67	4.10	3.94	3.73	3.54	3.13	2.45			
Low	8785	2.41	1.94	1.84	1.72	1.67	1.52	1.27			
S. D.	32	0.82	0.78	0.73	0.68	0.63	0.52	0.36			
L. C. L	8797	1.74	1.33	1.27	1.22	1.20	1.15	1.03			
H. C. L	8918	4.89	4.32	4.09	3.84	3.61	3.14	2.41			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						27568		22205		18710
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						190		153		129

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
170+25	8818	3.80	3.40	3.31	3.09	2.95	2.63	2.07	86.0		
170+75	8862	6.53	6.02	5.66	5.11	4.59	3.67	2.63	89.0		
171+25	8906	11.80	10.71	9.84	8.61	7.50	5.62	3.52	99.0		
171+75	8895	9.30	8.56	7.95	7.10	6.30	4.93	3.27	100.0		
172+25	8873	10.15	9.18	8.59	7.69	6.91	5.44	3.56	98.0		
172+75	8884	12.09	11.06	10.34	9.38	8.42	6.58	4.19	101.0		
173+25	8840	9.07	8.28	7.77	7.04	6.40	5.15	3.46	100.0		
173+75	8862	9.43	8.02	7.23	6.27	5.48	4.24	2.98	101.0		
174+25	8829	7.65	6.56	6.04	5.34	4.71	3.63	2.45	98.0		
174+75	8818	6.70	5.81	5.36	4.78	4.24	3.36	2.33	96.0		
Average	8859	8.65	7.76	7.21	6.44	5.75	4.53	3.05	96.80		
High	8906	12.09	11.06	10.34	9.38	8.42	6.58	4.19			
Low	8818	3.80	3.40	3.31	3.09	2.95	2.63	2.07			
S. D.	32	2.54	2.35	2.16	1.91	1.66	1.22	0.67			
L. C. L	8798	3.78	3.24	3.07	2.78	2.56	2.18	1.76			
H. C. L	8919	13.53	12.28	11.35	10.10	8.94	6.87	4.33			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						13051		10282		8541
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						90		71		59

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
175+25	8862	4.27	3.55	3.31	3.06	2.83	2.43	1.89	97.0		
175+75	8862	4.53	3.94	3.63	3.30	3.07	2.59	1.96	98.0		
176+25	8774	4.50	3.87	3.63	3.34	3.10	2.64	2.05	101.0		
176+75	8829	4.20	3.59	3.36	3.09	2.87	2.46	1.88	102.0		
177+25	8862	4.45	3.84	3.57	3.28	3.02	2.50	1.88	101.0		
177+75	8840	4.76	3.90	3.50	3.11	2.81	2.28	1.73	100.0		
178+25	8917	5.35	4.35	3.85	3.30	2.95	2.40	1.77	101.0		
178+75	8862	4.83	3.94	3.52	3.06	2.72	2.22	1.70	102.0		
179+25	8906	4.65	3.96	3.68	3.26	2.97	2.41	1.83	103.0		
179+75	8796	4.34	3.76	3.55	3.29	3.07	2.64	2.00	103.0		
Average	8851	4.59	3.87	3.56	3.21	2.94	2.46	1.87	100.80		
High	8917	5.35	4.35	3.85	3.34	3.10	2.64	2.05			
Low	8774	4.20	3.55	3.31	3.06	2.72	2.22	1.70			
S. D.	44	0.34	0.22	0.15	0.11	0.13	0.14	0.11			
L. C. L	8767	3.94	3.44	3.26	2.99	2.69	2.19	1.65			
H. C. L	8935	5.23	4.30	3.86	3.43	3.19	2.73	2.09			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						24016		22708		21580
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						166		157		149

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				15500.000	to	18500.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
180+25	8895	5.71	4.97	4.61	4.13	3.73	3.07	2.25	100.0		
180+75	8939	7.16	6.43	5.97	5.32	4.68	3.63	2.52	103.0		
181+25	8884	6.16	5.63	5.28	4.83	4.48	3.74	2.71	105.0		
181+75	8939	6.94	6.38	6.06	5.61	5.21	4.35	3.09	104.0		
182+25	8829	8.56	7.81	7.29	6.48	5.89	4.75	3.30	103.0		
182+75	8873	9.35	8.44	7.83	7.03	6.39	5.26	3.70	103.0		
183+25	8851	8.31	7.78	7.38	6.82	6.34	5.42	4.07	103.0		
183+75	8851	11.89	10.99	10.35	9.44	8.50	6.93	4.81	102.0		
184+25	8873	9.79	9.17	8.74	8.13	7.54	6.40	4.73	103.0		
184+75	8807	13.63	12.46	11.66	10.47	9.37	7.56	5.16	102.0	EOF	
Average	8874	8.75	8.01	7.52	6.83	6.21	5.11	3.63	102.80		
High	8939	13.63	12.46	11.66	10.47	9.37	7.56	5.16			
Low	8807	5.71	4.97	4.61	4.13	3.73	3.07	2.25			
S. D.	43	2.52	2.37	2.23	2.03	1.81	1.49	1.03			
L. C. L	8792	3.91	3.46	3.23	2.93	2.73	2.25	1.66			
H. C. L	8956	13.59	12.55	11.80	10.72	9.70	7.98	5.61			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						11575		8960		7363
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						80		62		51

LOCATION 1: SOUTHBOUND

COUNTY	Palm Beach			**Test Date**	8-Apr-10
PROJECT NO.	93140			**Analysis Date**	12-Apr-10
PFN	413804-1				
STATE ROAD	15				
MILEPOST LIMITS (SLMP)	########	to	########		SBTL

MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
155+25	8818	11.21	9.93	9.26	8.42	7.56	5.97	3.94	124.0	EOF
155+75	8862	13.53	11.74	10.89	9.77	8.75	6.96	4.64	124.0	
156+25	8862	9.65	8.25	7.59	6.72	5.94	4.70	3.28	123.0	
156+75	8873	15.86	13.85	12.55	10.52	8.72	6.24	4.19	123.0	
157+25	8917	11.06	9.23	8.33	7.32	6.46	5.11	3.57	124.0	
157+75	8829	8.11	6.97	6.39	5.60	4.89	3.81	2.72	124.0	
158+25	8764	12.67	10.82	9.72	8.26	7.06	5.30	3.54	121.0	
158+75	8829	10.79	9.35	8.44	7.26	6.18	4.69	3.32	124.0	
159+25	8917	13.98	11.90	10.36	8.43	6.86	4.72	3.05	124.0	
159+75	8829	12.61	10.93	9.99	8.67	7.37	5.39	3.39	123.0	
Average	8850	11.95	10.30	9.35	8.10	6.98	5.29	3.56	123.40	
High	8917	15.86	13.85	12.55	10.52	8.75	6.96	4.64		
Low	8764	8.11	6.97	6.39	5.60	4.89	3.81	2.72		
S. D.	47	2.25	1.98	1.76	1.44	1.20	0.91	0.56		
L. C. L	8761	7.63	6.49	5.97	5.33	4.67	3.55	2.49		
H. C. L	8939	16.27	14.10	12.73	10.86	9.29	7.03	4.64		

	D6	D6+SD	D6+1.96SD
AASHTO RESILIENT MODULI - EMBANKMENT (psi)	11155	9521	8347
AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)	77	66	58

COUNTY	Palm Beach			**Test Date**	8-Apr-10
PROJECT NO.	93140			**Analysis Date**	12-Apr-10
PFN	413804-1				
STATE ROAD	15				
MILEPOST LIMITS (SLMP)	########	to	########		SBTL

MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
160+25	8884	10.09	7.88	6.97	6.03	5.30	3.98	2.83	124.0	
160+75	8851	10.78	8.43	7.22	6.17	5.29	4.05	2.78	124.0	
161+25	8895	10.03	8.19	7.34	6.50	5.74	4.48	2.96	122.0	
161+75	8895	9.31	7.61	6.87	6.19	5.61	4.56	3.22	123.0	
162+25	8785	10.66	8.93	8.13	7.24	6.38	4.80	2.97	124.0	
162+75	8851	9.68	8.00	7.33	6.59	5.79	4.45	3.01	124.0	
163+25	8774	7.13	5.37	4.75	4.19	3.78	3.03	2.16	124.0	
163+75	8884	12.23	9.63	8.19	6.61	5.46	4.09	2.91	124.0	
164+25	8818	15.73	13.20	11.71	9.92	8.29	5.72	3.10	125.0	
164+75	8873	10.90	8.09	6.98	5.96	5.19	4.15	3.06	124.0	
Average	8851	10.65	8.53	7.55	6.54	5.68	4.33	2.90	123.80	
High	8895	15.73	13.20	11.71	9.92	8.29	5.72	3.22		
Low	8774	7.13	5.37	4.75	4.19	3.78	3.03	2.16		
S. D.	45	2.22	1.97	1.74	1.43	1.13	0.69	0.29		
L. C. L	8765	6.40	4.74	4.21	3.80	3.51	3.02	2.34		
H. C. L	8937	14.91	12.32	10.89	9.28	7.86	5.65	3.46		

	D6	D6+SD	D6+1.96SD
AASHTO RESILIENT MODULI - EMBANKMENT (psi)	13624	11764	10400
AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)	94	81	72

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	########					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
165+25	8840	11.69	10.27	9.53	8.55	7.62	5.94	3.80	122.0	
165+75	8862	11.12	10.11	9.65	8.90	8.12	6.59	4.34	124.0	
166+25	8796	9.41	8.52	8.07	7.39	6.68	5.37	3.60	124.0	
166+75	8862	7.71	6.85	6.64	6.23	5.78	4.87	3.40	123.0	
167+25	8774	10.43	9.48	9.06	8.43	7.73	6.36	4.25	122.0	
167+75	8851	11.38	10.16	9.65	8.85	8.11	6.69	4.64	123.0	
168+25	8873	10.98	10.07	9.59	8.79	7.97	6.52	4.61	121.0	
168+75	8807	9.46	8.65	8.27	7.68	7.11	5.93	4.09	120.0	
169+25	8862	6.09	5.34	5.09	4.78	4.45	3.82	2.87	119.0	
169+75	8851	10.11	8.67	7.81	6.69	5.68	4.13	2.65	118.0	
Average	8838	9.84	8.81	8.34	7.63	6.93	5.62	3.83	121.60	
High	8873	11.69	10.27	9.65	8.90	8.12	6.69	4.64		
Low	8774	6.09	5.34	5.09	4.78	4.45	3.82	2.65		
S. D.	34	1.77	1.62	1.52	1.37	1.25	1.04	0.69		
L. C. L	8773	6.45	5.70	5.42	4.99	4.52	3.63	2.49		
H. C. L	8902	13.23	11.93	11.25	10.26	9.33	7.62	5.16		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						10480		8845	7692
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						72		61	53

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	########					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
170+25	8884	8.15	7.21	6.72	6.07	5.32	4.15	2.76	119.0	
170+75	8851	6.54	5.63	5.27	4.83	4.42	3.67	2.64	117.0	
171+25	8774	5.33	4.65	4.44	4.09	3.73	3.09	2.24	118.0	
171+75	8796	5.48	4.84	4.68	4.40	4.16	3.61	2.70	117.0	
172+25	8895	5.13	4.46	4.24	3.99	3.74	3.25	2.49	116.0	
172+75	8785	4.63	4.02	3.80	3.58	3.39	2.96	2.31	117.0	
173+25	8818	5.35	4.58	4.32	3.93	3.61	2.99	2.20	118.0	
173+75	8851	4.96	4.33	4.10	3.82	3.56	3.03	2.26	120.0	
174+25	8873	5.01	4.22	3.99	3.67	3.38	2.83	2.11	121.0	
174+75	8917	6.34	5.30	4.90	4.41	3.96	3.26	2.47	119.0	
Average	8844	5.69	4.92	4.65	4.28	3.93	3.28	2.42	118.20	
High	8917	8.15	7.21	6.72	6.07	5.32	4.15	2.76		
Low	8774	4.63	4.02	3.80	3.58	3.38	2.83	2.11		
S. D.	49	1.05	0.94	0.85	0.73	0.59	0.41	0.23		
L. C. L	8750	3.68	3.12	3.01	2.87	2.79	2.50	1.98		
H. C. L	8939	7.71	6.73	6.28	5.69	5.06	4.07	2.85		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						17955		15965	14431
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						124		110	99

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				########	to	########					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
175+25	8906	7.73	6.47	5.89	5.16	4.59	3.55	2.41	118.0		
175+75	8906	7.23	6.02	5.54	4.98	4.48	3.59	2.50	119.0		
176+25	8829	9.50	7.80	6.91	5.92	5.07	3.74	2.46	119.0		
176+75	8851	8.14	6.79	6.17	5.42	4.75	3.76	2.82	120.0		
177+25	8818	7.27	5.98	5.38	4.66	4.02	3.08	2.19	118.0		
177+75	8829	8.21	6.50	5.71	4.76	4.01	3.04	2.17	116.0		
178+25	8873	9.30	6.91	5.61	4.31	3.48	2.59	1.95	116.0		
178+75	8829	8.30	6.42	5.47	4.43	3.67	2.72	2.00	117.0		
179+25	8906	9.47	7.25	5.96	4.57	3.81	2.88	2.21	114.0		
179+75	8862	10.52	7.94	6.50	4.97	4.08	3.11	2.32	112.0		
Average	8861	8.57	6.81	5.91	4.92	4.20	3.21	2.30	116.90		
High	8906	10.52	7.94	6.91	5.92	5.07	3.76	2.82			
Low	8818	7.23	5.98	5.38	4.31	3.48	2.59	1.95			
S. D.	35	1.08	0.68	0.49	0.49	0.51	0.43	0.26			
L. C. L	8793	6.48	5.51	4.97	3.98	3.22	2.39	1.81			
H. C. L	8929	10.65	8.11	6.85	5.85	5.17	4.02	2.80			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						18426		16265		14619
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						127		112		101

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				########	to	########					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
180+25	8840	12.71	9.60	7.63	5.65	4.40	3.26	2.50	111.0		
180+75	8764	13.35	10.67	8.97	7.04	5.74	4.18	2.93	110.0		
181+25	8917	12.18	10.20	8.86	7.23	6.02	4.33	2.91	111.0		
181+75	8851	12.59	10.82	9.59	8.04	6.78	5.01	3.28	113.0		
182+25	8862	16.69	13.71	11.86	9.59	7.91	5.85	3.89	114.0		
182+75	8928	12.26	10.22	9.05	7.64	6.48	4.89	3.38	114.0		
183+25	8895	16.28	13.31	11.63	9.81	8.31	6.28	4.20	114.0		
183+75	8917	16.91	14.40	12.63	10.42	8.66	6.36	4.13	114.0		
184+25	8928	13.65	12.36	11.47	10.30	9.25	7.33	4.96	115.0		
184+75	8917	14.23	12.64	11.63	10.32	9.18	7.30	4.93	113.0		
Average	8882	14.09	11.79	10.33	8.60	7.27	5.48	3.71	112.90		
High	8928	16.91	14.40	12.63	10.42	9.25	7.33	4.96			
Low	8764	12.18	9.60	7.63	5.65	4.40	3.26	2.50			
S. D.	53	1.87	1.69	1.69	1.69	1.63	1.37	0.85			
L. C. L	8780	10.50	8.54	7.08	5.35	4.14	2.86	2.08			
H. C. L	8983	17.67	15.05	13.58	11.86	10.41	8.10	5.34			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						10807		8650		7260
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						75		60		50

LOCATION 2: NORTHBOUND

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
227+25	8906	4.67	3.90	3.49	3.02	2.65	2.05	1.46	69.0	
227+75	8950	4.63	4.06	3.73	3.33	2.98	2.36	1.69	69.0	
228+25	8895	4.26	3.71	3.41	3.05	2.75	2.25	1.67	69.0	
228+75	8873	4.22	3.69	3.39	3.02	2.72	2.20	1.63	77.0	
229+25	8917	5.15	4.44	3.98	3.42	2.97	2.28	1.61	78.0	
229+75	8917	6.40	5.31	4.52	3.63	3.06	2.28	1.60	80.0	
230+25	8906	5.19	4.39	3.94	3.42	3.03	2.40	1.78	76.0	
230+75	8862	5.56	4.78	4.33	3.80	3.35	2.69	1.99	69.0	
231+25	8906	4.95	4.34	4.02	3.63	3.33	2.75	2.06	69.0	
231+75	8862	5.19	4.54	4.20	3.81	3.50	2.94	2.26	69.0	
Average	8899	5.02	4.32	3.90	3.41	3.03	2.42	1.78	72.50	
High	8950	6.40	5.31	4.52	3.81	3.50	2.94	2.26		
Low	8862	4.22	3.69	3.39	3.02	2.65	2.05	1.46		
S. D.	28	0.65	0.50	0.39	0.31	0.29	0.28	0.25		
L. C. L	8847	3.78	3.35	3.15	2.82	2.48	1.88	1.30		
H. C. L	8952	6.26	5.28	4.65	4.00	3.58	2.96	2.25		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						24516		21967	19974
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						169		151	138

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
232+25	8950	4.66	4.02	3.78	3.53	3.32	2.86	2.24	69.0	
232+75	8895	4.94	4.19	3.84	3.51	3.30	2.81	2.20	69.0	
233+25	8961	5.43	4.46	4.01	3.57	3.26	2.71	2.05	69.0	
233+75	8928	4.66	3.95	3.65	3.35	3.09	2.64	2.06	68.0	
234+25	8895	3.57	2.99	2.80	2.63	2.48	2.20	1.77	69.0	
234+75	8906	3.93	3.42	3.15	2.90	2.75	2.37	1.85	69.0	
235+25	8862	4.59	3.70	3.33	3.05	2.82	2.36	1.85	69.0	
235+75	8906	4.20	3.54	3.28	3.03	2.79	2.37	1.81	69.0	
236+25	8873	4.56	3.65	3.30	2.98	2.77	2.36	1.82	69.0	
236+75	8829	3.85	3.00	2.69	2.47	2.33	2.01	1.57	69.0	
Average	8901	4.44	3.69	3.38	3.10	2.89	2.47	1.92	68.90	
High	8961	5.43	4.46	4.01	3.57	3.32	2.86	2.24		
Low	8829	3.57	2.99	2.69	2.47	2.33	2.01	1.57		
S. D.	40	0.56	0.48	0.44	0.38	0.34	0.28	0.21		
L. C. L	8824	3.37	2.77	2.54	2.37	2.23	1.94	1.52		
H. C. L	8977	5.51	4.62	4.22	3.84	3.55	3.00	2.32		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						24033		21621	19720
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						166		149	136

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
237+25	8939	2.96	2.50	2.34	2.22	2.11	1.91	1.60	69.0		
237+75	8906	4.44	3.87	3.63	3.33	3.05	2.63	2.06	69.0		
238+25	8873	4.91	4.30	3.98	3.66	3.36	2.84	2.14	70.0		
238+75	8873	5.07	4.34	3.92	3.39	3.07	2.46	1.77	69.0		
239+25	8862	4.08	3.39	3.07	2.75	2.47	2.02	1.52	72.0		
239+75	8851	3.98	3.31	3.04	2.74	2.48	2.02	1.51	69.0		
240+25	8851	4.79	3.98	3.63	3.23	2.87	2.24	1.61	71.0		
240+75	8906	3.59	3.15	2.98	2.80	2.69	2.36	1.85	70.0		
241+25	8840	4.22	3.54	3.24	2.90	2.60	2.11	1.55	69.0		
241+75	8851	5.33	4.39	3.96	3.43	3.02	2.35	1.67	71.0		
Average	8875	4.34	3.68	3.38	3.05	2.77	2.29	1.73	69.90		
High	8939	5.33	4.39	3.98	3.66	3.36	2.84	2.14			
Low	8840	2.96	2.50	2.34	2.22	2.11	1.91	1.51			
S. D.	32	0.72	0.61	0.54	0.43	0.37	0.29	0.22			
L. C. L	8814	2.95	2.50	2.35	2.21	2.06	1.73	1.30			
H. C. L	8936	5.73	4.85	4.41	3.88	3.48	2.86	2.16			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						25793		22858		20608
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						178		158		142

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
242+25	8928	4.04	3.47	3.22	2.93	2.68	2.26	1.69	78.0		
242+75	8873	5.32	4.77	4.45	4.08	3.73	3.15	2.58	86.0		
243+25	8884	4.96	4.11	3.72	3.30	2.95	2.37	1.72	80.0		
243+75	8939	5.68	5.03	4.62	4.12	3.67	2.96	2.17	82.0		
244+25	8829	5.61	4.84	4.39	3.85	3.51	2.80	2.21	75.0		
244+75	8884	7.31	6.22	5.56	4.80	4.06	3.06	2.13	71.0		
245+25	8928	6.91	6.01	5.47	4.74	4.04	3.04	2.07	85.0		
245+75	8917	5.17	4.62	4.36	4.10	3.81	3.30	2.60	85.0		
246+25	8895	5.71	5.15	4.88	4.48	4.15	3.49	2.56	91.0		
246+75	8862	9.94	8.03	6.74	5.24	4.11	2.84	2.01	90.0		
Average	8894	6.07	5.23	4.74	4.16	3.67	2.93	2.17	82.30		
High	8939	9.94	8.03	6.74	5.24	4.15	3.49	2.60	91.00		
Low	8829	4.04	3.47	3.22	2.93	2.68	2.26	1.69			
S. D.	35	1.65	1.27	1.00	0.70	0.50	0.38	0.33			
L. C. L	8828	2.90	2.78	2.83	2.83	2.71	2.19	1.54			
H. C. L	8960	9.23	7.67	6.65	5.50	4.63	3.66	2.81			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						20257		17916		16127
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						140		124		111

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
247+25	8873	4.69	3.50	2.75	1.97	1.48	1.02	0.78	90.0	
247+75	8873	3.47	2.44	1.89	1.35	1.04	0.77	0.65	84.0	
248+25	8829	7.95	5.90	5.31	4.81	4.41	3.65	2.61	83.0	
248+75	8862	6.12	5.47	5.12	4.69	4.31	3.55	2.52	85.0	
249+25	8829	7.35	6.37	5.87	5.17	4.56	3.49	2.37	91.0	
249+75	8862	6.22	5.17	4.68	4.16	3.69	2.96	2.12	90.0	
250+25	8906	8.15	7.31	6.67	5.71	5.11	3.86	2.46	79.0	
250+75	8807	7.03	6.04	5.57	4.88	4.28	3.32	2.21	86.0	
251+25	8851	6.80	5.74	5.22	4.59	4.04	3.14	2.17	84.0	
251+75	8840	8.89	7.60	6.83	5.85	5.02	3.74	2.41	75.0	
Average	8853	6.67	5.55	4.99	4.32	3.79	2.95	2.03	84.70	
High	8906	8.89	7.60	6.83	5.85	5.11	3.86	2.61		
Low	8807	3.47	2.44	1.89	1.35	1.04	0.77	0.65		
S. D.	28	1.63	1.58	1.57	1.50	1.40	1.12	0.71		
L. C. L	8799	3.53	2.53	1.97	1.45	1.10	0.80	0.67		
H. C. L	8908	9.80	8.58	8.01	7.19	6.49	5.10	3.39		
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						20007		14510		11481
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						138		100		79

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			########	to	25700.000					NBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
252+25	8917	11.79	9.50	8.28	6.78	5.49	3.59	2.32	111.0	
252+75	8873	14.89	12.46	11.09	9.41	7.83	5.44	3.25	115.0	
253+25	8906	14.80	12.57	11.31	9.77	8.41	6.03	3.46	115.0	
253+75	8917	13.98	12.11	10.70	8.95	7.44	5.22	2.90	116.0	
254+25	8895	7.34	6.13	5.54	4.89	4.30	3.28	2.17	116.0	
254+75	8873	8.81	6.85	5.70	4.38	3.37	2.31	1.70	114.0	
255+25	8818	6.69	5.21	4.54	3.72	3.14	2.31	1.68	114.0	
255+75	8851	11.32	8.10	6.69	5.09	3.87	2.46	1.77	114.0	
256+25	8939	7.62	6.27	5.64	4.87	4.23	3.17	2.10	116.0	
256+75	8829	9.22	7.74	6.80	5.54	4.52	3.20	2.24	116.0	EOF
Average	8882	10.65	8.69	7.63	6.34	5.26	3.70	2.36	114.70	
High	8939	14.89	12.57	11.31	9.77	8.41	6.03	3.46		
Low	8818	6.69	5.21	4.54	3.72	3.14	2.31	1.68		
S. D.	40	3.15	2.80	2.55	2.25	1.94	1.37	0.64		
L. C. L	8805	4.60	3.31	2.73	2.03	1.54	1.07	1.13		
H. C. L	8959	16.69	14.08	12.53	10.65	8.98	6.33	3.58		
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						15999		11677		9272
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						110		81		64

LOCATION 2: SOUTHBOUND

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			######	to	######					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
227+25	8917	6.44	4.95	4.29	3.50	2.89	2.16	1.61	123.0	EOF
227+75	8950	6.19	4.91	4.42	3.69	3.22	2.45	1.78	123.0	
228+25	8884	7.44	6.08	5.24	4.20	3.51	2.61	1.92	123.0	
228+75	8961	7.44	5.73	4.82	3.78	3.03	2.19	1.64	123.0	
229+25	8884	6.87	5.11	4.46	3.54	2.93	2.12	1.38	121.0	
229+75	8917	5.38	4.14	3.73	3.23	2.82	2.23	1.70	120.0	
230+25	8983	6.33	5.03	4.53	3.87	3.34	2.61	1.92	119.0	
230+75	8950	5.87	4.32	3.99	3.66	3.32	2.78	2.09	119.0	
231+25	9015	5.56	4.52	4.11	3.65	3.30	2.70	2.01	120.0	
231+75	8917	5.96	5.04	4.60	4.18	3.84	3.15	2.39	116.0	
Average	8938	6.35	4.98	4.42	3.73	3.22	2.50	1.84		
High	9015	7.44	6.08	5.24	4.20	3.84	3.15	2.39		
Low	8884	5.38	4.14	3.73	3.23	2.82	2.12	1.38		
S. D.	42	0.72	0.59	0.43	0.30	0.31	0.33	0.29		
L. C. L	8857	4.97	3.85	3.60	3.16	2.62	1.86	1.30		
H. C. L	9019	7.72	6.12	5.24	4.30	3.82	3.14	2.39		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						23834		21034	18903
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						164		145	130

COUNTY			Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.			93140					**Analysis Date**		12-Apr-10
PFN			413804-1							
STATE ROAD			15							
MILEPOST LIMITS (SLMP)			######	to	######					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments
23225.000	8961	6.87	5.36	4.92	4.46	4.11	3.39	2.46	121.0	
23275.000	8972	6.15	4.76	4.27	3.89	3.58	2.99	2.28	121.0	
23325.000	8906	7.56	5.51	4.79	4.19	3.72	3.00	2.21	120.0	
23375.000	9037	5.57	4.18	3.73	3.38	3.07	2.62	2.04	120.0	
23425.000	8928	6.21	4.47	3.87	3.41	3.08	2.50	1.86	120.0	
23475.000	8906	6.91	5.01	4.28	3.67	3.22	2.54	1.91	121.0	
23525.000	8928	7.84	5.76	4.87	4.05	3.42	2.56	1.83	121.0	
23575.000	8906	7.17	5.10	4.28	3.63	3.12	2.47	1.87	121.0	
23625.000	8928	6.98	5.22	4.45	3.67	3.14	2.32	1.54	122.0	
23675.000	8928	7.36	5.38	4.59	3.90	3.41	2.65	1.95	117.0	
Average	8940	6.86	5.08	4.41	3.83	3.39	2.70	2.00		
High	9037	7.84	5.76	4.92	4.46	4.11	3.39	2.46		
Low	8906	5.57	4.18	3.73	3.38	3.07	2.32	1.54		
S. D.	41	0.70	0.49	0.40	0.34	0.34	0.32	0.26		
L. C. L	8862	5.52	4.14	3.63	3.17	2.74	2.08	1.49		
H. C. L	9018	8.21	6.01	5.18	4.48	4.04	3.32	2.50		
							D6		**D6+SD**	**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						22041		19687	17855
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						152		136	123

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				######	to	######					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
237+25	8851	6.15	5.20	4.77	4.28	3.87	3.19	2.39	120.0		
237+75	8939	6.29	5.22	4.76	4.30	3.88	3.22	2.38	122.0		
238+25	8884	6.26	5.17	4.68	4.14	3.65	2.90	2.09	123.0		
238+75	8939	5.77	4.57	4.09	3.52	3.07	2.37	1.72	122.0		
239+25	8961	4.38	3.39	3.07	2.74	2.48	2.08	1.58	122.0		
239+75	8950	6.03	4.72	4.05	3.44	2.95	2.28	1.67	121.0		
240+25	8884	5.33	4.07	3.70	3.25	2.92	2.31	1.71	121.0		
240+75	8939	5.26	4.38	3.98	3.64	3.31	2.81	2.17	120.0		
241+25	8906	5.72	4.50	3.98	3.43	2.98	2.33	1.72	122.0		
241+75	8884	5.02	4.00	3.61	3.07	2.70	2.11	1.54	122.0		
Average	8914	5.62	4.52	4.07	3.58	3.18	2.56	1.90			
High	8961	6.29	5.22	4.77	4.30	3.88	3.22	2.39			
Low	8851	4.38	3.39	3.07	2.74	2.48	2.08	1.54			
S. D.	37	0.62	0.60	0.55	0.52	0.48	0.43	0.33			
L. C. L	8843	4.43	3.38	3.02	2.58	2.25	1.73	1.27			
H. C. L	8984	6.81	5.66	5.12	4.58	4.11	3.39	2.53			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						23213		19866		17451
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						160		137		120

COUNTY				Palm Beach					**Test Date**		8-Apr-10
PROJECT NO.				93140					**Analysis Date**		12-Apr-10
PFN				413804-1							
STATE ROAD				15							
MILEPOST LIMITS (SLMP)				######	to	######					SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
242+25	8840	5.85	4.80	4.38	3.87	3.43	2.68	1.95	124.0		
242+75	8917	5.25	4.20	3.76	3.31	2.95	2.41	1.85	122.0		
243+25	8906	7.22	5.70	4.88	3.97	3.32	2.56	1.89	123.0		
243+75	8906	8.49	6.75	5.80	4.72	3.91	2.85	2.06	124.0		
244+25	8851	7.25	6.19	5.70	5.09	4.52	3.56	2.39	123.0		
244+75	8884	8.83	7.58	7.02	6.18	5.44	4.26	2.88	123.0		
245+25	8906	9.71	8.07	7.28	6.31	5.49	4.18	2.81	121.0		
245+75	8851	7.62	6.48	6.03	5.42	4.86	3.93	2.78	119.0		
246+25	8873	7.89	6.88	6.46	5.90	5.36	4.39	3.17	121.0		
246+75	8950	11.62	9.03	7.23	5.13	3.89	3.13	2.39	123.0		
Average	8888	7.97	6.57	5.85	4.99	4.32	3.40	2.42			
High	8950	11.62	9.03	7.28	6.31	5.49	4.39	3.17			
Low	8840	5.25	4.20	3.76	3.31	2.95	2.41	1.85			
S. D.	35	1.84	1.46	1.21	1.02	0.95	0.76	0.47			
L. C. L	8821	4.44	3.77	3.53	3.03	2.50	1.93	1.51			
H. C. L	8955	11.51	9.37	8.18	6.95	6.13	4.86	3.33			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						17454		14257		12126
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						120		98		84

COUNTY			Palm Beach					**Test Date**			8-Apr-10
PROJECT NO.			93140					**Analysis Date**			12-Apr-10
PFN			413804-1								
STATE ROAD			15								
MILEPOST LIMITS (SLMP)			######	to	######						SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
247+25	8840	9.00	6.28	4.54	2.75	1.79	1.13	0.92	124.0		
247+75	8884	4.28	2.80	2.17	1.53	1.18	0.89	0.71	123.0		
248+25	8807	7.80	5.87	5.07	3.98	3.24	2.43	1.82	122.0		
248+75	8862	6.63	5.06	4.42	3.80	3.35	2.67	1.95	122.0		
249+25	8829	8.51	6.80	5.96	4.99	4.30	3.17	2.09	123.0		
249+75	8818	11.81	9.26	7.80	6.21	4.95	3.28	2.14	124.0		
250+25	8785	10.15	7.90	6.54	5.17	4.17	2.91	2.10	124.0		
250+75	8829	13.15	10.81	9.02	6.95	5.39	3.45	2.27	124.0		
251+25	8851	10.35	7.94	6.68	5.38	4.43	3.08	2.01	123.0		
251+75	8851	10.13	8.04	6.81	5.48	4.42	3.13	2.13	117.0		
Average	8836	9.18	7.08	5.90	4.62	3.72	2.61	1.81			
High	8884	13.15	10.81	9.02	6.95	5.39	3.45	2.27			
Low	8785	4.28	2.80	2.17	1.53	1.18	0.89	0.71			
S. D.	28	2.56	2.25	1.94	1.63	1.35	0.90	0.54			
L. C. L	8781	4.27	2.76	2.18	1.50	1.13	0.89	0.77			
H. C. L	8890	14.09	11.40	9.62	7.75	6.31	4.34	2.86			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						22534		16779		13475
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						155		116		93

COUNTY			Palm Beach					**Test Date**			8-Apr-10
PROJECT NO.			93140					**Analysis Date**			12-Apr-10
PFN			413804-1								
STATE ROAD			15								
MILEPOST LIMITS (SLMP)			######	to	######						SBTL
MILEPOST	LOAD	D0	D8	D12	D18	D24	D36	D60	PVT Temp.	Comments	
252+25	8840	8.37	6.69	5.60	4.37	3.49	2.47	1.81	120.0		
252+75	8851	8.56	6.79	5.83	4.70	3.84	2.93	2.18	122.0		
253+25	8862	7.57	5.97	5.11	4.20	3.56	2.77	2.08	121.0		
253+75	8829	9.76	7.17	5.88	4.46	3.51	2.56	2.01	122.0		
254+25	8862	10.65	8.27	6.89	5.43	4.31	3.02	2.09	120.0		
254+75	8807	11.20	8.52	6.75	4.76	3.50	2.31	1.69	121.0		
255+25	8884	8.74	6.81	5.83	4.61	3.54	2.34	1.72	120.0		
255+75	8829	9.67	8.13	7.20	6.04	4.87	3.32	2.04	118.0		
256+25	8884	5.22	4.36	4.01	3.57	3.22	2.59	1.92	119.0		
256+75	8764	6.50	5.37	4.80	4.08	3.48	2.67	1.98	115.0		
Average	8841	8.62	6.81	5.79	4.62	3.73	2.70	1.95			
High	8884	11.20	8.52	7.20	6.04	4.87	3.32	2.18			
Low	8764	5.22	4.36	4.01	3.57	3.22	2.31	1.69			
S. D.	37	1.84	1.32	0.99	0.70	0.49	0.32	0.16			
L. C. L	8771	5.09	4.27	3.89	3.29	2.78	2.09	1.64			
H. C. L	8911	12.15	9.35	7.69	5.96	4.68	3.31	2.27			
							D6		**D6+SD**		**D6+1.96SD**
	AASHTO RESILIENT MODULI - EMBANKMENT (psi)						21846		19541		17744
	AASHTO RESILIENT MODULI - EMBANKMENT (Mpa)						151		135		122

APPENDIX 6

RIDE, RUT AND CRACKING DATA

(18-month)

93140R1.601

COUNTY:	93	DATE COLLECTED:	03/31/2010
ROUTE:	SR15,700/US98	TIME:	13:44:37
DIRECTION:	North(+)	OPERATOR:	Kyle Kroodsma
LANE:	R1	DRIVER:	Kyle Kroodsma
VEHICLE:	DOT30392	DCF:	3700.5
UNITS:	ENGLISH	WAVELENGTH-LONG:	300 ft
SECTION:	140	FIN:	413804-1-52-01
SUB SEC:	000		
COMMENT1:		RPT VERSION:	2.1.2.1
AVG SPEED:	51.4 mph	MDR VERSION:	WP3.7.6.0
SAMPLE DISTANCE:	0.678 in (1)	SENSOR CAL DATE:	03/23/2010
PROFILE DISTANCE:	6.000 in	ACCEL CAL DATE:	03/31/2010

OUTPUT FILE NAME: W:\District4\93 Palm Beach\93140 FIN 41380415201 SR15,700 EXP 03-31-10\Raw Data\R1\0M100331134404DOT30392_MDR\93140R1.601

MILES		IN			IN/MI						
FROM	TO	ROUGH DIST	RUT AVG	RUT STD	IRI 1	IRI 2	AVG IRI	RN 1	RN 2	COMBINED RN	
22.609*	22.704	0.085	0.06	0.025	87	91	89	3.96	4.05	4.00	(R)
22.704*	22.798	0.084	0.06	0.041	67	67	67	4.04	4.12	4.08	
22.798*	22.893	0.085	0.00	0.050	61	80	71	4.29	4.12	4.20	
22.893*	22.988	0.085	0.07	0.026	66	69	68	4.14	4.10	4.12	
22.988*	23.083	0.085	0.07	0.019	63	64	63	4.16	4.12	4.14	
23.083*	23.177	0.084	0.08	0.027	61	60	61	4.18	4.16	4.17	
23.972*	24.067	0.085	0.06	0.021	62	88	75	4.33	4.16	4.24	
24.067*	24.162	0.085	0.08	0.020	76	89	83	4.23	4.18	4.20	
24.162*	24.256	0.084	0.07	0.019	62	74	68	4.38	4.30	4.33	
24.256*	24.351	0.085	0.07	0.024	65	69	67	4.29	4.27	4.28	
24.351*	24.446	0.085	0.07	0.029	61	64	63	4.14	4.16	4.15	
24.446*	24.540	0.084	0.09	0.020	70	78	74	4.29	4.23	4.26	
22.609	24.540	1.016	0.06	0.039	67	74	71	4.19	4.16	4.18	

SENSOR	#1	#2	#3
GATE/ZERO	0	0	0
LOW	0	0	0
HIGH	0	0	0
DIFF	0	0	0
TOTAL	0	0	0
DUP 3X	1515	1510	1118
DUP 4X	160	150	95
DUP 5X	12	11	11
DUP >=6	5	2	1

PROFILE	#1	#2
SENSOR	0	0
MIN DIF	0	0
MAX DIF	0	0

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93140L1.601

COUNTY:	93	DATE COLLECTED:	03/31/2010
ROUTE:	SR15,700/US98	TIME:	13:39:50
DIRECTION:	South(-)	OPERATOR:	Kyle Kroodsma
LANE:	L1	DRIVER:	Kyle Kroodsma
VEHICLE:	DOT30392	DCF:	3700.5
UNITS:	ENGLISH	WAVELENGTH-LONG:	300 ft
SECTION:	140	FIN:	413804-1-52-01
SUB SEC:	000		
COMMENT1:		RPT VERSION:	2.1.2.1
AVG SPEED:	51.6 mph	MDR VERSION:	WP3.7.6.0
SAMPLE DISTANCE:	0.678 in (1)	SENSOR CAL DATE:	03/23/2010
PROFILE DISTANCE:	6.000 in	ACCEL CAL DATE:	03/31/2010

OUTPUT FILE NAME: W:\District4\93 Palm Beach\93140 FIN 41380415201 SR15,700 EXP 03-31-10\Raw Data\L1\OM100331133904DOT30392_MDR\93140L1.601

MILES		IN			IN/MI						
FROM	TO	ROUGH DIST	RUT AVG	RUT STD	IRI 1	IRI 2	AVG IRI	RN 1	RN 2	COMBINED RN	
24.541*	24.446	0.085	0.08	0.023	80	81	81	4.24	4.25	4.24	(R)
24.446*	24.352	0.084	0.01	0.028	78	73	75	4.14	4.20	4.17	
24.352*	24.257	0.085	0.02	0.020	54	53	53	4.44	4.45	4.44	
24.257*	24.162	0.085	0.02	0.020	43	49	46	4.49	4.40	4.44	
24.162*	24.068	0.084	0.03	0.022	54	70	62	4.37	4.08	4.21	
24.068*	23.973	0.085	0.04	0.027	50	57	53	4.32	4.24	4.28	
23.177*	23.083	0.084	0.05	0.032	72	71	71	4.23	4.33	4.27	
23.083*	22.988	0.085	0.09	0.033	60	74	67	4.34	4.27	4.31	
22.988*	22.893	0.085	0.02	0.028	61	87	74	4.37	4.18	4.26	
22.893*	22.799	0.084	0.02	0.026	60	52	56	4.31	4.38	4.35	
22.799*	22.704	0.085	0.05	0.033	55	54	55	4.30	4.30	4.30	
22.704*	22.610	0.084	0.03	0.023	49	44	47	4.34	4.42	4.38	
24.541	22.610	1.015	0.04	0.035	60	64	62	4.32	4.28	4.30	

SENSOR	#1	#2	#3
GATE/ZERO	0	0	0
LOW	0	0	0
HIGH	0	0	0
DIFF	0	0	0
TOTAL	0	0	0
DUP 3X	1493	1438	1072
DUP 4X	167	121	79
DUP 5X	16	13	6
DUP >=6	0	0	0

PROFILE	#1	#2
SENSOR	0	0
MIN DIF	0	0
MAX DIF	0	0

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NORTH BOUND **RUT AND CRACK SHEET** Section 1

LOCATION 1
CONTROL 1A

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft):**	500
Description:	Control 1A	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	TW & CF	**Ride:**	**4.05**	**Page:** 1 **of** 6	

Section No.: 1	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
155+25	0.05		
155+75	0.07		0.0
156+25	0.03		0.0
156+75	0.04		0.0
157+25	0.05		0.0
157+75	0.10		0.0
158+25	0.02		0.0
158+75	0.02		0.0
159+25	0.07		0.0
159+75	0.01		0.0
Section total(Rut)	0.46		
Average Rut (in.)	0.05		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 2

LOCATION 1
PETROGRID

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15	**Lenth of section (ft):**	500
Description:	PetroGrid	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.12**	**Page: 2 of**	6

Section No.: 2	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft)**
160+25	0.05		
160+75	0.01		0.0
161+25	0.02		0.0
161+75	0.02		0.0
162+25	0.00		0.0
162+75	0.02		0.0
163+25	0.01		0.0
163+75	0.03		0.0
164+25	0.06		0.0
164+75	0.01		0.0
Section total(Rut)	0.23		
Average Rut (in.)	0.02		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 3

LOCATION 1
GLASSGRID

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft):**	12	
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500	
Description:	GlasGrid	**Lane:**	NBTL		**No. Lanes:**	1	
Party/Crew:	JN & CF	**Ride:**	**4.12**		**Page: 3 of 6**		

Section No.: 3	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
165+25	0.09		
165+75	0.03		0.0
166+25	0.10		0.0
166+75	0.08		0.0
167+25	0.06		0.0
167+75	0.07		0.0
168+25	0.00		0.0
168+75	0.02		0.0
169+25	0.04		0.0
169+75	0.03		0.0
Section total(Rut)	0.52		
Average Rut (in.)	0.05		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 4

LOCATION 1
PAVETRAC

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft):**	500
Description:	PaveTrac	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.10**	**Page: 4 of**	6

Section No.: 4	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
170+25	0.03		
170+75	0.02		0.0
171+25	0.02		51.0
171+75	0.00		64.0
172+25	0.00		0.0
172+75	0.00		22.0
173+25	0.00		0.0
173+75	0.00		0.0
174+25	0.01		4.0
174+75	0.00		3.0
Section total(Rut)	0.08		
Average Rut (in.)	0.01		
	Total Cracking:		144
	Sq. ft./ 1000 sq. ft.		24.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 5

LOCATION 1
ARMI

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section ft):**	500
Description:	ARMI	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.12**	**Page: 5 of**	6

Section No.: 5	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
175+25	0.05		
175+75	0.02		0.0
176+25	0.02		0.0
176+75	0.02		0.0
177+25	0.02		0.0
177+75	0.03		0.0
178+25	0.02		0.0
178+75	0.02		0.0
179+25	0.04		0.0
179+75	0.02		0.0
Section total (Rut)	0.26		
Average Rut (in.)	0.03		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 6

LOCATION 1
CONTROL 1B

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft):**	12	
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500	
Description:	CONTROL 1B	**Lane:**	NBTL		**No. Lanes:**	1	
Party/Crew:	JN & CF	**Ride:**	**4.16**		**Page: 6**	**of**	6

Section No.: 5	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
180+25	0.01		
180+75	0.02		0.0
181+25	0.01		0.0
181+75	0.02		0.0
182+25	0.02		0.0
182+75	0.02		0.0
183+25	0.01		0.0
183+75	0.01		0.0
184+25	0.00		0.0
184+75	0.02		0.0
Section total(Rut)	0.14		
Average Rut (in.)	0.01		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND | **RUT AND CRACK SHEET** | Section 1

LOCATION 1
CONTROL 1A

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15	**Lenth of section (ft):**	500
Description:	CONTROL 1A	**Lane:**	SBTL	**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.42**	**Page: 1 of 6**	

Section No.: 1	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
159+75	0.01		
159+25	0.01		0.0
158+75	0.02		0.0
158+25	0.05		0.0
157+75	0.04		0.0
157+25	0.04		0.0
156+75	0.08		4.0
156+25	0.07		10.0
155+75	0.07		1.0
155+25	0.02		0.0
Section total(Rut)	0.41		
Average Rut (in.)	0.04		
	Total Cracking:		15
	Sq. ft./ 1000 sq. ft.		2.5

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 2

LOCATION 1
PETROGRID

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.):**	12
Location/County:	Palm Beach	**SR:**	15		**Lenth of section (ft.):**	500
Description:	PetroGrid	**Lane:**	SBTL		**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.30**		**Page: 2 of 6**	

Section No.: 2	**Wheelpath**		
Station/Location	**OWP (ft.)**	**IWP**	**Cracking (sq. ft.)**
164+75	0.00		
164+25	0.02		16.0
163+75	0.01		25.0
165+25	0.02		0.0
162+75	0.05		0.0
162+25	0.00		15.0
161+75	0.00		0.0
161+25	0.00		0.0
160+75	0.02		0.0
160+25	0.01		0.0
Section total(Rut)	0.13		
Average Rut (ft)	0.01		
	Total Cracking:		56
	Sq. ft./ 1000 sq. ft.		9.3

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 3

LOCATION 1

GLASGRID

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft):**	12	
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft):**	500	
Description:	GlasGrid	**Lane:**	SBTL	**No. Lanes:**	1	
Party/Crew:	JN & CF	**Ride:**	**4.38**	**Page: 3**	**of**	6

Section No.: 3	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
169+75	0.04		
169+25	0.07		39.0
168+75	0.05		13.0
168+25	0.03		22
167+75	0.04		21.0
167+25	0.01		0.0
166+75	0.00		0.0
166+25	0.00		0.0
165+75	0.00		1.0
165+25	0.00		4.0
Section total(Rut)	0.24		
Average Rut (in.):	0.02		
	Total Cracking:		100
	Sq. ft./ 1000 sq. ft.		16.7

OWP= Outside wheel Path

IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)

Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 4

LOCATION 1
PAVETRAC

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500
Description:	PaveTrac	**Lane:**	SBTL		**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.18**		**Page: 4 of**	6

Section No.: 4	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
174+75	0.01		
174+25	0.01		0.0
173+75	0.07		0.0
173+25	0.02		5.0
172+75	0.07		0.0
172+25	0.05		0.0
171+75	0.09		0.0
171+25	0.12		0.0
170+75	0.05		0.0
170+25	0.06		0.0
Section total(Rut)	0.55		
Average Rut (in.)	0.06		
	Total Cracking:		5
	Sq. ft./ 1000 sq. ft.		0.8

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 5

LOCATION 1
ARMI

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft):**	12	
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500	
Description:	ARMI	**Lane:**	SBTL		**No. Lanes:**	1	
Party/Crew:	JN & CF	**Ride:**	**4.27**		**Page: 5 of 6**		

Section No.: 5	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
179+75	0.00		
179+25	0.02		15.0
178+75	0.01		13.0
178+25	0.02		0.0
177+75	0.01		0.0
177+25	0.01		10.0
176+75	0.01		10.0
176+25	0.02		26.0
175+75	0.00		22.0
175+25	0.01		0.0
Section total(Rut)	0.11		
Average Rut (in.)	0.01		
	Total Cracking:		96
	Sq. ft./ 1000 sq. ft.		16.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 6

LOCATION 1

CONTROL 1B

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft):**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500
Description:	CONTROL 1B	**Lane:**	SBTL		**No. Lanes:**	1
Party/Crew:	JN & CF	**Ride:**	**4.33**		**Page: 6 of**	6

Section No.: 6	**Wheelpath**		
Station/Location	**OWP (in.)**	**IWP**	**Cracking (sq. ft.)**
184+75	0.01		
184+25	0.02		0.0
184+75	0.03		5.0
183+25	0.03		4.0
182+75	0.04		7.0
182+25	0.02		0.0
181+75	0.02		0.0
181+25	0.00		9.0
180+75	0.00		6.0
180+25	0.00		10.0
Section total(Rut)	0.17		
Average Rut (in.)	0.02		
	Total Cracking:		41
	Sq. ft./ 1000 sq. ft.		6.8

OWP= Outside wheel Path

IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)

Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 1

LOCATION 2
CONTROL 2A

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.):**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500
Description:	Control 2A	**Lane:**	NBTL		**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.16**		**Page:** 1 **of** 6	

Section No.: 1	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
227+25	0.01		
227+75	0.00		0.0
228+25	0.00		0.0
228+75	0.03		0.0
229+25	0.01		0.0
229+75	0.01		0.0
230+25	0.00		0.0
230+75	0.01		0.0
231+25	0.01		0.0
231+75	0.01		0.0
Section total(Rut)	0.09		
Average Rut (in.)	0.01		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 2

LOCATION 2

PETROGRID

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft)**	500
Description:	PetroGrid	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.18**	**Page: 2 of**	6

Section No.: 2	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
232+25	0.01		
232+75	0.03		24.0
233+25	0.02		0.0
233+75	0.00		50.0
234+25	0.02		20.0
234+75	0.02		8.0
235+25	0.02		0.0
235+75	0.02		0.0
236+25	0.01		10.0
236+75	0.04		3.0
Section total(Rut)	0.19		
Average Rut (in.)	0.02		
	Total Cracking:		115
	Sq. ft./ 1000 sq. ft.		19.2

OWP= Outside wheel Path

IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)

Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 2

LOCATION 2
PETROGRID

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft)**	500
Description:	PetroGrid	**Lane:**	NBTL		**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.18**		**Page: 2 of 6**	

Section No.: 2	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
232+25	0.01		
232+75	0.03		24.0
233+25	0.02		0.0
233+75	0.00		50.0
234+25	0.02		20.0
234+75	0.02		8.0
235+25	0.02		0.0
235+75	0.02		0.0
236+25	0.01		10.0
236+75	0.04		3.0
Section total(Rut)	0.19		
Average Rut (in.)	0.02		
	Total Cracking:		115
	Sq. ft./ 1000 sq. ft.		19.2

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 3

LOCATION 2
GLASGRID

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.):**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft):**	500
Description:	GlassGrid	**Lane:**	NBTL	**No. Lanes:** 1	
Party/Crew:	JN&CF	**Ride:**	**4.3**	**Page: 3 of 6**	

Section No.: 3	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
237+25	0.01		
237+75	0.03		24.0
238+25	0.02		0.0
238+75	0.00		50.0
239+25	0.02		20.0
239+75	0.02		0.0
240+25	0.02		0.0
240+75	0.02		0.0
241+25	0.01		0.0
241+75	0.04		0.0
Section total(Rut)	0.19		
Average Rut (in.)	0.02		
	Total Cracking:		94
	Sq. ft./ 1000 sq. ft.		15.7

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 4

LOCATION 2
PAVETRAC

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft)**	500
Description:	PaveTrac	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.27**	**Page: 4 of 6**	

Section No.: 4	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
242+25	0.01		
242+75	0.01		0.0
243+25	0.02		29.0
243+75	0.02		45.0
244+25	0.01		10.0
244+75	0.01		50.0
245+25	0.03		15.0
245+75	0.03		0.0
246+25	0.05		10.0
246+75	0.04		0.0
Section total(Rut)	0.23		
Average Rut (in.)	0.02		
	Total Cracking:		159
	Sq. ft./ 1000 sq. ft.		26.5

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND **RUT AND CRACK SHEET** Section 5

LOCATION 2
ARMI

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft)**	500
Description:	ARMI	**Lane:**	NBTL	**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.16**	**Page: 5 of 6**	

Section No.: 5	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
247+25	0.01		
247+75	0.02		0.0
248+25	0.07		0.0
248+75	0.02		0.0
249+25	0.03		0.0
249+75	0.02		0.0
250+25	0.00		0.0
250+75	0.02		0.0
251+25	0.01		0.0
251+75	0.00		0.0
Section total(Rut)	0.20		
Average Rut (in.)	0.02		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

NORTH BOUND

RUT AND CRACK SHEET

Section 6

LOCATION 2

CONTROL 2B

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.)**	12	
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft)**	500	
Description:	CONTROL 2B	**Lane:**	NBTL		**No. Lanes:**	1	
Party/Crew:	JN&CF	**Ride:**	**4.23**		**Page: 6 of 6**		

Section No.: 6	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
252+25	0.00		
252+75	0.01		0.0
253+25	0.06		40.0
253+75	0.01		50.0
254+25	0.03		10.0
254+75	0.02		2.0
255+25	0.02		35.0
255+75	0.02		40.0
256+25	0.02		47.0
256+75	0.04		0.0
Section total(Rut)	0.23		
Average Rut (in.)	0.02		
	Total Cracking:		224
	Sq. ft./ 1000 sq. ft.		37.3

OWP= Outside wheel Path

IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)

Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 1

LOCATION 2
CONTROL 2A

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.):**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft):**	500
Description:	CONTROL 2A	**Lane:**	SBTL		**No. Lanes:** 1	
Party/Crew:	JN & CF	**Ride:**	**4.24**		**Page: 1 of 6**	

Section No.: 1	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
231+75	0.07		
231+25	0.02		0.0
230+75	0.18		0.0
230+25	0.05		0.0
229+75	0.04		0.0
229+25	0.05		0.0
228+75	0.05		0.0
228+25	0.04		0.0
227+75	0.02		0.0
227+25	0.04		0.0
Section total(Rut)	0.56		
Average Rut (in.)	0.06		
		Total Cracking:	0
		Sq. ft./ 1000 sq. ft.	0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 2

LOCATION 2
PETROGRID

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.)**	12	
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft)**	500	
Description:	PetroGrid	**Lane:**	SBTL	**No. Lanes:**	1	
Party/Crew:	JN&CF	**Ride:**	**4.08**	**Page: 2**	**of**	6

Section No.: 2	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
236+75	0.04		
236+25	0.05		0.0
235+75	0.07		0.0
235+25	0.02		0.0
234+75	0.02		0.0
234+25	0.07		0.0
233+75	0.10		0.0
233+25	0.17		0.0
232+75	0.07		0.0
232+25	0.07		0.0
Section total(Rut)	0.68		
Average Rut (in.)	0.07		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 3

LOCATION 2
GLASGRID

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft)**	500
Description:	GlasGrid	**Lane:**	SBTL		**No. Lanes:** 1	
Party/Crew:	JN&CF	**Ride:**	**4.4**		**Page: 3 of 6**	

Section No.: 3	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
241+75	0.01		
241+25	0.02		0.0
240+75	0.03		0.0
240+25	0.01		0.0
239+75	0.03		0.0
239+25	0.04		0.0
238+75	0.00		0.0
238+25	0.02		0.0
237+75	0.03		0.0
237+25	0.02		0.0
Section total(Rut)	0.21		
Average Rut (in.)	0.02		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 4

LOCATION 2
PAVETRAC

Project # :	93140000	Date:	4/6/2010	Pavement Width (ft.)	12
Location/County:	Palm Beach	SR:	15	Length of section (ft)	500
Description:	PaveTrac	Lane:	SBTL	No. Lanes:	1
Party/Crew:	JN&CF	Ride:	4.45	Page: 4 of	6

Section No.: 4	Wheelpath		
Station/Location	OWP(in.)	IWP	Cracking (sq. ft.)
246+75	0.07		
246+25	0.02		0.0
245+75	0.01		0.0
245+25	0.01		0.0
244+75	0.04		0.0
244+25	0.03		0.0
243+75	0.02		0.0
243+25	0.03		0.0
242+75	0.00		0.0
242+25	0.03		0.0
Section total(Rut)	0.26		
Average Rut (in.)	0.03		
	Total Cracking:		0
	Sq. ft./ 1000 sq. ft.		0.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 5

LOCATION 2
ARMI

Project # :	93140000	**Date:**	**4/6/2010**		**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15		**Length of section (ft)**	500
Description:	ARMI	**Lane:**	SBTL		**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.2**		**Page: 5 of**	6

Section No.: 5	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
251+75	0.01		
251+25	0.02		2.0
250+75	0.06		0.0
250+25	0.03		0.0
249+75	0.05		0.0
249+25	0.01		0.0
248+75	0.01		0.0
248+25	0.02		0.0
247+75	0.02		0.0
247+25	0.04		0.0
Section total(Rut)			
Average Rut (in.)	0.03		
			2
	Sq. ft./ 1000 sq. ft.		0.3

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)

SOUTH BOUND **RUT AND CRACK SHEET** Section 6

LOCATION 2
CONTROL 2B

Project # :	93140000	**Date:**	**4/6/2010**	**Pavement Width (ft.)**	12
Location/County:	Palm Beach	**SR:**	15	**Length of section (ft)**	500
Description:	CONTROL 2B	**Lane:**	SBTL	**No. Lanes:**	1
Party/Crew:	JN&CF	**Ride:**	**4.25**	**Page: 6 of**	6

Section No.: 6	**Wheelpath**		
Station/Location	**OWP(in.)**	**IWP**	**Cracking (sq. ft.)**
256+75	0.01		
256+25	0.01		0.0
255+75	0.02		2.0
255+25	0.03		0.0
254+75	0.03		2.0
254+25	0.02		38.0
253+75	0.04		12.0
253+25	0.01		30.0
252+75	0.03		0.0
252+25	0.02		0.0
Section total(Rut)	0.22		
Average Rut (in.)	0.02		
	Total Cracking:		84
	Sq. ft./ 1000 sq. ft.		14.0

OWP= Outside wheel Path
IWP= Inside Wheel Path

NOTE: Area = (Length of section) X (Width of lane)
Square Ft. per 1,000 sq. ft. = (Total Cracking) X (1000) / (Area)