Florida Department of
TRANSPORTATION

FDOT's Asphalt Test Road

Construction and As-built Performance Report

FDOT Office
State Materials Office

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Table of Content

List of Tables

List of Figures

1. Introduction

1.1 Project Overview

The Florida Asphalt Test Road covers 2.3 miles of experimental asphalt pavement exposed to real-world traffic conditions. This facility allows for a comprehensive in-service performance evaluation of emerging asphalt pavement technologies and innovative concepts, focusing on the interactions among factors such as traffic loading, design features, material properties, construction practices, and environmental conditions.

The Asphalt Test Road was constructed along the southbound lanes of US-301 highway, parallel to the active roadway. The test road enables traffic to be diverted as needed, ensuring that extensive performance monitoring can be carried out without disrupting the traveling public. This feature makes the test road unique, as it is the only full-scale asphalt pavement testing facility in the Southeastern United States.

The distinct climate and environmental conditions in Florida further distinguish this test road from other full-scale facilities, such as MnRoad in Minnesota. This test road provides valuable data under unique weather and traffic circumstances. With an established Accelerated Pavement Testing (APT) program, this facility positions the Florida Department of Transportation (FDOT) as a global leader in advancing innovative pavement engineering technologies and practices.

1.2 Test Road Description

FDOT evaluated several potential locations for the test road and ultimately selected a southern segment of US-301 in Clay County (county segment 71030000, mile marker 0.116 to 3.510). Key criteria for this selection included a high volume of truck traffic and minimal interference from driveways or side streets. This test section is also adjacent and parallel to the existing concrete test road, making it conveniently located near the data center already used for the concrete test road.

The site is less than 40 miles from the State Materials Office (SMO), which will oversee performance monitoring through periodic surveys and pavement instrumentation measurements. The existing asphalt pavement between the concrete test road and this asphalt test road will remain in place and carry all northbound or southbound traffic during evaluations of the asphalt or concrete test sections. A weigh-in-motion (WIM) installation at the start of the test sections will record vehicle types and weights for traffic monitoring and analysis. Figures 1 and 2 show the location and details of the test road.

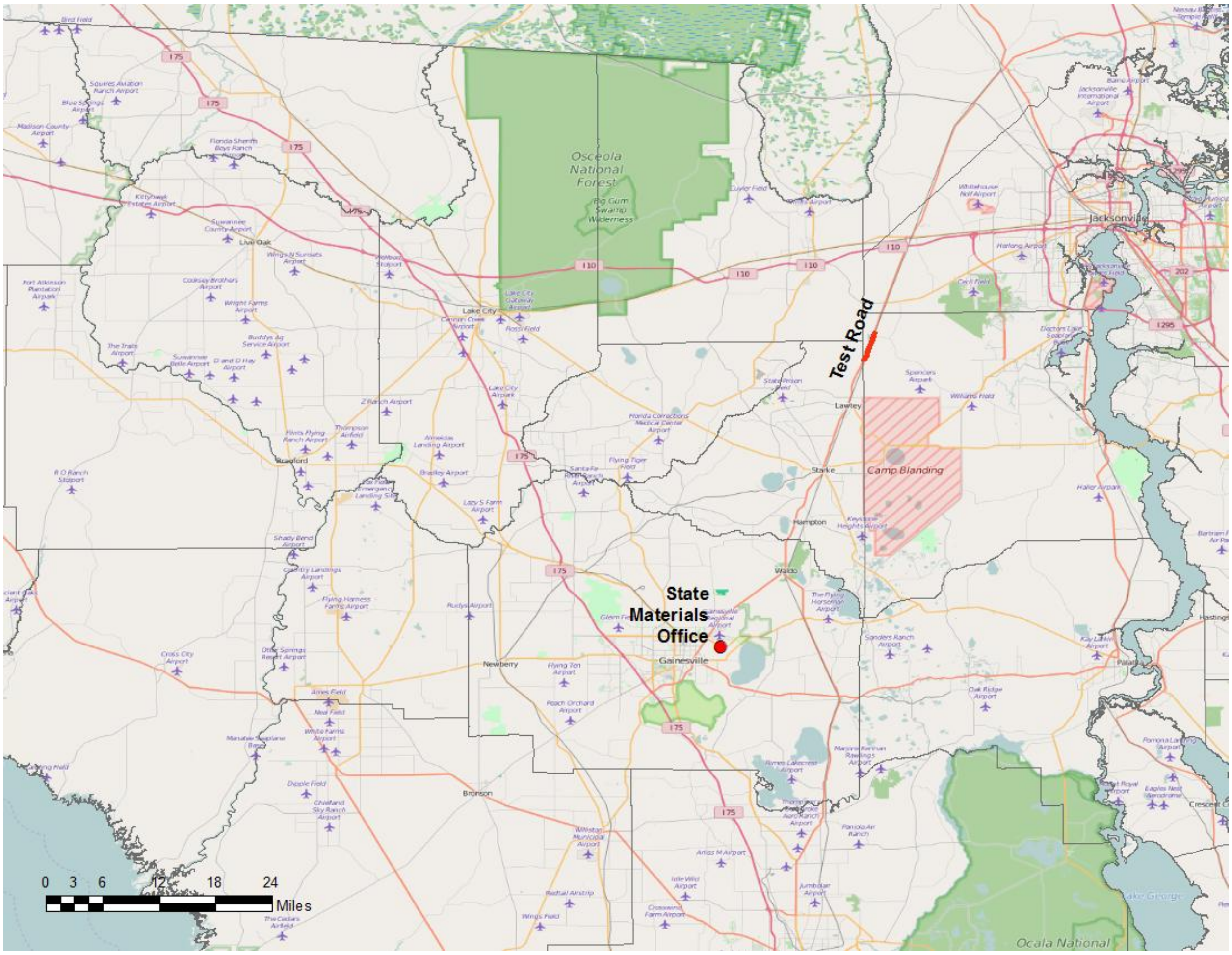


Figure 1 Test Road US-301

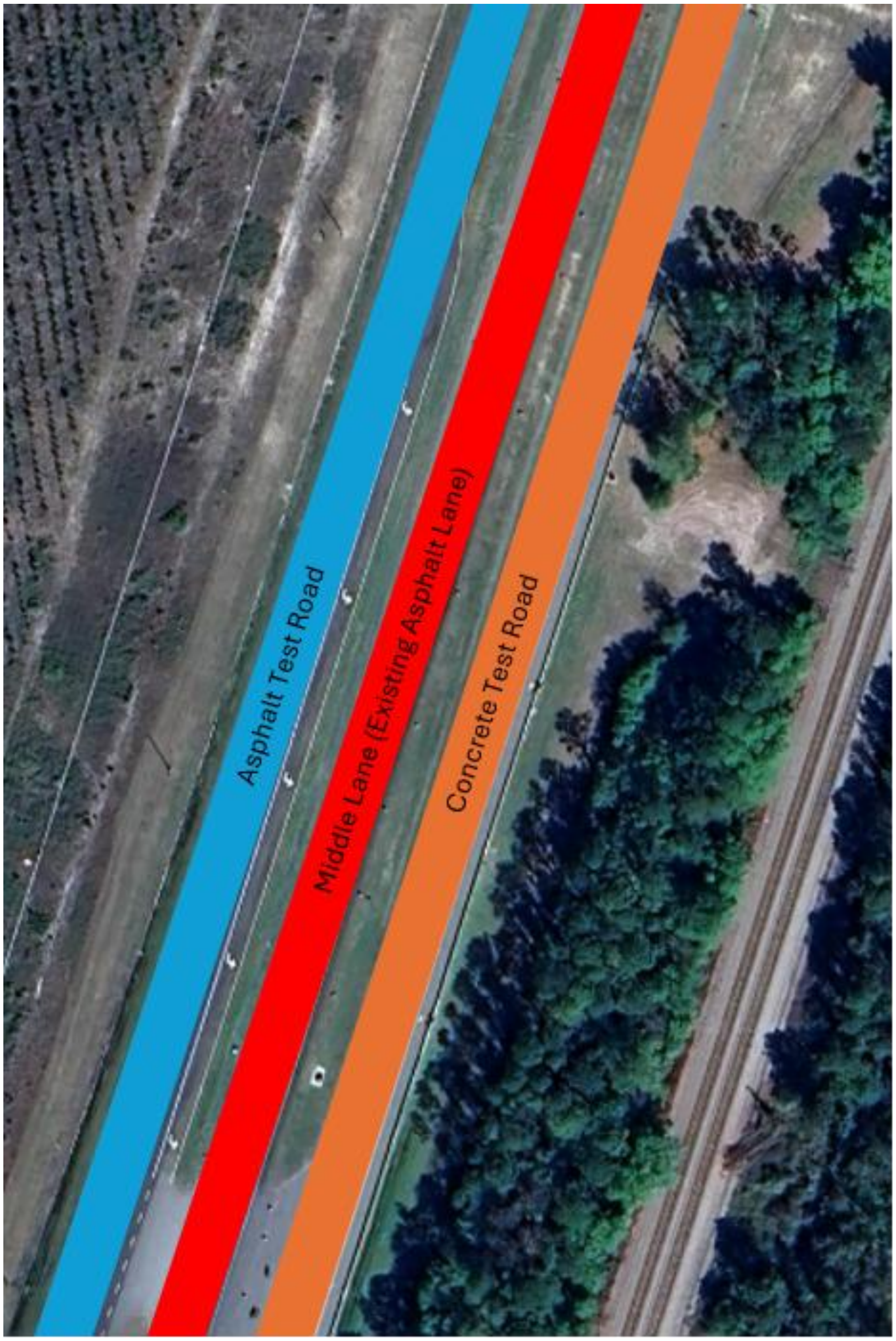


Figure 2 Test Road project details

1.3 Section Design

The Asphalt Test Road is divided into 12 sections, with Sections 8 and 10 further split into two sub-sections (see Figure 3). Each section spans 1,000 feet and includes both travel and passing lanes. Sections 1 through 7 are focused on the base layer study, featuring a standard Florida top layer structure with varying base configurations. In these sections, the existing material was removed down to the stabilized subgrade. The remaining sections were milled to the required depth.

The **Type SP** mix refers to the Superpave (SP) Mix, a pavement design method tailored to meet specific traffic and environmental conditions, while **TL** refers to the **Traffic Level**, a categorization of roadway traffic based on equivalent single-axle loads (ESALs). The Traffic Levels are defined by FDOT's Superpave specifications, as follows:

- **Traffic Level A**: < 0.3 million ESALs
- **Traffic Level B**: 0.3 to < 3 million ESALs
- **Traffic Level C**: 3 to < 10 million ESALs
- **Traffic Level D**: 10 to < 30 million ESALs
- **Traffic Level E**: ≥ 30 million ESALs

Section 1 is the control section, consisting of a 12'' limerock base (OBG 11), a 4'' Type SP (Traffic Level E) base course, a 2'' Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75'' FC-5 (PG 76-22) surface course.

Section 2 is the unstabilized RAP base test section, featuring a 12'' unstabilized RAP base, a 4'' Type SP (Traffic Level D) base course, a 2'' Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75'' FC-5 (PG 76-22) surface course.

Section 3 is the cold RAP mix base test section, consisting of a 12'' CCPR (Cold Central Plant Recycling with emulsion stabilization) RAP base, a 4'' Type SP (Traffic Level D) base course, a 2'' Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75'' FC-5 (PG 76-22) surface course.

Section 4 is the stabilized cold RAP mix base. It has a 12'' RAP base SF-1H Emulsions RAP stabilizer, a 4'' Type SP (Traffic Level D) base course, a 2'' Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75'' FC-5 (PG 76-22) surface course.

Section 5 is the Limerock/RAP mix base test section. This section features a 12’’ Limerock/RAP mix base (50% limerock and 50% RAP with a minimum LBR of 100), a 4’’ Type SP (Traffic Level D) base course, a 2’’ Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course.

Section 6 is another Limerock/RAP mix base test section, consisting of a 12’’ Limerock/RAP mix (75% limerock and 25% RAP with a minimum LBR of 100), a 4’’ Type SP (Traffic Level D) base course, a 2’’ Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course.

Section 7 is the full-depth reclamation (FDR) test section, featuring a 12’’ remixed layer of existing materials per FDOT FDR specifications after milling 6.75’’, a 4’’ Type SP (Traffic Level D) base course, a 2’’ Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course.

Section 8 focuses on the reflective cracking study and is divided into two sub-sections, 8A and 8B, each 500 feet long. Section 8A, the test section, consists of a 1.25’’ crack relief mix (HP binder) base course, a 1.75’’ Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course. Section 8B, the control section, consists of a 3.00’’ Type SP (PG 76-22) (Traffic Level D) binder course and a 0.75’’ FC-5 (PG 76-22) surface course. Both sections were milled to a depth of 3.75’’ and have longitudinal and transverse saw cuts to replicate cracks in the base.

Section 9 includes the Superpave 5 study. After being milled 3.75’’, it features a 3.00’’ Type SP5 (PG 76-22) (Traffic Level E) binder course and a 0.75’’ FC-5 (PG 76-22) surface course.

Section 10 is the deep lift study split into two 500-foot sub-sections. Section 10A consists of a 6.00’’ Type SP (PG 76-22) (Traffic Level D) base course, a 1.50” Type SP (PG 76-22) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course. Section 10B consists of a 6.00’’ Type SP (HP binder) (Traffic Level E) base course, a 1.50’’ Type SP (HP binder) (Traffic Level D) binder course, and a 0.75’’ FC-5 (PG 76-22) surface course.

Sections 11 and 12 involve a friction course study, both milled to a depth of 1.00’’. Section 11 is the control section, featuring a 1.00’’ FC-5 (PG 76-22) surface over the existing asphalt. Section 12, the test section, consists of a 1.00’’ FC-7 (PG 76-22) surface over the existing asphalt.

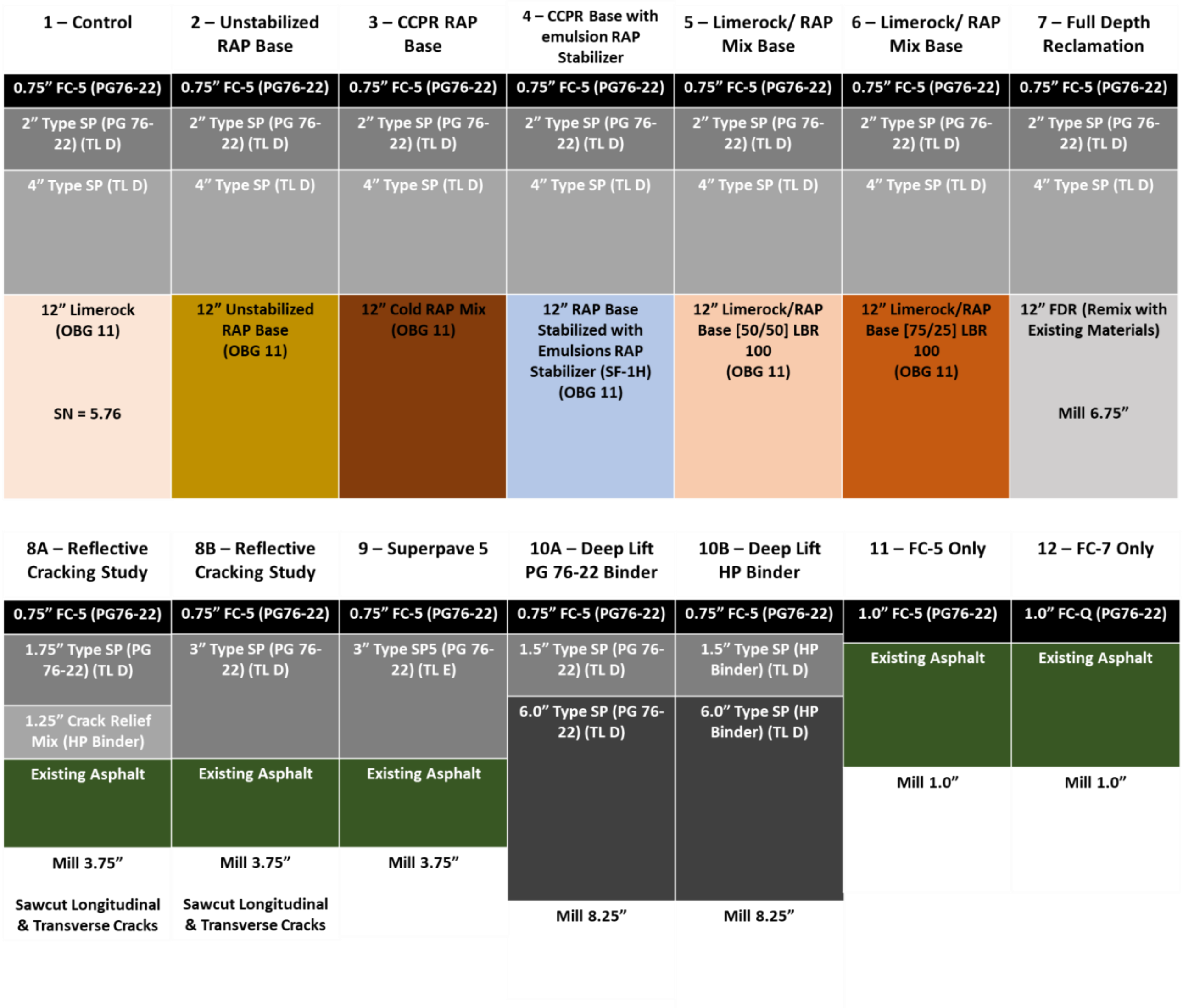


Figure 3 Test Road Sections

2. Instrumentation Plan

The instrumentation plan is illustrated in Figure 4 and 5. Table 1 displays the total amount of sensors installed in each pavement layer. The rationale that decides the location and number of the sensors is based on the objective and limitation of each section. For example, sections one to seven are the base layer material related research. However, due to construction methods, pressure cell at the bottom of the base layer may get damaged during the mixing process. Therefore, only section one to four had pressure cells installed.

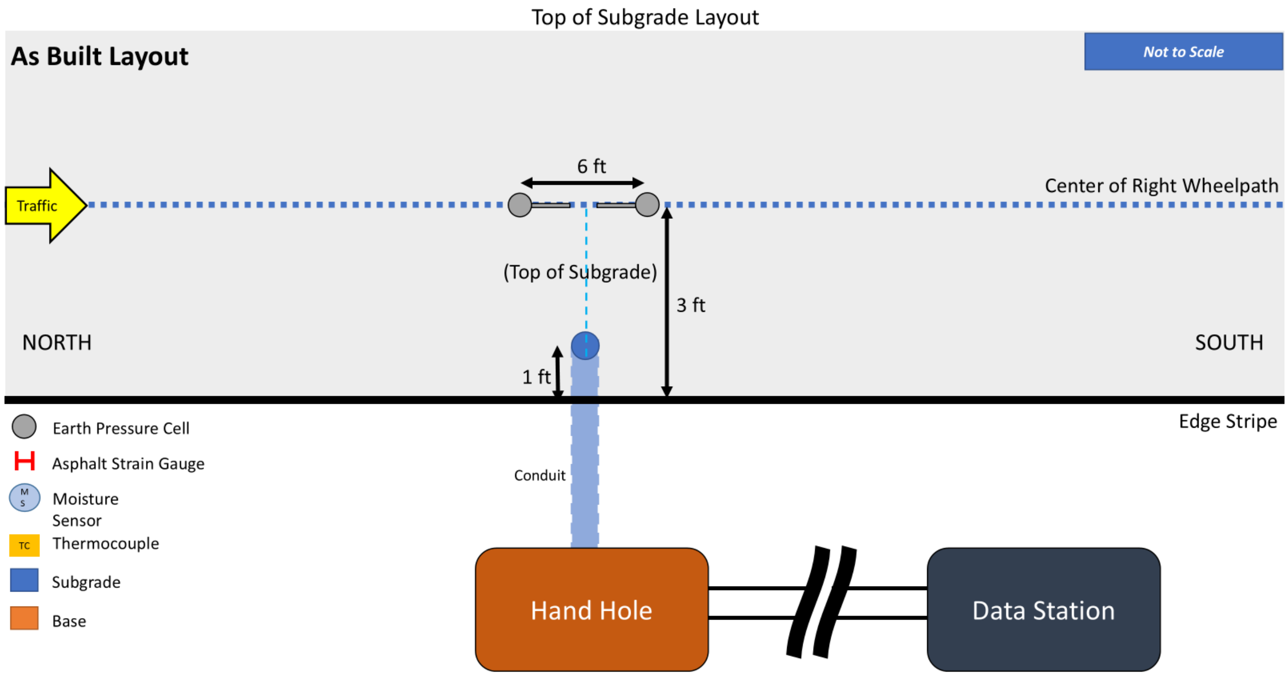


Figure 4 Plan View of Sensor Instrumentation (Top of Subgrade Layer)

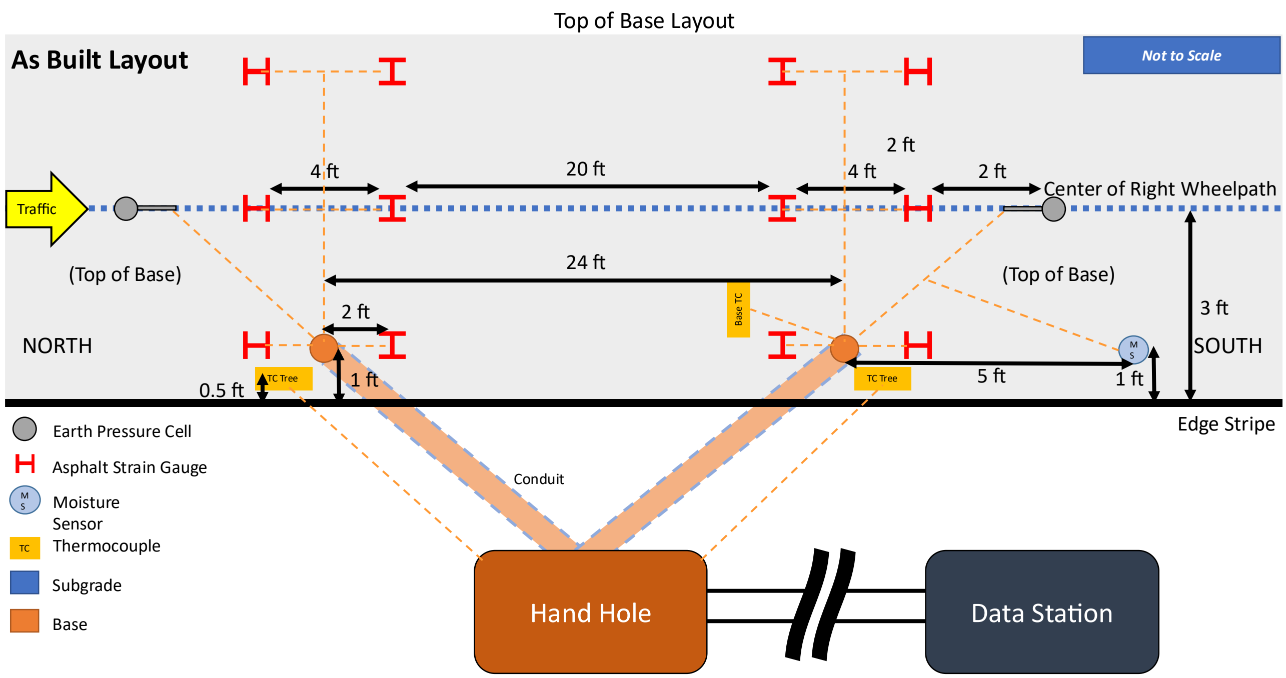


Figure 5 Plan View of Sensor Instrumentation (Top of Base Layer)

Table 1 Number and Location of the Sensor Instrumentation

Section	Strain Gauges	Base Pressure Cell	Subgrade Pressure Cell	Moisture Probe	Weather Station	Base Thermocouple	Thermocouple Tree	DHT11 (Humidity + Temperature)
1	12	2	2	1	0	1	2	1
2	12	2	2	1	0	1	n/a	1
3	12	2	2	1	0	1	n/a	1
4	12	2	2	1	0	1	n/a	1
5	12	2	n/a	1	0	1	n/a	1
6	12	2	n/a	1	1	1	n/a	1
7	12	2	n/a	1	0	1	n/a	1
8A	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
8B	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
9	12	0	n/a	0	0	1	2	1
10A	12	2	n/a	0	0	1	2	1
10B	12	2	n/a	0	0	1	n/a	1
11	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
12	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	120	18	8	7	1	10	6	10

2.1 Sensor Configuration

The sensors planned to be installed in the US-301 Asphalt Test Road are asphalt strain gauges, earth pressure cells, moisture probes, and thermocouples. A weather station will also be installed next to section 6 to collect environmental data like ambient temperature, precipitation, and wind speed. All sensors were calibrated before construction. The description and configuration of those sensors are introduced below:

Asphalt strain gauge

A total of 12 asphalt strain gauges were installed at the top of the base layer for section one to seven and section nine to 10. They were installed in both transverse and longitudinal directions along the wheel path, moreover, the strain gauges were also installed two feet offset from the wheel path to capture the traffic load as much as possible. The strain gauges were configured to record data every 15 minutes, but the frequency can be arranged to up to 1,000 Hz when needed. Figure 6 displays the photo of the asphalt strain gauge used in the Asphalt Test Road.

Figure 6 Asphalt Strain Gauge

Earth Pressure Cell

A total of four earth pressure cells were installed per section for sections one to four, two at the top of the subgrade and the remaining at the top of the base layer. On the other hand, two earth pressure cells were placed at the top of the base layer per section for section 5, 6 ,7, and 10. The reason for not installing at the top of the subgrade layer is due to the construction restraint. All the pressure cells were configured to collect data at 15-minute intervals. The frequency can be arranged to up to 1,000 Hz when needed. Figure 7 demonstrates the earth pressure cell installed in the Asphalt Test Road.

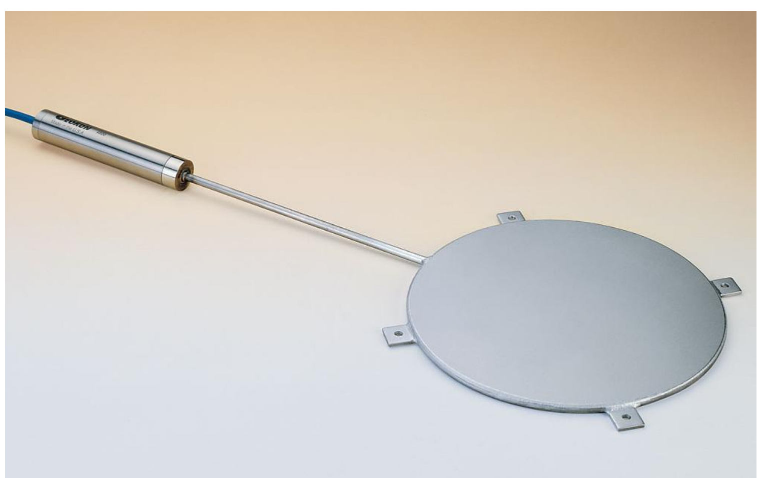


Figure 7 Earth Pressure Cell

Moisture Probe

One moisture probe per section was installed in the base layer for sections 1 to 7. This is to capture the moisture change for different base material. The moisture probe is 32 in long, with sensors at every 4-inch interval, and a total of eight sensors per probe. The moisture probe measures the volumetric water content (%) and temperature of the surrounding soil and was configured to record the data at 15-minute intervals.

Thermocouple

One thermocouple was installed at the top of the base layer for each section from section 1 to 7 and 9 to 10. Furthermore, a thermocouple tree measuring at 2-, 4-, and 6-inches depth was inserted in the asphalt surface layer to monitor the temperature change for section 1, 9 and 10A.

3. Construction Activities

3.1 Site Construction

The excavation of the existing layers started on October 24th, 2023. Photos are shown in Figure 8. The start of base layer compaction was in February 2024. The total construction time for all sections took approximately eight months. The highway was open to public traffic on September 18th, 2024. Before that, as-built laboratory test and field performance data were collected.

3.2 Preparation of Reflective Cracking Section

In order to generate the reflective cracking faster, pre-construction saw cuts were performed on the existing asphalt concrete surface after it was milled to 1 inch. A total of 20 transverse cut at 20 ft. intervals and three longitudinal cuts at 3 ft. interval were performed on both passing and travel lane. After saw cut, four cores were taken to check if the cut was all through to the base, and all the cores were found that the saw cut reached to the base layer.


Milling

Subgrade Preparation

Base Construction

Paving Surface

Figure 8 Construction Activities of Asphalt Test Road

3.3 Gauge Installation

Instrumentation processes are separated into two different phases. First, the pressure cells were installed at the top of the subgrade in sections one to four. Pressure cells were installed 2 inches below the subgrade surface and had one inch of sand placed beneath them. After leveling, the pressure cells were covered by sand and subgrade soil and hand compacted. After the base layer was paved, asphalt strain gauges, pressure cells, moisture probe, and thermocouples were installed on the top of the base layer surface. The asphalt strain gauges were stuck to the ground using emulsified asphalt binder and covered with asphalt loose mix before the paver and roller. All the sensor wires were protected by covering them with the metal conduit. The installation progress was shown in Figure 9 to 10.

Figure 9 Installation of Earth Pressure Cell

Figure 10 Installation of Asphalt Strain Gauge

4. Laboratory Testing Program and Results

The laboratory testing involves two different types of materials, one is asphalt concrete, the other is geotechnical granular and subgrade soil. Both materials were sampled by and tested in the State Materials Office in Gainesville, Florida.

4.1 Asphalt Test

Mix Design and Sample Collection Plan

The mix designs and the sample collection date of each section can be found in Table 2 and Appendix A.

Table 2 Mix Design and Sample Collection Date

Section	Mix Type	Thickness (in.)	Lift	Load Sampled	Date Sampled	Mix Design
1	SP-12.5	2	1	11	5/21/2024	SP 22-20832A
1	SP-12.5	2	2	12	5/23/2024	SP 22-20832A
1	SP-12.5	2	3	18	6/1/2024	SPM 22-20960A
1	FC-5	0.75	4	3	6/5/2024	SPM 23-22030A
2	SP-12.5	2	1	6	5/21/2024	SP 22-20832A
2	SP-12.5	2	2	8	5/23/2024	SP 22-20832A
2	SP-12.5	2	3	4	6/1/2024	SPM 22-20960A
2	FC-5	0.75	4	32	6/4/2024	SPM 23-22030A
3	SP-12.5	2	1	3	NA	SP 22-20832A
3	SP-12.5	2	2	48	5/22/2024	SP 22-20832A
3	SP-12.5	2	3	16	5/24/2024	SPM 22-20960A
3	FC-5	0.75	4	NA	NA	SPM 23-22030A
4	SP-12.5	2	1	28	5/9/2024	SP 22-20832A
4	SP-12.5	2	2	42	5/22/2024	SP 22-20832A
4	SP-12.5	2	3	4	5/24/2024	SPM 22-20960A
4	FC-5	0.75	4	NA	NA	SPM 23-22030A
5	SP-12.5	2	1	4	5/31/2024	
5	SP-12.5	2	2	11	5/31/2024	
5	SP-12.5	2	3	29	6/3/2024	
5	FC-5	0.75	4	NA	NA	SPM 23-22030A
6	SP-12.5	2	1	6	NA	SP 22-20832A
6	SP-12.5	2	2	32	5/22/2024	SP 22-20832A
6	SP-12.5	2	3	Not sampled	Not sampled	Not sampled
6	FC-5	0.75	4	18	6/4/2024	SPM 23-22030A
7	SP-12.5	2	1	6	NA	SP 22-20832A
7	SP-12.5	2	2	18	5/22/2024	SP 22-20832A
7	SP-12.5	2	3	20	5/30/2024	SPM 22-20960A
7	FC-5	0.75	4	NA	NA	SPM 23-22030A
8A	CRM	1.25	1	3	5/28/2024	LDH 24-2786A
8A	SP-12.5	1.75	2	6	5/30/2024	SPM 22-20960A
8A	FC-5	0.75	3	NA	NA	SPM 23-22030A
8B	SP-12.5	3	1	2	5/30/2024	SPM 22-20960A
8B	FC-5	0.75	2	NA	NA	SPM 23-22030A

9	SP5	3	1	21	5/30/2024	LDM 24-2787A
9	FC-5	0.75	2	NA	NA	SPM 23-22030A
10A	SP-12.5	6	1	21	5/23/2024	SPM 22-20960A
10A	SP-12.5	1.5	2	5	5/29/2024	SPM 22-20960A
10A	FC-5	0.75	3	NA	NA	SPM 23-22030A
10B	SP-12.5	6	1	22	5/28/2024	SPH 21-19506A
10B	SP-12.5	1.5	2	8	5/29/2024	SPH 21-19506A
10B	FC-5	0.75	3	NA	NA	SPM 23-22030A
11	FC-5	1	1	3	6/4/2024	SPM 23-22030A
12	FC-Q	1	1	5	6/4/2024	LDM 24-2785A

Volumetric Properties

Asphalt mix quality for sections 1 to 10 was evaluated using laboratory-compacted loose mix samples and field-obtained cores. The theoretical maximum specific gravity (Gmm) was determined from the loose mix using FM 1-T 209, while field cores were tested for bulk specific gravity (Gmb) by FM 1-T 166. Table 3 listed the volumetric properties for sections 1 to 10.

Table 3 Volumetric Properties for Sections 1 to 10

Spec. ID	Gmb	Gmm	Air Voids (%)	Field Density (%)
S1-L3	2.376	2.568	7.5	92.5
S1-L2	2.430	2.570	5.4	94.6
S1-L1	2.369	2.567	7.7	92.3
S1-L3	2.426	2.568	5.5	94.5
S1-L2	2.412	2.570	6.2	93.8
S1-L1	2.351	2.567	8.4	91.6
S2-L3	2.425	2.565	5.5	94.5
S2-L2	2.436	2.572	5.3	94.7
S2-L1	2.430	2.552	4.8	95.2
S2-L3	2.410	2.565	6.0	94.0
S2-L2	2.406	2.572	6.5	93.5
S2-L1	2.437	2.552	4.5	95.5
S3-L3	2.369	2.563	7.6	92.4
S3-L2	2.376	2.563	7.3	92.7
S3-L1	2.383	2.564	7.0	93.0
S3-L3	2.411	2.563	5.9	94.1
S3-L2	2.404	2.563	6.2	93.8
S3-L1	2.438	2.564	4.9	95.1
S4-L3	2.449	2.568	4.7	95.3
S4-L2	2.435	2.562	5.0	95.0
S4-L1	2.453	2.544	3.6	96.4
S4-L3	2.435	2.568	5.2	94.8
S4-L2	2.410	2.562	5.9	94.1

S4-L1	2.427	2.544	4.6	95.4
S5-L3	2.402	2.560	6.2	93.8
S5-L2	2.436	2.563	5.0	95.0
S5-L1	2.481	2.568	3.4	96.6
S5-L3	2.419	2.560	5.5	94.5
S5-L2	2.411	2.563	5.9	94.1
S5-L1	2.442	2.568	4.9	95.1
S6-L3	2.382	2.560	7.0	93.0
S6-L2	2.410	2.567	6.1	93.9
S6-L1	2.423	2.553	5.1	94.9
S6-L3	2.390	2.560	6.7	93.3
S6-L2	2.387	2.567	7.0	93.0
S6-L1	2.415	2.553	5.4	94.6
S7-L3	2.397	2.559	6.3	93.7
S7-L2	2.422	2.566	5.6	94.4
S7-L1	2.476	2.555	3.1	96.9
S7-L3	2.379	2.559	7.0	93.0
S7-L2	2.443	2.566	4.8	95.2
S7-L1	2.455	2.555	3.9	96.1
S8A L2	2.427	2.557	5.1	94.9
S8A-L1	2.417	2.501	3.4	96.6
S8B-L1	2.431	2.562	5.1	94.9
S9-L1	2.445	2.577	5.1	94.9
S9-L1	2.444	2.577	5.2	94.8
S10A-L2	2.386	2.567	7.1	92.9
S10A-L1	2.468	2.574	4.1	95.9
S10B-L2	2.409	2.563	6.0	94.0
S10B-L1	2.447	2.582	5.2	94.8

Performance Testing

The performance test for the collected asphalt mixtures from each section were Indirect Tensile Asphalt Cracking Test (Ideal-CT), High Temperature Indirect Tensile Test (HT-IDT), Asphalt Pavement Analyzer Test (APA), and Hamburg Wheel Track Test (HWTT). It should be noted that Section 3 was chosen to represent Section 1 to 7 since they all used the same asphalt concrete mixtures.

Ideal-CT Test (ASTM D 8225)

The Ideal-CT test is an indirect tension test that determines the cracking potential of asphalt mixtures with a fracture mechanics-based. Three 150 mm in diameter by 62 mm in height Samples with a target air void of 7±0.5% were tested at 25 °C to obtain the Cracking Tolerance Index (CT_{Index}). The test results are shown in Figure 11. It should be noted that Section 8A Lift 1 is having significantly higher CT_{Index} due to its crack resistance properties. All other Sections and Lifts are below 50.

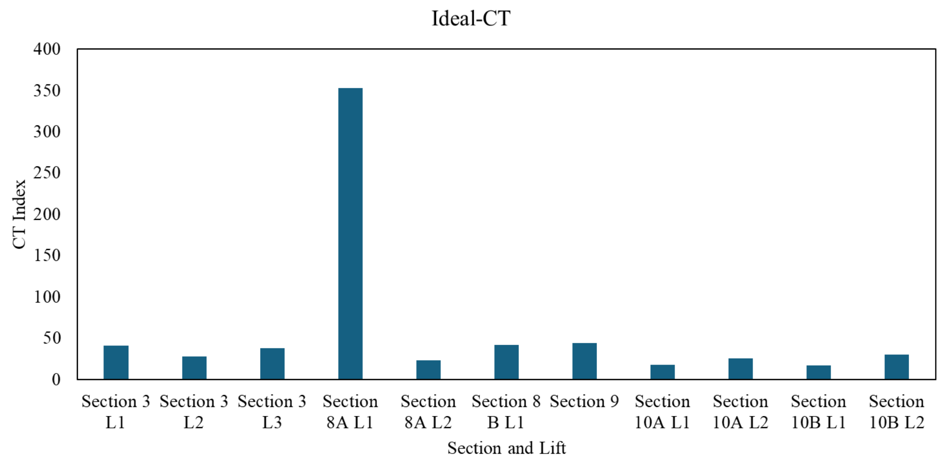


Figure 11 Ideal-CT Test Results

HT-IDT Test (ASTM WK 86870)

The High Temperature Indirect Tensile Test (HT-IDT) is a new test method which evaluates the rutting resistance of the asphalt concrete mixture via an indirect tensile method on a Marshall press. Three samples were prepared the same as a common IDT test (ASTM T312), which is 150 mm in diameter by 62 mm in height. However, the testing required conditioning the samples at 50±1℃ for 2 hours±10 minutes prior to testing. The test results are demonstrated in Figure 13. It should be noted that some sections' lift did not have sufficient materials to complete the test.

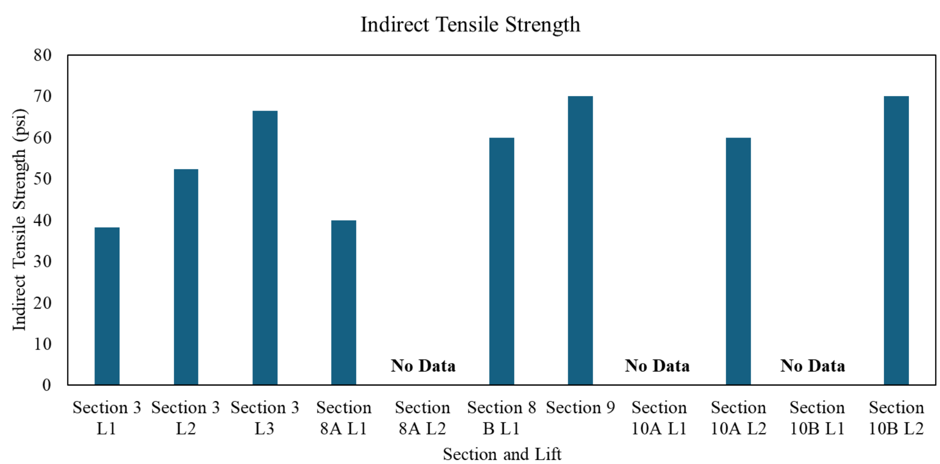


Figure 12 HT-IDT Test Results

APA Test (AASHTO T 340)

The Asphalt Pavement Analyzer Test (APA) is a test method used to determine the rutting susceptibility of the asphalt concrete mixtures. Figure 13 presents the APA test results. The test was conducted on 75 mm and 115 mm height samples. It could be seen that there is a significant difference in Section 10A Lift 1.

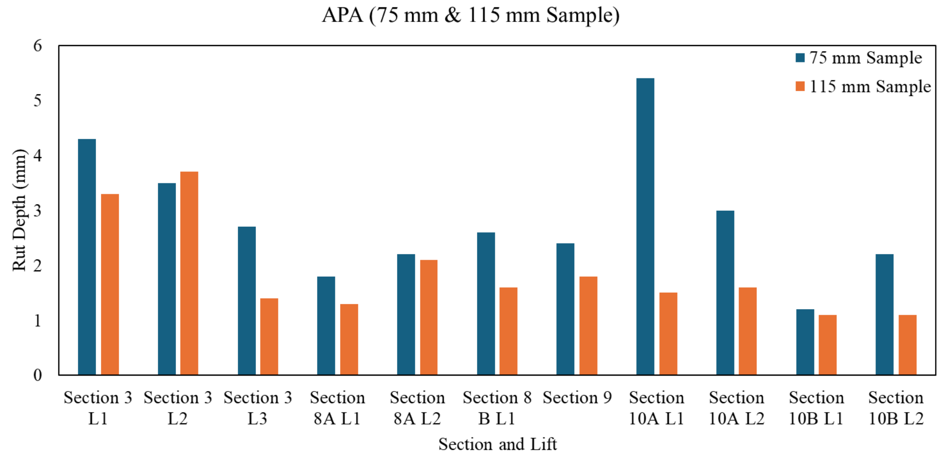


Figure 13 APA Test Results

Hamburg Wheel Track Test (HWTT)

The HWTT test is another rutting test for the asphalt concrete mixtures, except it immerses the samples in a heated water bath during testing to also evaluate its moisture susceptibility. Figure 14 displays the test results, excluding Section 3 Lift 2 and Lift 3 since there is a lack of material to perform the test.

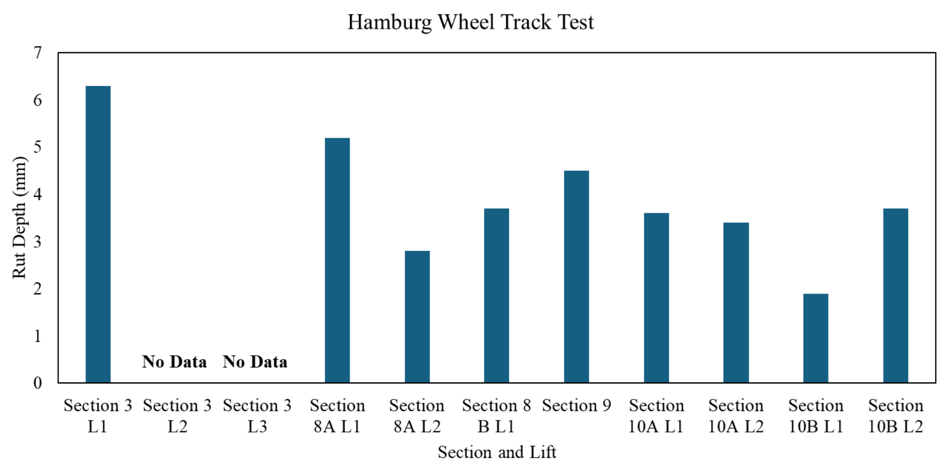


Figure 14 HWTT Test Results

4.2 Geotechnical Test

The base and subgrade material properties were evaluated by the SMO Geotech group. Moreover, field density of section one to six was obtained by the same group too. Table 4 and Appendix B provided the moisture content and compaction level for the subgrade and base layer acquired from QC test. Moreover, a comprehensive geotechnical test program and test results conducted by the SMO Geotech group can be found in Appendix C.

Table 4 Compaction Level for Subgrade and Base Layer (Sections 1 to 7)

Section	Layer	Compaction level (%)
Control	Subgrade	94.0
	Limerock Base	101.2
Unstabilized RAP Base	Subgrade	98.0
	RAP Base	98.8
CCPR RAP Base	Subgrade	99.0
	Base(RAP+Emulsion+Cement)	101.0
	CCPR Base	99.0
CCPR Base with emulsion RAP stabilizer	Subgrade	98.0
	Base(RAP+Emulsion+Cement)	99.0
	Cold RAP Base	100.9
Limerock/ RAP (50/50)	Subgrade	96.0
	Base	98.8
Limerock/ RAP (75/25)	Subgrade	96.0
	Base	98.5
Full Depth Reclamation	Full D Reclaim Base	97.8

5. Field Performance Testing Protocol

Two performance surveys will be conducted each year, one in the summer/Fall and one in the winter/Spring. Additional surveys will follow extreme events such as hurricanes and tropical storms. At a minimum, pavement performance measurements will include the following:

- Falling Weight Deflectometer (FWD): to assess pavement stiffness and structural capacity.
- Laser Crack Measurement System (LCMS): to measure rut depth, roughness (IRI), and cracking.
- Ground Penetrating Radar (GPR): to determine pavement layer thickness and condition.
- Friction Testing: to evaluate surface friction for the FC layers.
- Noise Testing: On-Board Sound Intensity (OBSI) tests for sections 11 and 12.

Figure 15 Performance Measurement Instruments

The pavement response (i.e., strain) to traffic loads and in situ pavement temperature will be measured with embedded strain gauges, pressure cells, and thermocouples. Thermocouples placed at different depths within the asphalt pavement will be used to record the temperature gradient throughout the asphalt layers. Moisture sensors will be placed for each test section to understand how water moves through a pavement system. Monitoring wells will also be used to track the water table.

Field tests will be performed to assess the pavement's structural and functional performance. The tests include FWD, LCMS, GPR, Friction, and Noise measurements. Figure 15 demonstrates the testing equipment. Testing locations will be distributed along the travel and passing lanes, focusing on the mid-lane and outer wheel paths. Additionally, replicate runs will be performed to ensure consistency of results.

5.1 Falling Weight Deflectometer (FWD)

The Falling Weight Deflectometer (FWD) is a key tool for evaluating pavement stiffness and structural performance. It simulates the effect of a moving wheel load by applying a controlled force to the pavement surface. Deflection sensors are placed at varying distances from the load application point to measure the deflection basin. This provides insight into the load-bearing capacity and potential structural deficiencies of the pavement layers.

FWD testing will be conducted at several predefined locations along the mid-lane and outer wheel paths, ensuring adequate coverage for each test section. Sixteen tests will be performed at 500-foot intervals, with additional testing at 50-foot intervals for project-level evaluations. Three target load levels (6000, 9000, and 12,000 pounds) will be applied, with deflections measured using sensors located at 0, 8, 12, 18, 24, 36, and 60 inches from the load point. Figure 16: Drop locations for Falling Weight Deflectometer (FWD) testing.

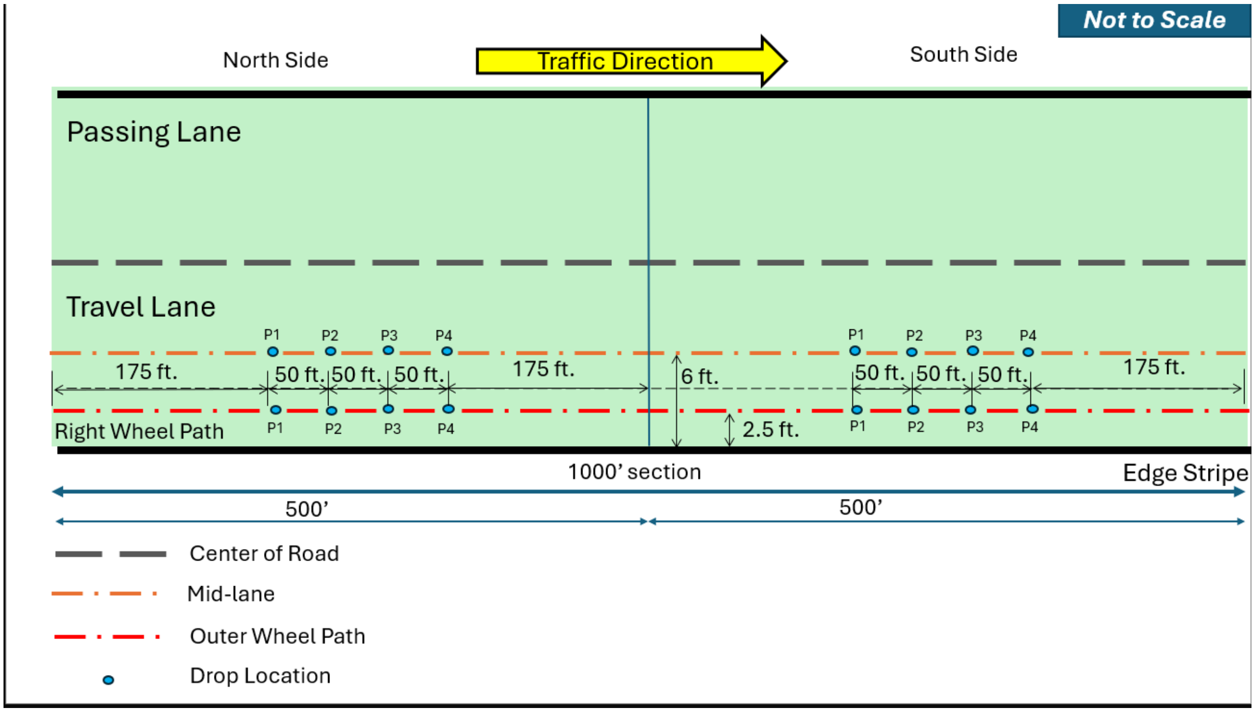


Figure 16 FWD Schematic

5.2 Laser Crack Measurement System (LCMS)

The LCMS test will measure surface roughness, rut depth, and cracking. It uses high-resolution laser scanning technology to capture detailed surface profiles. Rut depth, International Roughness Index (IRI), and surface cracking are essential indicators of pavement distress and are critical to assessing pavement functionality.

To ensure accurate measurements, two replicate runs will be performed on both the travel and passing lanes. The LCMS can provide a resolution of 0.001 inches, allowing for precise detection of surface defects.

5.3 Ground Penetrating Radar (GPR)

Ground-penetrating radar (GPR) will be used to evaluate the pavement's subsurface condition, including layer thickness and potential areas of moisture infiltration or voids. GPR uses radar pulses to image the subsurface and detect changes in material properties. Two types of GPR systems will be employed: air-launched GPR and Ground-Coupled GPR.

Air-launched GPR will be used for all sections, providing high-speed, non-contact measurements. Ground-coupled GPR will focus on the wheel paths of the travel lane, providing higher-resolution data on the subsurface condition.

5.4 Friction Testing

Friction testing is crucial for evaluating the skid resistance of the pavement surface, especially in high-speed areas. Friction will be measured using the locked-wheel method with both ribbed and smooth tires. The tests will be conducted at three speeds (40, 50, and 60 mph) to assess performance under varying conditions.

Two friction tests will be conducted on each section, covering the travel and passing lanes. Replicate runs will be performed to ensure accuracy, focusing on identifying any deficiencies in surface friction that could affect safety.

5.5 Noise Testing

Noise measurements will be conducted using On-Board Sound Intensity (OBSI) testing on sections 11 and 12. The OBSI test measures the noise generated by tire-pavement interaction, providing valuable data on the acoustic performance of the friction courses.

Each section will undergo three replicate OBSI tests and two-way-side noise measurements at 250 and 750 feet. This will allow for a comprehensive evaluation of noise levels, which are an important factor in public perception and compliance with environmental standards.

6. As Build Performance Survey Results

6.1 FWD Results

FWD Deflection Basin Parameters

The deflection basin, formed by measuring surface deflections at different radial distances from the load center, is crucial in assessing the condition of the pavement layers. Key parameters derived from the deflection basin include the Surface Curvature Index (SCI), Base Damage Index (BDI), and Area Under Pavement Profile (AUPP). The tensile strain at the bottom of the asphalt concrete (AC) layer, compressive strain at the top of the base layer, and compressive strain at the top of the subgrade are critical indicators of pavement distress, particularly fatigue cracking and rutting. Figure 17 presents the FWD test results for each section at the center location for 9000 lb load.

The maximum deflection (D0)

It is measured directly beneath the loading plate (D0). It is the point where the pavement experiences the greatest deformation due to the applied load. The D0 deflection provides critical information about the overall stiffness and structural condition of the pavement system. A higher D0 value indicates that the pavement is more flexible, which could suggest that the pavement structure is weaker or that the subgrade has lower stiffness. Conversely, a lower D0 value suggests a stiffer pavement, indicating stronger layers or a more competent subgrade.

Since D0 captures the entire pavement structure's response, it can indicate subgrade performance. A very high D0 often points to potential subgrade issues, such as low strength or moisture that reduces the bearing capacity. D0 can also help engineers assess whether the pavement has adequate structural capacity to carry the expected traffic loads. By comparing the measured D0 to design criteria or historical data, engineers can determine if the pavement is nearing its end of life or requires rehabilitation.

Surface Curvature Index (SCI):

SCI is the difference between the deflection directly under the load plate (center deflection) and the deflection measured at a specified distance from the center, usually 12 inches (300 mm).

Equation: SCI = D0 - D12

A lower SCI value suggests a stiffer AC layer, while a higher SCI value can indicate potential issues such as cracking or insufficient layer stiffness.

Base Damage Index (BDI):

BDI measures the deflection difference between two specific radial distances, typically between 12 inches (300 mm) and 24 inches (600 mm).

Equation: BDI = D12 - D24

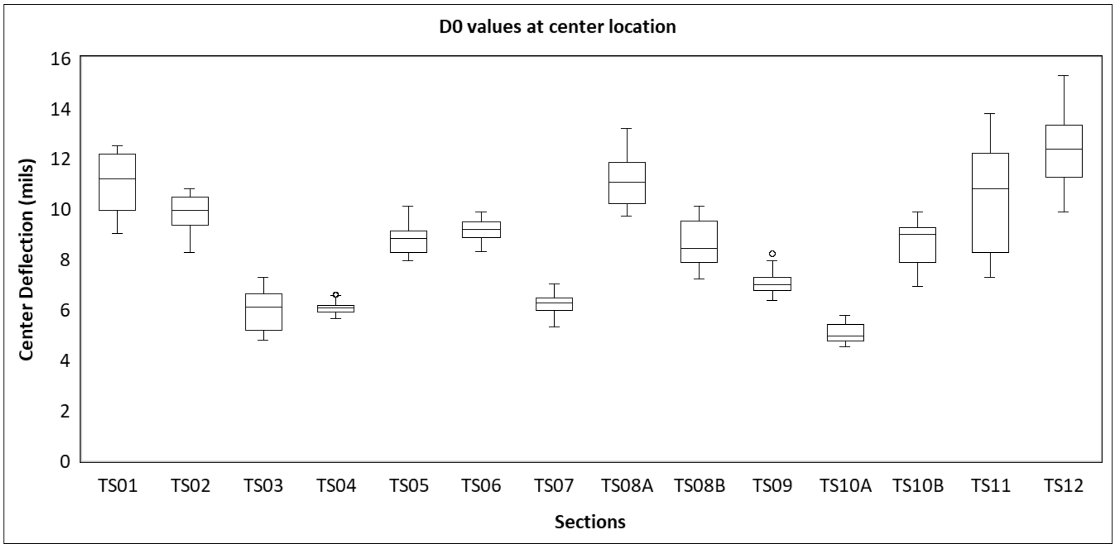
A high BDI value suggests a weaker or deteriorated base layer, often associated with excessive deformation or poor compaction.

Area Under Pavement Profile (AUPP):

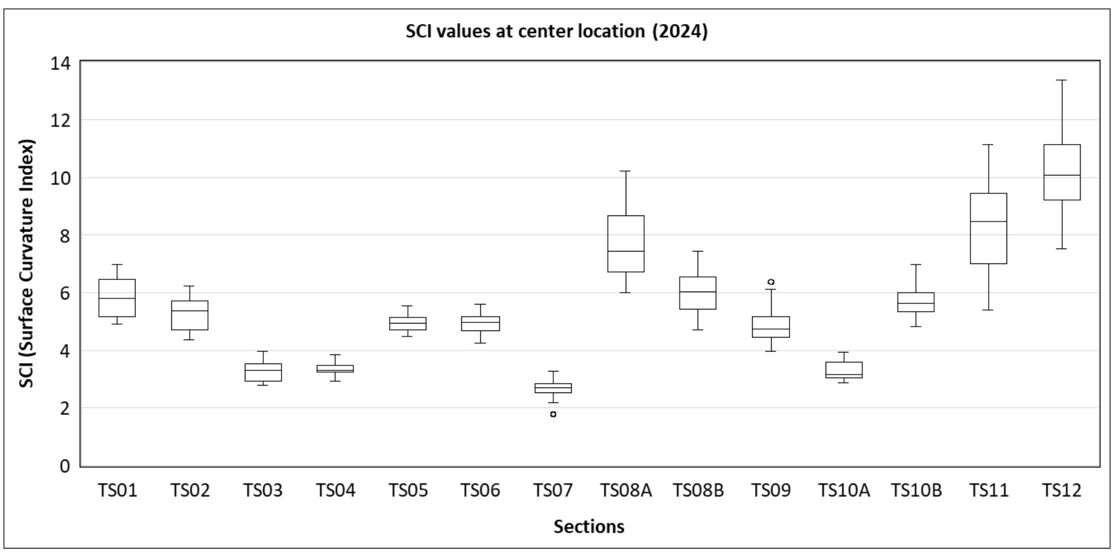
AUPP is a comprehensive parameter that considers the entire deflection basin and captures the deflection values at multiple radial offsets.

Equation: AUPP = (5*D0 – (2*D12 + 2*D24 + D36)) / 2

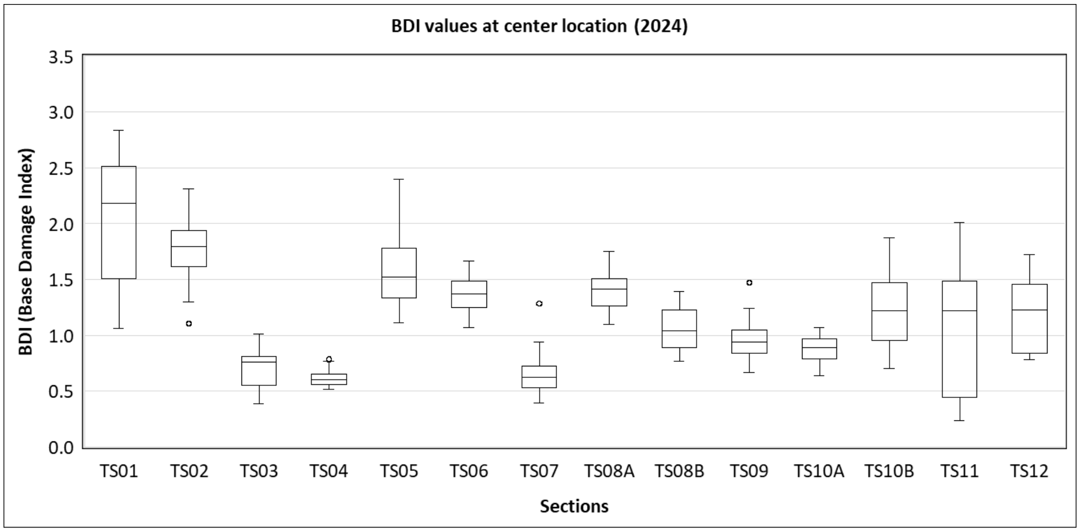
Interpretation: Lower AUPP values indicate stronger pavement structures, while higher values suggest weakened or deteriorated layers.


D0 values at center location
Center Deflection (mils)
0
2
4
6
8
10
12
14
16
TS01
TS02
TS03
TS04
TS05
TS06
TS07
TS08A
TS08B
TS09
TS10A
TS10B
TS11
TS12
Sections

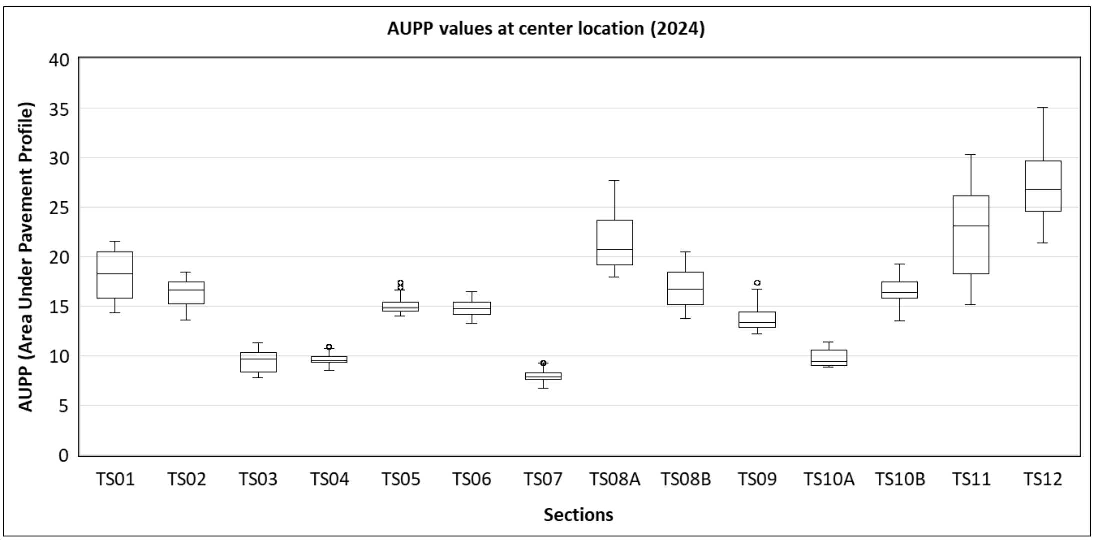
(a)


SCI values at center location (2024)
SCI (Surface Curvature Index)
0
2
4
6
8
10
12
14
TS01
TS02
TS03
TS04
TS05
TS06
TS07
TS08A
TS08B
TS09
TS10A
TS10B
TS11
TS12
Sections

(b)



(c)

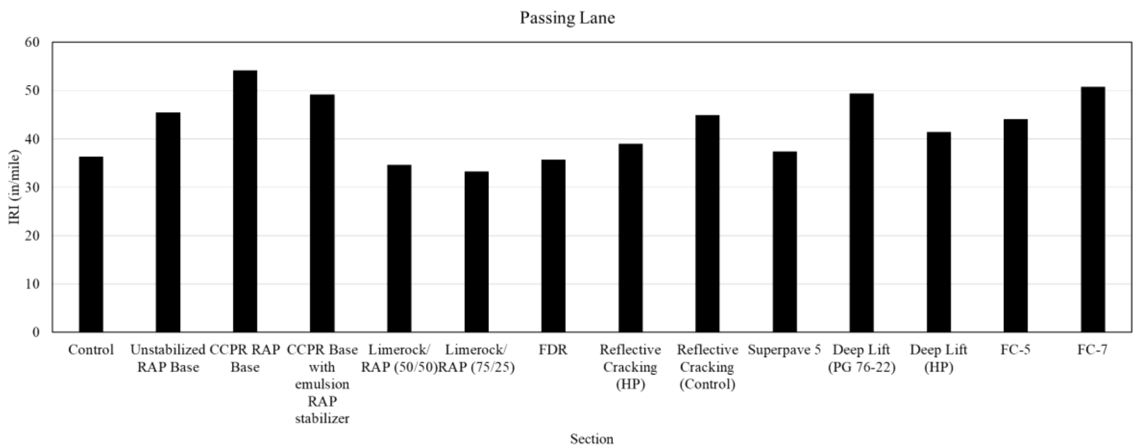


(d)

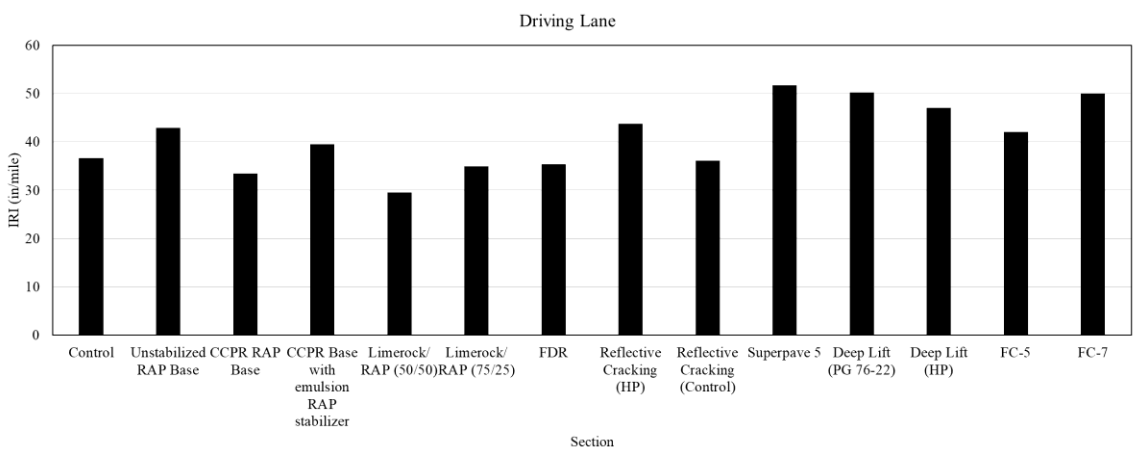
Figure 17 Results for (a) D0 Values (b) SCI Values (c) BDI Values (d) AUPP Values at Center Location

6.2 LCMS Results

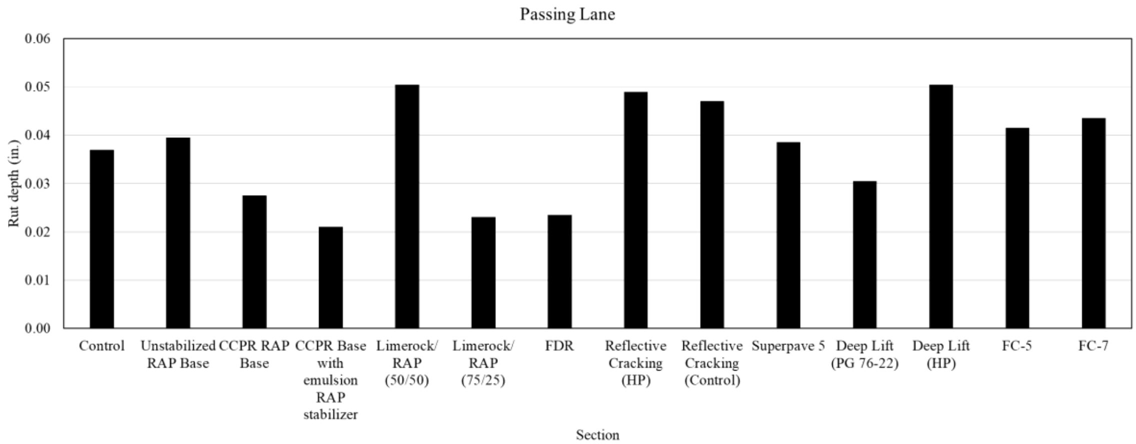
The IRI and Rut depth for each test section were measured by the LCMS. Results are shown in Figure 18 and 19.



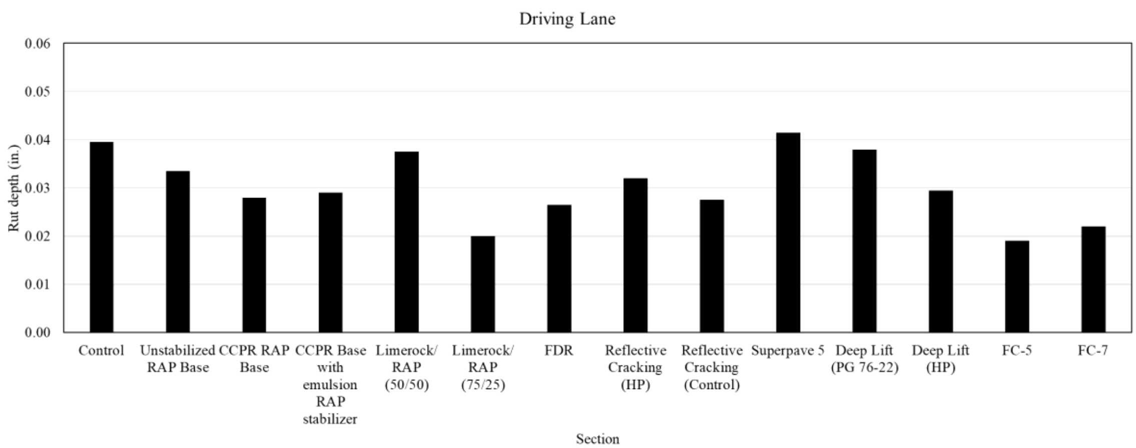
(a)



(b)
Figure 18 IRI Data for (a) Passing Lane (b) Driving Lane



(a)

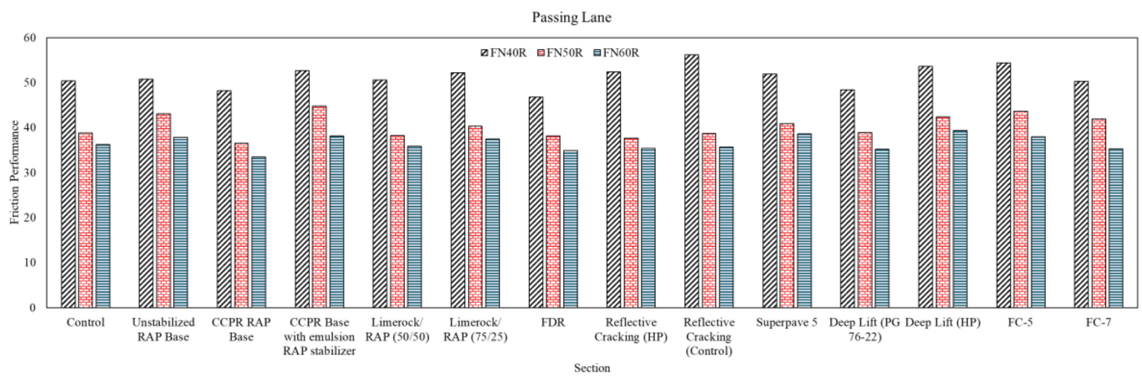


(b)

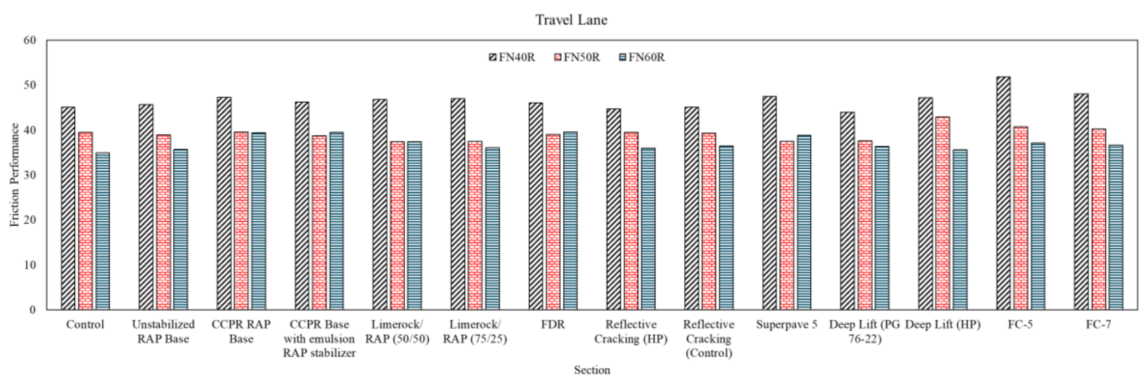
Figure 19 Rut Depth for (a) Passing Lane (b) Driving Lane

6.3 Friction Results

The results of the friction number obtained for each section at 40, 50, and 60 mph, using both ribbed and smooth tires, are presented in Figures 20 and 21. It should be noted that two test runs at an interval of 500 ft. were performed for each lane, with both ribbed tires and smooth tires set. However, it was found that several friction values demonstrated significantly higher results (57 to 60) from the sections that used the FC-5 mixture in the first run, which does not comply with experience in Florida. Moreover, the FC-5 friction data for 50 and 60 mph were converted into equivalent 40 mph friction values using the empirical equation developed by the Florida Department of Transportation (FDOT). It was found that the differences between 40 mph friction results versus the converted 40 mph data were less in the second run. Therefore, the second run data was selected to represent the friction performance. Finally, the texture data, including all the sections for both lanes, are shown in Figures 22.

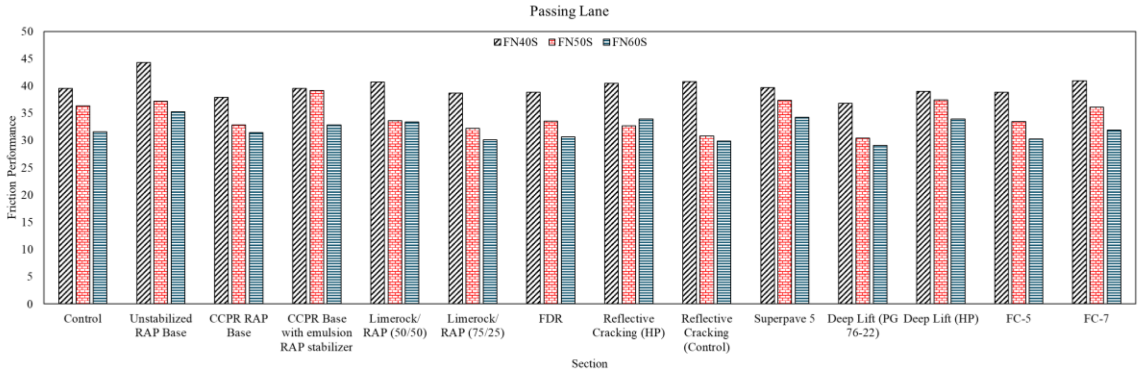


(a)

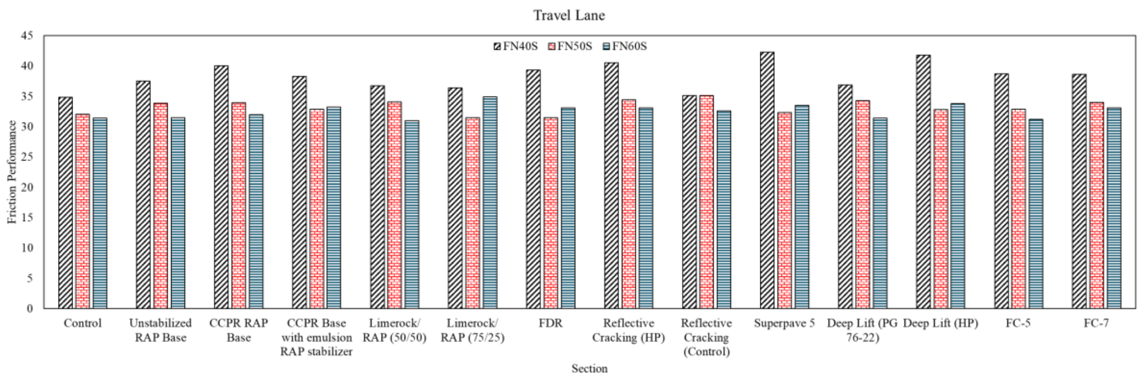


(b)

Figure 20 Ribbed Tire Friction Results for (a) Passing Lane (b) Travel Lane

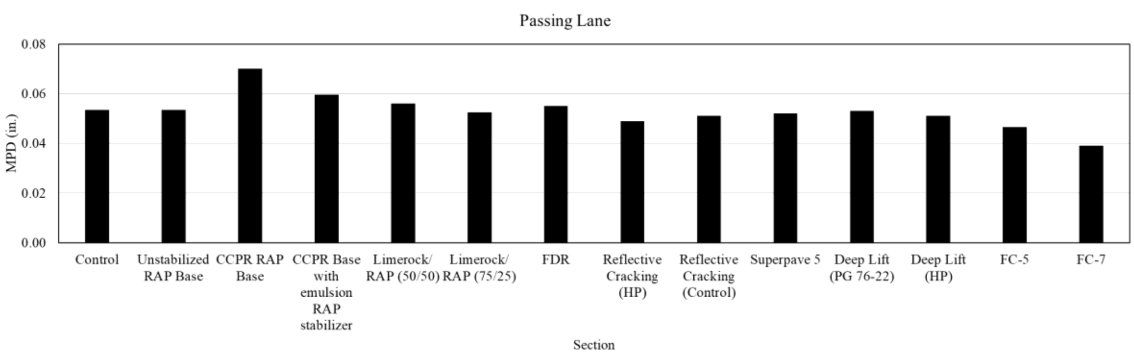


(a)

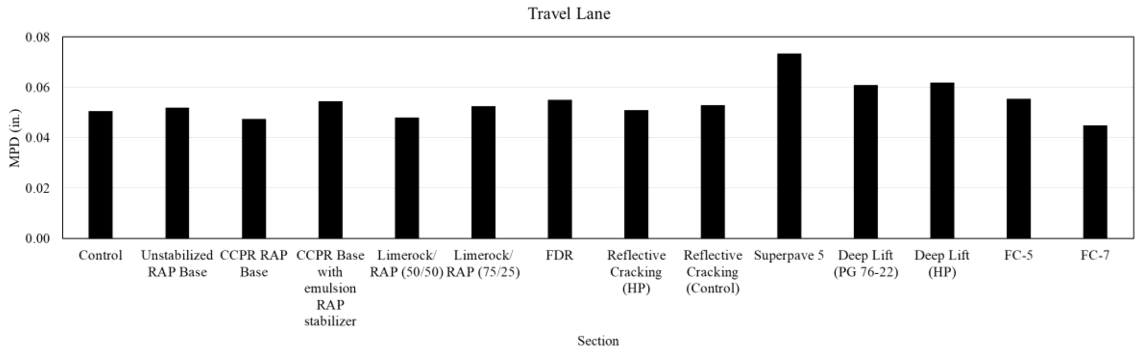


(b)

Figure 21 Smooth Tire Friction Results for (a) Passing Lane (b) Travel Lane



(a)



(b)

Figure 22 Texture Results for (a) Passing Lane (b) Travel Lane

6.4 OBSI Results

Table 5 shows a summary of the OBSI results for sections 11 and 12. The table includes the overall IL, number of runs used for the average, total number of runs conducted and some comments. Higher values represent louder noise generated by the pavement-tire interaction.

Table 5 OBSI Results for Sections 11 and 12

Section	Measured Overall IL [dBA]	Normalized Overall IL [dBA]	# of runs used in average	Total # of runs	Comments
FC-5	99.7	**99.6**	3	4	Valid results
FC-7	98.4	**98.4**	3	3	Valid results

6.5 Sensor Survivability

All the sensors were checked immediately after the construction. Pressure cells and moisture probes were found to have 100% survivability. Thermocouples were working for Section 1 and 10A, it was reported that there was a hydraulic spill during the construction and the contractor needed to repave some of the sections, which caused damage to the thermocouple in section 9. Finally, the overall survivability rate of asphalt strain gauge is 47%. A detailed list of functional gauges for each section is listed in Table 6.

Table 6 Asphalt Strain Gauge Survivability

Section	Total Gauges	Functional Gauges	% Survival
Control	12	8	67%
Unstabilized RAP Base	12	8	67%
CCPR RAP Base	12	9	75%
CCPR Base with emulsion RAP stabilizer	12	3	25%
Limerock/ RAP (50/50)	12	5	42%
Limerock/ RAP (75/25)	12	4	33%
FDR	12	8	67%
Superpave 5	12	4	33%
Deep Lift (PG 76-22)	12	4	33%
Deep Lift (HP)	12	3	25%
Total	120	56	47%

7. Next Steps

After the as built performance survey, the following tests are proposed to be performed every six months:

- Laser Crack Measurement System (LCMS): to measure rut depth, roughness (IRI), and cracking.
- Ground Penetrating Radar (GPR): to determine pavement layer thickness and condition.
- Friction Testing: to evaluate surface friction for the FC layers.
- Noise Testing: On-Board Sound Intensity (OBSI) tests for sections 11 and 12.

Furthermore, a full-scale performance test which required closing the test road will be conducted annually:

- Falling Weight Deflectometer (FWD): to assess pavement stiffness and structural capacity.
- Laser Crack Measurement System (LCMS): to measure rut depth, roughness (IRI), and cracking.
- Ground Penetrating Radar (GPR): to determine pavement layer thickness and condition.
- Friction Testing: to evaluate surface friction for the FC layers.
- Noise Testing: On-Board Sound Intensity (OBSI) tests for sections 11 and 12.
- Field Permeability test for sections 11 and 12

Appendix A

Date Ran: 7/15/2025 6:00:09 AM

ASPHALT MIX DESIGN SP 22-20832A

Contractor	ANDERSON COLUMBIA COMPANY, INC.		
Mix Type	SP-12.5	**Intended Use**	Structural
Mix Texture	Fine	**Recycled**	Y
Traffic Level	E	**Gyrations @ Ndes**	100

Sieve	Percent Passing
1"	100
3/4"	100
1/2"	99
3/8"	89
No. 4	66
No. 8	50
No. 16	37
No. 30	28
No. 50	17
No. 100	8
No. 200	4.4
Gsb	2.731

Total Binder Content	5.1	**Va**	4.0
Ign. Oven Corr. Factor	-0.14	**VMA**	14.3
Gmm Corr. Factor	0.000	**VFA**	72
Mixing Temp. (Plant)	310 °F	**P-200/Pbe**	1.0
Compaction Temp. (Roadway)	305 °F		
Spread Rate @ 1"	111 lb/yd²	**Effective Date**	6/20/2022
Gmb @ Ndes	2.467	**Expiration Date**	6/20/2028
Gmm	2.571		
Binder Type	PG 67-22	**Anti - Strip (%)**	For dosage rate, see APL.

Anti-Strip Not applicable for FC-5 Designs Containing Lime

Special Use Instructions

Anti-strip to be added. See APL for dosage rate.

Date Ran: 7/15/2025 6:01:44 AM

ASPHALT MIX DESIGN SPM 22-20960A

Contractor	ANDERSON COLUMBIA COMPANY, INC.		
Mix Type	SP-12.5	**Intended Use**	Structural
Mix Texture	Fine	**Recycled**	Y
Traffic Level	E	**Gyrations @ Ndes**	100

Sieve	Percent Passing
1"	100
3/4"	100
1/2"	99
3/8"	89
No. 4	66
No. 8	50
No. 16	37
No. 30	28
No. 50	17
No. 100	8
No. 200	4.4
Gsb	2.731

Total Binder Content	5.1	**Va**	4.0
Ign. Oven Corr. Factor	-0.14	**VMA**	14.3
Gmm Corr. Factor	0.000	**VFA**	72
Mixing Temp. (Plant)	325 °F	**P-200/Pbe**	1.0
Compaction Temp. (Roadway)	320 °F		
Spread Rate @ 1"	111 lb/yd²	**Effective Date**	6/20/2022
Gmb @ Ndes	2.467	**Expiration Date**	6/20/2028
Gmm	2.571		
Binder Type	PG 76-22 (PMA)	**Anti - Strip (%)**	For dosage rate, see APL.

Anti-Strip Not applicable for FC-5 Designs Containing Lime

Special Use Instructions

Anti-strip to be added. See APL for dosage rate.
Transferred from SP 22-20832A (TL-E)

FDOT

Date Ran: 7/15/2025 6:03:10 AM

ASPHALT MIX DESIGN SPH 21-19506A

Contractor	ANDERSON COLUMBIA COMPANY, INC.		
Mix Type	SP-12.5	**Intended Use**	Structural
Mix Texture	Fine	**Recycled**	N
Traffic Level	E	**Gyrations @ Ndes**	100

Sieve	Percent Passing
1"	100
3/4"	100
1/2"	99
3/8"	89
No. 4	66
No. 8	51
No. 16	41
No. 30	33
No. 50	19
No. 100	8
No. 200	4.0
Gsb	2.741

Total Binder Content	5.0	**Va**	4.0
Ign. Oven Corr. Factor	-0.12	**VMA**	14.8
Gmm Corr. Factor	0.000	**VFA**	73
Mixing Temp. (Plant)	335 °F	**P-200/Pbe**	0.9
Compaction Temp. (Roadway)	330 °F		
Spread Rate @ 1"	111 lb/yd²	**Effective Date**	5/25/2021
Gmb @ Ndes	2.459	**Expiration Date**	5/25/2027
Gmm	2.562		
Binder Type	HIGH POLYMER	**Anti - Strip (%)**	For dosage rate, see APL.

Anti-Strip Not applicable for FC-5 Designs Containing Lime

Special Use Instructions

Anti-strip to be added. See APL for dosage rate.
Transferred from SP 21-19451A (TL-E)

Date Ran: 7/15/2025 6:02:22 AM

ASPHALT MIX DESIGN SPM 23-22030A

Contractor	ANDERSON COLUMBIA COMPANY, INC.		
Mix Type	FC-5	**Intended Use**	Friction Course
Mix Texture	Open-graded	**Recycled**	N
Traffic Level	NA	**Gyrations @ Ndes**	N/A

Sieve	Percent Passing
1"	100
3/4"	100
1/2"	97
3/8"	74
No. 4	24
No. 8	10
No. 16	7
No. 30	5
No. 50	4
No. 100	3
No. 200	2.9
Gsb	2.769

Total Binder Content	6.3	**Va**	
Ign. Oven Corr. Factor	-0.03	**VMA**	
Gmm Corr. Factor		**VFA**	
Mixing Temp. (Plant)	325 °F	**P-200/Pbe**	
Compaction Temp. (Roadway)	325 °F		
Spread Rate @ 1"	112 lb/yd²	**Effective Date**	3/30/2023
Gmb @ Ndes		**Expiration Date**	8/28/2025
Gmm			
Binder Type	PG 76-22 (PMA)	**Anti - Strip (%)**	For dosage rate, see APL.

Anti-Strip Not applicable for FC-5 Designs Containing Lime

Special Use Instructions

Anti-strip to be added. See APL for dosage rate.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

ASPHALT MIX DESIGN

SUBMIT TO THE DIRECTOR, OFFICE OF MATERIALS, CENTRAL ASPHALT LABORATORY, 5007 NE 39TH AVE, GAINESVILLE, FL 32609

Contractor: Anderson Columbia Company, Inc. Address: ______

Phone No. ______ Fax No. ______ E-mail ______

Submitted By ______ Type Mix: Superpave 5 Intended Use of Mix: Structural

Gyrations @ Ndes: 50

Product Description	Product Code	Producer Name	Product Name	Plant/Pit Number	Terminal
1.					
2.					
3.					
4.					
5.					
6.					
7.					

PERCENTAGE BY WEIGHT TOTAL AGGREGATE PASSING SIEVES

	Blend Number	1	2	3	4	5	6	JOB MIX FORMULA	CONTROL POINTS	PRIMARY CONTROL SIEVE
	3/4" 19.0mm							100		
E	1/2" 12.5mm							98		
Z	3/8" 9.5mm							88		
I	No. 4 4.75mm							63		
S	No. 8 2.36mm							45		
	No. 16 1.18mm							33		
E	No. 30 600μm							25		
V	No. 50 300μm							16		
E	No. 100 150μm							8		
I	No. 200 75μm							4.4		
S	G_{sb}							2.734		

The mix properties of the Job Mix Formula have been conditionally verified, pending successful final verification during production at the assigned plant, the mix design is approved subject to F.D.O.T. specifications.

JMF reflects aggregate changes expected during production

Mayaca Or Honduran Mat'l?
No
Maj. FL. Agg.?
No

LDM 24-2787A (SP-5)

Director, Office of Materials: Sue Zheng, Ph.D., P.E.

Original document retained at the State Materials Office

Effective Date: 05 / 29 / 2024

Expiration Date: 05 / 29 / 2027

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

ASPHALT MIX DESIGN

SUBMIT TO THE DIRECTOR, OFFICE OF MATERIALS, CENTRAL ASPHALT LABORATORY, 5007 NE 39TH AVE, GAINESVILLE, FL 32609

Contractor Anderson Columbia Company, Inc. Address

Phone No. Fax No. E-mail

Submitted By Type Mix FC-Q Intended Use of Mix Friction Course

Design Traffic Level Gyrations @ Ndes

Product Description	Product Code	Producer Name	Product Name	Plant/Pit Number	Terminal
1.					
2.					
3.					
4.					
5.					
6.					
7.					

PERCENTAGE BY WEIGHT TOTAL AGGREGATE PASSING SIEVES

Blend Number	1	2	3	4	5	6	JOB MIX FORMULA	CONTROL POINTS	PRIMARY CONTROL SIEVE
3/4" 19.0mm							100		
1/2" 12.5mm							100		
3/8" 9.5mm							98	85 - 100	
No. 4 4.75mm							37	25 - 40	
No. 8 2.36mm							10	6 - 12	
No. 16 1.18mm							7		
No. 30 600µm							5		
No. 50 300µm							4		
No. 100 150µm							4		
No. 200 75µm							2.4	2 - 5	
G_{sa}							2.763		

The mix properties of the Job Mix Formula have been conditionally verified, pending successful final verification during production at the assigned plant, the mix design is approved subject to F.D.O.T. specifications.

Mayaca Or Honduran Mat'l?
No
Maj. FL. Agg.?
No

LDM 24-2785A (FC-Q)

Director, Office of Materials Sue Zheng, Ph.D., P.E.
Original document retained at the State Materials Office

Effective Date 05 / 20 / 2024

Expiration Date 05 / 20 / 2027

Appendix B

Subgrade

Section	Material	Proctor/ Sample #	Station	Depth	Wet Density	Moisture	Dry Density	Compaction
Section 1	Subgrade	118.3-5001V	155+71	12"	123.6	11	111.4	94
	Limerock Base		155+75	6"	128.4	14.1	112.6	
	Limerock Base		155+85	6"	121.6	8.6	112	
Section 2	Subgrade	116.7-5002V	165+75	12"	122.8	7.9	113.8	98
	RAP Base	2002V	165+75	6"	126.8	5.1	120.6	
	RAP Base		165+70	6"	127.4	4	122.5	
Section 3	Subgrade	115.8- 5003V	175+70	12"	121	5.8	114.4	99
	Base(RAP+Emulsion+Cement)	Max. 123	175+75	6"	131.9	5.1	125.5	102
	Base(RAP+Emulsion+Cement)	Max. 123	175+80	6"	128.1	4.4	122.7	100
Section 4	Subgrade	118.2-5004V	185+75	12"	126.3	9	115.9	98
	Base(RAP+Emulsion+Cement)	Max. 123.2	185+65	6"	123.4	6	130.8	100
	Base(RAP+Emulsion+Cement)	Max. 123.6	185+75	6"	123.4	7.9	133.2	98
Section 5	Subgrade	117.8-5005V	195+75	12"	120.1	6.2	113.1	96
	Limerock/RAP Base 50/50		195+70	6"	126.7	5.1	120.6	
	Limerock/RAP Base 50/50		195+75	6"	126.8	6	119.6	
Section 6	Subgrade	118.9-5006V	205+70	12"	121.5	7	113.6	96
	Limerock/RAP Base 50/50		205+75	6"	129	6.4	121.2	
	Limerock/RAP Base 50/50		205+75	6"	132.2	6	124.7	

Base

Section	Material	Proctor/ Sample #	Station	Depth	Wet Density	Moisture	Dry Density	Compaction
Section 1	Limerock Base	117.0-B001Q	150+75	6"	131.7	11.4	118.2	101
	Limerock Base	117.0-B001Q	148+25	6"	125.1	5.9	118.1	101
	Limerock Base	117.0-B001Q	149+25	6"	130.7	8	121	103
	Limerock Base Shoulder	117.0-B001Q	149+00	6"	125.2	9.5	114.3	98
	Limerock Base Shoulder	117.0-B001Q	150+00	6"	123.7	6.1	116.6	100
	Limerock Base	117.0-B001Q	155+68	6"	130.5	11.4	117.1	100
	Limerock Base	117.0-B001Q	153+00	6"	129.6	11.2	116.5	100
	Limerock Base	117.0-B001Q	154+00	6"	129.3	8	119.1	102
	Limerock Base Shoulder	117.0-B001Q	154+00	6"	126.6	9.1	116	99
	Limerock Base Shoulder	117.0-B001Q	156+00	6"	120.5	5.2	114.5	98
Section 2	RAP Base	125.0-R001Q	159+75	6"	128.4	3.3	124.3	99
	RAP Base	121.2-R003Q	157+75	6"	128.4	7.1	119.9	99
	RAP Base Shoulder	121.2-R003Q	158+75	4"	128.9	8.7	118.6	98
	RAP Base Shoulder	121.2-R003Q	157+75	4"	134.8	10.8	121.6	100
	RAP Base	126.0-R002Q	164+25	6"	130.7	5.1	124.4	99
	RAP Base	126.0-R002Q	162+10	6"	129.5	4.3	124.2	99
	RAP Base	124.5-R004Q	165+00	6"	130.2	6.9	121.8	98
	RAP Base Shoulder	124.5-R004Q	164+00	4"	131.5	8.3	121.4	98
Section 3	CCPR Base	123-CCPR001Q	171+25	6"	130.9	6.5	122.9	100
	CCPR Base	123CCPR001Q	171+05	6"	127.9	6.6	120	98
	CCPR Base	123-CCPR002Q	168+10	6"	128.3	6.5	120.5	98
	CCPR Base	123-CCPR002Q	170+30	6"	128.8	6.7	120.7	98
	CCPR Base	123-CCPR001Q	175+90	6"	129.7	5.1	123.4	100
	CCPR Base	123-CCPR001Q	176+15	6"	131.9	6.7	123.6	100
	CCPR Base	123-CCPR002Q	174+05	6"	128.1	5.5	121.4	99
	CCPR Base	123-CCPR002Q	172+80	6"	128.7	6	121.4	99

Section 4	Cold RAP Base	123.6-CR001Q	177+75	6"	135.9	7.9	125.9	102
	Cold RAP Base	123.6-CR001Q	179+25	6"	134.2	6.8	125.7	102
	Cold RAP Base	125.6 -CR002Q	178+75	6"	138.2	7.6	128.4	102
	Cold RAP Base	125.6-CR002Q	180+25	6"	135.7	7.7	126.8	101
	Cold RAP Base	123.6-CR001Q	182+25	6"	132	6.5	123.9	100
	Cold RAP Base	123.6-CR001Q	185+15	6"	139.3	11.8	124.6	101
	Cold RAP Base	125.6-CR002Q	184+00	6"	133.1	5.5	126.2	100
	Cold RAP Base	125.6-CR002Q	186+50	6"	133.2	2.2	124.3	99
Section 5	Base	124.0-LAR001Q	189+85	6"	129.5	6.6	121.5	98
	Base	127-LAR005Q	188+25	6"	134	5	127.6	100
	Base/Shoulder	127-LAR005Q	188+27	4"	135.7	8.7	124.8	98
	Base	126.7-LAR002Q	194+40	6"	131	4.1	125.8	99
	Base	122-LAR006Q	192+10	6"	127.3	6.2	119.9	98
	Base/Shoulder	122-LAR006Q	192+80	4"	135.2	9.4	123.6	101
Section 6	Base	122.6-LAR003Q	198+10	6"	129.3	7.5	120.3	98
	Base	121.0-LAR007Q	200+20	6"	126.9	6	119.7	99
	LAR Base Shoulder	121.0-LAR007Q	199+00	4"	127.1	4.5	121.6	101
	LAR Base Shoulder	121.0-LAR007Q	201+00	4"	127	5.1	120.8	100
	Base	121.9-LAR004Q	204+60	6"	126.7	6.4	119.1	98
	Base	128-LAR008Q	202+40	6"	134.6	6.7	126.1	99
	Base Shoulder	128-LAR008Q	204+00	4"	133.8	6	126.2	99
	Base Shoulder	128-LAR008Q	202+00	4"	135.8	7.4	126.4	99
Section 7	Full D Reclaim Base	Max. 122.8	207+85	12"	130.8	11.2	117.6	96
	Full D Reclaim Base	Max. 122.8	209+25	12"	133.8	10.4	121.2	99
	Full D Reclaim Base	Max. 122.8	212+70	12"	134.7	10.8	121.6	99
	Full D Reclaim Base	Max. 122.8	216+50	12"	131.5	10.8	118.7	97

Appendix C

Geotechnical Testing Program

The geotechnical testing program for the Florida Asphalt Test Road consisted of field testing and laboratory testing of existing subgrade material and proposed base materials.

Field Testing

Field testing was conducted on the existing subgrade and proposed base materials and consisted of ***FM 1-T 222 Nonrepetitive Static Plate Load Tests***, ***FM 1-T310 In-Place Density by Nuclear Methods***, ***FM 5-507 Moisture Content by Means of a Calcium Carbide Gas Pressure Moisture Tester*** also known as "Speedy", ***ASTM D6951 Dynamic Cone Penetrometer*** (DCP), and ***ASTM E2583 Deflection Measurements using a Light Weight Deflectometer*** (LWD). Subgrade testing was completed in sections 1 through 6, while testing of the base was completed on sections 1, 2, 5, and 6, with the exception of the LWD which was completed on sections 1 through 7.

Nonrepetitive static plate load tests consist of obtaining a modulus of elasticity and soil reaction for a material by measuring the surface deflection due to the application of a load to the surface. A circular steel plate with diameters ranging from 6 to 30 inches are placed atop the testing material surface and increasingly loaded. Deflections are recorded for each load increment to obtain a load-deflection curve. Thereafter, a modulus is obtained for the material using Burmister's theory for rigid circular plates from the following equations:

$$E = \frac{1.18(\sigma)(R)}{0.050}$$

$$k = \frac{E}{1.18(R)}$$

where,

E= Modulus of elasticity
1.18 = Constant for rigid plate
σ = Total stress at a deflection of 0.050 inches
R = Radius of selected bearing plate in inches
k = modulus of soil reaction

A single plate load test was performed at each section of the existing subgrade and three tests per section on the bases using a 12-inch diameter plate. E values for the subgrade material ranged from about 18,000 to 43,000 lb/in^2 with modulus of soil reaction ranging from about 2,400 lb/in^3 to just over 6,000 lb/in^3. For base materials, E values were more variable than those of the subgrade due to the various materials used for each section, varying from just over 4,400 to 25,800 lb/in^2 and modulus of soil reaction values of 626 to 3650 lb/in^3 (Table 2).

Density tests were conducted at the locations where the plate load tests were performed using nuclear density gauge in direct transmission mode. Nuclear density gauges use the interaction of gamma and neutron radiation with matter to measure the in-place density of materials. For direct transmission, a hole is made in the material to a determined depth and the gauge is placed over the material. A rod containing a gamma radiation source is lowered to the desired test depth. Gamma rays from the radiation source in the gauge at the tip of a rod penetrate the test material; those that are scattered back toward the detectors at the surface are counted and correlated to the average density of the material (Figure 12, left). This density reading is known as the "wet density". The moisture content of the material was determined using device known as a calcium carbide pressure moisture tester (Figure 12, right) which is a vessel consisting of an attached pressure gauge that measures the pressure of acetylene gas produced by the reaction of the water present in 20 grams of the material with a set amount of calcium carbide reagent. This pressure is correlated with the amount of water present in the sample. The dry density of the material is calculated using the equation shown below.

$$\gamma_{dry} = \frac{\gamma_{wet}}{(1+\omega)}$$

where,

γ_{dry} = dry density
γ_{wet} = wet density reading from the gauge
ω = moisture content of the material from the Speedy test as a decimal

Field dry densities for the subgrade materials were between 114 and 118 lb/ft^3 at moistures of 6.6% to 8.9%. Base materials had densities from 113 to 124 lb/ft^3 with moistures varying from 5.1% to 10.2%. Table 2 summarizes the results of the density and moisture of the material at the time of the plate load testing.

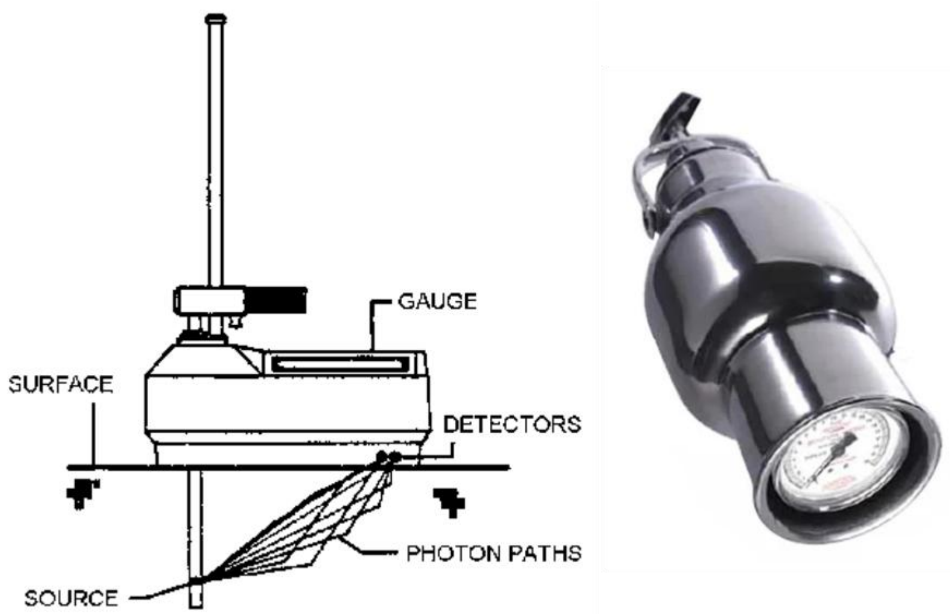


Figure 12. Gauge Direct Transmission Geometry (left), Speedy Moisture Tester (right).

Plate Bearing Test Results								
Section No.	Location (Station)	Test No.	Layer Tested	FM 1-T310 / FM 5-507		FM 5-527		
				Dry Density (lb/ft^3)	Moisture Content (%)	p (lb/in^2)	E (lb/in^2)	k (lb/in^3)
1	152+00	1	Subgrade	118.2	6.6	156.4	22,140	3,127
	148+00	1	Base	119.2	10.2	157.6	22,315	3,152
	152+00	2	Base	114.4	7.1	147.3	20,865	2,947
	154+00	3	Base	113	9.7	117.5	16,637	2,350
2	162+00	1	Subgrade	117.6	8.9	189.9	26,895	3,799
	158+00	1	Base	122.1	6.8	49.6	7,025	992
	162+00	2	Base	122.2	5.1	37.7	5,334	753
	164+00	3	Base	122.7	6.9	31.3	4,432	626
3	172+00	1	Subgrade	115.4	8.1	126.8	17,951	2,535
4	180+00	1	Subgrade	116.9	7.2	124.1	17,577	2,483
5	195+10	1	Subgrade	114.7	7.8	224.3	31,759	4,486
	180+00	1	Base	120.8	5.8	119.9	16,981	2,398
	192+00	2	Base	121.7	5.5	105	14,862	2,099
	194+00	3	Base	120.9	6.1	122.8	17,382	2,455
6	200+00	1	Subgrade	115.3	6.8	304.3	43,088	6,086
	198+00	1	Base	123.9	5.2	182.5	25,843	3,650
	202+00	2	Base	117.4	5.4	114.3	16,189	2,287
	204+00	3	Base	120.7	6.4	118.1	16,729	2,363

Table 2. Nonrepetitive Static Plate Load and Density Test Results

Three DCP tests were conducted at sections 1 through 7 on the subgrade and on the base material at sections 1, 2, 5, and 6. DCP tests consist of driving a dynamic cone penetrometer (Figure 13) by lifting a 17.6-pound hammer and releasing it, causing the tip to penetrate through the soil. The total penetration for a given number of blows is measured and recorded and is used to describe the stiffness, an in-situ California Bearing Ratio (CBR) strength for the material, and the bearing capacity.

Figure 13. DCP Device, SAPPER Automatic Dynamic Cone Penetrometer

A DCP index is determined by dividing penetration by the number of blows for each set of readings. This DCP index is used to estimate the in situ CBR using the following equations:

$$CBR = \frac{1}{(0.432283 \times DCP)^2} \text{ for CL soils with CBR < 10}$$

$$CBR = \frac{1}{(0.072923 \times DCP)} \text{ for CH soils}$$

$$CBR = \frac{292}{(DCP \times 25.4)^{1.12}} \text{ for all other soils}$$

Where DCP is in inches/blow. The Limerock Bearing Ratio (LBR) can be obtained by multiplying the CBR value by a factor of 1.25. An estimate of bearing capacity can be made from the following equation adapted from the Portland Cement Association's (PCA) 1955 guide on the Design of Concrete Airport Pavement:

$$q = 546.34 \times CBR^{0.664}$$

Where q is in pounds per square feet (psf).

DCP tests were conducted to depths of approximately 45 inches for the subgrade materials with single LBR values as high as 148 and as low as 1 with average values ranging from 15 to 85. Bearing strengths varied greatly (350 to 12,986 psf) with average values of 2,709 to 8,829 psf. It should be noted that Test 1 in

Section 3 located at station 168+00 indicates a very weak material or void from about 1.5 inches to the final test depth of 23 inches (Figure 16). Table 3 and figures 14 through 19 show the results of the DCP tests and the LBR and bearing strength of the materials as a function of depth.

Base materials were tested for their entire thickness. Average LBR values varied from 60 to 130 with average bearing strength ranging from 7,000 to 11,500 psf (Table 4). Figures 20 to 23 show the LBR and bearing values as a function of depth. The plots show that for all tests, the highest LBR and bearing values were at depths of between 8 to 10 inches below the surface.

Section No.	Location (Station)	Test No.	LBR			Bearing (psf)		
			Lowest	Highest	Average	Lowest	Highest	Average
1	148+00	1	8	30	21	1,799	4,506	3,503
	150+00	2	19	53	34	3,318	6,588	4,896
	152+00	3	10	53	24	2,202	6,588	3,790
	154+00	4	9	97	38	2,098	9,813	4,917
2	158+00	1	20	55	32	3,500	6,772	4,682
	161+00	2	4	38	15	1,271	5,297	2,709
	162+00	3	12	40	27	2,454	5,434	4,139
	164+00	4	8	24	20	1,938	3,891	3,382
3	168+00	1	1	34	29	350	4,873	4,313
	170+00	2	7	34	17	1,682	4,910	3,107
	172+00	3	9	60	26	2,046	7,179	4,036
	174+00	4	6	58	31	1,580	6,969	4,508
4	178+00	1	7	39	23	1,682	5,399	3,765
	180+00	2	5	58	32	1,446	6,986	4,459
	183+00	3	34	148	85	4,929	12,986	8,829
	184+00	4	27	103	75	4,172	10,200	8,203
5	188+00	1	31	74	58	4,632	8,221	6,967
	190+00	2	10	74	41	2,153	8,239	5,413
	192+00	3	9	65	42	1,977	7,545	5,483
	194+00	4	8	49	36	1,832	6,253	5,050
6	198+00	1	6	51	28	1,613	6,415	4,210
	200+00	2	11	34	22	2,340	4,910	3,683
	202+00	3	7	26	19	1,719	4,073	3,330
	204+00	4	5	23	17	1,456	3,807	3,056

Table 3. Summary of DCP Test Results for Subgrade Materials

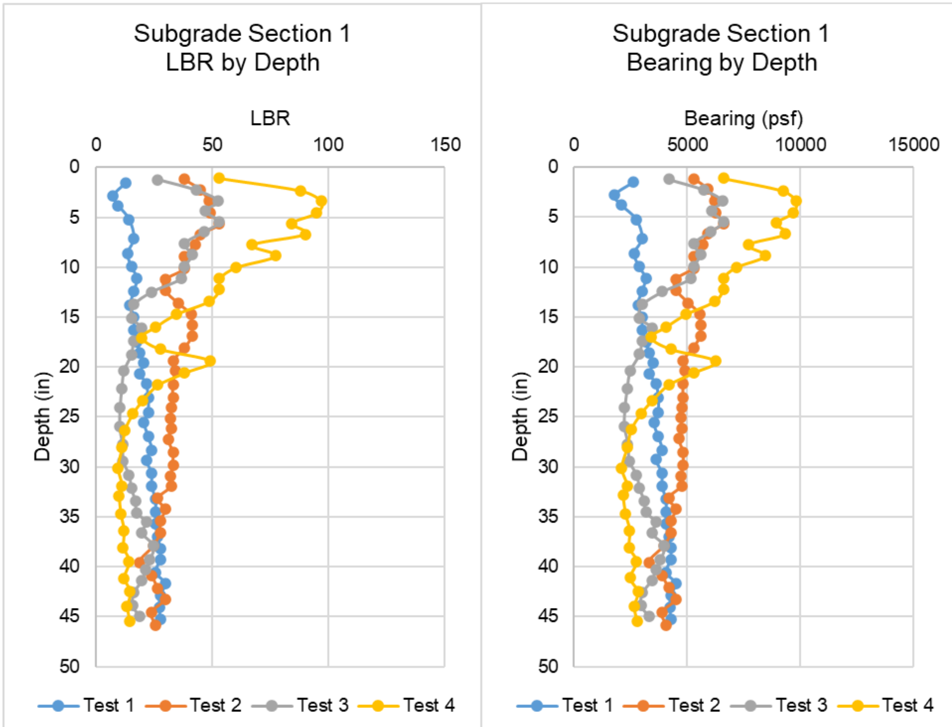


Figure 14. Plots of LBR and Bearing by Depth for Subgrade Section 1

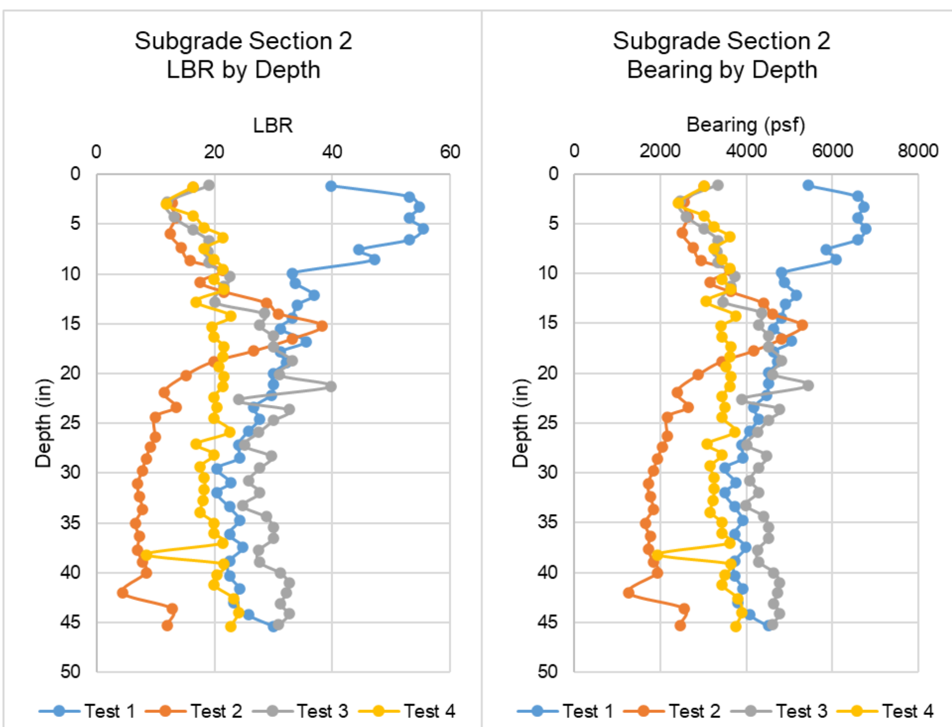


Figure 15. Plots of LBR and Bearing by Depth for Subgrade Section 2

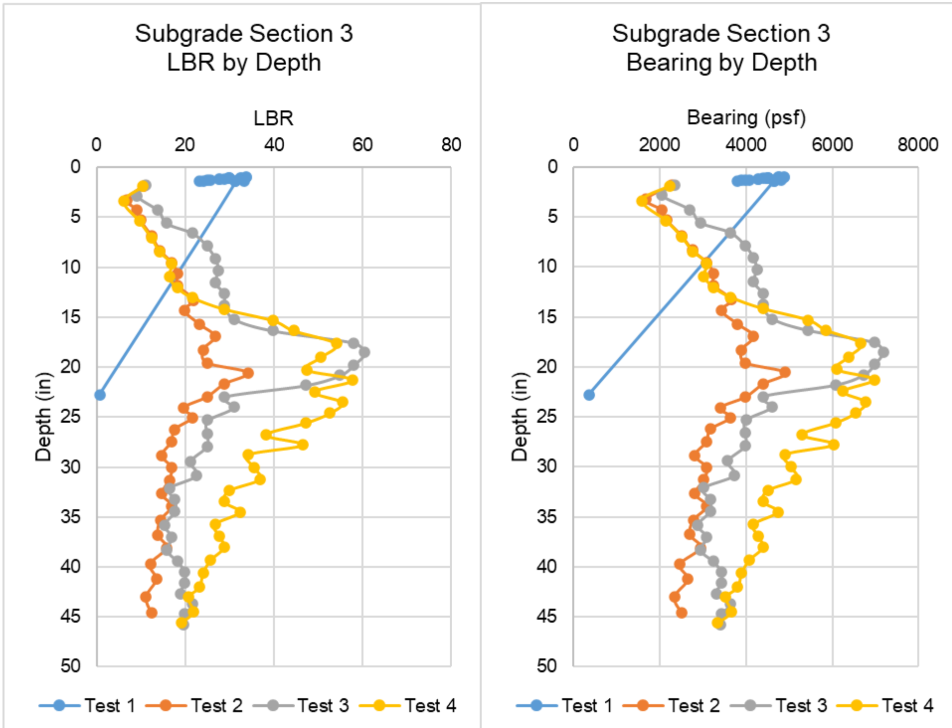


Figure 16. Plots of LBR and Bearing by Depth for Subgrade Section 3

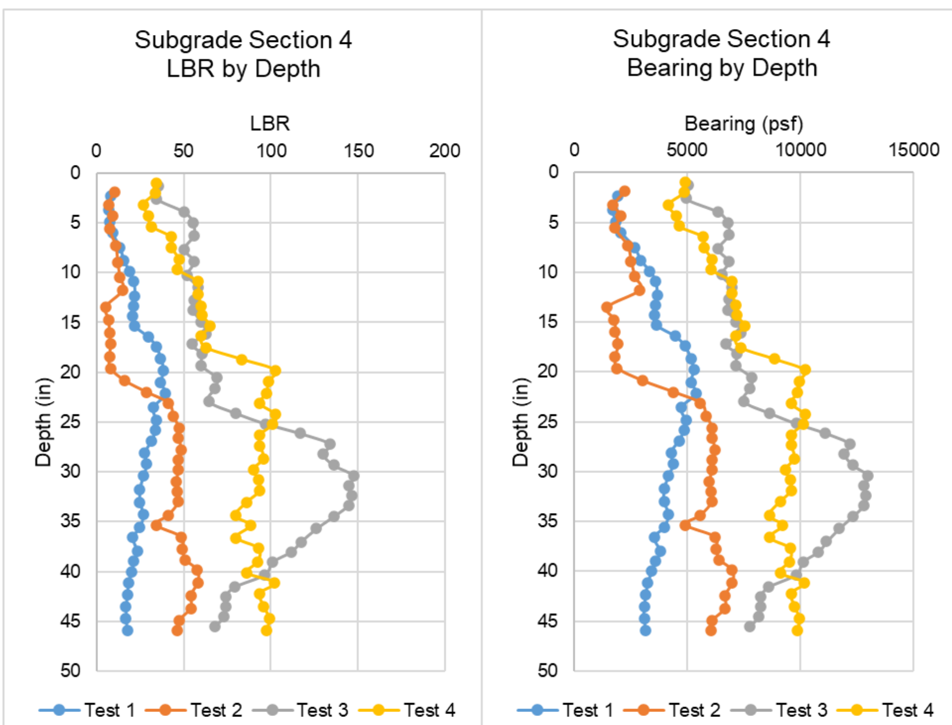


Figure 17. Plots of LBR and Bearing by Depth for Subgrade Section 4

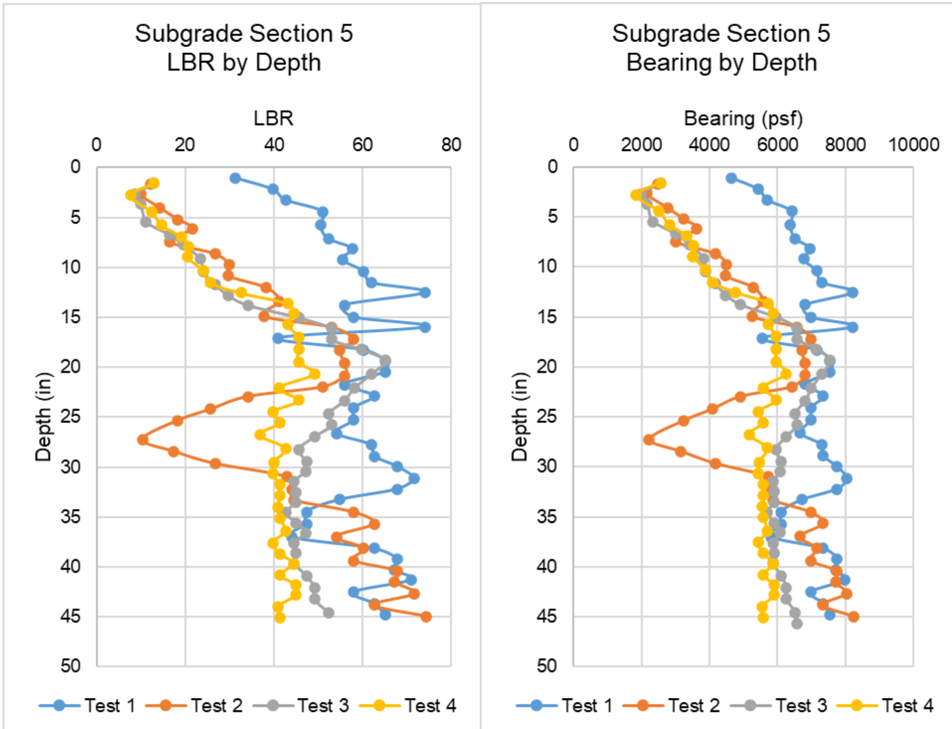


Figure 18. Plots of LBR and Bearing by Depth for Subgrade Section 5

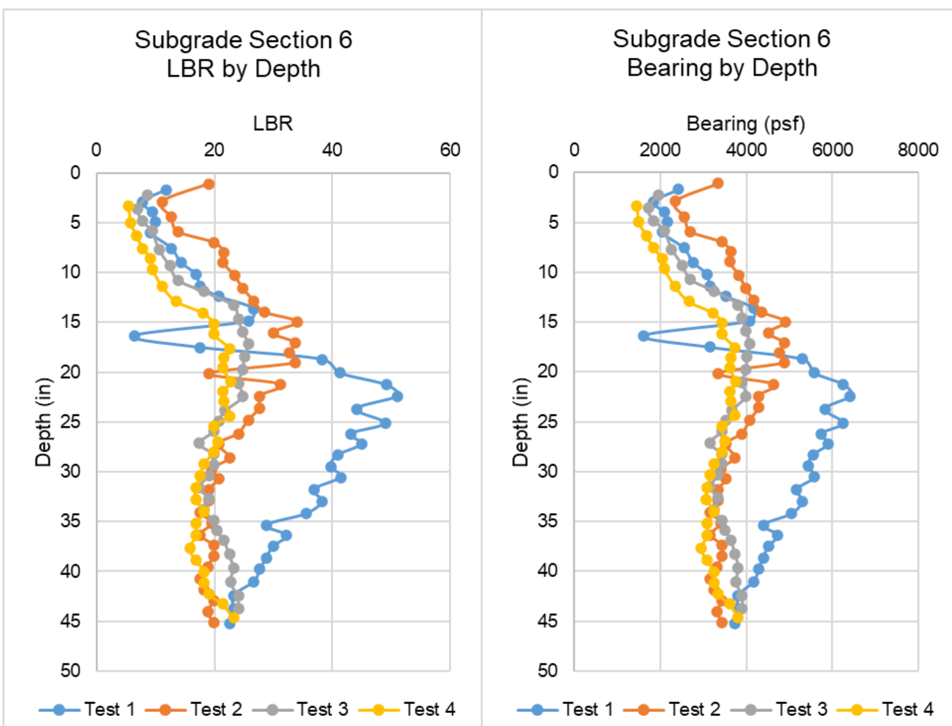


Figure 19. Plots of LBR and Bearing by Depth for Subgrade Section 6

Section No.	Location (Station)	Test No.	LBR			Bearing (psf)		
			Lowest	Highest	Average	Lowest	Highest	Average
1	148+00	1	60	86	75	7,179	9,100	8,277
	150+00	2	60	103	85	7,161	10,214	8,939
	152+00	3	27	241	130	4,172	17,987	11,516
	154+00	4	34	145	80	4,910	12,807	8,492
2	158+00	1	47	112	86	6,100	10,789	9,034
	160+00	2	51	159	104	6,415	13,663	10,114
	162+00	3	36	112	71	5,045	10,789	7,884
	164+00	4	38	90	60	5,264	9,344	7,031
5	188+00	1	53	120	87	6,588	11,339	9,106
	190+00	2	55	156	108	6,772	13,447	10,452
	192+00	3	53	149	101	6,588	13,056	9,953
	194+00	4	47	159	114	6,081	13,663	10,787
6	198+00	1	58	189	117	6,969	15,322	11,048
	200+00	2	65	168	113	7,545	14,144	10,795
	202+00	3	49	134	93	6,253	12,172	9,443
	204+00	4	51	115	85	6,415	11,031	8,935

Table 4. Summary of DCP Test Results for Base Materials

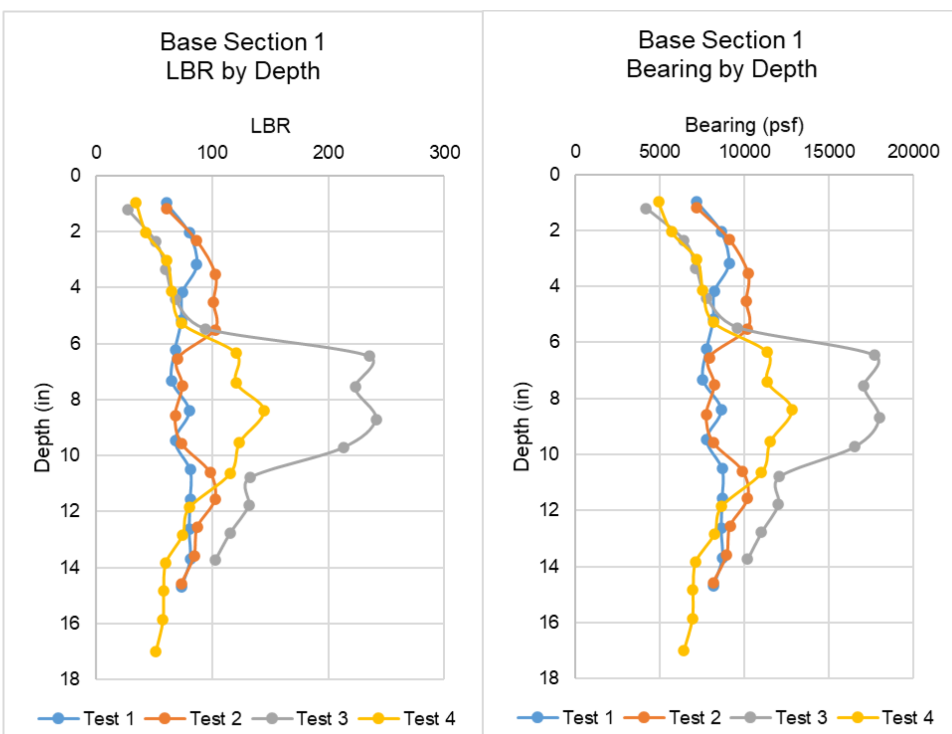


Figure 20. Plots of LBR and Bearing by Depth for Base Section 1

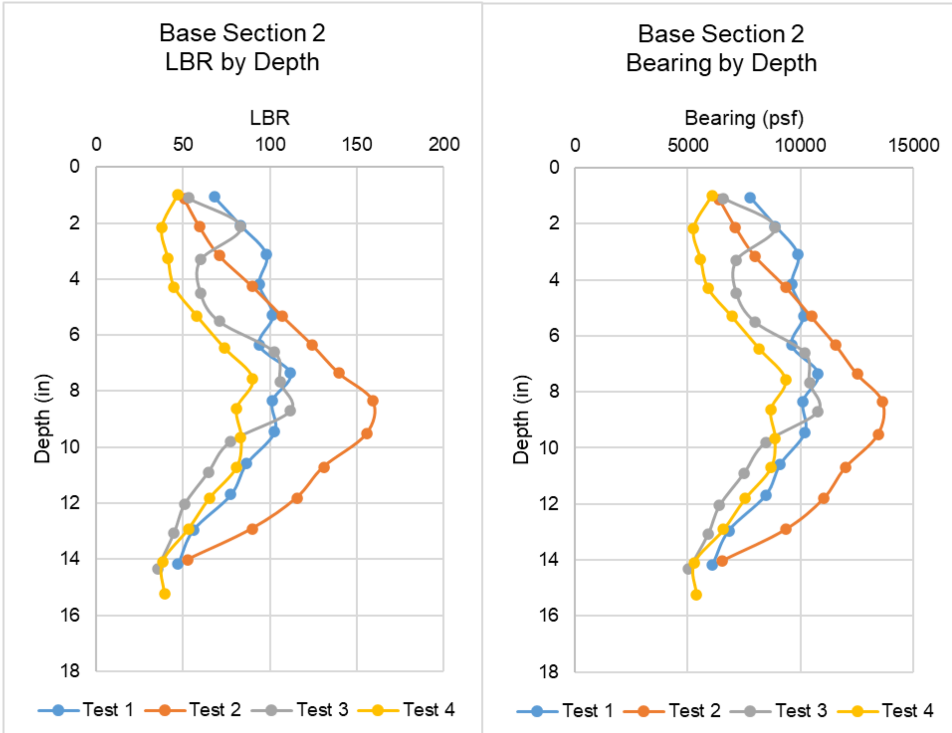


Figure 21. Plots of LBR and Bearing by Depth for Base Section 2

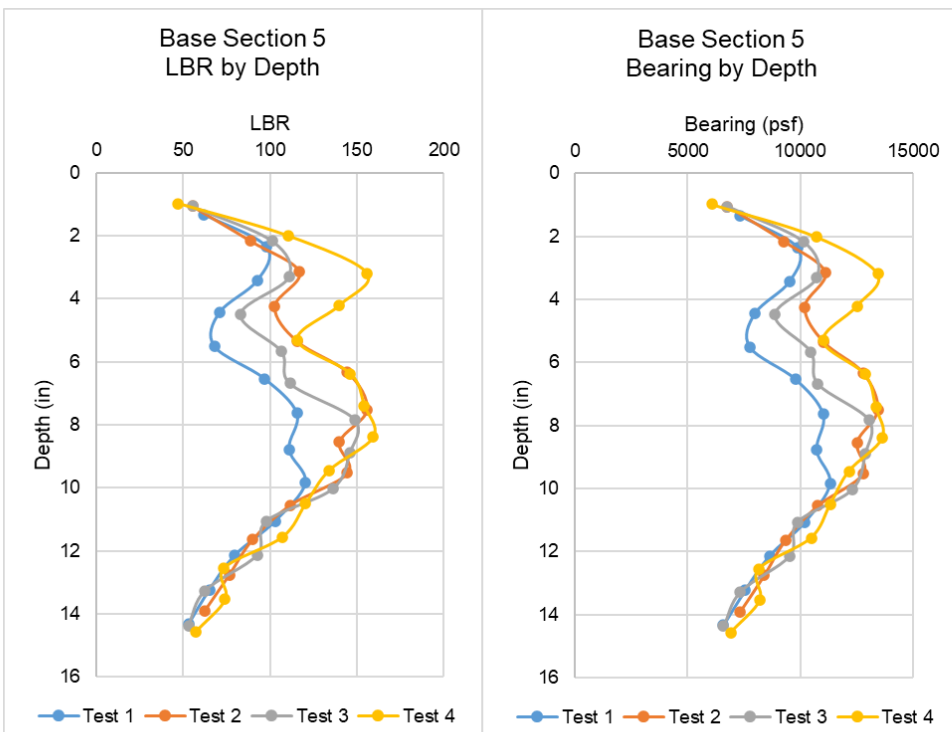


Figure 22. Plots of LBR and Bearing by Depth for Base Section 5

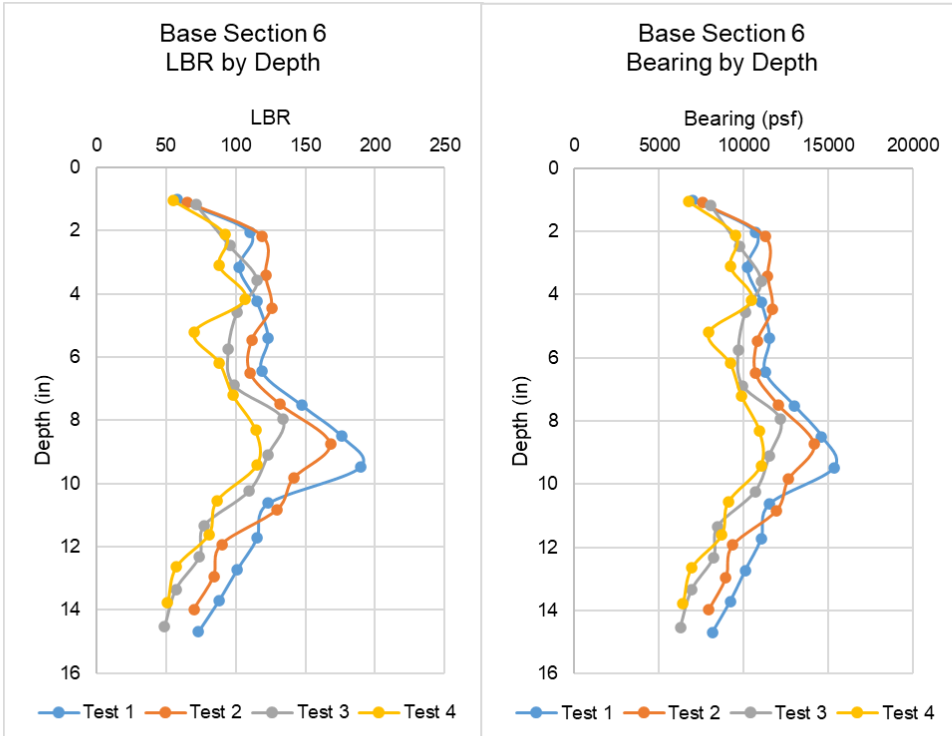


Figure 23. Plots of LBR and Bearing by Depth for Base Section 6

Lastly, Lightweight Deflectometer (LWD) testing was conducted on the subgrade and base materials. Much like the Falling Weight Deflectometer (FWD), the LWD measures deflections in pavement layers which are used to determine the stiffness of the layers. The test is a type of plate-bearing test where the load is generated by a falling mass dropped from a certain height (depending on the desired force) that transmits the load through a plate resting on the material. The resulting settlement and velocity from the load impact are measured and the peak and a dynamic deformation modulus, E_{vd}, is calculated. Testing of the subgrade and base consisted of dropping a 22 lb. (10 kg) mass from a distance of 11.8 inches (300 mm) three times to determine an average deflection and velocity.

E_{vd} is determined using the following equation:

$$E_{vd} = 1.5 * r * \frac{\sigma_{max}}{s_{max}}$$

Where:

r = radius of the load plate

σ_{max} = normal stress under the load plate

s_{max} = average value of the settlements out of three measuring impacts

The displacement of the soil to the hammer velocity (s/v) is a derived value relating to the soil's ability to be compacted during construction. Based on empirical correlations developed based on Northern Germany soils (i.e. glacial till), an s/v value of greater than 3.5 means the soil can be further compacted, while values of 3.5 or less means the soil cannot be compacted any further. It should be noted that s/v should never be considered separately, but always in combination with the plate deflection and the resulting E_{vd}.

Tables 5 and 6 show the results for the tests conducted on the subgrade and base, respectively. Guidance from the German Road and Transportation Research Association correlates an E_{vd} greater than 50 MPa to a degree of compaction of 100% and between 40 and 50 MPa to a degree of compaction of 98% for coarse-grained soils. Results show only three tests had values below 40 MPa but no less than 27 MPa.

Figure 24. LWD Device, ZORN ZFG 3.1

Section No.	Location (Station)	Test No.	Velocity (mm/s)				Deflection (mm)				E_{vd}		s/v (ms)
			v_1	v_2	v_3	v_{avg}	s_1	s_2	s_3	s_{avg}	MPa	lb/in^2	
1	148+00	1	130.8	132.4	134.0	132.4	0.47	0.47	0.47	0.47	48.28	7,002	3.52
	152+00	3	112.7	107.8	107.7	109.4	0.31	0.29	0.29	0.30	75.76	10,988	2.715
	154+00	4	48.9	45.7	45.1	46.6	0.16	0.15	0.15	0.15	146.10	21,190	3.305
2	158+00	1	45.2	44.2	44.7	44.7	0.15	0.15	0.15	0.15	148.03	21,470	3.4
	161+00	2	181.2	176.5	171.8	176.5	0.59	0.57	0.55	0.57	39.61	5,745	3.218
	162+00	3	138.2	132.7	128.4	133.1	0.41	0.39	0.37	0.39	57.84	8,389	2.923
	164+00	4	158.3	153.2	146.6	152.7	0.48	0.45	0.43	0.45	49.67	7,204	2.967
3	170+00	2	188.4	184.5	171.5	181.5	0.72	0.68	0.62	0.67	33.48	4,856	3.702
	172+00	3	144.2	143.5	141.0	142.9	0.46	0.46	0.45	0.46	49.45	7,172	3.184
	174+00	4	146.4	141.8	139.6	142.6	0.52	0.50	0.48	0.50	45.00	6,527	3.506
4	178+00	1	173.7	166.6	163.0	167.8	0.52	0.50	0.48	0.50	45.09	6,540	2.974
	180+00	2	195.9	193.4	187.2	192.2	0.85	0.82	0.78	0.82	27.51	3,990	4.256
	183+00	3	136.1	131.1	127.9	131.7	0.35	0.33	0.32	0.33	67.77	9,829	2.521
	184+00	4	47.6	47.6	47.0	47.4	0.14	0.13	0.13	0.13	169.17	24,536	2.806
5	188+00	1	67.2	75.8	64.7	69.2	0.22	0.21	0.21	0.21	107.14	15,539	3.035
	190+00	2	74.9	72.6	70.7	72.7	0.21	0.20	0.20	0.21	109.76	15,919	2.82
	192+00	3	185.3	175.9	174.6	178.6	0.49	0.45	0.44	0.46	49.13	7,126	2.564
	194+00	4	147.7	142.2	135.4	141.8	0.41	0.39	0.36	0.38	58.75	8,521	2.701
6	198+00	1	161.2	148.3	142.2	150.6	0.53	0.47	0.44	0.48	46.78	6,785	3.194
	200+00	2	98.5	98.1	95.4	97.3	0.27	0.27	0.26	0.27	84.27	12,222	2.744
	202+00	3	174.0	166.1	160.8	167.0	0.56	0.52	0.49	0.52	42.94	6,228	3.138
	204+00	4	192.4	181.2	182.9	185.5	0.58	0.53	0.53	0.55	41.13	5,965	2.949

Table 5. Summary of LWD Test Results for Subgrade Materials

Section No.	Location (Station)	Test No.	Velocity (mm/s)				Deflection (mm)				E_{vd}		s/v (ms)
			v_1	v_2	v_3	v_{avg}	s_1	s_2	s_3	s_{avg}	MPa	lb/in^2	
1	148+00	1	88.6	89.8	90.1	89.5	0.25	0.25	0.25	0.25	89.64	13,001	2.804
	150+00	2	79.7	68.3	65.3	71.1	0.20	0.19	0.18	0.19	119.68	17,358	2.644
	152+00	3	109.6	106.0	101.8	105.8	0.26	0.25	0.24	0.25	88.93	12,898	2.391
	154+00	4	114.1	110.2	107.2	110.5	0.30	0.29	0.29	0.29	76.79	11,137	2.652
2	158+00	1	82.4	79.1	77.9	79.8	0.25	0.23	0.22	0.23	96.15	13,945	2.932
	160+00	2	86.4	83.0	78.6	82.7	0.29	0.27	0.25	0.27	83.64	12,131	3.253
	162+00	3	56.3	54.9	52.6	54.6	0.21	0.20	0.19	0.20	110.84	16,076	3.718
	164+00	4	75.8	72.6	69.8	72.7	0.27	0.25	0.24	0.25	88.93	12,898	3.48
3	168+00	1	42.7	44.0	42.4	43.0	0.03	0.02	0.02	0.02	937.50	135,973	0.558
	174+00	4	45.6	43.4	42.0	43.7	0.14	0.13	0.13	0.14	166.67	24,173	3.089
4	178+00	1	41.3	40.9	39.4	40.5	0.16	0.14	0.14	0.15	154.11	22,352	3.605
	180+00	2	45.8	43.4	39.6	42.9	0.16	0.16	0.15	0.16	143.31	20,785	3.66
	182+00	3	75.3	67.7	64.3	69.1	0.26	0.23	0.21	0.23	96.15	13,945	3.386
	184+00	4	50.4	45.1	47.3	47.6	0.17	0.16	0.17	0.16	138.04	20,021	3.424
5	188+00	1	101.0	97.7	96.9	98.5	0.27	0.26	0.25	0.26	86.21	12,504	2.65
	190+00	2	66.1	65.9	62.8	64.9	0.20	0.19	0.18	0.19	117.80	17,085	2.943
	192+00	3	63.2	61.3	57.1	60.5	0.18	0.18	0.17	0.18	127.84	18,542	2.909
	194+00	4	50.8	52.7	49.6	51.0	0.15	0.16	0.14	0.15	148.03	21,470	2.98
6	198+00	1	16.1	14.6	13.9	14.9	0.09	0.08	0.08	0.08	267.86	38,850	5.638
	202+00	3	90.0	75.7	75.7	80.5	0.25	0.21	0.21	0.22	102.74	14,901	2.72
	204+00	4	77.3	77.1	73.5	76.0	0.23	0.22	0.21	0.22	103.21	14,969	2.868
7	208+00	1	83.3	83.9	81.0	82.7	0.23	0.21	0.21	0.22	103.69	15,039	2.624
	210+00	2	77.1	73.8	76.2	75.7	0.24	0.21	0.22	0.22	101.81	14,766	2.919
	214+00	4	43.2	43.7	45.7	44.2	0.04	0.05	0.05	0.05	489.13	70,942	1.041

Table 6. Summary of LWD Test Results for Base Materials

Laboratory Testing

Laboratory tests conducted on subgrade field samples from section 1 through 6 consisted of AASHTO T 88 Particle Size Analysis, AASHTO T27 Sieve Analysis of Coarse and Fine Aggregates, AASHTO T 89 & T 90 Atterberg Limits, FM 1-T 267 Organic Content, FM 1-T180 Modified Proctor Tests, and FM 5-515 Limerock Bearing Ratio (LBR) Tests.

Particle size analysis consists of shaking the material through a series of sieves with various opening sizes and the percentage of the material passing each sieve recorded. These values are then plotted on a semi-log graph and used to determine the amount of coarse and fine grained particles present in the sample and grading characteristics of the soil. These grading characteristics are determined using two geometric properties of the curve, the uniformity coefficient (C_u) and curvature coefficient (C_c). These are determined using the equations shown below:

$$C_u = \frac{D_{60}}{D_{10}}$$

$$C_c = \frac{(D_{30})^2}{D_{10} * D_{60}}$$

Where:

D_{10} = particle size at which 10% of the particles are finer.

D_{30} = particle size at which 30% of the particles are finer.

D_{60} = particle size at which 60% of the particles are finer.

Gradation analysis for limerock and subgrade used AASHTO T88 test method, and RAP and RAP blended material was in accordance with AASHTO T27. RAP and RAP blended materials were sieved up to U.S. Sieve #8, and the remaining particles retained on a pan due to finer particles sticking to each other. Results from the particle size distribution show well-graded to uniformly graded non-plastic select materials with organic contents between 0.6 and 1.2 percent. Tables 7 and 8 show the results for the particle size distribution and organic content and Figures 25 and 26 show the grain size distribution curves for subgrade and base materials, respectively.

It should be noted that for the RAP base and RAP-blended base material, samples were air-dried instead of oven-dried for gradation tests due to the asphalt present in the sample.

Section No.	Location (Station)	Classification		Particle Size Analysis Percent Passing Each Sieve									C_c	C_u	Organic Content (%)
		AASHTO	USCS	3/4"	1/2"	3/8"	#4	#10	#40	#60	#100	#200			
1	155+75	A-2-4	SP-SM	100.0	100.0	100.0	100.0	99.9	88.9	48.9	25.8	10.9	1.6	3.8	1.1
2	165+75	A-3	SP-SM	100.0	100.0	100.0	99.9	99.9	89.6	48.5	21.9	9.4	1.8	3.5	0.7
3	175+75	A-3	SP-SM	100.0	100.0	99.9	99.7	99.4	89.3	52.7	25.3	8.6	1.3	3.5	1.0
4	185+75	A-3	SP-SM	100.0	99.7	100.0	99.4	99.0	88.2	50.7	25.4	10.4	1.4	3.8	1.2
5	195+75	A-3	SP-SM	100.0	100.0	100.0	99.5	99.3	89.1	51.2	24.8	10.4	1.4	3.8	0.7
6	205+75	A-3	SP-SM	100.0	100.0	100.0	99.9	99.8	86.6	46.6	22.4	10.1	1.9	3.9	0.6

Table 7. Particle Size Analysis and Organic Content Results for Subgrade Materials

Section No.	Lift No.	Location (Station)	Material	Particle Size Analysis Percent Passing Each Sieve									
				3/4"	1/2"	3/8"	#4	#8	#10	#40	#60	#100	#200
1	1	155+75	Limerock	99.9	87.9	80.6	71.5	-	63.9	45.6	31.8	11.3	3.2
	2			91.6	86.7	83.5	75.2	-	43.0	28.8	17.8	8.9	4.1
2	1	165+75	RAP	100.0	89.3	69.7	39.8	24.1	-	-	-	-	-
	2			100.0	97.9	90.9	67.0	46.5	-	-	-	-	-
5	1	195+75	50/50 Limerock RAP Blend	95.5	90.8	82.8	62.5	50.8	-	-	-	-	-
	2			97.9	93.2	86.5	68.8	56.9	-	-	-	-	-
6	1	205+75	75/25 Limerock RAP Blend	98.2	95.0	90.1	73.4	59.9	-	-	-	-	-
	2			97.3	94.5	88.7	71.0	57.5	-	-	-	-	-

Table 8. Particle Size Analysis and Organic Content Results for Base Materials

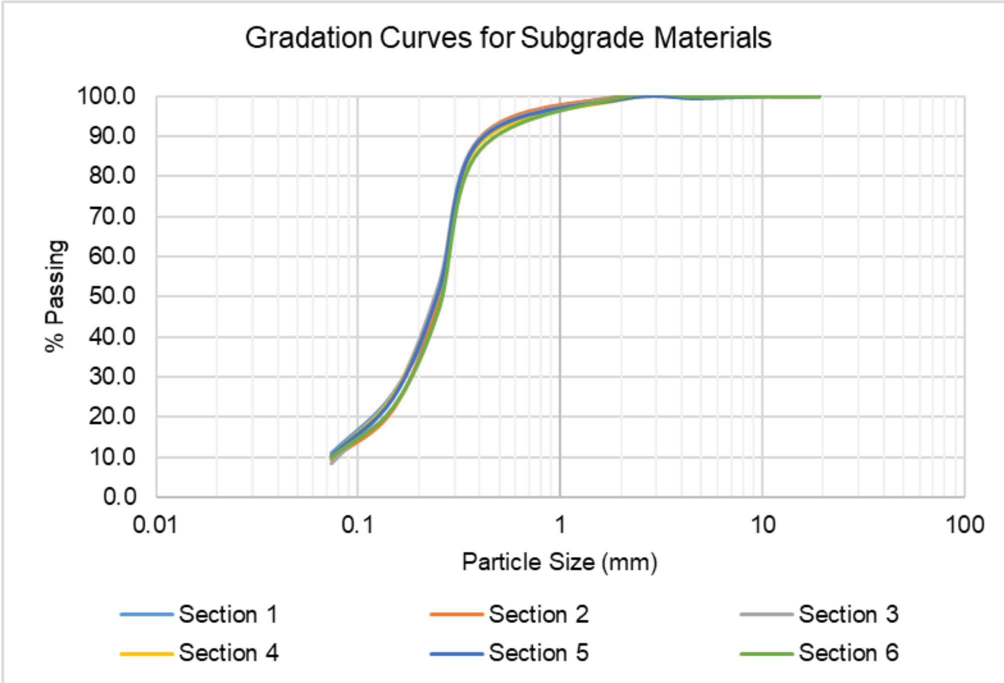


Figure 25. Gradation Curves for Subgrade Materials

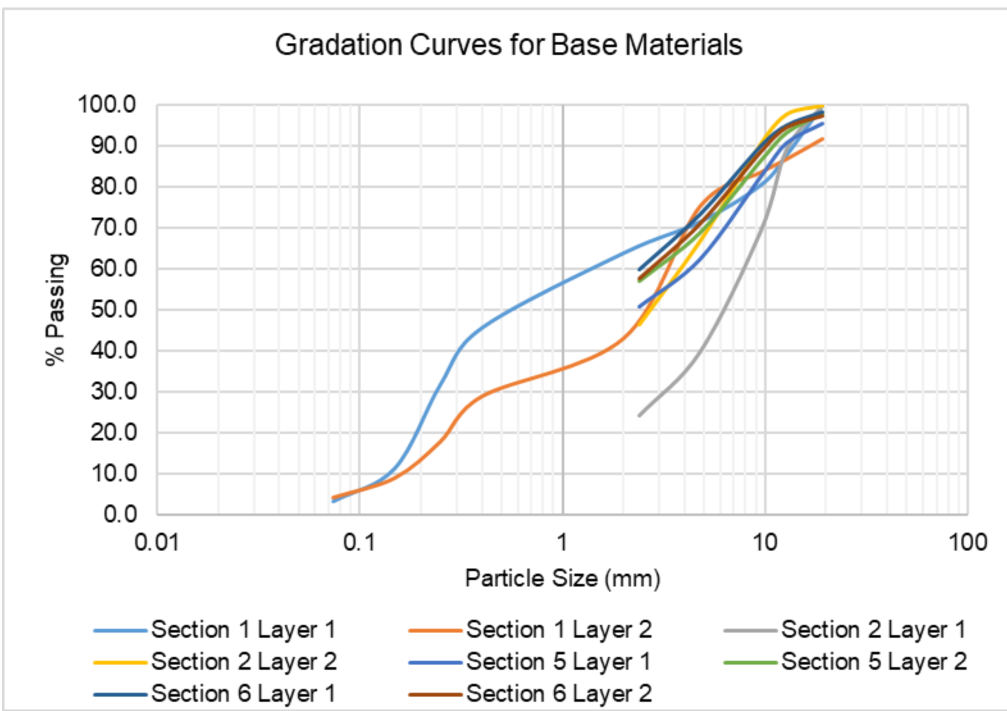


Figure 26. Gradation Curves for Base Materials

The modified Proctor test determines the maximum dry density and optimum moisture content of the material at a certain compactive effort and measured field densities are compared to this dry density value for acceptance. The test consists of compacting the material in a mold and increasing the moisture content successively. The dry unit weight at each moisture content is determined and plotted against each other. The relationship between the moisture content and the dry unit weight is parabolic and the highest point on the curve gives the maximum dry density value. The optimum moisture content is the point where the maximum dry density is achieved. Maximum dry densities for the subgrade materials ranged from 115 to 119 pcf with optimum moisture contents between 6.7 and 9.0 percent and for base between 115 pcf to 130 pcf with optimum moisture contents of 6.9 to 12.8 percent.

The LBR test is used to evaluate the bearing strength of materials by comparing the material's resistance to penetration to that of a standard sample of Florida limerock. Samples are compacted using the modified Proctor test and either soaked for 48 hours or left unsoaked. For our testing program all samples were soaked. The sample is then loaded using a piston and the penetration recorded for each load. The unit load on the piston is plotted against the penetration and corrected, if needed. The unit load at 0.1 inches of penetration is obtained and divided by 800 pounds per square inch (psi) which is the standard strength of Florida limerock. This ratio is then multiplied by 100 and the result is the LBR value in percent.

For the subgrade materials, the LBR values were found to be between 46 and 70, which meet the LBR 40 minimum requirement per FDOT specifications for stabilized subgrade. For the tested base materials, LBR values varied from 26 to 155, with the lowest values (26 and 31) for the RAP base material. Results are summarized in Tables 9 and 10.

Section No.	Location (Station)	Maximum Density (pcf)	Optimum Moisture (%)	LBR
1	155+75	118.3	8.6	57
2	165+75	116.7	6.7	44
3	175+75	115.8	9.0	46
4	185+75	118.2	8.0	59
5	195+75	117.8	6.7	56
6	205+75	118.9	8.2	70

Table 9. Modified Proctor and LBR Results for Subgrade Materials

Section No.	Lift No.	Location (Station)	Material	Maximum Density (pcf)	Optimum Moisture (%)	LBR
1	1	155+75	Limerock	118	12.0	155
	2			114.8	12.8	109
2	1	165+75	RAP	125.9	7.3	26
	2			123.1	6.9	31
5	1	195+75	50/50 Limerock RAP Blend	128	8.0	77
	2			126	8.2	77
6	1	205+75	75/25 Limerock RAP Blend	129.8	7.4	90
	2			128.7	7.9	109

Table 10. Modified Proctor and LBR Results for Base Materials