EVALUATION 0F

GRADED AGGREGATE

As A BASE MATERIAL

PROJECT NOS, 60040-3536 & 60040-3527

PAVEMENT EVALUATION STUDY NUMBER 92-2

STATE ROAD 83 (331)

WALTON COUNTY

By

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AND

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AUGUST 1992

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METRIC (SI*) CONVERSION FACTORS

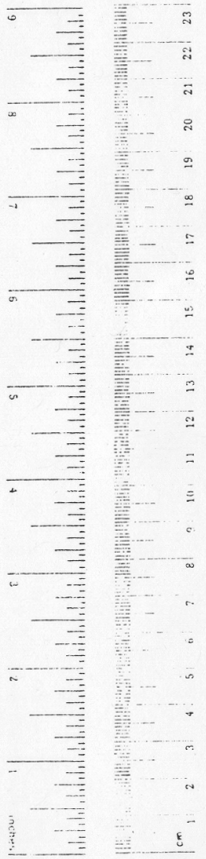
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	millimetres squared	mm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

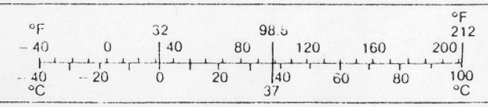


APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectares (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

LIST OF TABLES

INTRODUCTION

As part of the Department's policy for approving new materials and or material sources two test sites were constructed on SR 83 (US 331) South of Freeport, Florida.

The two test sections were constructed as a portion of Project Number 60040-3536 and 60040-3527. The test sections were located on the South (Section 1, Limerock) and North (Section 2 Grated Aggregate) side of Choctawhatchee Bay Bridge. Test section Number 1 has an eight- inch limerock base constructed over a twelve inch stabilized subgrade between stations 103+50 and 108+50. Test Section Number 2 has an eight inch graded limestone aggregate base constructed over a twelve inch stabilized subgrade between stations 187+50 and 192+50. The graded limestone aggregate came from Trinity Quarry in Alabama.

Special tests were done in addition to job control tests to assure the uniformity of the construction layers. The data summarized in this report is for the special tests only and should not be construed as job acceptance tests. Appendix A contains a listing of the special tests which were conducted (Project Evaluation Plan).

EMBANKMENT

Special tests were conducted on the embankment material through access holes in the subgrade. Results of the specialized field and laboratory testing accomplished on the embankment material are summarized on Tables 1 and 2 for the limerock and graded aggregate sections respectively.

Comparing average results of the twelve inch plate bear “E” tests, the embankment in Section 2 appears to be slightly stronger (22,014 psi) than Section 1 (20,241 psi).

Field density values for the embankment in Section 1 ranged from 98.7 pcf to l08.9 pcf with an average of 103.1 pcf. Section 2 field density values were somewhat higher ranging from l07.l pcf to ll8.8 pcf with a 111.8 pcf average.

Field moistures for the embankment (oven dried) in Section 1 were consistent ranging from 2.8 percent to 3.7 percent with a 3.4 percent average. Section 2 embankment moistures (oven dried) varied from a low of 3.9 percent to a high of 10.0 percent.

Laboratory maximum density values AASHTO T-99 (Florida Method of Test FM 5-525) for Section 1 embankment ranged from 100.0 pcf to 103.0 pcf with an average of 101.3 pcf. The embankment density in Section 2 was higher ranging from 111.0 pcf to ll7.0 pcf with an average of ll3.3 pcf.

Optimum moisture values (AASHTO T-99) for the embankment material in Section 1 ranged from 13.0 to 16.0 percent. Section 2 was slightly lower ranging from 11.0 to 13.0 percent.

Percent of laboratory maximum density values on the embankment in Section 1 averaged 101.7 while Section 2 averaged 98.6. The difference should not be detrimental to the performance of the pavement.

Embankment limerock bearing ratio (LBR) values averaged lower for Section 1 (37) than Section 2 (55).

SUBGRADE

The subgrade material was in place and compacted prior specialized testing being conducted.

Twelve inch plate bearing “E” values, Tables 1 and 2, show the composite embankment plus subgrade values to be very similar in both sections. Section 1 ranged from 16,177 psi to 22,035 psi with an overall average of 19,114 psi while Section 2 ranged from 18,529 psi to 21,409 psi with an average of 19,489 psi.

Field density values for the subgrade in Section 1 averaged 115.9 pcf while the subgrade in Section 2 averaged 115.5 pcf.

Field moisture (oven dried) values for the subgrade in Section 1 averaged 8.0 percent while Section 2 subgrade average 8.8 percent.

Laboratory maximum density values for the subgrade were very uniform averaging 123.0 pcf for both sections Maximum density for the subgrade was established using Method D of AASHTO T-180 (Florida Method of Test FM 5-521) as modified by the Department’s Research Bulletin 22-B.

Optimum moisture values for the subgrade averaged 9.0 percent for both sections.

Percent of laboratory maximum density values showed the sections to be very similar averaging 94.2 for Section 1 and 94.0 for Section 2.

Limerock Bearing Ratio values were also close averaging 120 for Section 1 and 122 for Section 2.

Actual thickness for the subgrade in Section 1 averaged 12.5 inches. Section 2 averaged 12.1 inches.

BASE

The base materials, limerock in Section 1 and graded aggregate in Section 2, were placed and compacted after specialized testing was completed on the subgrade and embankment. Tables 1 and 2 summarize results of the specialized field and laboratory testing conducted on the base materials.

Twelve- inch plate bearing “E” values performed on top of the base material indicate a composite strength of the embankment, subgrade and base. Section 1 had an average plate bearing “E” value of 19,239 psi while Section 2 averaged slightly higher at 23,392 psi.

Field density values for the base materials showed Section 2 to be higher averaging 144.0 pcf with Section 1 averaging 110.4 pcf.

Field moistures (oven dried) showed Section 1 to be wetter averaging 12.9 percent than Section 2 which averaged 3.7 percent. A reason for the difference in moisture content between materials was not readily apparent.

Laboratory maximum density values (AASHTO T-l80) (Florida Method of Test FM 5-521) show Section 2 to be somewhat higher averaging l42.7 pcf while Section 1 averaged 116.0 pcf.

Optimum moisture values show that Section 1 averaged 13.0 percent and Section 2 averaged 5.0 percent.

Percent of laboratory maximum density values indicate Section 1 averaged 95.1 while Section 2 averaged 100.9. The percent of laboratory maximum density values listed were not used for project acceptance.

Limerock bearing ratio values show that Section 1 averaged 127 while Section 2 averaged 167.

Table 3 summarized results of gradation and carbonates test on the base materials. The base materials for both sections appear similar, however, the limerock in Section 1 has a greater percent of fines.

Actual thickness for the limerock in Section 1 averaged 8.8 inches. The graded aggregate in Section 2 averaged 8.1 inches.

SURFACE

Table 4 summarizes the initial condition data (7/01/91) acquired on the completed wearing surface, along with the six month (1/21/92) condition survey. Initially Section 1 had less rutting with 0.04 inch compared to Section 2 with 0.07 inch. Section 1 continued to have less rutting with the l/21/91 survey, reporting a 0.09 inch compared to 0.12 inch for Section 2.

Ride values were initially smoother for Section 1 with a 4.29 Present Serviceability Index (PSI_{sv}) value while Section 2 had a 4.16 Present Serviceability Index (PSI_{sv}) value.

Tables 5 & 6 summarized the initial deflection testing conducted on the completed wearing surface using a Dynaflect. Testing was done on fifty-foot intervals. Results indicate materials are very similar in strength.

The asphalt layer consisted of 1¼ inch of S-1 structure mix, 3/4 inch of S-3 structural mix and 1 inch of FC-1 (Friction Course).

CONCLUSIONS

Testing conducted during and immediately after construction leads to the following conclusions:

1) Plate bearing composite data subgrade plus embankment indicates the overall strength of both sections is equivalent. Therefore performance should relate to the base layer.
2) Plate bearing data on the base layer also indicate that the graded aggregate is slightly stronger.
3) Deflection data obtained with the Dynaflect shows the test sections to be very comparable in strength.

The two base materials should perform in a similar manner based on preliminary testing. However, the true indicator of performance will be how the sections perform over time. The materials should be observed for five years or until terminal serviceability has been achieved.

TABLE 1
PROJECT NUMBER 60040-3536
LIMEROCK SECTION
SECTION 1

MATERIAL AND STATION	PLATE "E"	BEARING "K"	FIELD DENSITY NUCLEAR (PCF)	FIELD MOIST. NUCLEAR (%)	FIELD MOIST. OVEN (%)	LAB MAX. DENSITY (PCF)	OPT. MOISTURE (%)	% LAB MAX DENSITY	LBR
EMBANKMENT									
107+11	17,403	2,458	98.7	7.3	3.7	100.0	12.0		36
						101.0+	15.0+	97.7+	
105+83	21,284	3,006	101.6	5.5	3.6	100.0	13.0		35
						100.0+	16.0+	101.6+	
104+70	22,035	3,112	108.9	4.6	2.8	104.0	13.0		40
						103.0+	13.0+	105.7+	
AVERAGE	20,241	2,859	103.1	5.8	3.4	101.3+	14.7+	101.7+	37
SUBGRADE									
107+11	18,529	2,617	116.9	12.9	8.0	123.0	9.0	95.0	123
105+83	22,035	3,035	117.1	12.9	7.6	123.0	9.0	95.2	118
104+70	16,777	2,370	113.7	13.9	8.5	123.0	9.0	92.4	118
AVERAGE	19,114	2,674	115.9	13.2	8.0	123.0	9.0	94.2	120
BASE									
107+11	20,407	2,882	111.8	16.7	10.5	116.0	14.0	96.4	131
105+83	21,409	3,024	111.6	16.0	13.1	116.0	13.0	96.2	120
104+70	15,900	2,246	107.7	19.6	15.0	116.0	13.0	92.8	130
AVERAGE	19,239	2,717	110.4	17.4	12.9	116.0	13.0	95.1	127

+ T-99

TABLE 2
PROJECT NUMBER 60040-3536
GRADED AGGREGATE SECTION
SECTION 2

MATERIAL AND STATION	PLATE "E"	BEARING "K"	FIELD DENSITY NUCLEAR (PCF)	FIELD MOIST. NUCLEAR (%)	FIELD MOIST. OVEN (%)	LAB MAX. DENSITY (PCF)	OPT. MOISTURE (%)	% LAB MAX. DENSITY	LBR
EMBANKMENT									
186+63*	21,785	3,077	118.8	10.4	10.0	114.0	11.0		60
						117.0+	11.0+	101.5+	
189+52	19,719	2,785	107.1	6.3	3.9	110.0	13.0		48
						111.0+	12.0+	96.5+	
191+84	24,539	3,466	109.5	10.8	7.1	111.0	11.0		57
						112.0+	13.0+	97.8+	
AVERAGE	22,014	3,109	111.8	9.2	7.0	113.3+	12.0+	98.6+	55
SUBGRADE									
186+63*	18,529	2,626	114.9	13.1	9.0	122.0	8.0	94.2	118
189+52	18,529	2,617	116.5	10.9	8.8	124.0	10.0	94.2	133
191+84	21,409	3,024	115.1	12.7	8.7	123.0	9.0	93.6	115
AVERAGE	19,489	2,756	115.5	12.2	8.8	123.0	9.0	94.0	122
BASE									
186+63*	29,735	4,200	144.8	2.8	3.1	144.0	6.0	100.6	175
189+52	21,159	2,989	141.6	3.7	3.8	142.0	4.0	99.7	180
191+84	19,281	2,723	145.5	4.0	4.2	142.0	5.0	102.5	145
AVERAGE	23,392	3,304	144.0	3.5	3.7	142.7	5.0	100.9	167

* Station outside of area to be monitored
+ T-99

TABLE 3
BASE MATERIAL
PROJECT NUMBER 60040-3536 & 3537

LIMEROCK BASE	GRADATION - SIEVE SIZE - % PASSING												PERCENTAGE OF CARBONATES
	3 1/2"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	#4	#10	#40	#60	#200	
104+70	100							64				40	90
105+83	100							63				28	92
107+11	100							62				37	91
GRADED AGGREGATE BASE													
186+63	100	100	100	95	90	78	71	55	44	25	20	15	91
189+52	100	100	100	97	89	70	60	46	35	23	19	13	92
191+84	100	100	100	97	88	72	63	45	33	23	18	13	92

TABLE 4
FLORIDA DEPARTMENT OF TRANSPORTATION
MATERIALS OFFICE

PAVEMENT CONDITION AND SERVICEABILITY SURVEYS

PROJECT NUMBER 60040-3536
STATE ROAD NO. 331
SECTION NUMBER 1 & 2
LOCATION WALTON COUNTY

TYPE SURFACE
TYPE BASE
TYPE SUBGRADE
DIRECTION/LANE SBTL

HISTORY FILE

DATE	SOUTHBOUND TRAFFIC LANE SECTION 1 LIMEROCK BASE			SOUTHBOUND TRAFFIC LANE SECTION 2 GRADED AGGREGATE BASE		
	RUTTING (IN)	CR&PT/1000 SQ. FT.	RIDE IRI/PSI	RUTTING (IN)	CR&PT/1000 SQ. FT.	RIDE IRI/PSI
07/01/91	0.04	000.0	89/4.29	0.07	000.0	106/4.16
01/21/92	0.09	000.0	75/4.40	0.12	000.0	91/4.28

TABLE 5
FLORIDA DEPARTMENT OF TRANSPORTATION
MATERIALS OFFICE
DYNAMIC DEFLECTION DATA

PROJECT NUMBER 60040-3536 TEST SECTION NUMBER 1 SOUTHBOUND TRAFFIC LANE

	TRAFFIC LANE (OWP)					TEMPERATURE	
DATE	D(1)	D(2)	D(3)	D(4)	D(5)	AIR	PAVT
07/01/91	0.90	0.63	0.54	0.42	0.35	88	94
01/21/92	0.82	0.57	0.44	0.36	0.30	68	78

TABLE 6
FLORIDA DEPARTMENT OF TRANSPORTATION
MATERIALS OFFICE
DYNAMIC DEFLECTION DATA

PROJECT NUMBER 60040-3536 TEST SECTION NUMBER 2 SOUTHBOUND TRAFFIC LANE

	TRAFFIC LANE (OWP)					TEMPERATURE	
DATE	D(1)	D(2)	D(3)	D(4)	D(5)	AIR	PAVT
07/01/91	0.75	0.61	0.49	0.40	0.33	88	94
01/21/92	0.71	0.54	0.42	0.34	0.29	68	78

APPENDIX A

PROJECT NUMBER 60040-3536

AND PROJECT NUMBER 60040-3527

PROJECT EVALUATION PLAN

FLORIDA DEPARTMENT OF TRANSPORTATION

STRENGTH EQUIVALENCY STUDY

LIMEROCK VERSUS GRADED AGGREGATE

AS A BASE MATERIAL

STATE PROJECT NUMBER 60040-3536 & 60040-3527

STATE ROAD 83

PROJECT EVALUATION PLAN

INTENT AND SCOPE

Project Number 60040-3536 will be constructed in compliance with the Department's Standard Specifications for Road and Bridge Construction 1986 edition, the special provisions to the contract, and the supplemental agreements to the contract.

Included in the project are two experimental sections each about 500 feet in length, to be constructed in the Southbound Roadway. In these sections, the work includes the construction of a limerock base section and a crushed stone base section. The limerock base section will be constructed between stations 103+50 and 108+50. The graded aggregate base section will be constructed between stations 187+50 and 192+50.

Testing of the materials and measurements of the quality of all phases of construction in the test sections will be in compliance with the Department's Standard Specifications for Road and Bridge Construction 1986 edition. Exceptions are noted to the attached specifications for the purpose of this evaluation.

In addition to the acceptance testing done by project personnel, additional testing will be done by project personnel and personnel from the Materials Office. The contractor shall coordinate his construction operations with the District Office as they pertain to the sequence of operations and planned times of completion of the various phases of construction in these sections.

After the embankment and subgrade have been accepted, special testing will be conducted on each of these layers within the test sections. Resultsof these tests will not be used for accepting or rejecting the construction work, but will be completed on the embankment and subgrade prior to commencing work on the base material.

Special testing will include density tests, plate bearing tests, and material sampling (the contractor will be responsible for replacing the sample material).

After the base materials have been accepted, special testing will be conducted within the test sections. Again, results of these tests will not be used for accepting or rejecting the base layer, but will be completed prior to commencing work on the surface layer. The contractor will be responsible for replacing sampled materials.

It is not anticipated that tests made during construction of the sections will delay the contractor's operations, but any costs and/or delays to the contractor due to coordination shall not be paid for separately, but shall be included in the applicable pay item under the contract.

Once constructed, the test sections will be monitored performance for a period of five years.

ACCEPTANCE AND TESTING

The following acceptance testing, conducted by Project personnel, will be necessary to assure the uniformity of the material within the test sections.

EMBANKMENT - Field Tests

1) In-place density – 5 per section randomly selected within each 100' lot. Top lift acceptance requirement will be 100 to 105 percent of maximum laboratory density (T-99).

SUBGRADE -

1) In-place density – 5 per lift per section randomly selected within each 100' lot. Acceptance requirement will be 98 to 103 percent of maximum laboratory density (T-180).
2) Thickness Measurement – Measured on 50' intervals. Acceptance requirement will be ± ½ inch of design.
3) LBR's – 5 per section randomly selected within each 100' lot. Acceptance requirement will be 40 ± 5.

BASE -

1) In-place density – 5 per lift per section randomly selected within each 100' lot. Acceptance requirement will be 98 to 103 percent of maximum laboratory density (T-180).
2) Thickness Measurement – Measured on 50' intervals. Acceptance requirement will be ± ½ inch of design.

Note: All other acceptance criteria will be normal project specifications.

SPECIALIZED TESTING

The following testing will be conducted in addition to acceptance testing during or immediately after construction. These tests will be conducted by the Materials Office.

EMBANKMENT – Field Tests

1) 12” Plate Bearing Tests – 3 per section randomly selected.
2) In-place Density Test – 3 per section @ plate bearing test sites.
3) Material Samples – 4 bags of material per test site/or 12 – samples per section @ plate bearing test sites.
4) Material Samples (Oven Moisture) – 3 per section @ plate bearing test sites.

EMBANKMENT – Laboratory Test

1) Laboratory Maximum Density – 3 per section from plate bearing test sites.
2) Oven Moistures – 3 per section from plate bearing test sites.
3) Material Gradations – 3 per section from plate bearing test sites.
4) LBR’s – 3 per section from plate bearing test sites.

SUBGRADE – Field Tests

1) 12” Plate Bearing Tests – 3 per section randomly selected.
2) In-Place Density Test – 3 per section @ plate bearing test sites.
3) Material Samples – 4 bags of material per test site /or 12 – samples per section @ plate bearing test sites.
4) Material Samples (Oven Moisture) – 3 per section @ plate bearing test sites.

SUBGRADE – Laboratory Tests

1) Laboratory Maximum Density – 3 per section from plate bearing test sites.

2) Oven Moistures – 3 per section from plate bearing test sites.

3) Material Gradations – 3 per section from plate bearing test sites.

4) LBR's – 3 per section from plate bearing test sites.

BASE – Field Tests

1) 12" Plate Bearing Tests – 3 per section randomly selected.

2) In-place Density Test – 3 per section @ plate bearing test sites.

3) Materials Samples – 4 bags of material per test site/or 12 – samples per section @ plate bearing test sites.

4) Material Samples (Oven Moisture) – 3 per section @ plate bearing test sites.

BASE – Laboratory Test

1) Laboratory Maximum Density – 3 per section from plate bearing test sites.

2) Oven Moistures – 3 per section from plate bearing test sites.

3) Material Gradations – 3 per section from plate bearing test sites.

4) LBR's – 3 per section from plate bearing test sites.

POST CONSTRUCTION TESTING

The following testing will be conducted, after construction, by personnel from the Materials Office in order to evaluate the performance of the Base Materials. Evaluation testing will be confined to the Westbound traffic lane.

Immediately following Construction

1) Dynamic Deflections (Dynaflect) - 50 foot intervals.

2) Rut Depth - 50 foot intervals

3) Cracking and Patching - square feet/1000 square foot surface.

4) Roughness (Mays Ride Meter or Equivalent). Six Months after Construction

Six Months after Construction

1) Dynamic Deflections (Dynaflect) - 50 foot interval.

2) Rut Depth - 50 foot intervals.

3) Cracking and Patching - square feet/1000 square feet of surface.

4) Roughness (Mays Ride Meter or Equivalent).

One Year After Construction and Annually

1) Dynamic Deflections (Dynaflect) - 50 foot interval

2) Rut Depth - 50 foot intervals

3) Cracking and Patching - square feet/1000 square feet of surface.

4) Roughness (Mays Ride Meter or Equivalent).

Project will be monitored until conclusive evaluation of the base materials performance can be made or for a five year period.

Documentation of test results will be in the form of a letter report.

PROJECT NUMBER 60040-3536

BASE STRENGTH EQUIVALENCY STUDY