EAR
Workshop

- EAR Guidelines
- Model EAR

Department Guidelines for Preparing an Engineering Analysis Report

Following is a list of the basic requirements that should be included in an Engineering Analysis Report (EAR)

1. Identification information: This should be included at the beginning of the EAR identifying the project information, the name and address of the company submitting the EAR and the name and address of the company the EAR is being prepared for.

2. Problem statement: Describe in detail the problem which required the EAR. Provide a summary of the test results (QC, IV, as applicable) and specification requirements that triggered the EAR. Provide the location within the project of the questionable material. If possible, use Global Positioning System (GPS) coordinates to identify the location of the material.

3. Testing laboratory: Identify the laboratory that will be used and discuss the laboratory's qualifications and personnel that will perform the required tests. Provide technician identification numbers (TIN).

4. Engineering: Identify the Engineer responsible for analyzing the data and making final recommendations. Include a brief résumé listing similar past work efforts.

5. Testing plan: Discuss the testing approach that will be used, including the test methods and number of test replicates. Include information on who will provide the samples for the analysis, where they will be located (within the area of the questionable material) and when they will be obtained.

6. Analysis approach: Describe the approach and reasoning that will be used to evaluate the test data and determine the quality of the questionable material.

Approval of the testing plan and analysis approach must be obtained from the Department prior to obtaining any samples and/or testing.

7. Data presentation: Present the data in a tabular and/or graphical format.

8. Statistical analysis: Conduct statistical tests, as applicable, to determine the viability of the data. The statistical analysis should also determine if the samples used in the analysis are representative of the questionable material in-place.

9. Recommendations: Based on the test data obtained and current engineering practice, provide and justify the recommendations for the disposition of the questionable material. Discuss the quantities and locations of the material determined to be questionable.

10. P.E. Seal: The Professional Engineer responsible for the EAR and its recommendations must sign and seal the EAR

11. Attachments: Present any accreditation, certification, or other supporting documents, including pictures, plant and field records, control charts, etc. that are needed for the EAR Include a copy of the Department's correspondence to the Contractor that indicates approval to perform an EAR for this particular problem.

FICTITIOUS ASPHALT ENGINEERING, INC.

November 18, 2004

Mr. George W. Kerry
QC Manager
First American Asphalt Contractors, Inc.
3171 N.W. 43rd Avenue
Gainesville, Florida 32606

Subject: Engineering Analysis Report – SP-12.5 LOT 8, sublot 1
Financial Project Number: 321456-1-52-01
Road No.: SR-121
County: Alachua

Dear Mr. Kerry:

At your request, an engineering analysis was performed on the failing material from LOT 8, sublot 1 of the subject project. The Engineering Analysis Report for this investigation is attached. Should you have any questions or require additional information, please let me know.

Sincerely,

John Q. Fictitious, P.E.
Bituminous Engineer

JQF/

Attachment

5007 NE 39TH AVENUE • GAINESVILLE, FLORIDA • 32609
PHONE: 352.867.5309 • FAX: 352.867.5308

Engineering Analysis Report

Financial Project Number: 321456-1-52-01
Road No.: SR-121
County: Alachua

Superpave Asphalt Concrete
Type SP-12.5, Fine Graded
Mix Design Number: SP 04-9999A
LOT 8, sublot 1

Prepared for:

Mr. George W. Kerry
QC Manager
First American Asphalt Contractors, Inc.
3171 N.W. 43rd Avenue
Gainesville, Florida 32606

Prepared by:

John Q. Fictitious, P.E.
Fictitious Asphalt Engineering, Inc.
5007 NE 39th Avenue
Gainesville, FL 32609

November 18, 2004

Problem Statement:

During the production of the SP-12.5 Superpave fine graded asphalt mix on the night of September 13, 2004, the air voids, as measured by the Independent Verification sample for LOT 8, sublot 1, were 2.18%. Article 334-7 of the Florida Department of Transportation (FDOT) Specifications for this project requires that the air voids be maintained within the range of 2.30 to 6.00%; consequently the sample failed to meet the Specification requirements. Since low air voids have been associated with plastic deformation (rutting) of asphalt pavements, an analysis of this failing material is warranted to determine the appropriate disposition.

The Quality Control (QC), Independent Verification (IV) and Verification (VT) data for the SP-12.5 mix in question has been summarized and can be found in Table 1. The failing IV test result is identified by the blue circle in Table 1. Preliminary review of the data indicates that the probable cause of the low air voids was primarily a high asphalt binder content in the mix. The gradation appears to be a contributing problem with a coarser gradation compared to the job mix formula (JMF) on all of the sieves except for the No. 200 sieve. Since the mix in question is a fine graded mix, a coarser gradation than the JMF would tend to cause lower air voids.

The IV sample was pulled from load number 35, at approximately 700 tons. The QC test for LOT 8, sublot 1 was pulled from load number 21, at approximately 420 tons. The QC test results were acceptable. The IV testing and results were not finished and available until after the completion of sublot 1 on September 13. Therefore, it is proposed that the asphalt mixture placed between the QC test result and the end of sublot 1 be evaluated. This represents 580 tons (1000 tons – 420 tons) of asphalt mixture. This questionable mix was placed on the project from Sta 223+05 to Sta 281+05 (5,800 ft.), in Lane L-1. The average spread rate for the material was 150.0 lbs/sy, equating to a compacted thickness of approximately 1.5 inches.

Testing Laboratory:

All testing associated with this Engineering Analysis Report was conducted by Fictitious Asphalt Engineering, Inc., Asphalt Laboratory. The FAE Asphalt Laboratory is an accredited laboratory meeting all of the requirements set forth under AASHTO R18. All personnel involved in testing activities in the FAE Asphalt Laboratory are qualified through the FDOT Construction Training Qualification Program (CTQP), and are actively evaluated through the FDOT Independent Assurance (IA) Program as well as the AASHTO Materials Reference Laboratory (AMRL) proficiency sampling program. Technician Identification Numbers are available upon request.

Engineering:

The following FAE staff were involved in various stages of the analysis:

Suburban Meyer, Senior Engineer – Supervised all field sampling
Robert Bowden, Junior Technician – Conducted all laboratory testing

The final recommendation will come from John Q. Fictitious, PE. A brief resume outlining Mr. Fictitious's related work experiences is given in Attachment 1.

Table 1 – Summary of Quality Control, Verification and Independent Verification Data

Project Summary																															
Project No.:	321456-1-52-01		SR No. :	121			Date:	9/13/2004	9/13/2004	9/13/2004	9/15/2004	9/15/2004	9/20/2004	9/20/2004	9/23/2004	9/23/2004	9/27/2004	9/27/2004	9/27/2004	9/27/2004	9/27/2004	9/27/2004	9/27/2004	9/29/04	9/29/04
Contractor:	First American Asphalt			Gyrations			Tested by:	QC	QC	IV	QC	VT	QC	QC	QC	QC	QC	QC	QC	IV	QC	VT	QC	QC	QC
Mix Design No.:	SP04-9999A	(mm):	12.5	@ N_i:	7		Lot / Sublot	8,1PC	8,1	8,1	8,2	8,2	8,3PC	8,3	8,4	9,1	PC	9,2	9,2	9,3	9,3	9,3	PC - 9/4	9/4
Traffic Level:	C	Gmm:		@ N_d:	75		Load #:	4	21	35	1		4	25	3	23	4	13	6	29	29	29	1	13
VMA:	14.0% MIN	VFA:	65-75%	@ N_m:	115		Tons/day:																				310.18	310.18
Design Temp:	Production:		Compaction:				Cumulative tons:																				310.18	310.18

Property	JMF	AVG	STD	MIN	MAX	RNG	CNT																			
25.0mm (1")		100.00	0.00	100.00	100.00	0.00	17.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
19.0mm (3/4")		100.00	0.00	100.00	100.00	0.00	17.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
12.5mm (1/2")	95	93.82	1.65	90.14	96.26	6.12	17.00	96.08	93.13	94.36	91.82	96.26	91.96	93.48	94.68	94.21	95.77	91.42	94.96	94.19	93.40	94.19	94.83	90.14
9.5mm (3/8")	89	87.42	1.83	84.34	91.26	6.92	17.00	89.45	86.73	87.26	84.93	91.26	84.89	86.28	88.63	87.98	88.37	84.34	88.32	88.51	86.67	88.51	88.92	85.10
4.75mm (#4)	66	65.56	2.01	62.65	68.99	6.34	17.00	64.83	63.81	63.10	64.29	68.99	63.12	63.04	67.64	66.59	68.55	62.65	67.73	66.83	64.43	66.83	65.29	66.79
2.36mm (#8)	45	45.11	1.81	42.64	48.38	5.74	17.00	**42.81**	**43.37**	**43.00**	**42.97**	**45.78**	**42.64**	**43.39**	**45.69**	**46.31**	**48.38**	**44.69**	**47.83**	**46.81**	**44.16**	**46.81**	**46.06**	**46.19**
1.18mm (#16)	32	31.86	1.85	28.68	34.44	5.76	17.00	29.69	30.11	29.37	28.68	30.68	30.68	30.45	33.96	33.62	34.44	31.43	34.33	33.91	32.01	33.91	32.49	31.90
600um (#30)	24	24.20	1.55	21.13	26.33	5.20	17.00	22.47	22.73	22.35	21.13	22.63	24.04	23.66	25.75	25.54	26.33	24.00	26.31	25.87	25.08	25.87	24.15	23.57
300um (#50)	18	18.22	1.38	15.36	20.30	4.94	17.00	16.66	16.98	16.75	15.36	16.59	18.64	18.20	18.10	19.51	20.17	18.35	20.30	19.63	19.26	19.63	17.93	17.62
150um (#100)	7	6.94	0.84	5.38	8.28	2.90	17.00	5.38	5.95	5.83	5.56	6.57	6.90	6.71	7.08	7.44	8.08	7.16	8.28	7.58	7.87	7.58	6.77	7.32
75um (#200)	2.9	2.42	0.24	2.15	3.10	0.95	17.00	**2.15**	**2.24**	**3.10**	**2.32**	**2.76**	**2.21**	**2.45**	**2.31**	**2.30**	**2.51**	**2.28**	**2.73**	**2.36**	**2.45**	**2.36**	**2.20**	**2.35**
Ext. AC %:	6.1	6.04	0.18	5.81	6.55	0.74	17.00	**6.10**	**6.00**	**6.55**	**6.09**	**6.32**	**5.82**	**5.87**	**6.11**	**5.92**	**6.14**	**5.84**	**6.10**	**6.04**	**5.81**	**6.04**	**5.90**	**5.96**
Rice MSG (Gmm):	2.399	2.399	0.01	2.385	2.412	0.03	17.00	**2.396**	**2.397**	**2.385**	**2.398**	**2.399**	**2.401**	**2.400**	**2.399**	**2.400**	**2.401**	**2.401**	**2.395**	**2.397**	**2.412**	**2.397**	**2.398**	**2.402**
Avg. Bulk (Gmb):	2.303	2.311	0.01	2.300	2.333	0.03	17.00	**2.315**	**2.305**	**2.333**	**2.307**	**2.300**	**2.306**	**2.311**	**2.310**	**2.308**	**2.317**	**2.311**	**2.320**	**2.313**	**2.313**	**2.313**	**2.303**	**2.306**
Agg. Sp. Gr. (Gsb):	2.557	2.557	0.00	2.557	2.557	0.00	17.00	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**	**2.557**
Hgt.@N int.:		123.9	1.21	122.5	126.3	3.80	17.00	**126.3**	**124.4**	**126.0**	**125.4**	**125.7**	**123.7**	**123.4**	**122.9**	**123.3**	**122.7**	**123.4**	**122.6**	**122.9**	**122.5**	**122.9**	**123.7**	**123.8**
Hgt.@N des.:		115.9	0.57	115.2	117.3	2.10	17.00	**117.3**	**116.0**	**117.0**	**116.4**	**116.6**	**116.1**	**115.7**	**115.5**	**115.8**	**115.3**	**115.8**	**115.2**	**115.6**	**115.3**	**115.6**	**115.8**	**115.9**
%Gmm @ Ni	≤ 89.0	90.2	0.55	88.9	91.0	2.09	17.00	**89.73**	**89.67**	**90.83**	**89.30**	**88.93**	**90.14**	**90.28**	**90.49**	**90.32**	**90.68**	**90.28**	**91.02**	**90.76**	**90.26**	**90.76**	**89.90**	**89.88**
% Gmm @ Nd	96.0	96.4	0.45	95.9	97.8	1.95	17.00	**96.62**	**96.16**	**97.82**	**96.21**	**95.87**	**96.04**	**96.29**	**96.29**	**96.17**	**96.50**	**96.25**	**96.87**	**96.50**	**95.90**	**96.50**	**96.04**	**96.00**
% Air Voids @ Nd	4	3.65	0.45	2.18	4.13	1.95	17.00	**3.38**	**3.84**	**2.18**	**3.79**	**4.13**	**3.96**	**3.71**	**3.71**	**3.83**	**3.50**	**3.75**	**3.13**	**3.50**	**4.10**	**3.50**	**3.96**	**4.00**
% VMA @ Nd		15.07	0.23	14.74	15.74	1.00	17.00	**14.99**	**15.27**	**14.74**	**15.27**	**15.74**	**15.07**	**14.93**	**15.18**	**15.08**	**14.95**	**14.90**	**14.80**	**15.00**	**14.79**	**15.00**	**15.25**	**15.19**
% VFA @ Nd		75.83	2.82	72.28	85.21	12.93	17.00	**77.45**	**74.85**	**85.21**	**75.18**	**73.76**	**73.72**	**75.15**	**75.56**	**74.60**	**76.59**	**74.83**	**78.85**	**76.67**	**72.28**	**76.67**	**74.03**	**73.67**
Dust/Asphalt		0.48	0.04	0.41	0.56	0.15	17.00	**0.41**	**0.44**	**0.56**	**0.45**	**0.54**	**0.45**	**0.49**	**0.46**	**0.46**	**0.49**	**0.46**	**0.53**	**0.46**	**0.51**	**0.46**	**0.44**	**0.47**
Gmb @ Nd		2.311	0.01	2.30	2.333	0.03	17.00	**2.315**	**2.305**	**2.333**	**2.307**	**2.300**	**2.306**	**2.311**	**2.310**	**2.308**	**2.317**	**2.311**	**2.320**	**2.313**	**2.313**	**2.313**	**2.303**	**2.306**
Density lbs/cf		144.2	0.46	143.52	145.6	2.060	17.00	**144.46**	**143.83**	**145.58**	**143.96**	**143.52**	**143.89**	**144.21**	**144.14**	**144.02**	**144.58**	**144.21**	**144.77**	**144.33**	**144.33**	**144.33**	**143.71**	**143.89**
Gse		2.6	0.01	2.62	2.6	0.02	17.00	**2.62**	**2.62**	**2.63**	**2.62**	**2.64**	**2.62**	**2.62**	**2.63**	**2.62**	**2.63**	**2.62**	**2.62**	**2.62**	**2.63**	**2.62**	**2.62**	**2.62**
Pba		1.02	0.09	0.97	1.27	0.30	17.00	**0.97**	**0.97**	**1.12**	**0.97**	**1.27**	**0.97**	**0.97**	**1.12**	**0.97**	**1.12**	**0.97**	**0.97**	**0.97**	**1.12**	**0.97**	**0.97**	**0.97**
Pbe		5.08	0.15	4.76	5.50	0.74	17.00	**5.19**	**5.09**	**5.50**	**5.18**	**5.13**	**4.91**	**4.96**	**5.06**	**5.01**	**5.09**	**4.93**	**5.19**	**5.13**	**4.76**	**5.13**	**4.99**	**5.05**
Roadway Core 1 Gmb									2.234		2.153	2.143		2.230	2.250	2.237		2.195		2.217	2.216	2.217		2.163
Roadway Core 2 Gmb									2.223		2.235	2.236		2.182	2.210	2.214		2.211		2.220	2.220	2.220		2.243
Roadway Core 3 Gmb									2.228		2.239	2.239		2.204	2.225	2.225		2.190		2.181	2.177	2.181		2.243
Roadway Core 4 Gmb									2.212		2.21	2.21		2.251	2.209	2.222		2.213		2.2	2.196	2.200		
Roadway Core 5 Gmb									2.226		2.179	2.174		2.187	2.241	2.223		2.200		2.212	2.241	2.212		
Average Core Gmb		2.21	0.01	2.20	2.23	0.03	11.00		2.225		2.203	2.200		2.211	2.227	2.224		2.202		2.206	2.210	2.206		2.216
Sublot Gmm		2.40	0.01	2.39	2.41	0.03	17.00	2.391	2.397	2.385	2.398	2.399	2.401	2.400	2.399	2.400	2.401	2.401	2.395	2.397	2.412	2.397	2.398	2.402
% of Sublot Gmm		92.15	0.42	91.63	92.83	1.20	11.00		92.81		91.88	91.72		92.12	92.83	92.68		91.70		92.03	91.63	92.03		92.27

Testing Plan:

In order to evaluate the questionable material placed on the project, a set of four six-inch diameter roadway cores were taken at a frequency of one set of cores per 500 feet of roadway. The first set of cores is located 500 feet from Sta 223+05 and a set of cores was then obtained every 500 ft. after that. Cores 1 and 2 were taken between-the-wheelpath and cores 3 and 4 were taken within the wheelpath. Prior to cutting cores, the pavement was inspected by Department & Contractor personnel for any signs of premature rutting. The samples were obtained by staff of First American Asphalt Contractors, Inc., under the direction and supervision of Fictitious Asphalt Engineering, Inc. personnel on October 14, 2004. Of each set of cores, the following tests were performed:

Bulk specific gravity - G_{mb} (FM 1-T 166) – Cores 1-4.
Maximum specific gravity – G_{mm} (FM 1-T 030) – Combined Cores 1 & 2.
Determination of asphalt binder content - P_b (FM 5-563) – Combined Cores 3 & 4.
Gradation analysis – (FM 1-T 030) – Combined Cores 3 & 4.

Analysis Approach:

Based on a review of the production data, the low air voids in the asphalt mixture that occurred on the night of September 13, 2004 were primarily due to high asphalt binder content (6.55% with a target of 6.10%). In addition, the gradation of the material on all of the sieves, except for the No. 200 sieve, is slightly on the coarse side.

Since the pavement was only opened to traffic for thirty one days prior to cutting the cores used in this analysis and the roadway in question does not have heavy truck traffic (8.7% with an AADT of 19,500), the pavement has not had adequate time to further densify and in-place air voids is not likely to be a good indicator of performance. Consequently, this analysis focused primarily on the characteristics that caused the low air voids (high binder content and a coarse gradation) rather than in-place air voids alone.

This analysis focused on 1) identifying the limits of the questionable material, and 2) determining whether the questionable material is suitable to remain in place or should be removed.

The following test data was summarized for each coring location:

- Asphalt binder content
- Gradation
- Maximum specific gravity (Gmm)
- Bulk specific gravity (Gmb)
- In-Place Density, expressed as % Gmm

Approval of Testing Plan and Analysis Approach:

The testing plan and analysis approach of this EAR were submitted to the Department for review on October 1, 2004. Approval was received on October 4, 2004.

Data presentation:

A summary of the data is presented in Table 2.

Analysis:

The IV sample was obtained from load number 35. This mix was placed approximately at Sta 251+05. Examination of the data shows that the asphalt binder content is close to the design target until Sta 248+05, where the asphalt binder content was 6.30 %. Core test results obtained at stations 253+05 and 258+05 show asphalt binder contents of 6.51 % and 6.39 %, respectively. The asphalt binder contents at the remaining stations were close to the design target. There appears to be an isolated section between stations 248+05 and 258+05 where the binder content was excessive.

The gradation at Sta 253+05 appears to be slightly coarser than the gradations at the other stations and this effect could cause a fine graded mix to have low air voids for specimens compacted in the gyratory compactor.

There appears to be no difference in the densities for the wheelpath and between-the-wheelpath cores. Also, no observed rutting was noticed by Department and Contractor personnel in the area near Sta 251+05.

The data obtained from the field cores corroborates the IV sample test data. The asphalt binder content at Sta 248+05 is 6.30, which is 0.20 % higher than the mix design, but is not unreasonable. However, the asphalt binder content at Sta 253+05 is 6.51 %, which is excessive. The asphalt binder content at Sta 258+05 is 6.39%, which is borderline excessive, but should not require removal.

Recommendations:

It is recommended that First American Asphalt Contractors, Inc. mill and replace the asphalt from Sta 248+05 to Sta 258+05. The milling should encompass the entire twelve foot width of lane L-1 and be the full depth of the paved layer, which is 1.5 in. This is approximately 100 tons of asphalt mix. This remedial action should alleviate any concerns of premature rutting in the area of concern.

Sincerely,

John Q. Fictitious

Table 2 – Summary of Test Data from Roadway Cores

Property	Design	Sta 228+05		Sta 233+05		Sta 238+05		Sta 243+05		Sta 248+05		Sta 253+05		Sta 258+05		Sta 263+05		Sta 268+05		Sta 273+05		Sta 278+05	
Pb	6.1	6.05		6.21		6.15		6.09		6.30		6.51		6.39		6.20		6.01		6.07		5.98	
3/4 “	100	100		100		100		100		100		100		100		100		100		100		100	
1/2"	95	94		95		96		94		93		94		94		95		94		93		95	
3/8”	89	88		88		89		87		86		85		88		89		87		86		87	
No. 4	66	65		66		66		65		64		64		65		65		65		65		66	
No.8	45	44		45		46		45		44		43		44		44		45		46		46	
No. 16	32	30		30		31		31		30		29		29		30		30		31		32	
No. 30	24	23		24		24		23		22		21		22		23		24		24		24	
No. 50	18	17		16		18		17		16		17		17		19		18		19		18	
No. 100	7	6		7		6		6		5		4		5		6		6		7		6	
No. 200	2.9	2.3		2.4		2.5		2.4		2.7		3.4		3.4		3.1		3.0		2.9		2.7	
Gmm	2.399	2.403		2.401		2.405		2.397		2.397		2.383		2.392		2.405		2.403		2.399		2.400	
Gmb	2.231	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP	BWP	WP
		2.231	2.235	2.224	2.223	2.220	2.218	2.230	2.235	2.221	2.215	2.209	2.215	2.220	2.218	2.215	2.210	2.231	2.235	2.236	2.239	2.240	2.245
%Gmm	93.00	92.84	93.01	92.63	92.59	92.31	92.22	93.03	93.24	92.66	92.41	92.70	92.95	92.81	92.73	92.10	91.89	92.84	93.01	93.21	93.33	93.33	93.54