WESTEST
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SPECIALISTS TO THE PAVING INDUSTRY
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Federal Highway Administration
Central Federal Lands Division
Denver Federal Center
Building 52, PO Box 25246
Denver, CO 80225

November 1, 2006

Attention: Mr. Randall S. Caley

Subject: Hot Mix Asphalt Mix Design - Marshall Method – 75 Blows per Side
FHWA Grading E
Pohakuloa Training Area Quarry, Tesoro Refining PG 64-16 Binder
Saddle Road, FHWA Project No.: Hawaii – A-AD/STP 6(3) & 200(1)
WesTest Mix Design No. 166206

Gentlemen:

Enclosed are the results of a hot mix asphalt mix design done in general accordance with the Asphalt Institute's *Mix Design Methods for Asphalt Concrete* Marshall procedures, using 75 blows per side compactive effort. All tests have been conducted in general accordance with AASHTO procedures current at the time of design. The aggregate used in the mix design is from Pohakuloa Training Area Quarry. The asphalt cement used in the mix design consisted of a PG 64-16, with a specific gravity of 1.020, supplied by Tesoro Refining.

The aggregate gradations and blend percentages were provided, and are presented on Figure 1, along with a graphical presentation of the combined gradation plotted on a 0.45 Power Graph. The results of additional aggregate testing performed by WesTest or the FHWA are also included on Figure 1. Gradations of the aggregate as delivered are included on Table 2. The results of sodium sulfate soundness testing will be provided when complete.

The design was performed at asphalt cement contents of 5.0, 5.5, 6.0 and 6.5 percent. The results of the tests performed at each asphalt content are outlined on Table 1 and graphically presented on Figures 2 and 3. At a target asphalt cement content of 5.8% this mix indicates a theoretical maximum specific gravity of 2.605, bulk specific gravity of 2.474, unit weight of 154.0 pcf, 5.0% voids in total mix, 16.2% voids in mineral aggregate, 69.2% voids filled with asphalt, Marshall stability of 4600 lbs. and a flow of 0.13 inches. The effective specific gravity of the aggregate in the mix is 2.880.3

This hot mix asphalt mix design is based on specific materials and laboratory preparation of the test specimens. Variations between laboratories and variation between laboratory produced and field produced samples should be anticipated. It is recommended the mix design be field verified during initial production. Field verification often results in the optimum asphalt cement content being adjusted to meet design voids in total mix or voids in mineral aggregate criteria.

If you have any questions on the design presented, please contact us at your convenience.

Sincerely,
WesTest

COLORADO REGISTERED ERIC R. WEST 20475 11/1/06 PROFESSIONAL ENGINEER

Eric R. West, P.E.

AAP AASHTO R18

WESTEST
SPECIALISTS TO THE PAVING INDUSTRY

Client:	Federal Highway Administration	November 1, 2006
Mix Design No.:	166206	
Mix Design Method:	Marshall, 75 Blows per Side	
Grading:	E	
Aggregate Source:	Pohakuloa Training Area Quarry	

AGGREGATE BLEND*

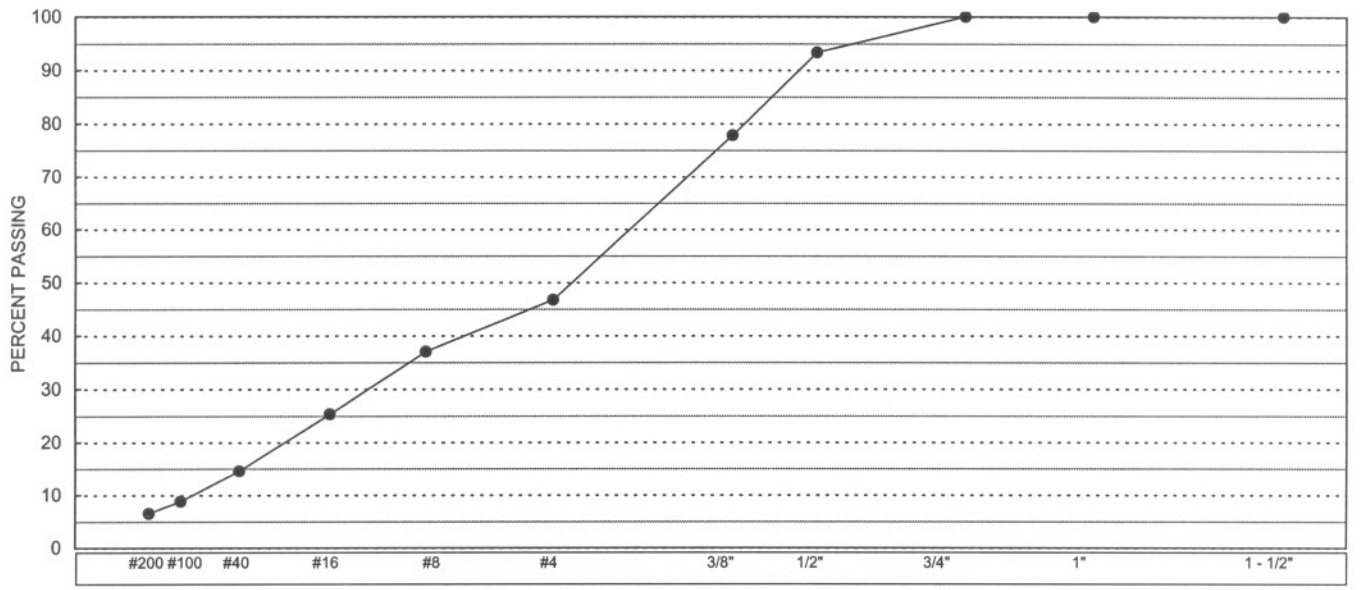
PERCENT OF BLEND	29%	27%	43%			1%	100%	Grading	PRODUCTION
DESCRIPTION	#67 Crushed Stone	#8 Crushed Stone	Manuf. Stone Sand			Lime	Combination	E	GRADATION
SOURCE	PTA Quarry	PTA Quarry	PTA Quarry			Hawaiian Cement	Job Mix	Spec.	TOLERANCE
1 1/2"	100	100	100			100	100		
1"	100	100	100			100	100		
3/4"	100	100	100			100	100	97 - 100	97 - 100
1/2"	77	100	100			100	93		86 - 100
3/8"	36	87	100			100	78		71 - 85
#4	5	7	99			100	47		41 - 53
#8	3	2	80			100	37		
#16	2	2	54			100	25		
#40	2	1	30			100	15		11 - 19
#100	1	1	17			100	9		
#200	1.1	0.7	11.7			97.0	6.5	4.0 - 8.0	3.5 - 9.5

AGGREGATE PHYSICAL PROPERTIES

BULK SPECIFIC GRAVITY						2.430	2.783		
APPARENT SPECIFIC GRAVITY						2.430	2.900		
WATER ABSORPTION (%)							1.5		
L.A. ABRASION (% LOSS)**							22	45 Max.	
FRACTURED FACES, 2+ (%)							100	80 Min.	
FLAT & ELONGATED 1:3 (%)							0	10 Max.	
AGGREGATE DURABILITY INDEX D_c**							96	35 Min.	Procedure A
AGGREGATE DURABILITY INDEX D_f**							90	35 Min.	Procedure B
FINE AGGREGATE ANGULARITY (%)							51.7	45.0 Min.	
LIQUID LIMIT (%)**							NV		
PLASTICITY INDEX**							NP	Non-Plastic	
SAND EQUIVALENT (%)							77	45 Min.	
SODIUM SULFATE SOUNDNESS, 5 CYCLES (% LOSS)								12 Max.	

*Aggregate gradations and blend percentages provided by client.
**Data provided by client.

0.45 POWER GRAPH



SIEVE SIZE RAISED TO THE 0.45 POWER

FIGURE 1

WESTEST
SPECIALISTS TO THE PAVING INDUSTRY

Client: FHWA
Mix Design No.: 166206
Mix Design Method: Marshall, 75 Blows per Side

November 1, 2006

Grading: E
Aggregate Source: Pohakuloa Training Area Quarry

Mixing Temperature: 312 ± 5 °F
Compaction Temperature: 292 ± 4 °F

A.C. Source & Grade: Tesoro Refining

ASPHALT CONTENT DETERMINATION

MIX PROPERTIES	LABORATORY TRIAL DATA				SPEC.	OPTIMUM
ASPHALT CEMENT CONTENT (% BY WEIGHT OF MIX)	5.0	5.5	6.0	6.5		5.8
THEORETICAL MAXIMUM SPECIFIC GRAVITY	2.640	2.618	2.596	2.575		2.605
THEORETICAL MAXIMUM DENSITY (PCF)	164.3	162.9	161.6	160.3		162.1
BULK SPECIFIC GRAVITY	2.445	2.460	2.486	2.510		2.474
DENSITY (PCF)	152.2	153.1	154.7	156.2		154.0
% VOIDS IN TOTAL MIX	7.4	6.0	4.3	2.5	3.0 - 6.0	5.0
% VOIDS IN MINERAL AGGREGATE	16.5	16.5	16.0	15.7	13.0 Min.	16.2
% VOIDS FILLED WITH ASPHALT	55.4	63.4	73.5	83.9		69.2
STABILITY (LBS.)	4685	5111	4277	3696	2000 Min.	4600
FLOW (0.01in.)	10	13	13	14	8 - 16	13

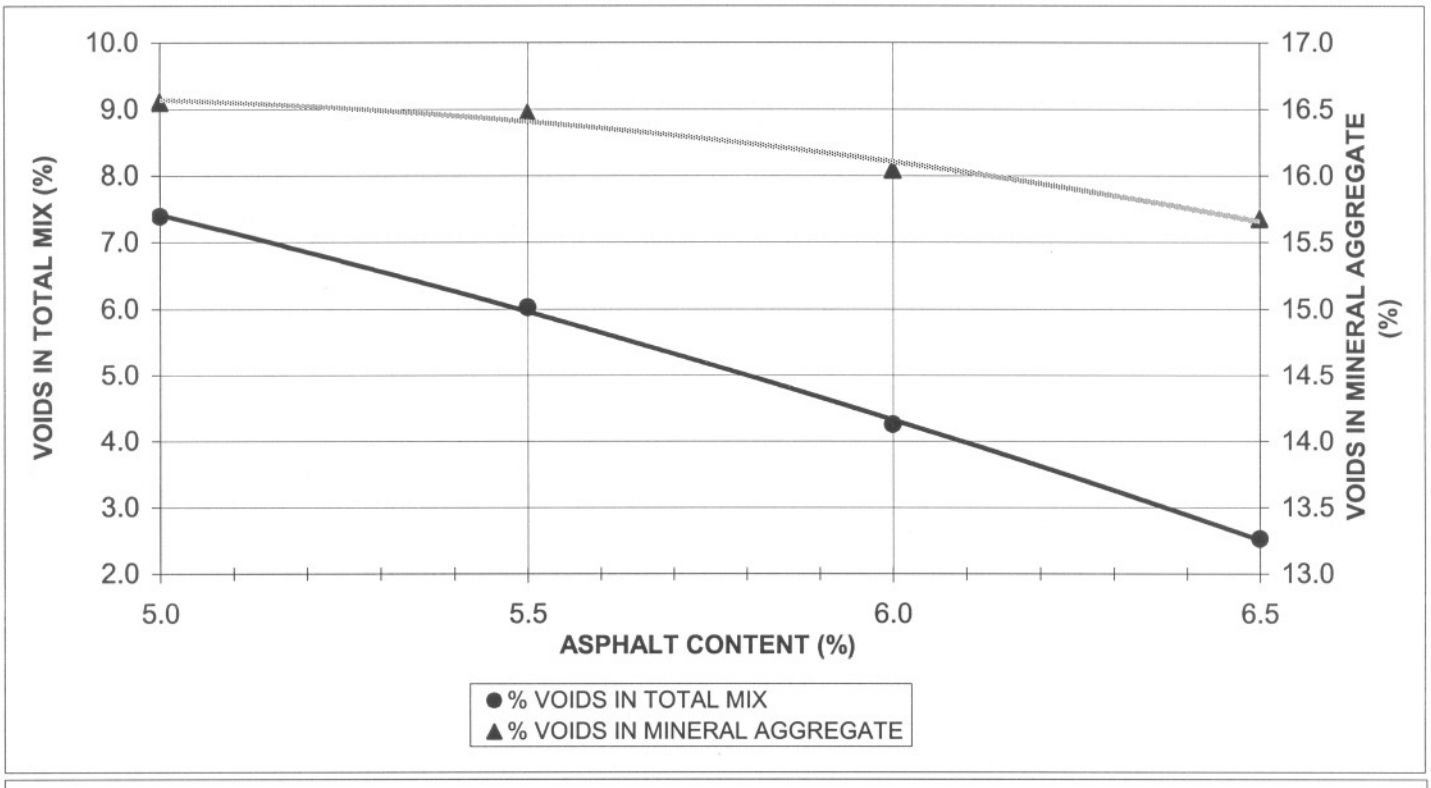
MOISTURE SENSITIVITY TEST

LOTTMAN MOISTURE SENSITIVITY TEST RESULTS (AASHTO T 283), FREEZE CYCLE INCLUDED, 6.0% BINDER			
DRY SUBSET	AVERAGE SPECIMEN VOIDS, 3 SPECIMENS (%)	6.5 - 7.5	7.0
	TENSILE STRENGTH, SPECIMEN A (PSI)		94
	TENSILE STRENGTH, SPECIMEN B (PSI)		104
	TENSILE STRENGTH, SPECIMEN C (PSI)		94
	AVERAGE TENSILE STRENGTH (PSI)		97
CONDITIONED SUBSET	AVERAGE SPECIMEN VOIDS, 3 SPECIMENS (%)	6.5 - 7.5	7.0
	TENSILE STRENGTH, SPECIMEN A (PSI)		84
	TENSILE STRENGTH, SPECIMEN B (PSI)		84
	TENSILE STRENGTH, SPECIMEN C (PSI)		87
	AVERAGE TENSILE STRENGTH (PSI)		85
TENSILE STRENGTH RATIO		70 Min.	88
Minor moisture damage noted in a few of the finer aggregate particles, Scale:1.			
Several broken aggregate particles in conditioned and dry specimens.			

TABLE 1

Client:	FHWA	November 1, 2006
Mix Design No.:	166206	
Grading:	E	
Mix Design Method:	Marshall, 75 Blows per Side	

VOLUMETRIC PROPERTIES



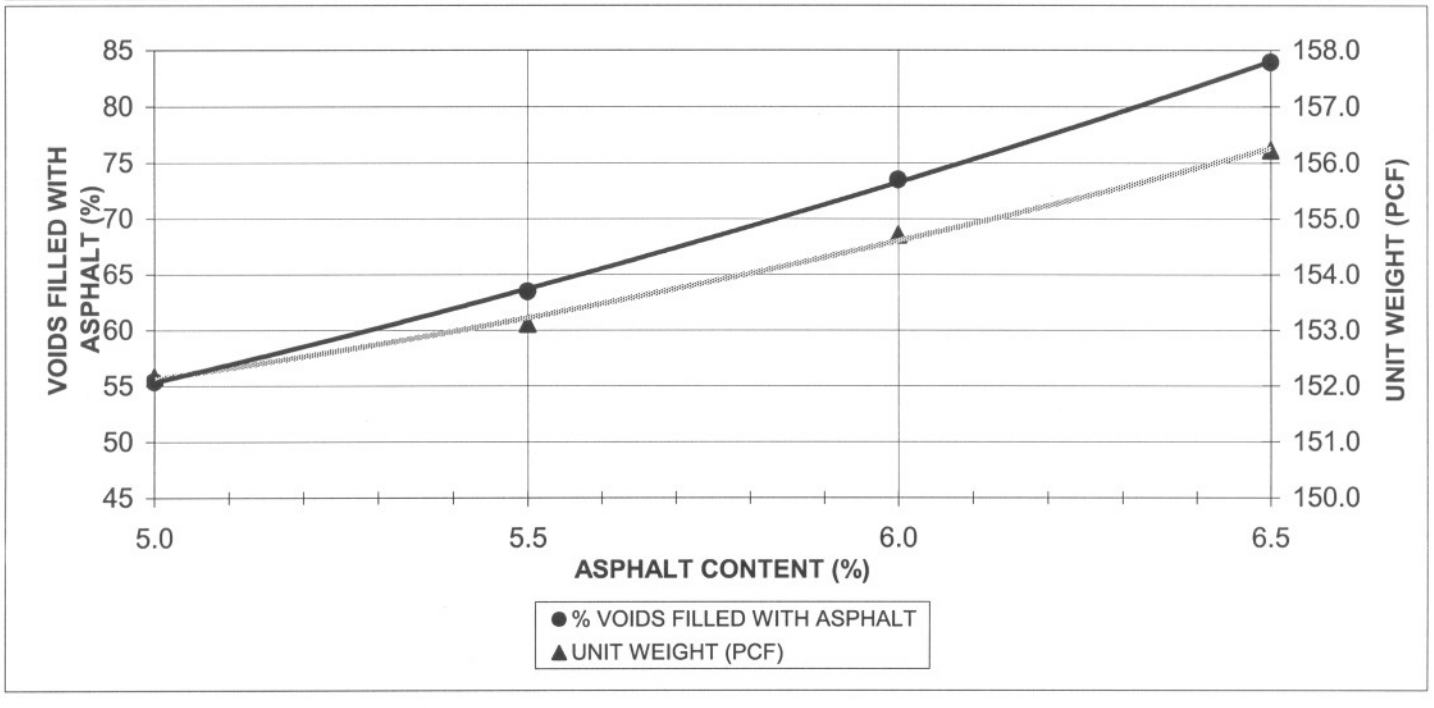


FIGURE 2

Client:	FHWA	November 1, 2006
Mix Design No.:	166206	
Grading:	E	
Mix Design Method:	75 Blows per Side	

MARSHALL PROPERTIES

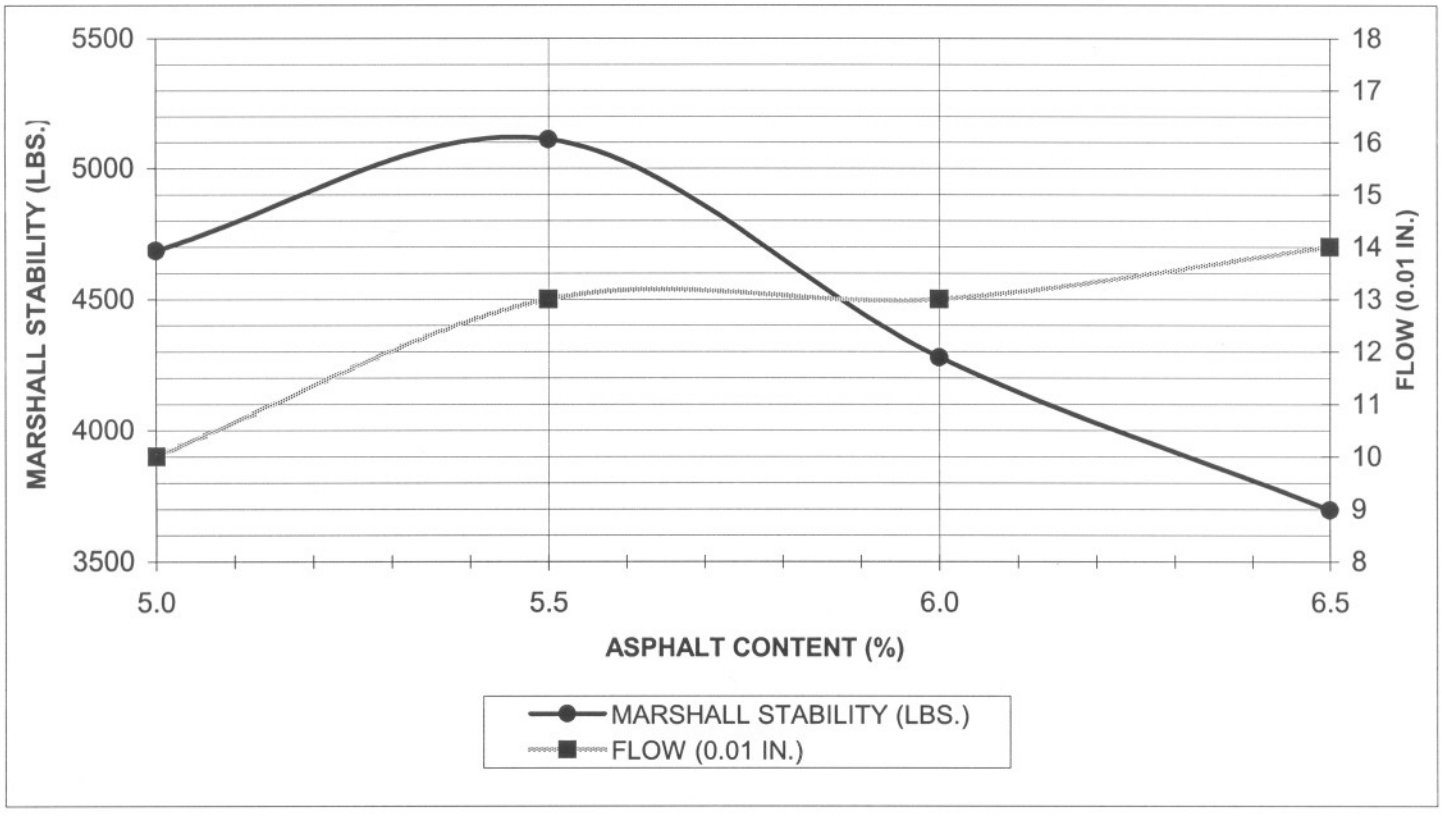


FIGURE 3

WESTEST
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LABORATORY TEST REPORT

AS DELIVERED GRADATIONS

REPORT DATE: October 26, 2006
DATE SAMPLED: September 19, 2006
DATE RECEIVED: October 23, 2006
DATE TESTED: October 24, 2006
SAMPLED BY: Client
SOURCE: Pohakuloa Training Area Quarry

PROJECT: Saddle Road
FHWA PROJECT NO.: HI A-AD/STP 6(3) & 200(1)

WesTest PROJECT NO.: 166206
CLIENT: Federal Highway Administration
Denver Federal Center
Randall S. Caley
Building 2
Box 25246
Denver, CO 80225

GRADATION ANALYSIS - AASHTO T 11 & T 27

SIEVE SIZE	PERCENT PASSING					
SAMPLE DESCRIPTION	#67 CRUSHED STONE	TARGET	#8 CRUSHED STONE	TARGET	MANUF. STONE SAND	TARGET
2						
1 - 1/2"						
1"						
3/4"	100	100				
1/2"	72	77	100	100		
3/8"	27	36	92	87	100	100
#4	3	5	17	7	98	99
#8	2	3	3	2	73	80
#16	2	2	3	2	48	54
#40	2	2	2	1	26	30
#100	1	1	2	1	15	17
#200	1.2	1.1	1.9	0.7	11.4	11.7

TABLE 2