WesTest

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January 21, 2020

Connell Resources, Inc.
7785 Highlands Meadow Parkway Suite 100
Fort Collins, CO 80528

Attention: Mr. Ed Wells

Subject: Asphalt Mix Design
Superpave Design Method
Grading SX, $N_{DESIGN} = 75$
Carr and Windsor Pits, Timnath RAP, Suncor PG 64-22 Binder
Mix Design No. 682620
Connell Resources, Inc. Mix No. 10150

Gentlemen:

Enclosed are the results of an asphalt mix design done in general accordance with Colorado, AASHTO and/or ASTM procedures, using the Superpave Gyratory Compactor for specimen compaction. The aggregate used in the mix design is from Carr and Windsor Pits and Timnath RAP. The asphalt cement used in the mix design consisted of a PG 64-22, with a specific gravity of 1.037, supplied by Suncor. The antistripping additive used consisted of 1% hydrated lime.

The aggregate was blended to meet CDOT Grading SX criteria by combining 25% Carr 5/8" Rock, 27% Carr Crusher Fines, 10% Carr Washed Crusher Fines, 17% Windsor Washed Sand, 20% Timnath RAP and 1% Pete Lien hydrated lime. The individual gradations, combined blend and aggregate physical properties are presented on Figure 1, along with a graphical presentation of the combined gradation plotted on a 0.45 Power Graph. The asphalt cement content of the RAP was 5.06%.

This design was performed using Superpave technology incorporating 100mm diameter molds and design gyrations of 75. The design was performed at asphalt cement contents of 4.9, 5.4, 5.9 and 6.4 percent. The results of the tests performed at each asphalt content are outlined on Table 1 and graphically presented on Figures 2 and 3. Based on these test results, CDOT, Fort Collins and Larimer County design criteria, an optimum asphalt cement content of 5.4% was determined. This asphalt cement content indicates a theoretical maximum specific gravity of 2.465, 4.0% voids in total mix, 15.0% voids in mineral aggregate, 74% voids filled with asphalt and a Hveem stability of 42. The effective specific gravity of the aggregate in the mix is 2.675. The coarse aggregate bulk specific gravity is 2.679, the fine aggregate bulk specific gravity is 2.609 and the combined bulk specific gravity is 2.635.

This 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

Quyen T. Liu, EIT

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DYLAN A. HULLINGER
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1/21/20
PROFESSIONAL ENGINEER

Reviewed by:

Dylan A. Hullinger, P.E.

AASHTO ACCREDITED

WESTEST
SPECIALISTS TO THE PAVING INDUSTRY

Client:	Connell Resources, Inc.	January 21, 2020
Mix Design No.:	682620	
Mix Design Method:	Superpave	
CDOT Grading:	SX	
Aggregate Source:	Carr and Windsor Pits, Timnath RAP	

AGGREGATE BLEND

PERCENT OF BLEND	25%	27%	10%	17%	20%	1%	100%	Grading	PRODUCTION
DESCRIPTION	5/8" Rock	Crusher Fines	Washed Crusher Fines	Washed Sand	RAP	Lime	Combination	SX	GRADATION
SOURCE	Carr	Carr	Carr	Windsor	Timnath	Pete Lien	Job Mix	Spec.	TOLERANCE
1 1/2"	100	100	100	100	100	100	100		
1"	100	100	100	100	100	100	100		
3/4"	100	100	100	100	100	100	100	100	100
1/2"	97	100	100	100	96	100	98	90 - 100	90 - 100
3/8"	61	100	100	100	89	100	88		82 - 94
#4	5	81	78	100	71	100	63		58 - 68
#8	2	54	48	98	56	100	49	28 - 58	44 - 54
#16	2	37	29	73	43	100	35		
#30	2	26	17	39	32	100	23		19 - 27
#50	2	18	8	15	21	99	14		
#100	2	12	4	4	15	97	9		
#200	1.6	8.4	1.9	1.3	10.0	94.4	6.0	2 - 10	4.0 - 8.0

AGGREGATE PHYSICAL PROPERTIES

BULK SPECIFIC GRAVITY	2.676	2.618	2.633	2.609	2.647*	2.380	2.635		
APPARENT SPECIFIC GRAVITY	2.712	2.672	2.681	2.667	2.689*	2.380	2.682		
WATER ABSORPTION (%)	0.5	0.7	0.7	0.8			0.7		
MICRO-DEVAL (CP-L 4211) (% LOSS)							4.4	18 Max.	COMBINED
L.A. ABRASION (% LOSS)	28						28	45 Max.	
FRACTURED FACES, 2+ (%)							100	90 Min.	
FINE AGGREGATE ANGULARITY (%)							45.9	45.0 Min.	
SAND EQUIVALENT (%)							81	45 Min.	
LIQUID LIMIT (%)		NV	NV	NV			NV		
PLASTIC LIMIT (%)		NV	NV	NV			NV		
PLASTICITY INDEX		Non-Plastic	Non-Plastic	Non-Plastic			Non-Plastic	Non-Plastic	
FLAT AND ELONGATED 1:5 (%)							0	10 Max.	

* RAP Effective Specific Gravity used for Apparent Specific Gravity. Assumed asphalt absorption of 0.61% used to back-calculate Bulk Specific Gravity.

0.45 POWER GRAPH

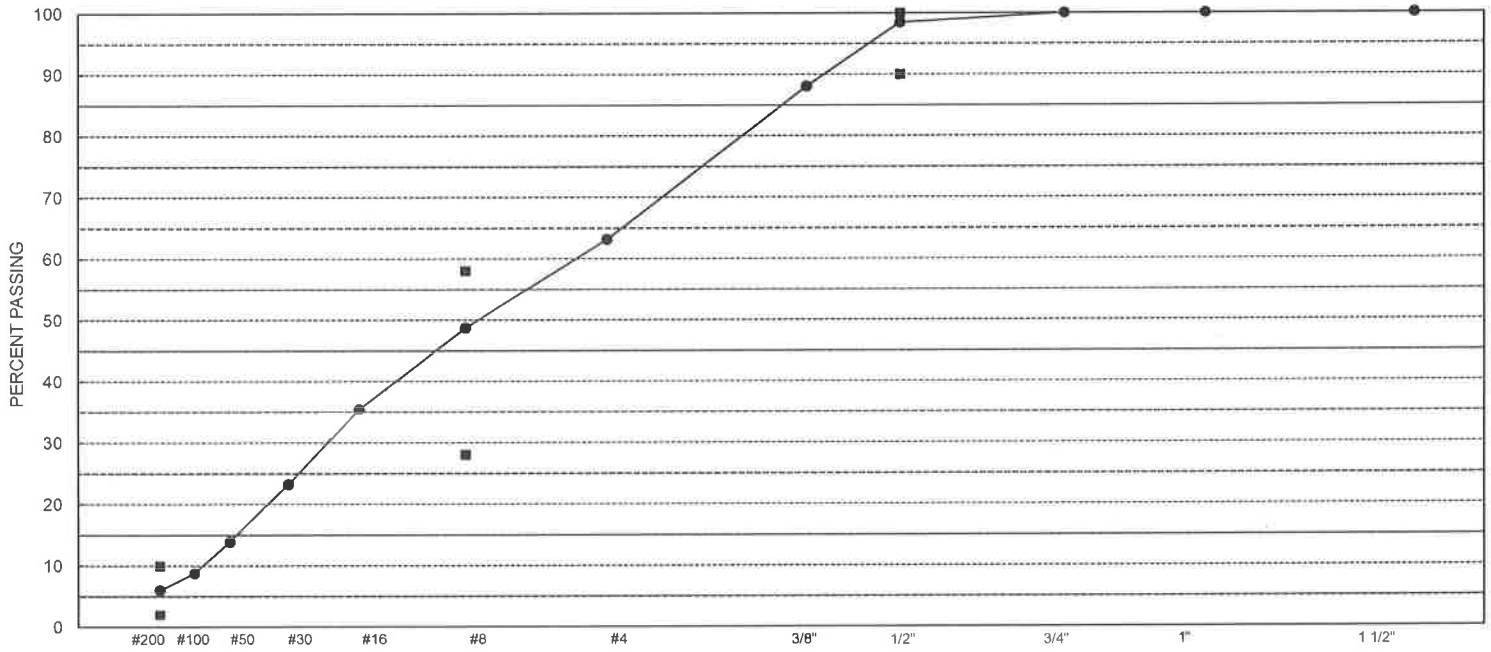


FIGURE 1

WesTest
SPECIALISTS TO THE PAVING INDUSTRY

Client: Connell Resources, Inc.
Mix Design No.: 682620
Mix Design Method: Superpave

January 21, 2020

CDOT Grading: SX
Aggregate Source: Carr and Windsor Pits, Timnath RAP

Mixing Temperature: 325 °F
Compaction Temperature: 300 °F
Design Gyrations : 75

A.C. Source & Grade: Suncor PG 64-22

ASPHALT CONTENT DETERMINATION

MIX PROPERTIES		LABORATORY TRIAL DATA				SPEC.	OPTIMUM
ASPHALT CEMENT CONTENT (% BY WEIGHT OF MIX)		4.9	5.4	5.9	6.4		5.4
THEORETICAL MAXIMUM SPECIFIC GRAVITY		2.483	2.465	2.447	2.429		2.465
THEORETICAL MAXIMUM DENSITY (PCF)		154.5	153.4	152.3	151.2		153.4
TEST DATA @ N_{DESIGN} GYRATIONS							
	BULK SPECIFIC GRAVITY	2.316	2.367	2.379	2.385		2.367
	DENSITY (PCF)	144.1	147.3	148.1	148.4		147.3
	% VOIDS IN TOTAL MIX	6.7	4.0	2.8	1.8	3.5 - 4.5	4.0
	% VOIDS IN MINERAL AGGREGATE	16.4	15.0	15.1	15.3	15.0 Min.	15.0
	% VOIDS FILLED WITH ASPHALT	59	74	82	88	65 - 80	74
	HVEEM STABILITY	41	42	41	39	28 Min.	42
DUST TO ASPHALT RATIO		1.39	1.24	1.12	1.03		1.24
DUST TO ASPHALT RATIO (CP-50)		1.16	1.04	0.94	0.86	0.60 - 1.20	1.04
PERCENT BINDER REPLACED		23	21	19	17	23 Max.	21

MOISTURE SENSITIVITY TEST

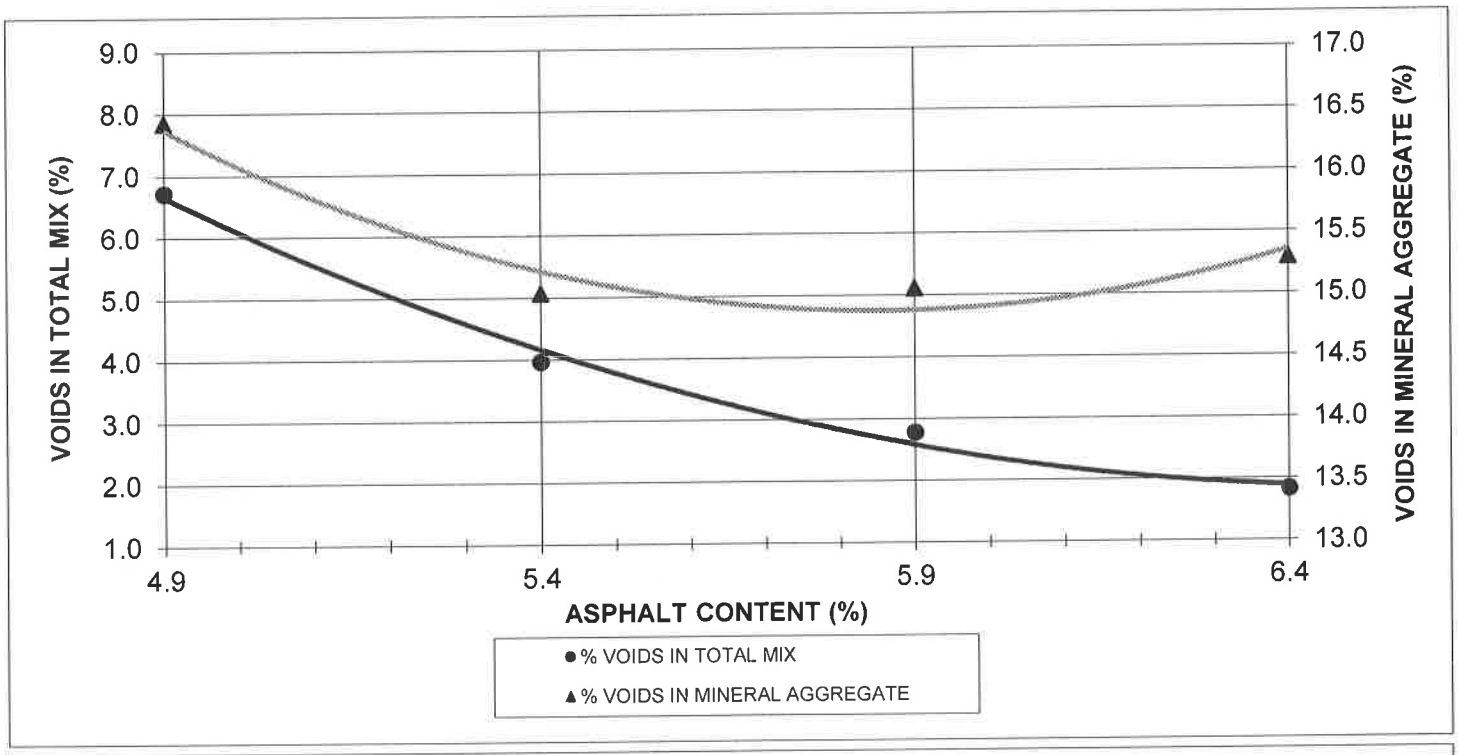
LOTTMAN MOISTURE SENSITIVITY TEST RESULTS (CP-L 5109)			
	AVERAGE SPECIMEN VOIDS (%)	6.0 - 8.0	7.3
	AVERAGE SATURATION (%)		82
	AVERAGE DRY TENSILE STRENGTH (PSI)	30 Min.	125
	AVERAGE CONDITIONED TENSILE STRENGTH (PSI)		108
	TENSILE STRENGTH RATIO (%)	80 Min.	86

TABLE 1

WesTest
SPECIALISTS TO THE PAVING INDUSTRY

Client:	Connell Resources, Inc.	January 21, 2020
Mix Design No.:	682620	
CDOT Grading:	SX	
Mix Design Method:	Superpave	

VOLUMETRIC PROPERTIES



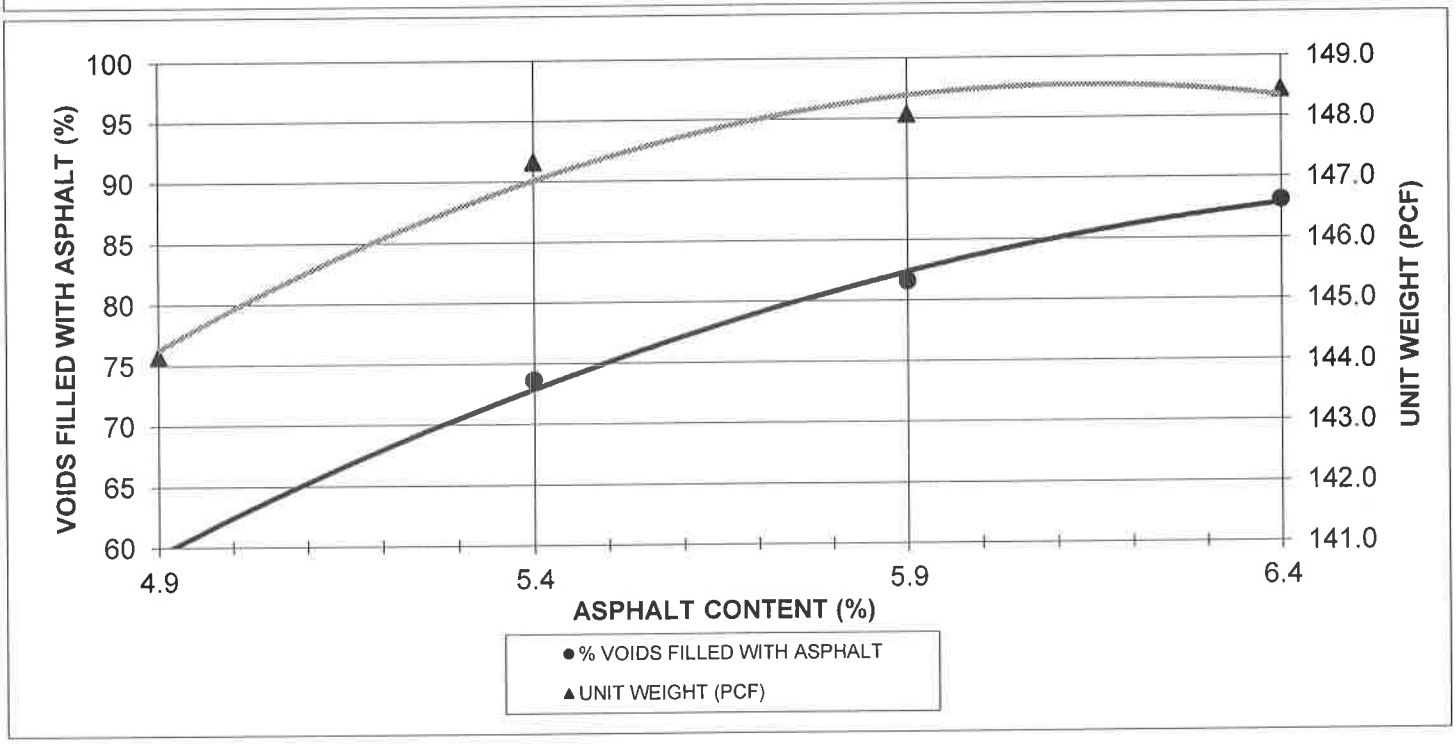


FIGURE 2

WesTest SPECIALISTS TO THE PAVING INDUSTRY

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Mix Design Method:	Superpave	

HVEEM STABILITY

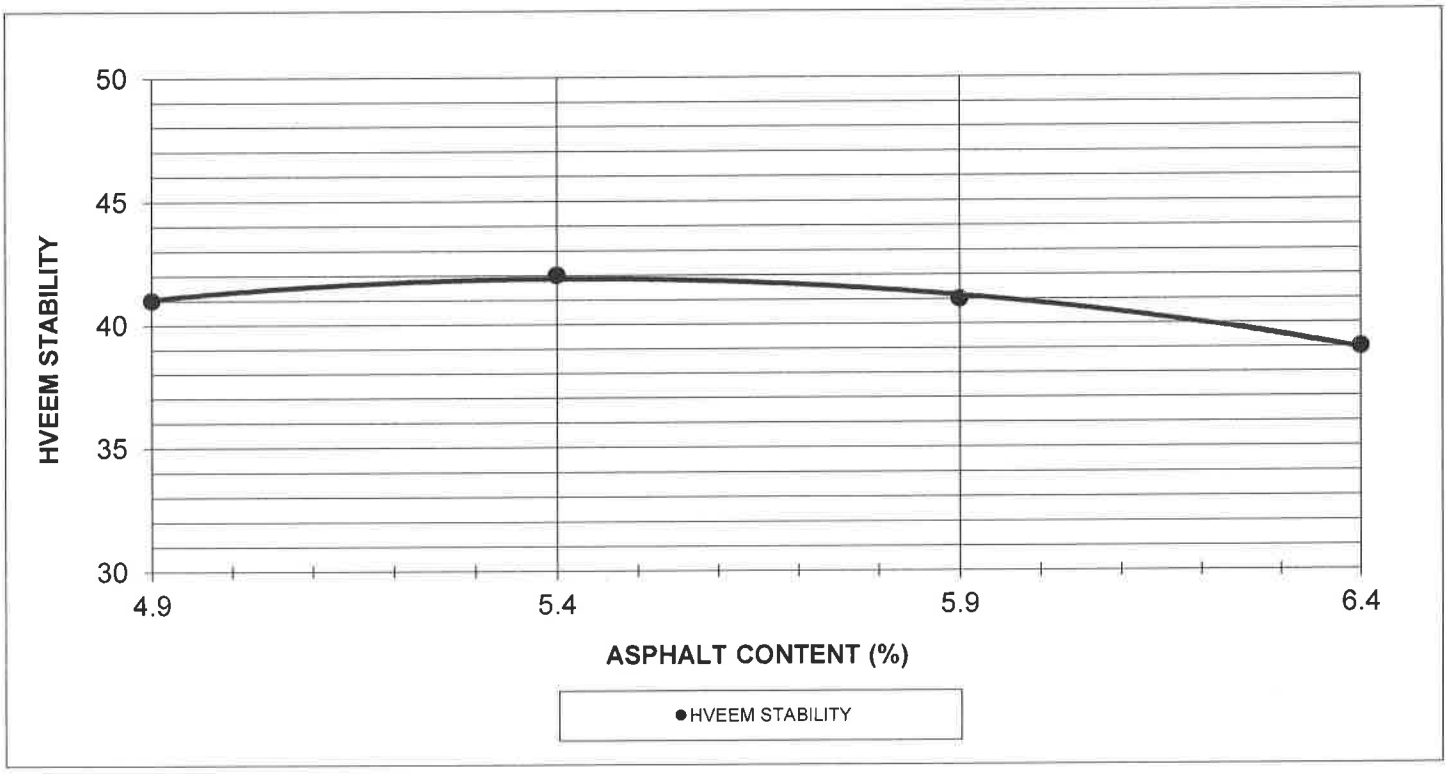

FIGURE 3