

## Kraton Ultra-thin HMA / WMA Overlay Study

### I. Overview

<b>Project:</b>	Oregon Department of Transportation I-5 Rock Point – Evans Creek
<b>Contractor:</b>	Knife River Materials
<b>Existing Pavement Condition:</b>	-
<b>Binder Utilized:</b>	70-22ERH (HiMA) & 70-22ER (Control)
<b>Production Quantity:</b>	-
<b>Design ESALs:</b>	-
<b>Design Gyration:</b>	100

### II. Mixture Designs

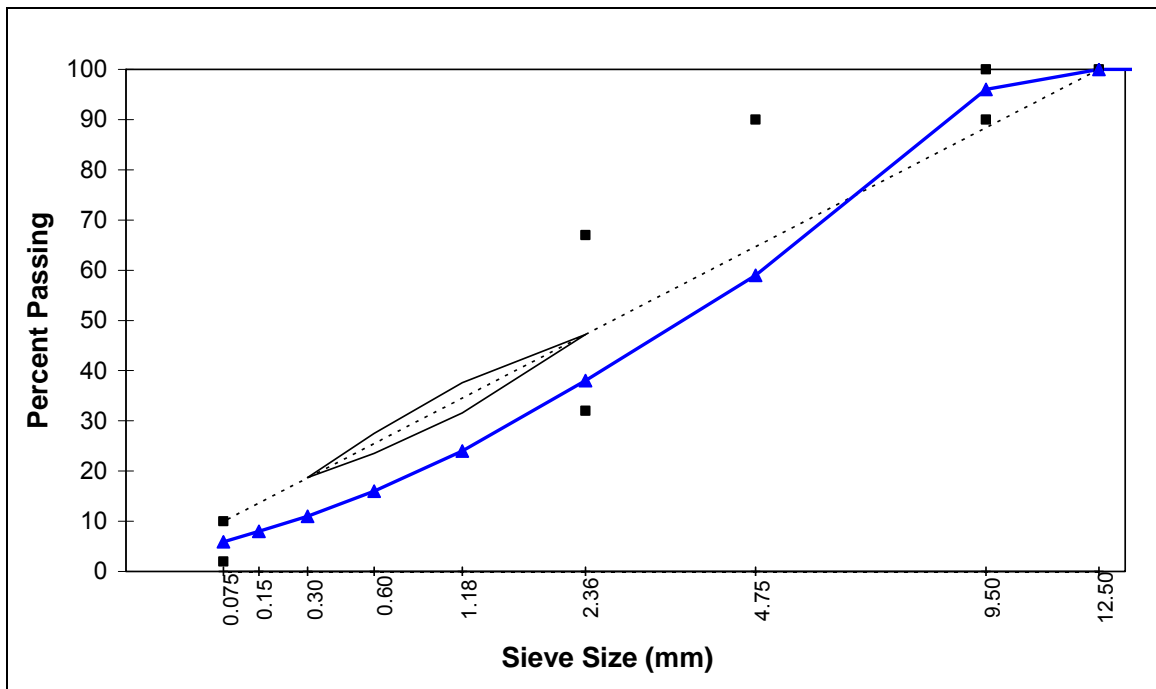
(As submitted by the contractor)

**Table 1. Mixture Composition**

HiMA 70-22ERH & Control 70-22ER Mixtures		
Percentage	Percentage	Stockpile
-	-	-
-	-	-
-	-	-
-	-	<b>Reclaimed Asphalt Pavement</b>

**Table 2. Job Mix Formula**

Sieve Size (mm)	Sieve Size (inch)	HiMA & Control Job Mix Formula	Polymer-Modified Thin Overlay (PMTOL) Specification	PMTOL Specification – Production Tolerance
12.5	1/2	100	<b>100</b>	<b>± 6</b>
9.5	3/8	96.0	<b>90-100</b>	<b>± 6</b>
4.75	No. 4	59.0	<b>≤90</b>	<b>± 6</b>
2.36	No. 8	38.0	<b>32 - 67</b>	<b>± 4</b>
1.18	No. 16	24.0	-	-
0.600	No. 30	16.0	-	-
0.300	No. 50	11.0	-	-
0.150	No. 100	8.0	-	-
0.075	No. 200	5.9	<b>2 - 10</b>	<b>± 1</b>
<b>Binder Content =</b>		6.5%	<b>6.5% min.</b>	<b>± 0.3</b>



**Figure 1: Oregon I-5 JMF Gradation**

### III. Mixing and Compaction Temperatures

**Table 3. Oregon Mixing and Compaction Temperatures**

Binders	Mixing Temperature	Compaction Temperature
PG70-22ERH & PG70-22ER	335°F-324°F (168°C-162°C)	312°F - 304°F (156°C-151°C)

### IV. Volumetric Verification

**Table 4. Laboratory Verification of Volumetric Properties**

Property	HiMA 70-22ERH	Control 70-22ER	PMTOL Specification (AASHTO M323 Table 6)
Air Voids, %	3.0%	2.9%	<b>4.0%</b>
Voids in Mineral Aggregate (VMA), %	14.8%	14.7%	<b>15.0% min.</b>
Voids Filled with Asphalt (VFA), %	79.8%	80.5%	<b>65-75</b>
Dust to Binder Ratio	1.2	1.1	<b>0.6 -1.2</b>
Maximum Theoretical Specific Gravity $G_{mm}$ (AASHTO T209)	2.423	2.422	-

## V. Binder Testing

### Section V – Part A: Thermal Cracking

Testing in accordance with AASHTO TP92 “Determining the Cracking Temperatures of Asphalt Binder Using the Asphalt Binder Cracking Device (ABCD)”

**Table 5. Thermal Cracking Temperature of the Asphalt Binder**

	<b>HiMA 70-22ERH</b>	<b>Control 70-22ER</b>
Replicate 1	°C	°C
Replicate 2	°C	°C
Replicate 3	°C	°C
Replicate 4	°C	°C
Average	°C	°C

**Table 6. Thermal Cracking Temperature of the Extracted Binder from the Mixture**

	<b>HiMA 70-22ERH</b>	<b>Control 70-22ER</b>
Replicate 1	°C	°C
Replicate 2	°C	°C
Replicate 3	°C	°C
Replicate 4	°C	°C
Average	°C	°C

### Section V – Part B: Performance Grade

Testing in accordance with AASHTO R29 “Standard Practice for Grading or Verifying the Performance Grade (PG) of an Asphalt Binder.”

**Table 7. Performance Grade of the Asphalt Binder**

	<b>HiMA 70-22ERH</b>		<b>Control 70-22ER</b>	
	Continuous Grade	PG Grade	Continuous Grade	PG Grade
Replicate 1				
Replicate 2				

## VI. Mixture Performance Testing

### Section VI – Part A: Thermal Cracking

Testing in accordance with AASHTO TP10 “Test Method for Thermal Stress Restrained Specimen Test.”

**Table 8. TSRST Results**

<b>HiMA 70-22ERH</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>Failure Temperature</b>	<b>Load at Failure</b>
1	6.92%	-20.2°C	6,981 N
2	7.38%	-21.1°C	6,590 N
3	7.41%	-20.8°C	7,146 N
<b>Average</b>	<b>7.24%</b>	<b>-20.7°C</b>	<b>6,906 N</b>
<b>PMTOL Specification</b>	-	<b>±6°C from the Low Temperature PG Grade of Binder</b>	-
<b>Control 70-22ER</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>Failure Temperature</b>	<b>Load at Failure</b>
1	6.56%	-20.1°C	7,449 N
2	7.30%	-19.5°C	7,304 N
3	7.31%	-19.0°C	7,075 N
<b>Average</b>	<b>7.06%</b>	<b>-19.5°C</b>	<b>7,276 N</b>
<b>PMTOL Specification</b>	-	<b>±6°C from the Low Temperature PG Grade of Binder</b>	-

*Test Notes:* Cooling rate of 10°C/hr utilized.

**Section VI – Part B: Cracking**

Testing in accordance with Texas Department of Transportation Test Designation Tex-248-F “Overlay Test.”

**Table 9. Overlay Test Results**

<b>HiMA 70-22ERH</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>OT Cycles to 93% Load Reduction</b>	<b>PMTOL Specification</b>
1	7.04%	10	-
2	6.70%	305	-
3	6.74%	10	-
<b>Average</b>	<b>6.83%</b>	<b>108</b>	<b>Mixture Incorporating RAP Shall Exhibit Cycles to Failure Within <math>\pm 10\%</math> of OT Results for Specimens without RAP*</b>
<b>Control 70-22ER</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>OT Cycles to 93% Load Reduction</b>	<b>PMTOL Specification</b>
1	6.82%	9	-
2	5.94%	10	-
3	6.13%	2	-
<b>Average</b>	<b>6.30%</b>	<b>7</b>	<b>Mixture Incorporating RAP Shall Exhibit Cycles to Failure Within <math>\pm 10\%</math> of OT Results for Specimens without RAP*</b>

*Test Notes:* Overlay test temperature of 15°C (59°F). OT testing completed in displacement control mode.

**Section VI – Part C: Fatigue Cracking**

*Testing in accordance with AASHTO T 321 “Determining the Fatigue Life of Compacted Hot-Mix Asphalt (HMA) Subjected to Repeated Flexural Bending.”*

**Table 10. Beam Fatigue Results**

<b>HiMA 70-22ERH</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>N<sub>f</sub> (Number of Cycles to 50% Reduction in Modulus per AASHTO T321)</b>	<b>PMTOL Specification</b>
1	7.46%	30,998	-
2	7.56%	30,118	-
<b>Average</b>	<b>7.51%</b>	<b>30,558</b>	<b>≥ 100,000 cycles</b>
<b>Control 70-22ER</b>			
<b>Replicate</b>	<b>Air Voids</b>	<b>N<sub>f</sub> (Number of Cycles to 50% Reduction in Modulus per AASHTO T321)</b>	<b>PMTOL Specification</b>
1	7.72%	6,955	-
2	7.66%	11,619	-
<b>Average</b>	<b>7.69%</b>	<b>9,287</b>	<b>≥ 100,000 cycles</b>

*Test Notes:* Specimens tested at 750 $\mu$ e and a test temperature of 15°C (59°F).

**Section VI – Part C1: Rutting**

Testing in accordance with AASHTO T 340 “Determining the Rutting Susceptibility of Hot Mix Asphalt (HMA) Using the Asphalt Pavement Analyzer (APA).”

**Table 11. APA Rutting Results**

<b>HiMA 70-22ERH</b>		
<b>Average Air Voids, %</b>	<b>Average Rut Depth (mm)</b>	<b>PMTOL Specification</b>
6.94%	2.83 mm	<b>Average Rut Depth ≤ 4 mm at 8,000 Loading Cycles</b>
<b>Control 70-22ER</b>		
<b>Average Air Voids, %</b>	<b>Average Rut Depth (mm)</b>	<b>PMTOL Specification</b>
6.92%	2.68 mm	<b>Average Rut Depth ≤ 4 mm at 8,000 Loading Cycles</b>

Test Notes: APA test temperature was 60°C (140 °F).

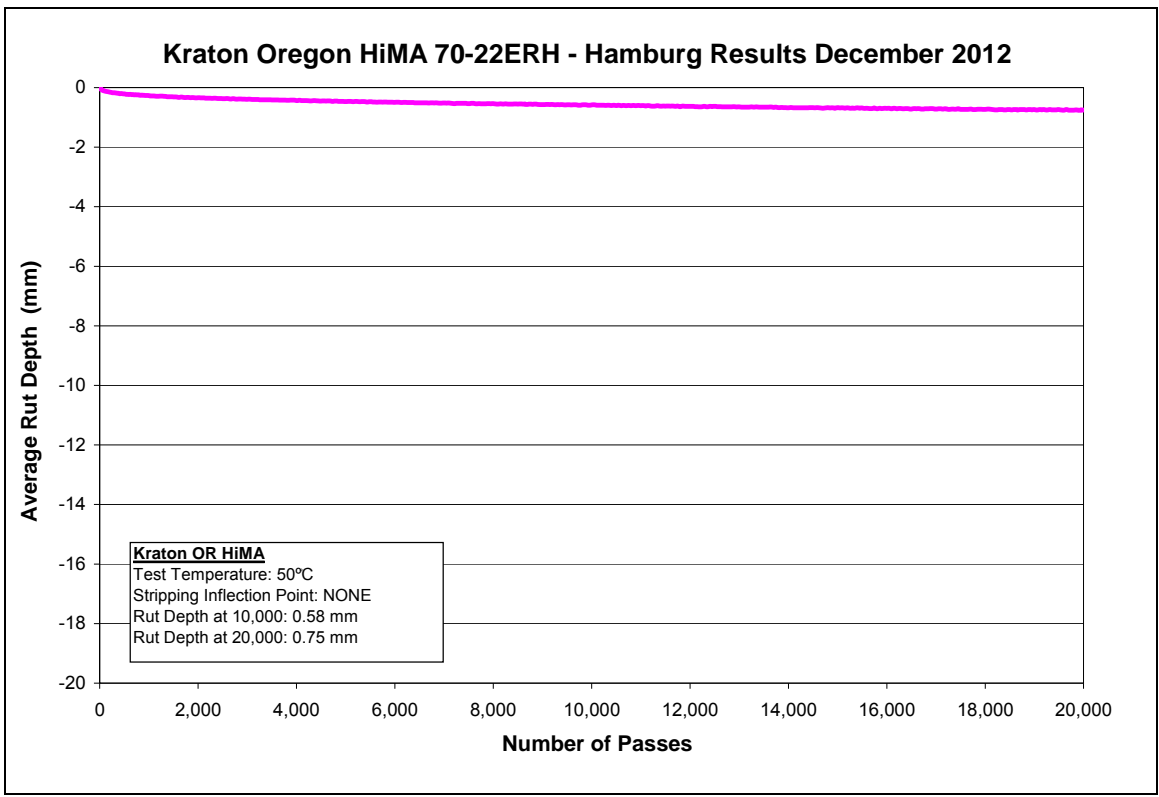
**Section VI – Part C2: Rutting/Moisture Susceptibility**

Testing in accordance AASHTO T 324 “Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA).”

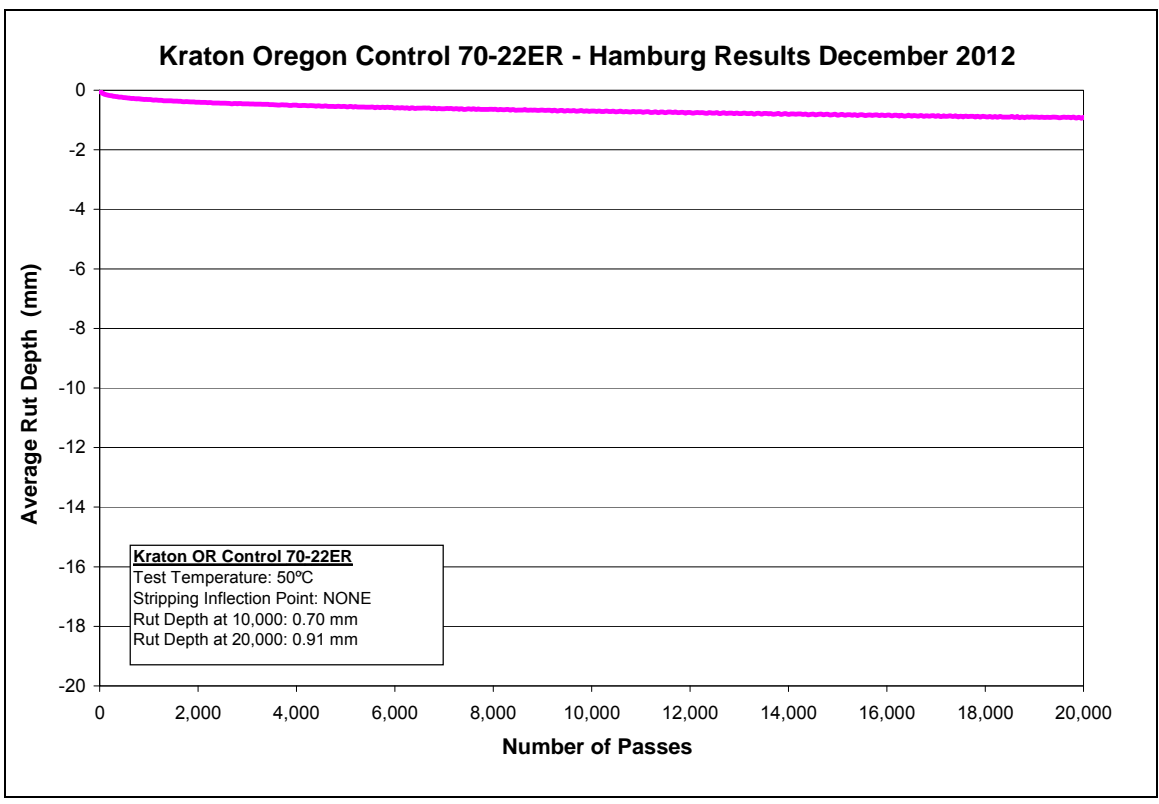
**Table 12. Hamburg Wheel Tracking Device (HWTD) Results**

<b>HiMA 70-22ERH</b>			
<b>Air Voids</b>	<b>Stripping Inflection Point (SIP)</b>	<b>Average Rut Depth at 10,000 Cycles</b>	<b>Average Rut Depth at 20,000 Cycles</b>
7.95%	NONE	0.58 mm	0.75 mm
<b>Control 70-22ER</b>			
<b>Air Voids</b>	<b>Stripping Inflection Point (SIP)</b>	<b>Average Rut Depth at 10,000 Cycles</b>	<b>Average Rut Depth at 20,000 Cycles</b>
7.68%	NONE	0.70 mm	0.91 mm

Test Notes: HWTD water temperature was 50°C (122°F).



**Figure 2: Oregon HiMA 70-22ERH Mixture HWTD Results**



**Figure 3: Oregon Control 70-22ER Mixture HWTD Results**