ASPHALT MIX DESIGN 101

Rocky Mountain Asphalt Conference & Equipment Show
February 20, 2020

WESTEST
SPECIALISTS TO THE PAVING INDUSTRY

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MIX DESIGN DEVELOPMENT

- Specification Review
- Aggregate Analysis
- Aggregate Blend Trials
- Run Design - Mix, Mold, Bulk
- Volumetric Analysis
- Moisture Susceptibility Determination
- Performance Tests – Balanced Mix Design Alternatives

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Mix Design
Specification Review

- Design Type – Superpave, Marshall
- Aggregate Grading – CDOT S, SX, ST, SMA FHWA 3/4" NMAS, 1/2" NMAS, 3/8" NMAS, FAA Gradation 1, 2 or 3 – Max. Size
- Aggregate Quality Requirements
- Binder Grade – e.g. PG 64-22, PG 58-28, PG 64-28
- Antistrip Requirements – Liquid, Lime or Performance Based Criteria
- Compactive Effort - # of Gyrations, # of Blows/Side
- Mixing & Compaction Temperatures

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Mix Design
Specification Review

Volumetric Requirements
- Voids in Total Mix (% Air Voids, %VTM) – Range or Target
- Voids in Mineral Aggregate (%VMA) – Minimum or Range – Based on NMAS
- Voids Filled with Asphalt (%VFA) – Range or Max.

Physical Requirements
- Dust to Asphalt Ratio – Range
- Allowable RAP % - Total % or Binder Replacement
- Allowable Natural/Native %

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Aggregate Analysis

Gradations of Individual Components -
- Generally 2 to 5 Aggregates + RAP, e.g. ¾" Rock, ½" Rock, Crusher Fines, Natural Fines, Washed Sand
- Gradations used for design should be averages of tests run during aggregate crushing and screening, verified by gradation on samples used in design
- RAP extractions and gradations – averages from production verified on mix design sample

Specific Gravity & Absorption

Angularity – Fractured Faces, Uncompacted Void Content – FAA

Quality/Durability– L.A. Abrasion, Soundness, Micro-Deval, Flat & Elongated

Cleanliness/Deleterious – Plasticity, Sand Equivalent, Clay Lumps & Friable Particles

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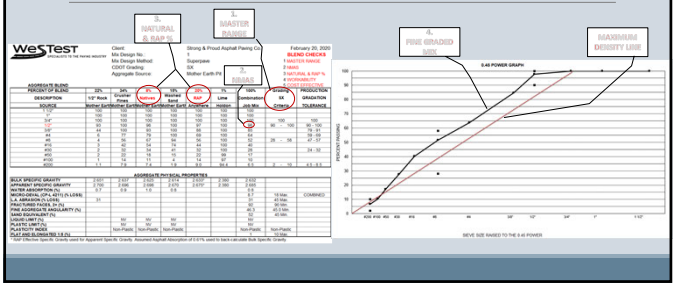
Aggregate Blend



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Run Design – Mix, Mold & Bulk

- Dry Material, Split to #8, -#8, Blend Each Sample to Proper Weight
- Determine Theoretical Maximum Specific Gravity (Rice Value)
- Batch Aggregate to Weight Based on Rice Value (CDOT) or Height (AASHTO)
- Run 4 Asphalt Contents – Generally 0.5% Apart with Anticipated Optimum at 2nd to 3rd Point
- Determine Bulk Specific Gravity of Each Puck

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AGGREGATE BLENDING

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SUPERPAVE GYRATORY COMPACTOR

MARSHALL HAMMER

COMPACTED SUPERPAVE DESIGN SPECIMENS

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Volumetric Analysis

WesTest SPECIALISTS TO THE PAVING INDUSTRY

Client: Strong & Proud Asphalt Paving Co. 02/20/20
Mix Design No.: 1
Mix Design Method: Superpave

CDOT Grading: SX
Aggregate Source: Mother Earth Pit
A.C. Source & Grade: Black Sticky PG 64-28

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

ASPHALT CONTENT DETERMINATION

MIX PROPERTIES		LABORATORY TRIAL DATA				CRITERIA	OPTIMUM
ASPHALT CEMENT CONTENT (% BY WEIGHT OF MIX)		5.1	5.6	6.1	6.6		5.6
THEORETICAL MAXIMUM SPECIFIC GRAVITY		2.475	2.456	2.438	2.421		2.456
THEORETICAL MAXIMUM DENSITY (PCF)		154.0	152.9	151.8	150.7		152.9
TEST DATA @ N_{DESIGN} GYRATIONS							
	BULK SPECIFIC GRAVITY	2.335	2.365	2.384	2.393		2.365
	DENSITY (PCF)	145.3	147.2	148.4	149.0		147.2
	% VOIDS IN TOTAL MIX	5.6	3.7	2.2	1.1	3.5 - 4.5	3.7
	% VOIDS IN MINERAL AGGREGATE	15.8	15.2	15.0	15.1	14.6 Min.	15.2
	% VOIDS FILLED WITH ASPHALT	64	76	85	93	65 - 80	76
	HVEEM STABILITY	47	48	44	36	28 Min.	48
DUST TO ASPHALT RATIO		1.47	1.32	1.20	1.10		1.32
DUST TO ASPHALT RATIO (CP-50)		1.24	1.12	1.01	0.93	0.60 - 1.20	1.12
PERCENT BINDER REPLACED		19	17	16	14	23 Max.	17

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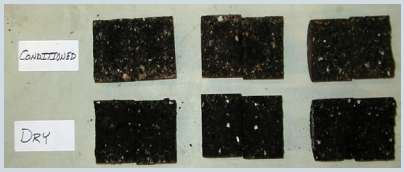
Moisture Susceptibility Determination

MOISTURE SENSITIVITY TEST

LOTTMAN MOISTURE SENSITIVITY TEST RESULTS (CP-L 5109)		SPEC.	
	AVERAGE SPECIMEN VOIDS (%)	6.0 - 8.0	7.7
	AVERAGE SATURATION (%)		85
	AVERAGE DRY TENSILE STRENGTH (PSI)	30 Min.	75
	AVERAGE CONDITIONED TENSILE STRENGTH (PSI)		66
	TENSILE STRENGTH RATIO (%)	80 Min.	88



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Balanced Mix Design Alternatives – In Development

- Performance Tests
  - Cracking – Thermal, Reflective, Fatigue
    - Disk-Shaped Compact Tension Test
    - Indirect Tensile Test
    - IDT Fracture Energy
  - Rutting
    - Asphalt Pavement Analyzer
    - Hamburg Wheel Tracking Test
  - Moisture Susceptibility
    - Hamburg Wheel Tracking Test
    - Tensile Strength Ratio (Lottman Test)

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