

DATE: August 2, 2012

TO: MAG Specification and Details Committee Members

FROM: Brian Gallimore, Materials Working Group/AGC  
Jeff Benedict, Asphalt Working Group/ARPA  
Jeff Hearne, Concrete Working Group/ARPA

RE: Reclaimed Materials - Asphalt

PURPOSE: Addresses the incorporation of Reclaimed Asphalt Pavement (RAP) into Asphalt Concrete along with proper reference adjustments to their respective corresponding sections

REVISIONS:

**Section 709 and 719**

Remove these in their entirety

**Section 710**

- 1) **NOTE: As the starting point for this revision, we have used the most current Section 710 that was approved by the Standards Committee on May 2, 2012 – not the language that is in the published 2012 Specifications book.**
- 2) Added a new Section 710.2.3 "Reclaimed Asphalt Pavement (RAP)". This section references Section 701.5 regarding material constituents and provides the appropriate methods for the incorporation of RAP into an asphalt mix design. **References used here are: NAPA IS123, COP SHIA Specification for P-403, and the NCAT Third Edition HMA Materials Mixture Design and Construction**
- 3) Renumber existing 710.2.3 "Mineral Admixture" to 710.2.4
- 4) Renumber existing 710.3.1 to include new language for inclusion of RAP and RAP binder in the mix design.
- 5) Corrected two spelling errors in the third paragraph of 710.3.2.2 "Gyratory Mix Design", by adding an "r" to the make the word "Traffic" . And deleted the 's in the title of table 710-1 "thickness" Changed the word "Utilized" to "when used" or "used".

**ASPHALT CONCRETE****710.1 GENERAL:**

Asphalt concrete shall be a mixture of asphalt cement and mineral aggregates. Mineral admixture shall be included in the mixture when required by the mix design or by the Engineer. Asphalt concrete shall be produced in accordance with Section [321](#).

The designation for asphalt concrete mixes shall be based on the nominal maximum aggregate size of the mix. The applicable mix designations are 3/8 inch, ~~1/2~~ [1/2](#) inch, ~~3/4~~ [3/4](#) inch and Base (1") mix.

Each mix shall be designed using Marshall or Gyratory compaction methods. Either Gyratory or Marshall Mixes may be used for low or high traffic conditions, as determined by the agency. Low traffic conditions are conditions where the asphalt mix will be subject to low volume and low weight vehicle usage. Examples of this condition are residential streets, most parking lots and residential minor collector streets. High traffic conditions are conditions where the asphalt mix will be subject to high volume and/or heavy weight vehicle usage as found on major collector, arterial and commercial streets. Street classifications (i.e. minor collector and major collector) shall be determined by the specifying agency.

The following table (Table [710-1](#)) displays the recommended lift thickness for various asphalt concrete mix designations found within Section [710](#). Please note that these recommended lift thicknesses are minimums based on each mix designation's "Nominal Aggregate Size" and the relative coarseness of its gradation. The compacted thickness of layers placed shall not exceed 150% of the Minimum Lift Thickness of Table [710-1](#) except as otherwise provided in the plans and specifications, or if approved in writing by the Engineer.

<b>TABLE 710-1</b>		
<b>RECOMMENDED MINIMUM LIFT THICKNESS'S <del>for</del> <a href="#">FOR</a> ASPHALT CONCRETE MIXES</b>		
Asphalt Concrete Mix Designation (inches)	Minimum Lift Thickness Marshall Mixes	Minimum Lift Thickness Gyratory Mixes
3/8"	1.0 inches	1.5 inches
<del>1/2</del> <a href="#">1/2</a>	1.5 inches	2.0 inches
3/4"	2.5 inches	3.0 inches
Base	3.0 inches	n/a

**710.2 MATERIAL:**

**710.2.1 Asphalt Binder:** The asphalt binder specified in this section has been developed for use in desert climate conditions. ~~When used~~ [Should it be utilized](#) in other climates, consideration should be given to adjustments in the asphalt binder selection. The asphalt binder shall be Performance Grade Asphalt conforming to the requirements of Section [711](#) for PG 70-10, unless otherwise approved by the Engineer or specified differently in the plans or special provisions.

**710.2.2 Aggregate:** Coarse and Fine aggregates shall conform to the applicable requirements of this section. Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Coarse aggregate for hot mix asphalt is material retained on or above the No. 4 sieve and Fine aggregate is material passing the No. 4 sieve. Aggregates shall be relatively free of deleterious materials, clay balls, and adhering films or other material that prevent coating with the asphalt binder. Coarse and Fine aggregates shall conform to the following requirements when tested in accordance with the applicable test methods.

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<b>TABLE 710-2</b>			
<b>COARSE/FINE AGGREGATE REQUIREMENTS</b>			
Characteristics	Test Method	Low Traffic	High Traffic
Fractured Faces, % (Coarse Aggregate Only)	Arizona 212	75, 1 or more	85, 1 or more 80, 2 or more
Uncompacted Voids, % Min.	AASHTO T-304, Method A	42	45
Flat & Elongated Pieces, % 5:1 Ratio	ASTM D 4791	10.0 Max.	10.0 Max.
Sand Equivalent, %	AASHTO T-176	50 Min.	50 Min.
Plasticity Index	AASHTO T-90	Non-plastic	Non-plastic
L.A. Abrasion, % Loss	AASHTO T-96	9 max. @ 100 Rev. 40 max. @ 500 Rev.	9 max. @ 100 Rev. 40 max. @ 500 Rev.
Combined Bulk Specific Gravity	AI MS-2/SP-2	2.35 – 2.85	2.35 – 2.85
Combined Water Absorption	AI MS-2/SP-2	0 – 2.5%	0 – 2.5%

Tests on aggregates used in asphalt concrete outlined above, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation.

Blend sand (naturally occurring or crushed fines) shall be clean, hard and sound material which will readily accept asphalt binder coating. The blend sand grading shall be such that, when it is mixed with the other mineral aggregates, the combined product shall meet the requirements of Table [710-2](#).

The natural sand shall not exceed 20 percent for the Marshall mixes and 15 percent for the Gyratory mixes by weight of the total aggregate for a mix.

**710.2.3 Reclaimed Asphalt Pavement (RAP):** When allowed by the Engineer, Reclaimed Asphalt Pavement (RAP), as defined in Section 701.5, may be used in asphalt concrete provided all requirements of Section 710 are met. References to use of RAP in Section 710 apply only if RAP is utilized as part of the mixture.

When RAP is utilized in asphalt concrete, it shall be of a consistent gradation, asphalt content, and properties. When RAP is fed into the plant, the maximum RAP particle size shall not exceed  $\pm 1 \frac{1}{2}$  in. The percentage of asphalt in the RAP shall be established in the mix design. The percentage of RAP of RAP binder shall be established in the mix design.

When RAP is utilized in base and intermediate courses, the amount of RAP aggregate and RAP binder should not exceed 30% contribution; Surface courses should be limited to 20% RAP aggregate and RAP binder contribution.

In addition to the requirements of Section 710.3.1, the job mix formula shall indicate the percent of reclaimed asphalt pavement RAP and the percent and viscosity performance grade of virgin (added) asphalt cement binder.

When less than or equal to 15% RAP binder is used by weight of total binder in the mix, the added virgin binder shall meet the requirements for PG 70-10 as shown in Section 711. When greater than 15% RAP is used by weight of the total binder in the mix, the added virgin binder will be dropped one grade for low and high temperature properties to a PG 64-16, unless testing indicates that the blend of the recovered RAP binder and virgin binder meets the requirements for PG 70-10 as shown in Section 711. The virgin asphalt cement binder shall not be more than one standard asphalt material grades different than the specified mix design binder grade.

**710.2.34 Mineral Admixture:** Mineral admixture when used as an anti-stripping agent in asphalt concrete shall conform to the requirements of AASHTO M-17. Mineral admixture used in asphalt concrete shall be dry hydrated lime, conforming to the requirements of ASTM C1097 or Portland cement conforming to ASTM C150 Type II or ASTM C595 Type IP. The amount of hydrated lime or Portland cement used shall be determined by the mix design. The minimum Mineral admixture content within a mix will be 1.00 percent, by weight of total aggregate.

**710.3 MIX DESIGN REQUIREMENTS:**

**710.3.1 General:** The mix design for asphalt concrete shall be prepared by a laboratory that is accredited through the AASHTO Accreditation Program (AAP) in Hot Mix Asphalt Aggregates and Hot Mix Asphalt. The laboratory shall be under the direct supervision of a Civil Engineer, registered by the State of Arizona, and who is listed by ADOT as a “Qualified Asphaltic Concrete Mix Design Engineer” within ADOT’s latest list of approved laboratories. The latest list of approved laboratories is available on ADOT’s web page [www.azdot.gov](http://www.azdot.gov). The date of the design shall not be older than one year from the date of submittal, unless supportive documentation is provided and approved by the Engineer.

The mix design report shall include the following elements as a minimum.

- (1) The name and address of the testing organization and the person responsible for the mix design report.
- (2) The mix plant identification and/or location, as well as the supplier or producer name.
- (3) A description of all products that are incorporated in the asphalt concrete along with the sources of all products, including admixtures and asphalt binder, and their method of introduction.
- (4) The supplier and grade of asphalt binder, the source and type of mineral aggregate, and the percentage of asphalt binder and mineral admixture used.
- (5) The percentage of RAP and RAP binder being contributed to the total mix shall be included in the mix design report.
- ~~(56)~~ The mix design report, whether Gyratory or Marshall, shall state the traffic condition (low or high traffic) and size designation.
- ~~(67)~~ The results of all testing, determinations, etc., such as: specific gravity and gradation of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, Tensile Strength Ratio (AASHTO T-283), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources. The submittal should include a plot of the gradation on the Federal Highway Administration’s 0.45 Power Gradation Chart, plots of the compaction curves and the results of moisture sensitivity testing.
- ~~(78)~~ The laboratory mixing and compaction temperature ranges for the supplier and grade of asphalt binder used within the mix design.
- ~~(89)~~ A specific recommendation for design asphalt binder content and any limiting conditions that may be associated with the use of the design, such as minimum percentages of crushed or washed fine aggregate.
- ~~(910)~~ The supplier’s product code, the laboratory Engineer’s seal (signed and dated), and the date the design was performed.

The mix design shall be submitted to the Agency or Engineer by the Contractor/Supplier for which it was developed as part of his project submittals. Once the mix design has been approved by the agency or Engineer, the Contractor and/or his supplier shall not change plants nor ~~utilize~~ use additional mixing plants without prior approval of the Engineer. Any changes in the plant operation, the producer’s pit, the asphalt binder, including modifiers in the asphalt binder, or any other item that will cause an adjustment in the mix, shall be justification for a new mix design to be submitted.

**710.3.2 Mix Design Criteria:** The mix design shall be performed by one of two methods, Marshall Mix Design or Gyratory Mix Design. The method shall be specified on the plans, special provisions, or by the Engineer. A minimum of 4 points will be used to establish the mix design results. The oven aging period for both Marshall and Gyratory mix design samples shall be 2 hours.

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**710.3.2.1 Marshall Mix Design:** The Marshall Mix Design shall be performed in accordance with the requirements of the latest edition of the Asphalt Institute’s Manual, MS-2 “Mix Design Methods for Asphalt Concrete.” The mix shall utilize the compactive effort of 75 blows per side of specimen. The mix shall comply with the criteria in Table 710-3.

<b>TABLE 710-3</b>					
<b>MARSHALL MIX DESIGN CRITERIA</b>					
<b>Criteria</b>	<b>Requirements</b>				<b>Designated Test Method</b>
	<b>3/8” Mix</b>	<b>1/2” Mix</b>	<b>3/4” Mix</b>	<b>Base Mix</b>	
Voids in Mineral Aggregate: %, min	15.0	14.0	13.0	12.0	AI MS-2
Effective Voids: %, Range	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	AI MS-2
Absorbed Asphalt: %, Range *	0 - 1.0	0 - 1.0	0 - 1.0	0 - 1.0	AI MS-2
Dust to Eff. Asphalt Ratio, Range **	0.6 – 1.4	0.6 – 1.4	0.6 – 1.4	0.6 – 1.4	AI MS-2
Tensile Strength Ratio: %, Min.	65	65	65	65	ASTM D4867
Dry Tensile Strength: psi, Min.	100	100	100	100	ASTM D4867
Stability: pounds, Minimum	2,000	2,500	2,500	3000	AASHTO T-245
Flow: 0.01-inch, Range	8 - 16	8 - 16	8 - 16	8 - 16	AASHTO T-245
Mineral Aggregate Grading Limits					AASHTO T-27
	<b>Percent Passing with Admix</b>				
<b>Sieve Size</b>	<b>3/8 inch Mix</b>	<b>1/2 inch Mix</b>	<b>3/4 inch Mix</b>	<b>Base Mix</b>	
1-1/4 inch				100	
1 inch			100	90-100	
3/4 inch		100	90 – 100	85-95	
1/2 inch	100	85 – 100	---	---	
3/8 inch	90-100	62 – 85	62 – 77	57-72	
No. 8	45-60	40 – 50	35 – 47	33-43	
No. 40	10-22	10 – 20	10 – 20	9-18	
No. 200	2.0 – 10.0	2.0 – 10.0	2.0 – 8.0	1.0 – 7.0	

\* Unless otherwise approved by the Engineer.

\*\* The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the indicated range.

**710.3.2.2 Gyratory Mix Design:** Gyratory Mix Designs shall be performed in accordance with the requirements of latest edition of the Asphalt Institute’s SP-2 manual. Mix design laboratory compacted specimens shall be prepared using a gyratory compactor in accordance with AASHTO T-312.

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The mix design shall be formulated in a manner described for volumetric mix designs in the current edition of the Asphalt Institute Manual SP-2, except the number of trial blend gradations necessary will be determined by the mix design laboratory. Duplicate gyratory samples shall be prepared at a minimum of four (4) binder contents to select the recommended binder content. The gyratory specimens shall be compacted to 160 gyrations. Volumetric data for the design number of gyrations,  $N_{des}$ , and the initial number of gyrations,  $N_{ini}$ , are then back calculated based on the bulk specific gravity,  $G_{mb}$ , of the  $N_{max}$  specimens and the height data generated during the compaction process of those same specimens.

For Low Traffic designs, volumetric data for 115 gyrations,  $N_{max}$  for Low Traffic designs, is also back calculated from the specimens compacted to 160 gyrations.

The corrected density of the specimens shall be less than 89.0 percent of maximum theoretical density at  $N_{ini}$ . The corrected density of the specimens shall be less than 98.0 percent of maximum theoretical density at  $N_{max}$ . The Gyratory mix shall comply with the criteria in Table 710-4.

<b>TABLE 710-4</b>				
<b>GYRATORY MIX DESIGN CRITERIA</b>				
<b>Criteria</b>	<b>Requirements</b>			<b>Designated Test</b>
	<b>3/8" Mix</b>	<b>1/2" Mix</b>	<b>3/4" Mix</b>	<b>Method</b>
1. Voids in Mineral Aggregate: %, Min.	15.0	14.0	13.0	AI SP-2
2. Effective Voids: %, Range	4.0 ± 0.2	4.0 ± 0.2	4.0 ± 0.2	AI SP-2
3. Absorbed Asphalt: %, Range *	0 - 1.0	0 - 1.0	0 - 1.0	AI SP-2
4. Dust to Eff. Asphalt Ratio, Range **	0.6 – 1.4	0.6 – 1.4	0.6 – 1.4	AI SP-2
5. Tensile Strength Ratio: %, Min.	75	75	75	ASTM D4867
6. Dry Tensile Strength: psi, Min.	75	75	75	ASTM D4867
7. Mineral Aggregate Grading Limits				AASHTO T-27
	<b>Percent Passing with Admix</b>			
<b>Sieve Size</b>	<b>3/8 inch Mix</b>	<b>1/2 inch Mix</b>	<b>3/4 inch Mix</b>	
1 inch			100	
3/4 inch		100	90-100	
1/2 inch	100	90-100	43-89	
3/8 inch	90-100	53-89	-	
No. 8	32-47	29-40	24-36	
No. 40	2-24	3-20	3-18	
No. 200	2.0-8.0	2.0-7.5	2.0-6.5	
<b>8. Number of Gyrations</b>	<b>Low Traffic</b>		<b>High Traffic</b>	
$N_{ini}$	7		8	
$N_{des}$	75		100	
$N_{max}$	115		160	

\* Unless otherwise approved by the Engineer.

\*\* The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the indicated range.

**710.3.2.3 Moisture Sensitivity Testing:** Moisture sensitivity testing will be performed in accordance with ASTM D4867 for both Marshall and Gyratory mix designs, without the freeze/thaw cycle(s). The minimum required Tensile Strength Ratio is indicated in the tables above.