



Today decides tomorrow!!!

Asphalt Rubber Materials

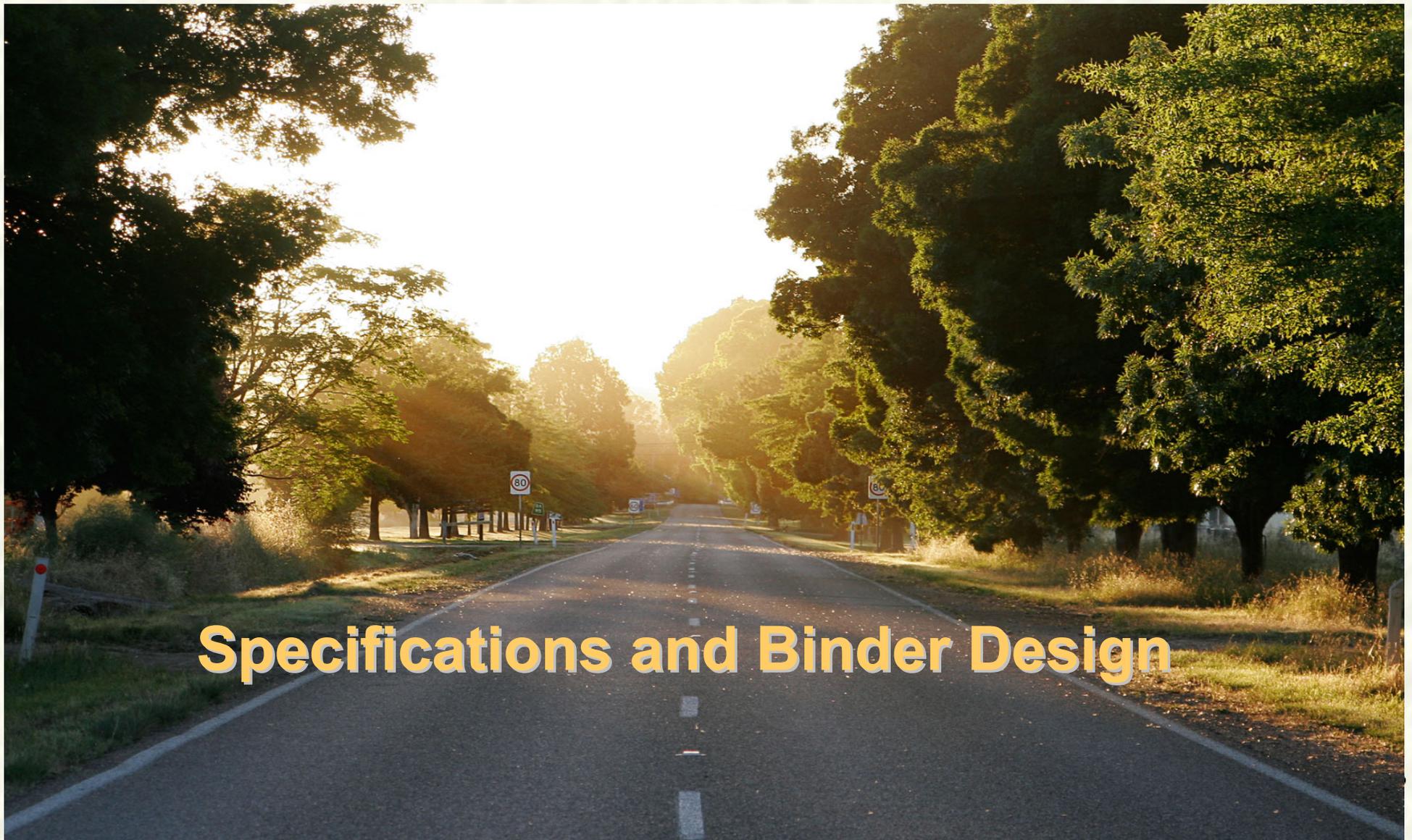
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asphalt



AR Material



Outline

- **Definitions**
- **Asphalt rubber binder**
- **Asphalt rubber binder design**
- **Types of mixes**
- **Cautions**

AR Definitions

Asphalt Rubber Definition: ASTM D 8

A blend of asphalt cement, reclaimed tire rubber and certain additives in which the rubber component is at least 15% by weight of the total blend and has reacted in the hot asphalt cement sufficiently to cause swelling of the rubber particles.



AR Definitions

Related Specification: ASTM D 6114

Standard Specification for Asphalt Rubber Binder

High viscosity material (usually field-blended) that typically requires agitation to keep CRM particles dispersed.



Definitions

The Wet Process can produce a wide variety of CRM modified binders from high viscosity (field blend) to no agitation (terminal blend) types

- **Rotational Viscosity** is the discriminator for appropriate use, although rotational viscosity of terminal blends is not typically measured
- **May be blended in field or at terminal**

Definitions

Wet Process

Method of modifying asphalt cement with scrap tire CRM and other components

- **Most widely used approach (AZ, CA, TX, FL, others)**
- **Thoroughly mix CRM & other components with hot (400-425°F) asphalt cement**
- **Interact at 350-375°F for designated period (typical minimums 45-60 minutes)**
 - **CRM particles swell, exchange oils with asphalt binder**

Definitions

Terminal Blends are:

- **Low viscosity, no agitation**
- **Typically $\leq 10\%$ CRM content, some @ 15%**
- **May include polymers and/or other modifiers**
- **Content in hot mixes is similar to neat asphalt cement**

High Viscosity (Field Blend) vs. No Agitation (Terminal Blend)



Definitions

Dry Process

Substitutes CRM for 1 to 3% of aggregate in hot mix

- **Not considered to modify binder, although some asphalt- CRM interaction may occur in place over time**
- **CRM gradations have ranged from coarse (1/4") to fine (#80)**
- **Mixed performance history – limited current use**
 - **May be related to mix design – need to account for long term absorption without starting out too rich**
 - **Not widely used in CA**

Asphalt Rubber Binder

Components:

- **Crumb Rubber Modifier (CRM)**
 - **Scrap Tire Rubber**
 - **High Natural Rubber Content Scrap Rubber**
- **Asphalt Cement**
- **Extender oil - Caltrans**

Caltrans Specifications for High Viscosity (Field Blend) AR Binders

- **Asphalt modifier: Extender oil at 1 to 6% by mass of asphalt (For chip seal binders, CT may continue to require minimum 2.5% extender oil)**
- **Asphalt + extender oil: 78-82% by total mass of AR binder**
- **Total CRM: 18-22% by total mass of AR binder, of which:**
 - **Scrap tire CRM = 73-77% of total CRM**
 - **High natural CRM = 23-27% of total CRM**

Crumb Rubber Modifier (CRM)

- CRM is produced from grinding whole scrap tires, tread buffings, and other waste rubber products; CRM comes in a variety of grades and size designations from various suppliers and/or sources
- CRM gradation and content affects not only AR binder properties, but also influences the voids structure of RHMA-G mixes
- Gradation limits used by Caltrans and ADOT are broad and allow considerable variation; changes are being considered
- Check project special provisions to verify CRM gradation limits in effect for specific projects

Crumb Rubber Modifier (CRM)



Tire Processing Video Clips

[Clip 1](#)

[Clip 2](#)

[Clip 3](#)

Crumb Rubber Modifier (CRM)

- **High natural rubber CRM is used to improve adhesion and flexibility, chip seal aggregate retention, and to compatibilize asphalt and CRM interactions**
- **It has a high natural rubber content (40-48% by mass) and may be made from scrap tires or other non-tire sources**
- **Caltrans also requires that “high natural” be used in binders for RHMA mixes**

Asphalt Cements

- **Asphalt cements come in a variety of grades and designations**
- **AR-4000 was used to make asphalt rubber in the past**
- **Caltrans adopted the Performance Graded (PG) system in 2006**
- **Do not use modified asphalts as the base asphalt cement for CRM modification**

PG Asphalt Cements

- **For high mountain and high desert areas, use PG 58-22 as the base asphalt.**
- **For other areas (coastal, inland valleys, low and south mountain, and desert) use PG 64-16 as base asphalt.**

Additives

- **Extender oils:**
 - **Aid in the interaction of the crumb rubber and asphalt by providing aromatics which are absorbed by the rubber**
 - **Help with dispersion by chemically suspending the rubber in the asphalt (required by Caltrans)**
- **Anti-stripping agents:**
 - **Improve adhesion of binder to aggregate**

Asphalt & Rubber Interactions

Depend On:

- **Asphalt Cement Source and Grade**
- **Rubber Type/Source**
- **Amount of Rubber**
- **Gradation of Rubber**
- **Interaction Time**
- **Interaction Temperature**

Asphalt Rubber Blend Design Submittals

- **Supplier and identification (or type) of scrap tire and high natural CRM**
- **Typical gradation of each type of CRM material used in the asphalt rubber binder design**
- **Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend**
- **If CRM from more than one supplier is used, info will be required for each CRM supplier used**
- **Laboratory test results for test parameters shown in the special provisions**

Asphalt Rubber Blend Design Submittals

- **Base asphalt PG binder grade, supplier, and Certificate of Compliance**
- **Percentage of the combined blend of asphalt and asphalt modifier by total mass of asphalt rubber binder**
- **Asphalt modifier type, supplier, identification, and test results demonstrating conformance to specs**
- **Percentage of asphalt modifier by mass of asphalt**
- **Design profile**
- **Minimum interaction time and temperature**
- **Material Safety Data Sheets for everything**

Asphalt Rubber Blend Design Profile

- **A design profile is developed to**
 - **Evaluate the compatibility between materials**
 - **Check compliance of component interaction properties**
 - **Check for stability of the AR blend over time**
- **For hot mix and spray applications, a 24-hour design profile will be required**

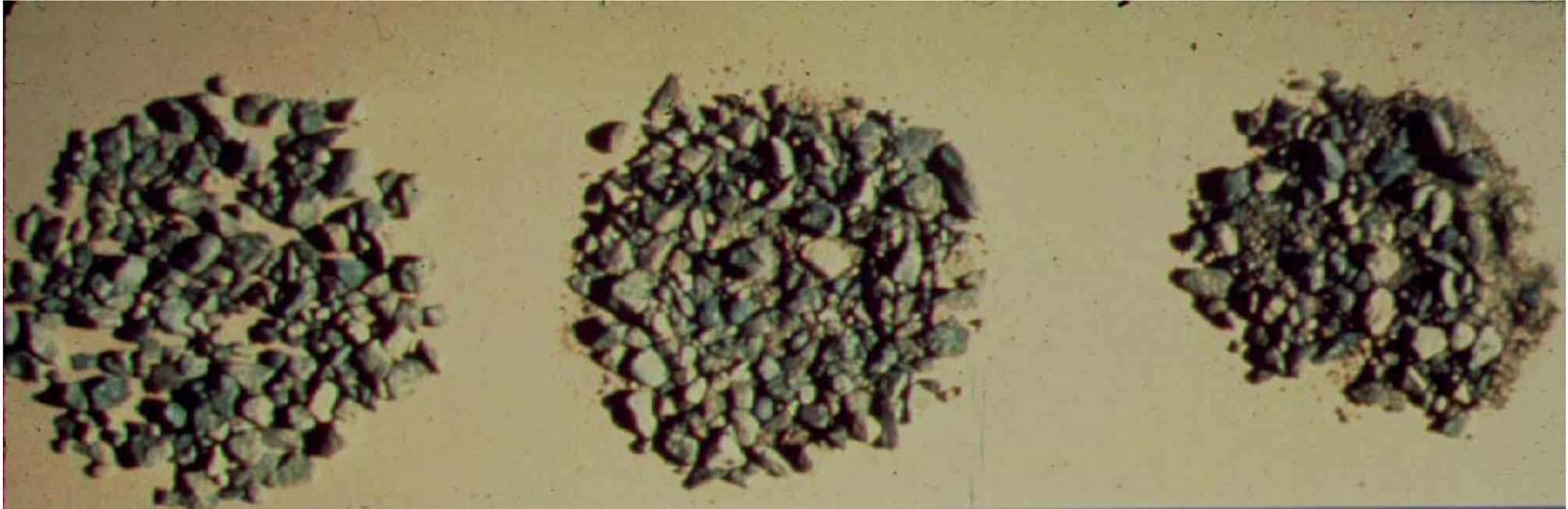
Asphalt Rubber Blend Design Example Design Profile

TEST	Minutes of Reaction					Spec. Limits @ 45 minutes (Caltrans 12/2005)
	45	90	240	360	1,440	
Viscosity, cP Haake@ 190°C	2400	2800	2800	2800	2100	1500 - 4000
Resilience@ 25°C (% Rebound) (ASTM D 5329)	27	--	33	--	23	18 Minimum
R & B Softening Pt., °C (ASTM D36)	59.0	59.5	59.5	60.0	58.5	52 – 74 (125-165°F)
Cone Pen @ 25°C (ASTM D217)	39	--	46	--	50	25 – 70

Types of RHMA

- **Dense-graded (limited usage by Caltrans)**
- **Gap-graded**
- **Open-graded**
- **Open-graded (High Binder, HB)**

Aggregate Gradation Comparison



Open Graded

Gap Graded

Dense Graded

Dense-Graded Mixes (RHMA-D)

- **Early use**
 - **Limited performance improvements vs. cost**
 - **Inadequate void space to accommodate sufficient AR binder to modify mix behavior**
- **Discontinued use with high viscosity (field blend) binders**
- **Suitable for use with no agitation CRM-modified binders (terminal blend) such as MB**

Gap-Graded Mixes (RHMA-G)

RHMA-G is the most commonly used RHMA mix type

Purpose – Structural mix that provides increased resistance to:

- **Rutting**
- **Fatigue**
- **Reflective cracking**
- **Oxidative aging**

Slide 27

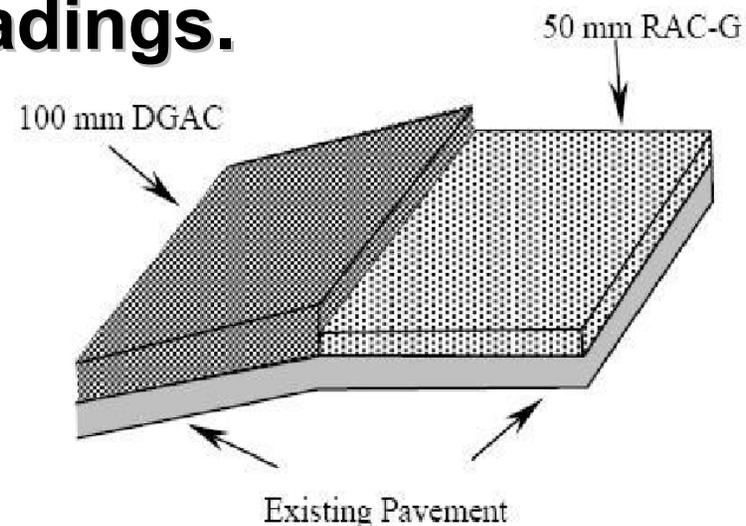
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Add a picture of RHMA-G.

DingXin Cheng, 7/22/2008

Gap-Graded Mixes (RHMA-G)

Appropriate use: Most effective in relatively thin surface lifts (max 60 mm) as overlay of aged or distressed flexible or rigid pavements that are structurally sound. May be used as surface course for new construction. Suitable for wide range of traffic volumes and loadings.



Gap-Graded Mixes (RHMA-G)

- **Thickness design**
 - **See Module 2 for details**
 - **New pavements**
 - **Overlays**
- **Overlay systems – two and three layer**
 - **SAMI-R, not SAMI-F**

Gap-Graded Mixes (RHMA-G)

Standard Special Provisions for RHMA-G with high viscosity (field blend) AR binder are currently being updated to address PG binder implementation.

Revisions include:

- **Remove test methods from body of SSP, develop corresponding CT Lab Procedures for CRM sieve analysis and measuring rotational viscosity of AR binder**
- **Format SSP for inclusion in Section 39 of Caltrans Standard Specifications**

Gap-Graded Mixes (RHMA-G)

- **Adjustments to Hveem Mix Design Method (CT 367), including:**
 - **Modify coarse aggregate gradation requirements, particularly for 600 μm sieve, to facilitate achieving minimum VMA (18%)**
 - **Add maximum VMA limit of 23%**
 - **Test 3 briquettes at each binder content, use average values for calculations and plots**

Gap-Graded Mixes (RHMA-G)

- **Adjustments to Hveem Mix Design Method, cont'd**
 - **Design air voids content may range from 3 to 5% based on traffic index and climate, and as designated by the engineer in project special provisions**
 - **Still requires minimum AR binder content of 7.0% by weight of dry aggregate to provide durability (Must have sufficient binder content to provide expected performance benefits)**

Gap-Graded Mixes (RHMA-G)

Adjustments to Hveem Mix Design Method, cont'd

- **Use Caltrans Laboratory Procedures LP-1 through LP-4 for volumetric calculations**
- **Report Voids Filled with Asphalt (VFA) and Dust Proportion for information only**
- **Plot average unit weight, stability, % air voids, VMA, and VFA, versus asphalt rubber binder content**

Open-Graded Mixes (RHMA-O, RHMA-O-HB)

- **Standard Special Provisions for RHMA-O and RHMA-O-HB have incorporated PG binder implementation**
- **Changes are similar to those for RHMA-G, but with less impact on mix design method**
- **Effects of CRM gradation and content in binder have relatively little effect on voids structure of open-graded mixes**

Open-Graded Mixes (RHMA-O)

- **RHMA-O is designed to provide a free-draining surface (reduced splash, spray, and hydroplaning) that maintains good frictional characteristics in wet or dry conditions**
- **Such mixes are not considered to be structural elements and no thickness reduction applies**
- **RHMA-O is typically placed in thin lifts, nominally 24 to 30 mm thick**

Open-Graded Mixes (RHMA-O)

Appropriate Use:

RHMA-O may be used as an overlay or as a surface for new construction where traffic flow is essentially uninterrupted by signalization, such as freeways, and some rural and secondary highways.



Open-Graded Mixes (RHMA-O)

- **Do not use open-graded mixes where there is a significant amount of stop and go traffic or turning vehicles, such as city streets or in parking lots**
- **These porous low modulus pavements are susceptible to tire scuffs from simultaneous braking and turning motions, and to damage from leaking vehicle fluids**
- **Caltrans does not use RHMA-O in snow country**

RHMA-O Mix Design

- **RHMA-O mixture design is performed according to California Test 368, with asphalt rubber binder content set at 1.2 times the optimum bitumen content for the designated PG binder grade**
- **A check test is used to verify that binder drain down is not excessive**
- **If long hauls are anticipated, drain down should also be checked in the laboratory for the expected haul time**

Open-Graded Mixes (RHMA-O-HB)

- **RHMA-O-HB mixes have higher binder contents (1.6 times demand for PG asphalt instead of 1.2)**
- **HB provides improved friction course durability and performance due to thicker AR binder films**
- **Drain down check is more critical for high binder mixes**
- **RHMA-O-HB does not drain as freely as RHMA-O due to higher binder content, but still drains more freely than DGAC**

Open-Graded Mixes

- **RHMA-O and RHMA-O-HB provide safety benefits, and also have proved to:**
 - Provide smooth ride
 - Significantly reduce tire noise
- **Joint Caltrans/ADOT/FHWA studies are in progress to measure and document noise reduction over a ten-year period**

Caution

- **The specifications and mix design methods discussed in this presentation apply to use of high viscosity asphalt rubber binders (field blend) in gap- and open-graded RHMA mixes**
- **No agitation binders (low viscosity, terminal blend) should never be directly substituted for high viscosity binders in any RHMA mix**
- **The two different types of CRM-modified binders have very different viscosity ranges and behave very differently from each other in asphalt concrete hot mixes**

Summary

- **Material Definitions**
- **Mix Design Profiles**
- **Material Testing**
- **RHMA-D**
- **RHMA-G**
- **RHMA-O, and RHMA-O-HB**



Questions ?



The Beginning

Keeping roads good with asphalt paving materials



<http://www.cp2info.org/center>

