

ASPHALT BINDER

Section 5 – Marshall Mix Design

Section 5 - 1

Mix Design-Marshall Method

- Test Procedure – AASHTO T 245 (Wyoming Modified)*
- General
 - 4 inch ϕ x 2.5 inch specimens
 - Same aggregate blend
 - Varying binder content
 - Multiple specimens at each binder content
- Components
 - Bulk Specific Gravity Measurement
 - Density – Voids Analysis
 - Stability – Flow Test

Section 5 - 2

Procedure

- Sample Preparation
 - Obtain representative Asphalt and Aggregate Samples
 - ◆ Proposed for Use
 - Dry Aggregate
 - ◆ 230°F
 - ◆ Constant Weight
 - Conduct Sieve Analysis
 - Determine S.G. of Aggregate and binder

Section 5 - 3

Procedure (continued)

- **Prepare Mix Samples**
 - ▶ **Select binder Content Range**
 - ▶ **Heat binder and Aggregate to mix temperature specifications**
 - ▶ **Combine binder and Aggregate**
 - ▶ **Mix to thoroughly coat**
 - ▶ **Cure 2 hours at compaction temperature (Wyoming modified)**
 - ▶ **Place in heated molds**

Section 5 - 4

Procedure (continued)

- ▶ **Compact with Marshall Hammer**
 - ◆ **10 lbs**
 - ◆ **18" drop**
 - ◆ **50 or 75 blows per side**
- ▶ **Cool and remove for molds**

Section 5 - 5

Marshall Compactor



Section 5 - 6

Procedure (continued)

➤ **Testing**

- ▶ **Measure Bulk S.G. of samples**
 - ◆ **AASHTO T 166**
 - ◆ **Weight in air – dry mass**
 - ◆ **Immerse in water 3 – 5 minutes and determine mass in water**
 - ◆ **Remove and blot dry with damp cloth**
 - ◆ **Weight immediately – SSD mass**
 - ◆ **Calculate Bulk S.G.**

$$BULK \ S.G. = \frac{dry \ mass}{(SSD \ mass - mass \ in \ water)}$$

Section 5 - 7

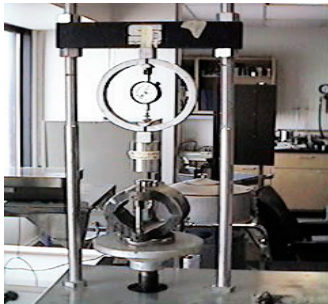
Procedure (continued)

➤ **Measure Stability And Flow Of Samples**

- ▶ **Immerse in water - 140°F, 30 minutes**
- ▶ **Remove from water and place in Marshall Tester**
- ▶ **Apply load to failure**
 - ◆ **2 inches per minute**
- ▶ **Record Stability – failure load**
- ▶ **Record Flow – 0.01 inch**
- ▶ **Complete in < 30 seconds**

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Marshall Stability Device



Section 5 - 9

Procedure (continued)

- **Analyze Density And Voids**
 - ▶ Calculate Density
 - ▶ Calculate Air Voids
 - ▶ Calculate VMA
 - ▶ Calculate VFA

Section 5 - 10

Procedure (continued)

- **Plot Test Results Versus Asphalt Content**
 - ▶ Stability
 - ▶ Air Voids
 - ▶ Density
 - ▶ Flow
 - ▶ VMA

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Procedure (continued)

- **From Plots, Find Binder or Asphalt Content At:**
 - ▶ Maximum Density
 - ▶ Maximum Stability
 - ▶ 4% Air Voids
- Calculate Average
- Determine Characteristics at Average
- Compare vs. Criteria
- Select Binder Content

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Percent Voids in Mineral Aggregate (VMA)

Table 401.4.1-3

	1 in Maximum Nominal Size	¾ in Maximum Nominal Size	½ in Maximum Nominal Size	3/8 in Maximum Nominal Size
	9.9 - Fail	Laboratory Mix		
CLASS IM, IIM	12.0-15.0	13.0-16.0	14.0-17.0	14.0-17.0
CLASS IIIM	11.0-14.0	12.0-15.0	13.0-16.0	13.0-16.0
	Production Mix			
CLASS IM, IIM	11.0-15.0	12.0-16.0	13.0-17.0	13.0-17.0
CLASS IIIM	10.0-14.0	11.0-15.0	12.0-16.0	12.0-16.0

Due to Fails -- Need to Redesign Mix

Section 5 - 16

Mix Design- Moisture Resistance

Test Procedure – AASHTO T 283

Procedure

- ▶ Mix samples at Marshall Design AC Content
- ▶ Cure 16 hours at 140°F
- ▶ Heat to compaction temperature
- ▶ Compact to 7.0 ± 0.5% air voids with Marshall hammer
- ▶ Remove from molds and cure in air for 24 ± 3 hours
- ▶ Divide into two subsets

Section 5 - 17

Mix Design-Moisture Resistance (continued)

▶ Procedure

- ▶ Test one subset in indirect tension
- ▶ Condition other subset
 - ◆ Vacuum saturate to 70% to 80%
 - ◆ Freeze 16 hours at 0°F
 - ◆ Immerse in water 24 hours at 140°F
- ▶ Immerse in water bath 1 hour at 77°F
- ▶ Test in indirect tension
- ▶ Calculate % retained strength

$$\frac{\text{Conditioned Subset Average Strength}}{\text{Unconditioned Subset Average Strength}} (100) = \% \text{ Retained Strength}$$

WYDOT – greater than 80% retained

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