ASPHALT BINDER

Section 4 – Mix Design

Section 4 - 1

Mix Design

- Purpose
  - To select the optimum combination of materials (aggregates, asphalt, etc.) to meet specific mixture characteristics and performance properties
- Methods
  - Marshall
  - Hveem
  - Superpave

Section 4 - 2

Mixture Characteristics

- Density
- Air voids
- VMA
- Binder content
- Film thickness
- Dust to effective asphalt ratio

Section 4 - 3

Density

- **Definition – Weight per unit volume lb/ft^3**
- **Density – Bulk S.G. x unit weight of water (62.4 lb/ft^3)**
- **High Density ⟶ Performance**

Section 4 - 4

Maximum Density (Voidless unit weight)

- Theoretical Maximum Specific Gravity of Bituminous Paving Mixtures (ASTM D2041) – The ratio of the weight in air of a unit volume of an uncompacted bituminous paving mixture at a stated temperature to the weight of an equal volume of gas-free distilled water at a stated temperature. It is also called Rice Specific Gravity, or theoretical maximum density (TMD).

Section 4 - 5

Air Voids

- **Definition**
  - **Air spaces between coated aggregate in compacted mix**
- **Some necessary**
- **Too high vs too low**
- **Design – usually 3% to 5%**
- **Related to density**

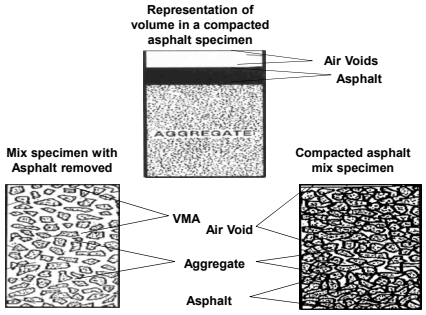
Section 4 - 6

Voids in the Mineral Aggregate (VMA)

- Definition
  - Void spaces between aggreate in compacted mix
- Air voids and asphalt volume
- Total space available for asphalt
- High VMA
  - High film thickness
  - High durability
- Low VMA
  - Low film thickness
  - Dry mix
  - Low durability

Section 4 - 7

VMA



Section 4 - 8

Asphalt Content

- Definition
  - % of asphalt by weight, in a mix
  - The optimum % of asphalt to meet mix design and performance criteria
- Function of:
  - Gradation
    - Surface area
    - % minus #200
  - Aggregate Absorption
- Total vs. Effective

Section 4 - 9

Performance Properties

- Stability
- Durability
- Impermeability
- Workability
- Flexibility
- Fatigue Resistance
- Skid Resistance

Stability

- Definition – Ability to resist shoving and rutting under loads
- Requirements can vary with load

Stability (continued)

- Function of:
  - Internal Friction of Aggregate
    - Shape
    - Size
    - Surface characteristics
  - Cohesion
    - Increases with loading
    - Increases with binder viscosity
    - Decreases with time
  - Asphalt Content
  - Temperature

Durability

- Definition – Ability to resist weather, traffic, time
- Function of:
  - Asphalt Content
    - Film thickness
    - Low air voids
  - Aggregate Gradation
    - Dense mixes
    - Impermeability
  - Aggregate Water Susceptibility
    - Stripping
  - Asphalt Aging
  - Compaction

Section 4 - 13

Impermeability

- Definition – Resistance to passage of air or water
- Function of:
  - Asphalt Content
    - High air voids
  - Compaction

Section 4 - 14

Workability

- Definition – Ease of placing and compacting
- Function of:
  - Aggregate Gradation
    - Coarse Fraction
    - Sand Fraction
    - Minus #200
  - Aggregate Shape
  - Asphalt Content
  - Asphalt Viscosity

Section 4 - 15

Flexibility

- Definition – Ability to adjust to movements due to loads or settlement without cracking
- Function of:
  - Aggregate Gradation
    - Dense vs. open
  - Asphalt Content
  - Temperature
  - Asphalt Grade

Fatigue Resistance

- Definition – Resistance to repeated bending under load without cracking
- Function of:
  - Asphalt Content
    - Air Voids
  - Compaction
  - Asphalt Viscosity
    - Grade
    - Aging
  - Pavement Thickness

Skid Resistance

- Definition – Ability to minimize slipping or hydroplaning, especially when wet
- Function of:
  - Aggregate Gradation
  - Surface Texture
  - Asphalt Content
  - Aggregate Durability
  - Mix Stability

Mix Design

- Purpose – To select the optimum combination of materials to meet mixture characteristics and performance properties
- Properties to be Balanced
  - Stability vs. Workability
  - Durability vs. Skid Resistance
  - Durability vs. Flexibility
  - Stability vs. Flexibility

Mix Design (continued)

- Optimize Properties
  - Enough AC for Durability
  - Adequate Stability for Traffic
  - Adequate Voids for Additional Compaction under Traffic
  - Low Enough Voids to keep out Air and Moisture
  - Adequate Workability