ASPHALT PAVEMENT CONFERENCE

GREENBOOK MIX DESIGN V. CALTRANS MIX DESIGN PROCEDURES November 3, 2011 Steve Marvin, P.E.

Terminology

Asphalt Cement

- Grade
 - Climate criteria
 - Traffic criteria
 - Grade 'bumping'
- Aggregate
 - Size
 - Shape
 - Specific Gravity
 - Apparent
 - Bulk
 - Saturated Surface Dry (SSD)
- Maximum Specific Gravity
 - Compacted Specimen
 - Theoretical Maximum
 - Rice Gravity
 - Traffic Specific number of gyrations



Terminology

Air Voids Climate Modified Voids in Mineral Aggregate, VMA Aggregate size sensitive Voids Filled with Asphalt, VFA Absorption Fine Aggregate Coarse Aggregate Film Thickness Dust Ratio



Terminology

- Stability Strength
 - Hveem
 - Rut resistance
 - Modulus
- Moisture Sensitivity Stripping
 - Moisture Vapor Susceptibility, MVS
 - Retained Strength
 - Lottman
- Extended Tamp Conditions
 - Stability
 - Air Voids



Block Ice

- Hard, durable and difficult to handle
- Melts slowly
- Poor heat transfer
- May not fit in glass



Cubed Ice

- Fairly hard and durable
- Reasonable melt rate
- Reasonable heat transfer
- Fits in glass



Crushed Ice

- Easily handled
- Fast melt rate
- Fast heat transfer
- Easy to fill glass



Shaved Ice
Flavor infusion
Soft and easy to use
Low spillage





Goals of the mix design

Bar Owner
Minimize whiskey
Maximize ice
Profit



Goals of the mix design

Bar TenderSatisfy customer

Provide appearance of heavy pour

Satisfy owner



Goals of the mix design

Bar Patron
 Maximize whiskey
 Full glass

Receive value



Fill glass nearly full Leave Room to Prevent Spillage Space function of planned consumption At bar Across room Taste Let ice melt for short time Taste



- Fill glass nearly full
- Measure Spaces in Glass not Filled with Ice, VFW
- Measure Percentage of Spaces filled with Whiskey, VFB
- Calculate Amount of Whiskey Stuck to Ice
- Calculate Amount of Whiskey Soaked Up by Ice
- Measure Room Left to Prevent Spillage
 - Space function of planned consumption
 - At bar
 - Across room
- Taste



- Repeat Process under Working conditions
- Measure Spaces in Glass not Filled with Ice
- Measure Percentage of Spaces filled with Whiskey
- Calculate Amount of Whiskey Stuck to Ice
- Calculate Amount of Whiskey Soaked Up by Ice
- Measure Room Left to Prevent Spillage
 - Space function of planned consumption
 - At bar
 - Across room
- Taste



- Repeat Process under Party conditions
- Measure Spaces in Glass not Filled with Ice
- Measure Percentage of Spaces filled with Whiskey
- Calculate Amount of Whiskey Stuck to Ice
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- Measure Room Left to Prevent Spillage
 - Space function of planned consumption
 - At bar
 - Across room
- Taste
 - ATF Agent
 - Bartender/Bar Owner
 - Customer



Select Aggregate Size and Shape

Large Aggregate
 Hard, durable
 Difficult to handle/finish
 Thick placement layers



Select Aggregate Size and Shape

Crushed Aggregate
 Reasonable stress transfer – strong
 May be blended with additional sizes
 Difficult to handle/finish



Select Aggregate Size and Shape

Round Agg/ High Sand Content

- Ease of use
- Aesthetically pleasing
- Very reliant on binder properties



Asphalt Concrete Mix Design

- Select different binder contents
- Compact
- Leave Room to Prevent Bleeding
 - Air Voids
- Test Strength
- Subject to Moisture Vapor
- Test Strength



Test During Use

Aggregate Gradation
Maximum Density
Air Voids (may be info only)
Test Strength



Binder Proportions

- Select different binder contents
- Compact
- Measure Voids In Mineral Aggregate, VMA
 - Variable requirement
 - Proposed use
 - Selected aggregate size
 - Selected aggregate gradation
- Measure Voids Filled, VFA
- Calculate thickness of binder on aggregate
- Calculate dust ratio
- Calculate Air Voids
 - Variable requirement
 - Climate conditions
- Test Strength
- Test Retained Strength/Stripping





Mix Verification

Repeat Mixing Process at Batch Plant
 Obtain Samples
 Compare test results to Design

Repeat Process During Production
 Add various layers of quality control
 Agency or Agencies
 Contractor
 Material Supplier



Greenbook Design

Traditional Caltrans Mix Design Pyramid
 Select Aggregate Gradation
 Mix samples at variable binder contents
 Measure Stability and Air Voids
 Visually inspect specimens

Greenbook Design

Using Pyramid

- Select highest binder content that satisfies
 - Minimum stability (strength)
 - Range of required Air Voids
 - Absent bleeding

Mix Design Valid for one yearMay be renewed with certain qualifications

Select Aggregate gradation and aggregate shape

- Select Binder Type and Target Air Void Content
 - Climate Use Sensitive
- Measure properties used previously
 - Hveem Stability
 - Air Voids

Measure Additional Parameters

- Voids in Mineral Aggregate, VMA
- Voids Filled with Asphalt, VFA
- Percent Voids Filled
- Film Thickness
- Dust Ratio
- Retained strength

May be project or Region Specific
 Voids in Mineral Aggregate, VMA

- Voids Filled with Asphalt, VFA
- Percent Voids Filled
- Film Thickness
- Dust Ratio
- Retained strength

- Verify at Plant with Trial Production
 - Measure All Parameters
 - Voids in Mineral Aggregate, VMA
 - Voids Filled with Asphalt, VFA
 - Percent Voids Filled
 - Film Thickness
 - Dust Ratio
 - Retained strength
 - Stability

Verify during Actual Production
 Measure All Parameters
 Plant producer laboratory
 Contractor laboratory
 Caltrans Laboratory
 Third Party
 Independent Assurance



Superpave Mix Design

- All of the above
- Add a few more tests
- Tasting/strength testing is optional