Asphalt Pavement
The Road to Quality

Materials 104- Introduction to Asphalt Mixes

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Aggregate Industries

Asphalt Pavements:

The Flexible Solution

Mix Selection- Introduction

- Why have different mixes?
- Why not put one mix everywhere?
- Why have different thicknesses?
- Are all kinds of soil / dirt the same?
- What else impacts a road?
  - Traffic levels?
  - Types of vehicles?
  - Speed of travel?

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Presentation Overview

- The past / present: Historical review
  - AASHTO Method of design
  - Impact of traffic
  - Structural numbers
  - MEPDG- Mechanistic Empirical Pavement Design Guide
- Laboratory Mix Designs
  - How we do Asphalt Mix designs

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Historical Background-

- Maryland Road Test (1941)
  - Findings
    - Heavier weight = More distress
    - Pumping occurred on plastic clays
    - Vehicle speed affected pavement response
- Washo Road Test (1953, Idaho)
  - Similar findings to Maryland
- AASHO Road Test (1958, Illinois)
  - Developed the AASHTO Method

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AASHTO Method

- Came up with methods to classify the underlying Base materials-
  - Based on the following test procedures:

    Direct shear
    California Bearing Ratio (CBR)
    R-Value
    Triaxial shear test
    Resilient Modulus
    Falling Weight Deflectometer – Backcalculated Modulus

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AASHTO Method-

- Drainage-
  - Water causes problems!
  - Stripping in the asphalt mat
  - Differential heaving
    - Swelling soils
  - Frost heave

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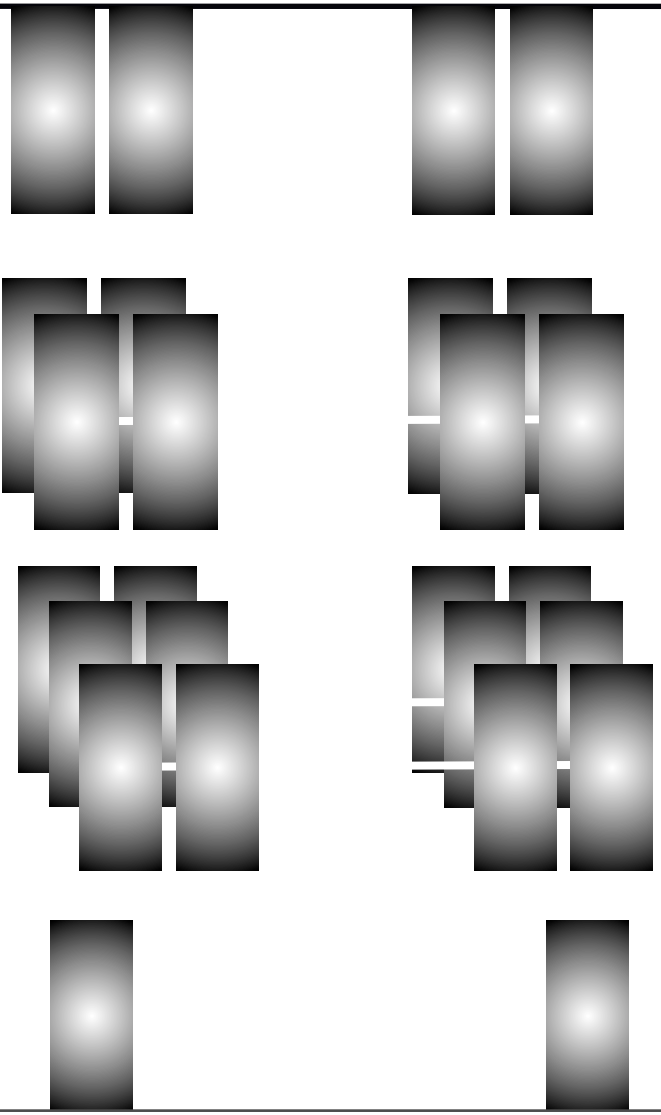
AASHTO Method-

- Traffic-
  - All vehicles are not equal.
  - Roads have different amounts of traffic.

Traffic – Axle Configurations

- Single
- Tandem
- Tridem
- Steer Axles



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Traffic-

- Need a way to quantify traffic loading!
  - ESAL
    - Equivalent Single Axle Load
  - This allows us to compare car traffic to buses and trucks!

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Traffic-

- How many cars do you think equals one truck??

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Traffic-

- 1 truck = 18,000 cars
- Approximately (depends on the truck size and the axel configuration)

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Structural numbers

- So there needs to be a way to make sure that there is enough structure to support the loading that it will receive.

- Structural numbers were created to assign a structural value to each layer of the pavement system.

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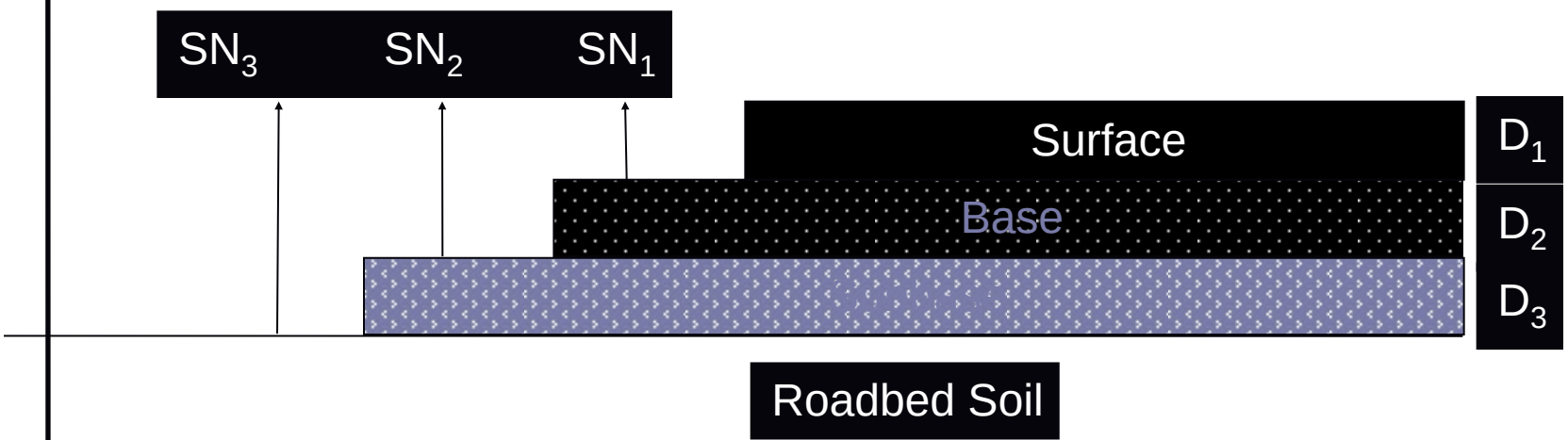
AASHTO Structural numbers

- Each layer plays a part in the system
  - Need to determine the Sn required above each layer. Then find the thickness to satisfy the Sn above each layer.



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Structural Coefficients-

- **Recommended Structural Coefficients**
- **HMA surface: 0.40 to 0.44 (0.35 in Nevada)**
- **HMA base: 0.35 to 0.40**
- **Aggregate base: 0.09 to 0.14**

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Structural Coefficients-

Example SN Calculation	Coefficient	Thickness	SN
Surface HMA	0.44	4.50	1.98
Base HMA	0.44	5.00	2.20
Aggregate	0.12	6.00	0.72
Aggregate	0.12	4.00	0.48
Total SN		16.50	5.38

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How a Flexible Pavement Works

- "Typical" Layered System-
  - Recompacted Subgrade or Imported Base
  - Bottom Asphalt Layer
    - Grading SG (100% passing 1 ½" Sieve)
    - Grading S (100% passing 1" Sieve)
  - Top Asphalt Layer
    - Grading SX (100% passing ¾" Sieve)
    - SMA (Stone Mastic Asphalt- Higher Volume Roads)

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Is this your neighborhood?

New approaches need to be looked at!!

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MEPDG Design Method-

- MEPDG =
- **M**echanistic
- **E**mpirical
- **P**avement
- **D**esign
- **G**uide

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MEPDG Design Method-

Huh?!?!?!

This is covered in Asphalt 401!

(ie. Come back next year!)

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How a Flexible Pavement Works

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Mix Designs- Lab Overview

- Stages of design-
- Aggregate Combination
- Blending / Mixing
- Volumetric Properties
- Optimum AC Selection
- Hveem Stabilities / Lottman's

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Mix Designs- Lab Overview

- Aggregate Combination
- Based on the asphalt plant location and the number of feed bins on the plant.
- The more products that are used the lower the individual product variability impacts the overall mix.

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Mix Designs- Lab Overview

- Aggregate Combination-
- Example Combination (Grading SX)

30%	27%	22%	20%	1%
1/2" Nomin	Granite Sand	Cr. Squee	Conc. Sand	Hydrated Lime
Morrison	Morris	Platte River	Platte River	Pete Lien

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Mix Designs- Lab Overview

- Aggregate Combination

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Mix Designs- Lab Overview

- Aggregate Combination- Split into size fractions

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Mix Designs- Lab Overview

- Aggregate Combination- Add Lime and if needed RAP

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Mix Designs- Lab Overview

- Add Binder by weight / Mixing

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Mix Designs- Lab Overview

- Heating / Compacting

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Mix Designs- Lab Overview

- Compaction / Extrusion

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Mix Designs- Lab Overview

- Volumetric Properties-
- Air Voids, VMA, VFA

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Mix Designs- Lab Overview

- Rice Test (Maximum Theoretical Specific Gravity)

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Mix Designs- Lab Overview

- Optimum AC Selection

Mix Properties	Lab Trial Data			
Asphalt Content (% by Wt of mix)	4.8%	5.3%	5.8%	6.3%
Theoretical Maximum Specific Gravity, Gmm	2.459	2.441	2.423	2.405
Theoretical Maximum Specific Gravity, (PCF)	153.0	151.9	150.8	149.7
Test Data @ N initial Gyrations (Info Only)				
Bulk Specific Gravity	2.146	2.171	2.188	2.201
% Voids in Total Mix	12.7	11.1	9.7	8.5
Test Data @ N Design Gyrations				
Bulk Specific Gravity	2.290	2.317	2.338	2.354
Density (PCF)	142.6	144.2	145.5	146.5
% Voids in Total Mix, VTM	6.9	5.1	3.5	2.1
VMA	16.8	16.3	16.0	15.9
VFA	59.3	69.0	78.0	86.7
Stability	44	44	44	43
Dust to Asphalt Ratio (CP- 50)	1.1	1.0	0.9	0.8

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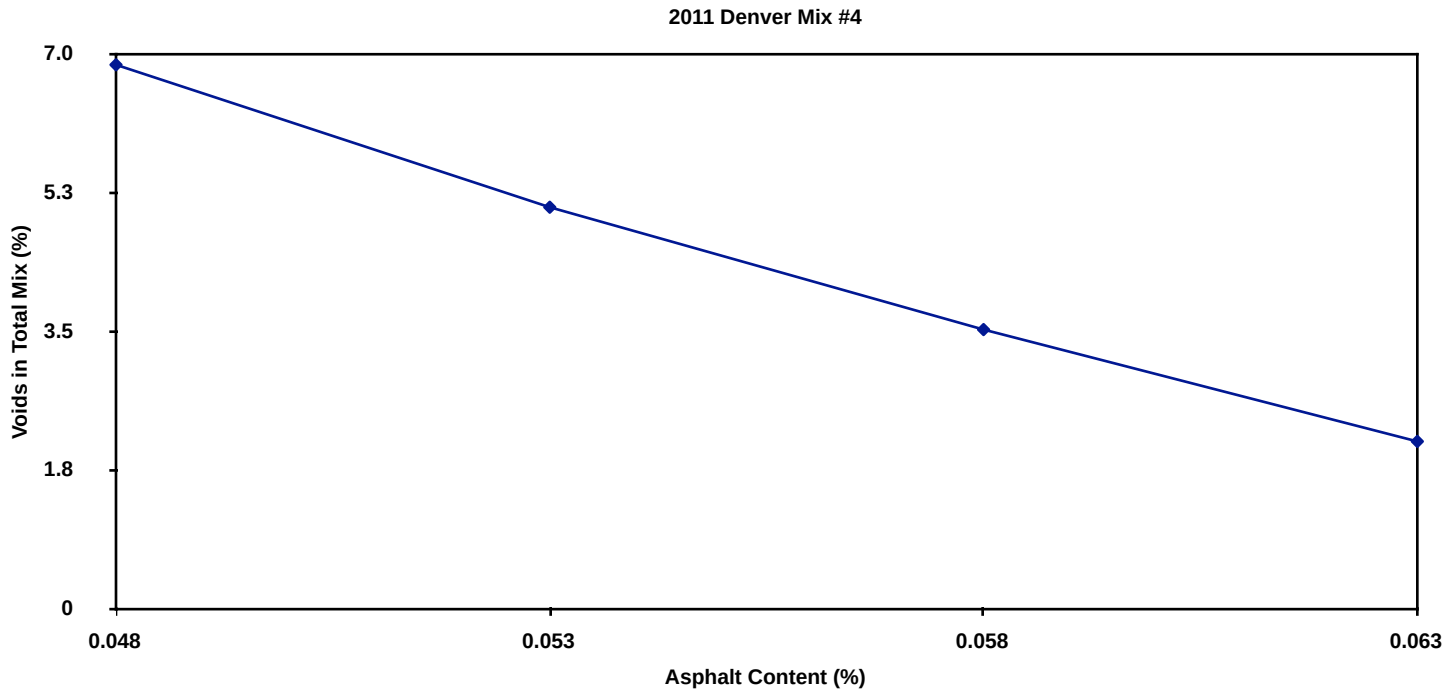
Mix Designs- Lab Overview

- Optimum AC Selection- Air Voids



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Mix Designs- Lab Overview

- Hveem Stability

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Mix Designs- Lab Overview

- Hveem Stability

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Mix Designs- Lab Overview

- Lottman Test
- 6 Pucks @ 7 ± 1% Air Voids
- 3 Pucks vacuum saturated and then frozen = Wet samples
- 3 Pucks tested Dry
- Lottman = (Wet / Dry) x 100

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Mix Designs- Lab Overview

Lottman Test-

80% TSR Minimum

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Mix Designs-

So where do we go from here?

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Contractor Innovations-

- Mix Optimization
- Warm mix / Shingles
- Daily plant monitoring
- On Site Project QC

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Ignition Ovens-

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Conclusion- Pavement Selection

- The past / present:
  - AASHTO Method of design
  - MEPDG
  - Laboratory mix Designs

- The future: Mix Design Optimization
  - “Automatically choosing the proven strategies of the past may not be the most cost effective solution.”
    - » The New Economy, CDOT 16 January 2007

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Questions?

The past- 2001

The present - 2014

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