MARTCP

Training/ Qualification Program

Asphalt

Plant Technician

Level I

Introduction & HMA Terminology

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QUALITY

Meets or exceeds the expectations or needs of the customer

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Quality Asphalt Mixtures

- Constructability
- Conforms to specifications
- Satisfies functional requirements

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Customer Driven Expectations Of Asphalt Mixtures

1. Smooth surface
2. Minimization of traffic disruptions
3. Adequate friction at surface
4. Minimization of overall costs

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HMA Mixture Characteristics

Page 2 2

- Resistance to Permanent Deformation
- Fatigue Resistance
- Durability
- Permeability
- Workability / Compactability

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Quality will not result from focusing on a couple of key parts of an operation...
Quality will result only when EVERYTHING is done right.

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Quality Starts Here!!

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It Continues Here
Good Materials Management
is Important

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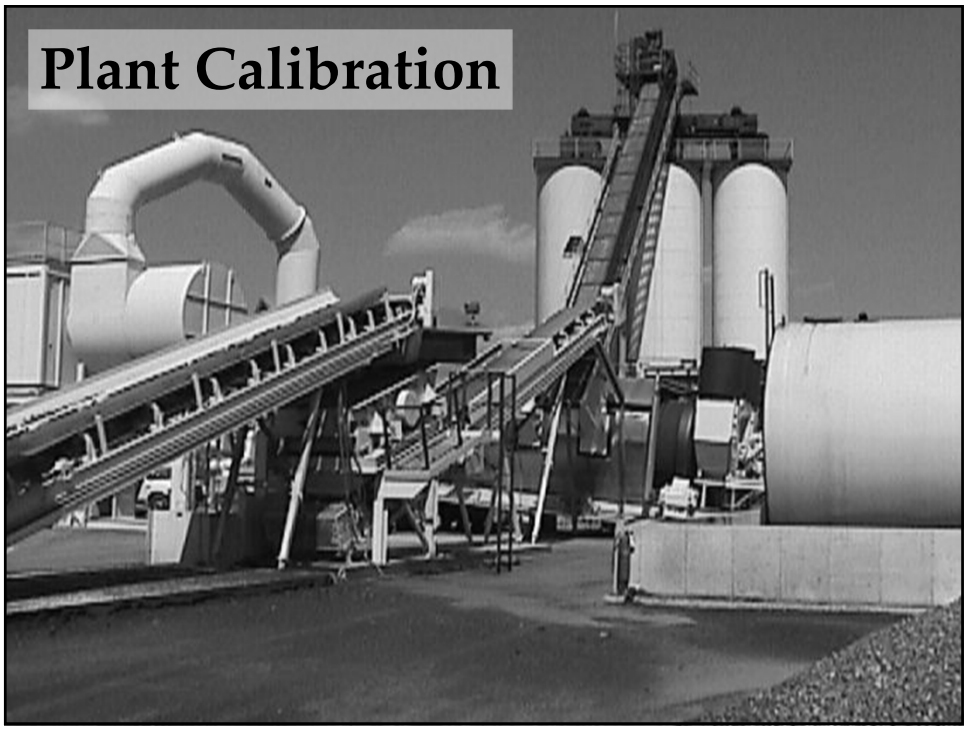
Plant Calibration

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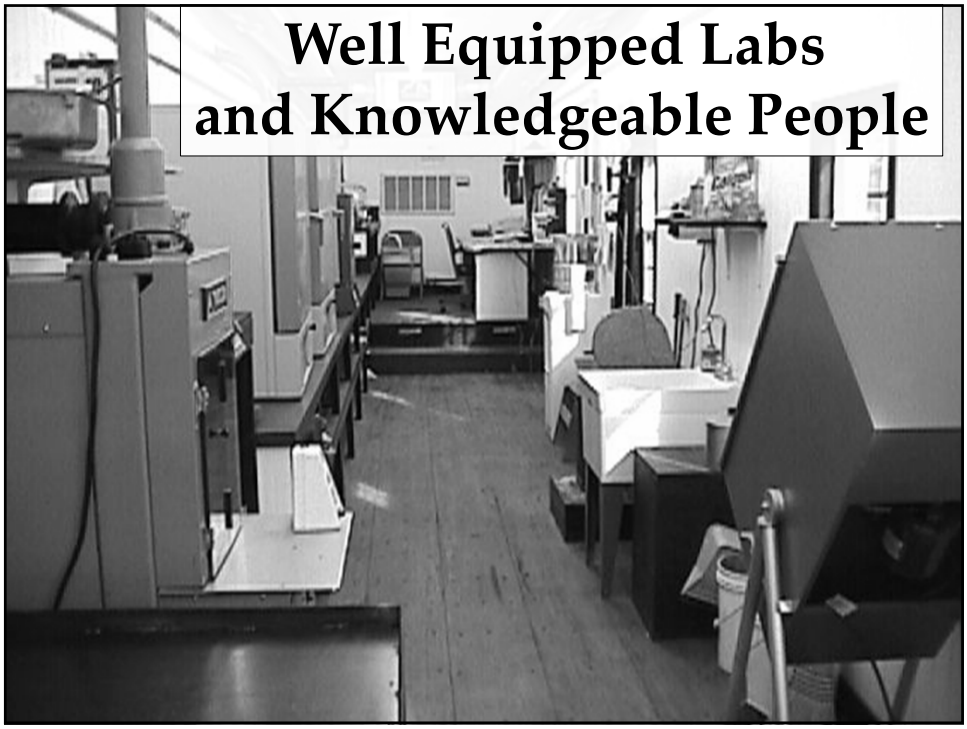
Well Equipped Labs
and Knowledgeable People

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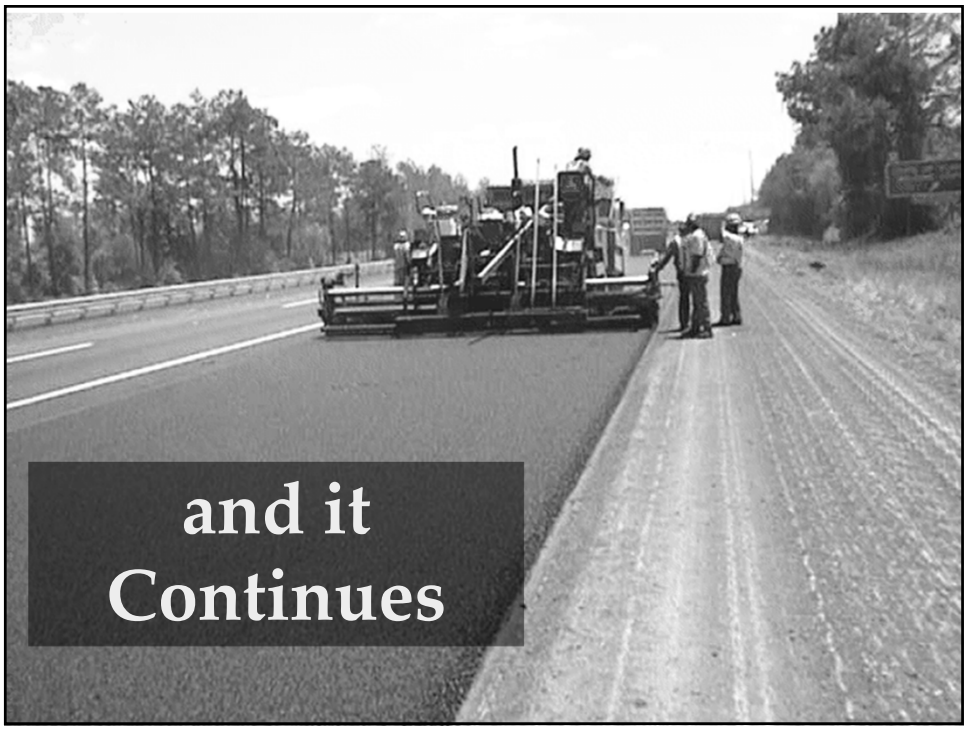
and it
Continues

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Background and Standard Terminology Used in Asphalt Technology

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HMA is a mixture of asphalt and aggregates. The proper combination of these materials will provide a long-lasting paved surface that will support the nation's traffic for many years.

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Background

- Asphalt
  - Generally a by-product of petroleum distillation process
  - Can be naturally occurring
  - Soluble in petroleum products
- Tar
  - Generally by-product of coke (from coal) production
  - Resistant to petroleum products

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- Several sources
  - Island of Trinidad
  - Bermuda, Venezuela
  - California
- First US Asphalt Mixture constructed in 1870's
  - Pennsylvania Ave., Washington D.C.
  - Used naturally occurring asphalt from surface of lake on Island of Trinidad

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Background

- **Each lake asphalt source very consistent**
  - **Used solubility test to determine source**
    - » **Insolubles differed substantially between sources**
- **Demand for paved roads exceeded the supply of lake asphalts in late 1800's**
  - **Led to use of petroleum asphalts**

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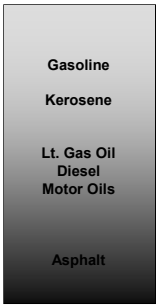
Petroleum-Based Asphalts



Barrel of Crude Oil

- **Asphalt is a waste product from refinery processing of crude oil**
  - **Sometimes called the "bottom of the barrel"**
- **Properties depend on:**
  - **Refinery operations**
  - **Composition crude source-dependent**

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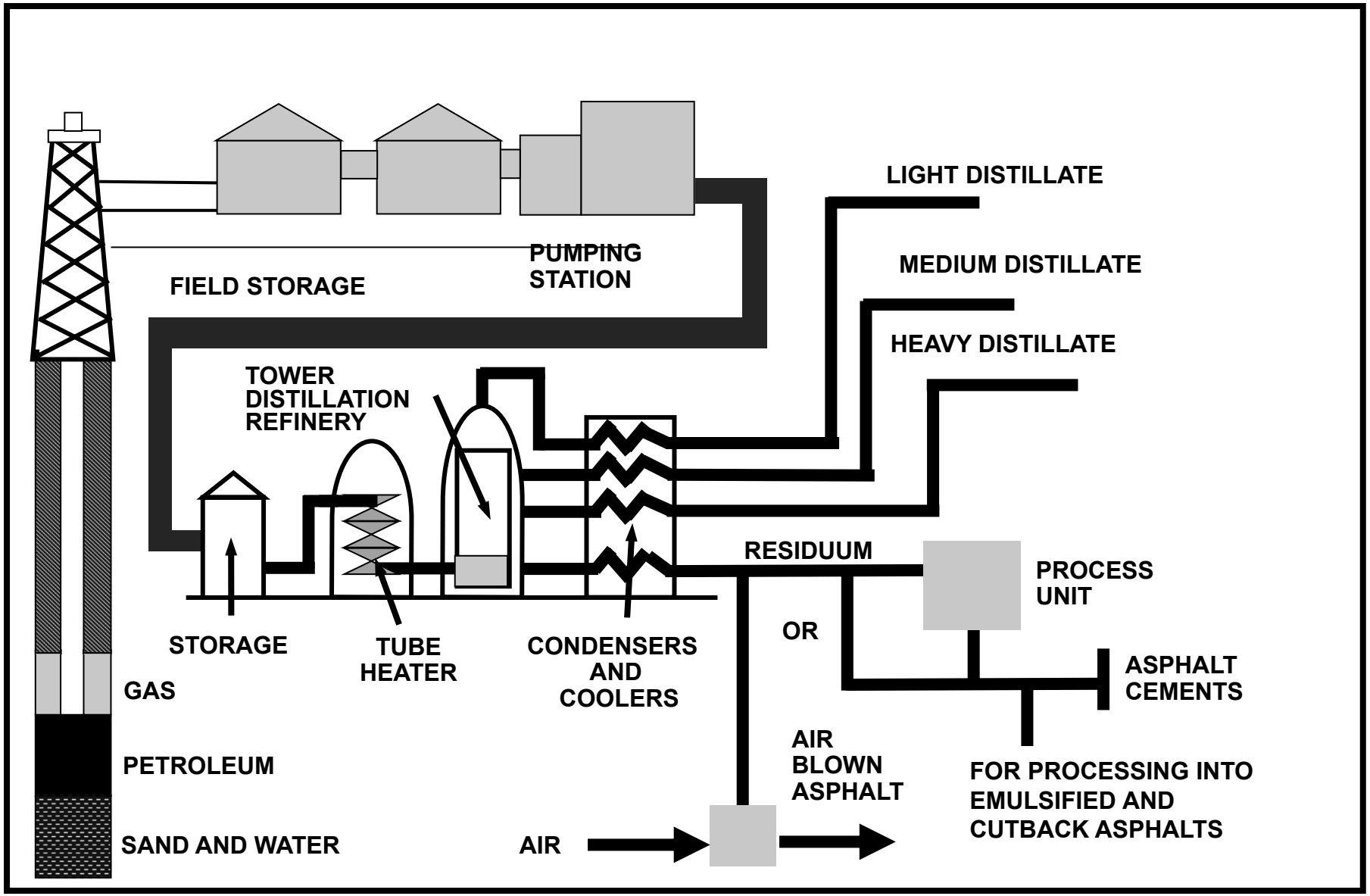
Refinery Operation



Asphalt Cement Components

- Asphaltenes
  - Large, discrete solid inclusions (black)
  - High viscosity component
- Resins
  - Semi-solid or solid at room temperature
    - » Fluid when heated
    - » Brittle when cold
- Oils
  - Colorless liquid
  - Soluble in most solvents
  - Allows asphalt to flow

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Types of Asphalt Cement

- Asphalt cements
  - Generally refinery produced material
  - Air blown asphalt cements
- Cutbacks
  - Asphalt cements "cut" with petroleum solvents
- Emulsions
  - Mixture of asphalt cement, water, and emulsifying agent

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Cutbacks (Use Petroleum Solvents)

- Rapid cure (RC) (Naphtha or Gasoline)
  - High volatility of solvent
  - Tack coats, surface treatments
- Medium cure (MC) (Kerosene)
  - Moderate volatility
  - Stockpile patching mix
- Slow cure (SC) (Low viscosity oil)
  - Low volatility
  - Prime coat, dust control

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Emulsions (Use Water and an Emulsifier)

- Emulsifier gives surface charge to asphalt droplets suspended in water medium
  - Anionic
    - » Negative charge
    - » Alkaline
    - » Good with limestones (positive charge)
  - Cationic
    - » Positive charge
    - » Acid
    - » Good with silica gravels (negative charge)

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Early Specifications

- Lake Asphalts
  - Appearance
  - Solubility in carbon disulfide
- Petroleum asphalts (early 1900's)
  - Consistency
    - » Chewing
    - » Penetration machine
    - » Measure stiffness

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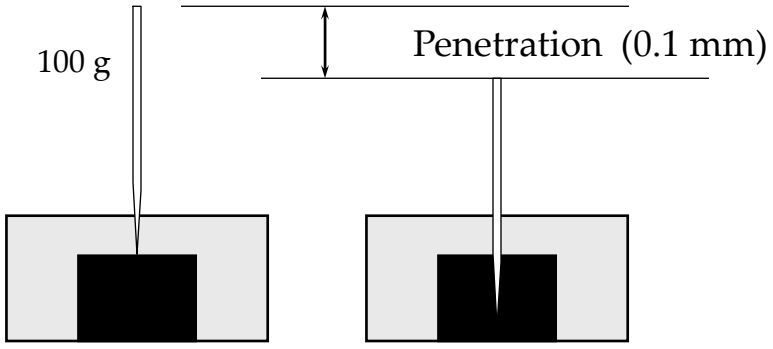
Penetration Testing

- **Sewing machine needle**
- **Specified load, time, temperature**



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Penetration Specification

- **Five Grades**
  - **40 - 50**
  - **60 - 70**
  - **85 - 100**
  - **120 - 150**
  - **200 - 300**

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Viscosity Graded Specifications
AC-5, AC-10, AC-20, AC-30, etc.

Viscosity is the internal friction of a fluid, caused by molecular attraction, which makes it resist a tendency to flow. (Webster's Dictionary)

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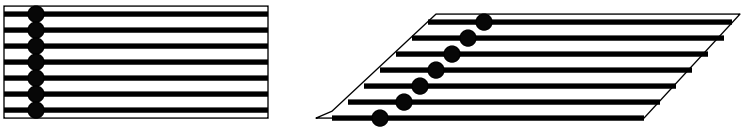
Definition

Viscosity: the ratio between the applied shear stress and the rate of shear.

$$\eta = \tau / \dot{\gamma}$$



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Superpave Asphalt Binders

- Grading System and Selection Based Primarily on Climate

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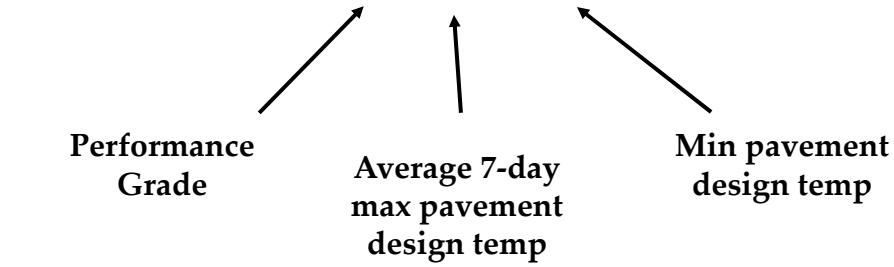

Performance Grade	Average 7-day max pavement design temp	Min pavement design temp

More, later . . .

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Aggregates

Usually refers to a soil that has in some way been processed or sorted.

- Excavation
- Crushing
- Transportation
- Sizing
- Stockpiling

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Excavation

* **Natural sands and gravels**

  - **Underwater sources**
    + **Rivers & lakes**
    + **Barge-mounted dredges, draglines, scoop, conveyors, or pumps**
    + **Relatively clean**

  - **Land sources**
    + **Gravel or sand pits**
    + **Bucket loader**

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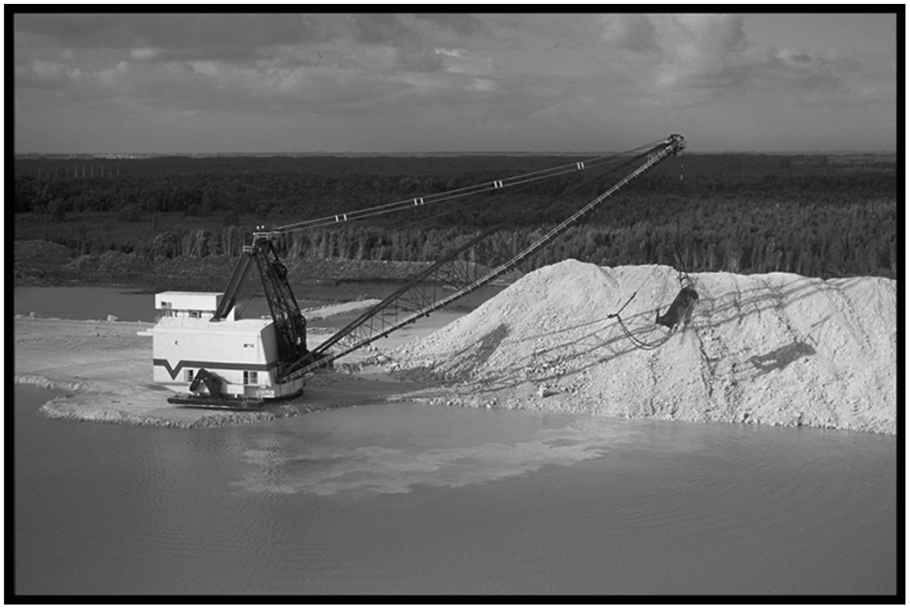
Excavation



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Excavation

* **Crushed stone and rock**

  - **Rock depths < 50 ft., overburden washed out during processing**

  - **Rock depths > 50 ft., remove overburden**

    + **Soil stripped with bulldozers and scrapers**

  - **Blasting required**

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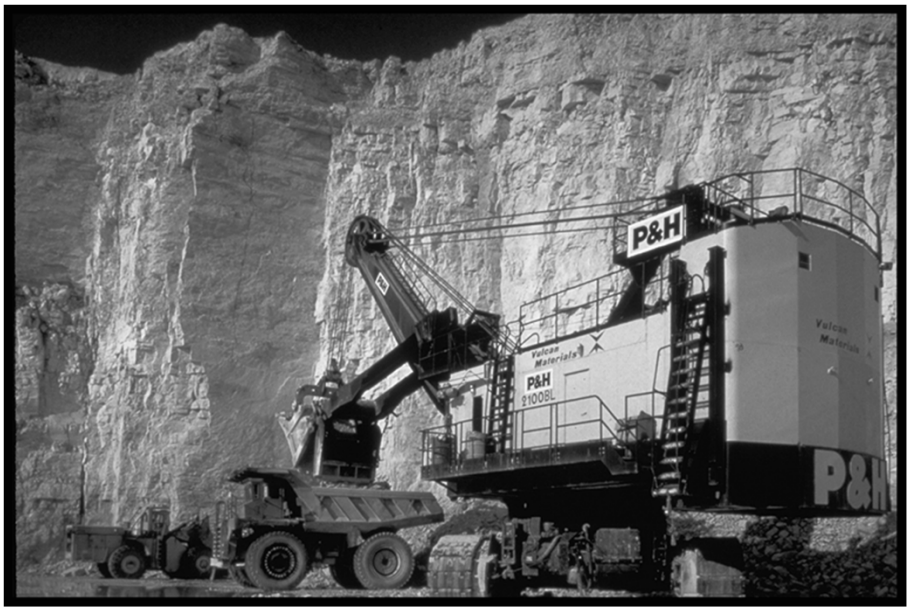
Excavation



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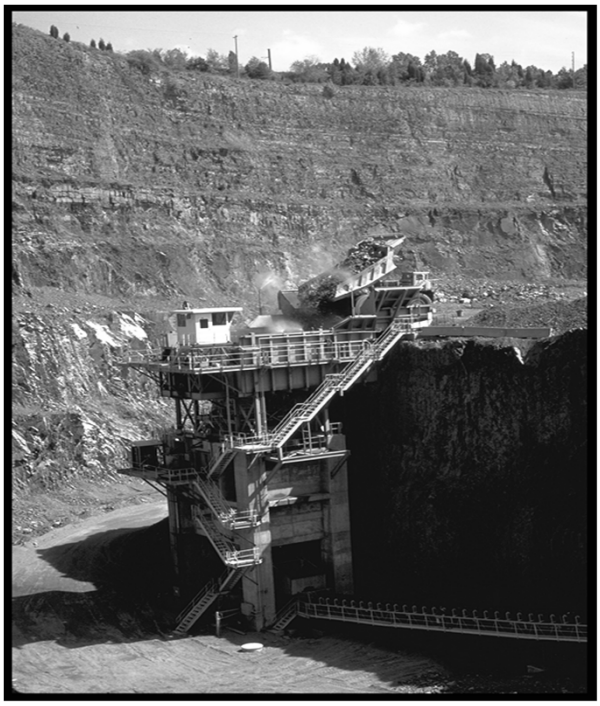

Crushing

The first step in preparing stockpiles for specific uses is the crushing the larger boulders and aggregates into usable sizes.

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Crushing

River Gravel

Partially Crushed River Gravel

Change the shape of the aggregate particles.

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Sizing

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Stockpiling

- Prevent segregation and contamination
- Good stockpiling = uniform gradations
  - Short drop distances
  - Minimize moving
  - Don't use "single cone" method
  - Separate stockpiles

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Transportation

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Transportation

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Transportation

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Stockpiling

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Desired Aggregate Properties

- **Toughness**
- **Soundness**
- **Deleterious Materials**
- **Gradation**

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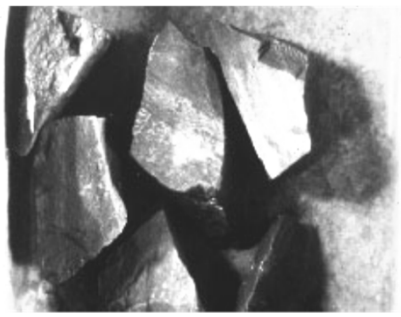
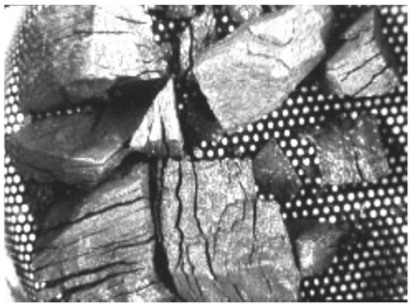
Soundness



Before



After

Damage to the aggregate after a number of wet-dry cycles can be seen by visual examination as well as in the change in gradation.

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Gradations

- Aggregate Gradation
  - The distribution of particle sizes expressed as a percent of total weight.
  - Determined by sieve analysis

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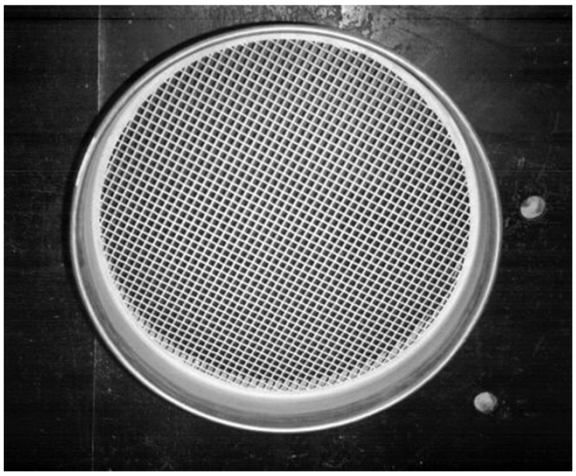
Mechanical Sieve



Individual Sieve

Stack of Sieves

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Mechanical Sieve

Stack in Mechanical Shaker

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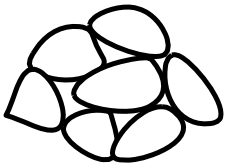
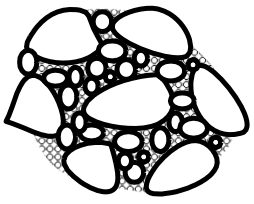
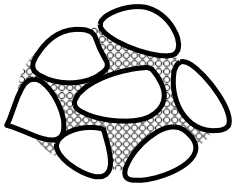
Types of Gradations



- **Uniformly graded (OGFC)**
  - **Few points of contact**
  - **Poor interlock (shape dependent)**
  - **High permeability**



- **Well graded (Dense)**
  - **Good interlock: ± equal amounts**
  - **Low permeability**



- **Gap graded (SMA)**
  - **Only limited sizes**
  - **Low permeability**

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Aggregate Size Definitions

100	100
100	99
90	89
72	72
65	65
48	48
36	36
22	22
15	15
9	9
4	4

- ***Nominal Maximum* Aggregate Size**
  - **One size larger than the first sieve to retain more than 10%**
- ***Maximum* Aggregate Size**
  - **One size larger than nominal maximum size**

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Asphalt Mixture Volumetric Terms

- Bulk Specific Gravity (BSG) of compacted asphalt
- Maximum Specific Gravity (Gmm)
- Air Voids (Va)
- Effective Specific Gravity of aggregate (Gse)
- Voids in Mineral Aggregate, VMA
- Voids Filled with Asphalt, VFA

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Volumetric Analysis

- All matter has mass and occupies space.
- Volumetric analysis is a way of evaluating the relationships between mass and volume

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Specific Gravity, G

$$\frac{\text{Mass}}{\text{Volume}}$$

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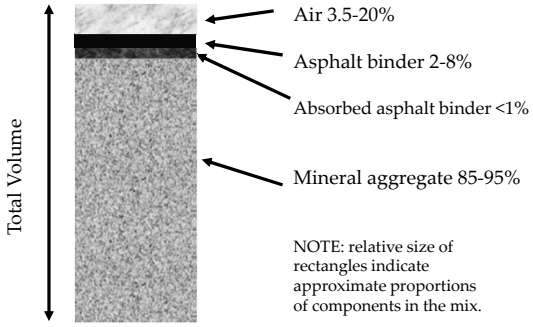
Asphalt Mixture Components



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Volumetric Abbreviations

- V_{mb} - Bulk Volume of Mixture
- V_{sb} - Bulk Volume of Stone
- V_b - Binder Volume
- V_{se} - Effective Volume of Stone
- V_{ba} - Volume of Absorbed Binder
- V_{mm} - Maximum Volume of Mixture
- V_a - Air voids
- VMA - Voids Mineral Aggregate

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Volumetric Abbreviations (Continued)

- G_{sb} - Bulk Specific Gravity of Stone
- G_{se} - Effective Specific Gravity of Stone
- G_b - Bulk Specific Gravity of Binder
- G_{mb} - Bulk Specific Gravity of Mix
- G_{mm} - Theoretical Maximum Specific Gravity of Mixture

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Asphalt Mix Design Methods

Marshall

Hveem

Superpave

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Asphalt Mix Design

- **Objective:**
  - **Develop an economical blend of aggregates and asphalt that meet design requirements**

- **Historical mix design methods**
  - **Marshall**
  - **Hveem**

- **Newest**
  - **Superpave gyratory**

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Requirements in Common

- Sufficient asphalt to ensure a durable pavement
- Sufficient stability under traffic loads
- Sufficient air voids
  - Upper limit to prevent excessive environmental damage
  - Lower limit to allow room for initial densification due to traffic
- Sufficient workability

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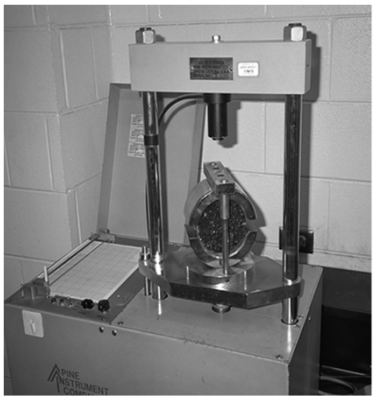
Marshall Mix Design

- Uses impact hammer to prepare specimens
- Determine stability with Marshall stabilometer
- Uses volumetrics to select optimum asphalt content



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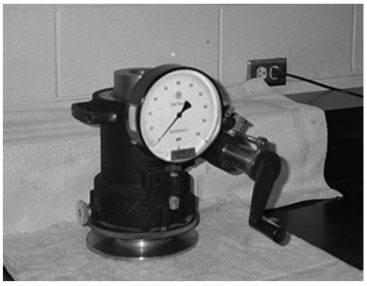
Hveem Mix Design

- Use kneading compactor to prepare specimens
- Determine stability with Hveem stabilometer
- Visual observation, volumetrics, and stability used to select optimum asphalt content



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Superpave Mix Design

- Uses gyratory compactor to prepare specimens
- Uses volumetric analysis to select optimum asphalt content

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Specification Development
Process Control
Training & Communication
Quality Management
Lab & Technician Certification
Product Acceptance

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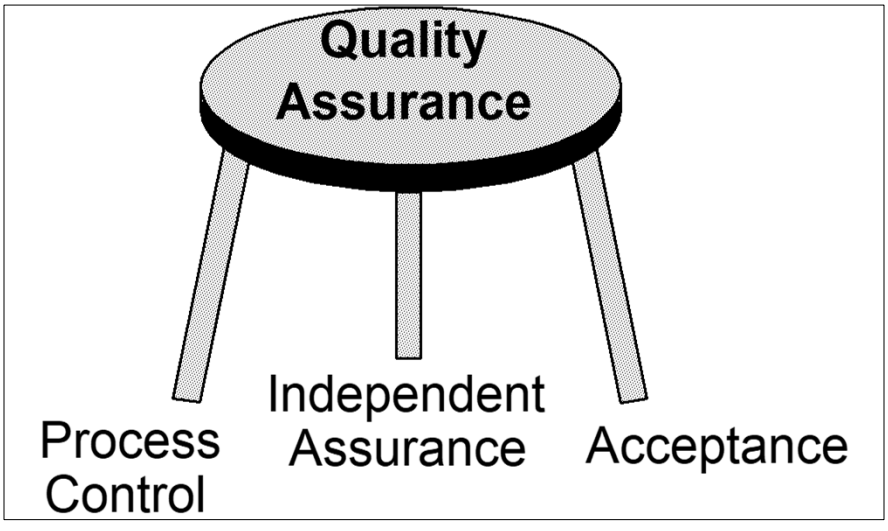
Quality Assurance
Process Control
Independent Assurance
Acceptance

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Method Specification

Maximum Control by

Recipe

Specifying Agency

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End-Result Specification

Specifying agency sets limits for the Contractor

$\bar{X} \geq$ Limit

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QUESTIONS ?

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