INDIANA DEPARTMENT OF TRANSPORTATION

CERTIFIED ASPHALT TECHNICIAN PROGRAM

(ICAT)

HMA POLICIES AND PROCEDURES

2025

INDOT CERTIFIED ASPHALT TECHNICIAN PROGRAM

Objectives

The Indiana Department of Transportation (INDOT) Certified Asphalt Technician Program (ICAT) is conducted in cooperation with the Asphalt Pavement Association of Indiana (APAI).

The principal objective of the ICAT Program is to provide the necessary training to plant personnel so that they may administer quality control of Hot Mix Asphalt (HMA). Knowledge of materials, mix design, HMA plants, laboratory test methods, and specifications are provided to enhance the technician's ability to meet the program requirements.

INDOT requires that a Level 1 Asphalt Technician perform or supervise all sampling and testing of HMA materials produced by a Certified HMA Producer. Explanation of how to achieve Level 1 status can be found in the Certification Requirements portion of this document.

Program Committee

The Program Committee acts as the steering committee which establishes the needs for the certification program and provides technical assistance for course materials and examinations. The committee is composed of representatives from INDOT, FHWA, and APAI.

Certification Committee

The Certification Committee is responsible for revocation or suspension of certifications for technicians. The Committee tasks include reviewing the violations of standard policies, rendering judgement of the seriousness of the violation, and hearing any subsequent appeal. The committee is composed of selected members of the Program Committee.

Certification Requirements

A technician is required to pass a written examination to become Certified. The examination will be given at the completion of the training course.

A technician is required to fulfill the requirements of the INDOT Independent Assurance and Qualified Acceptance Personnel Program to become Qualified.

A technician that is both Certified and Qualified becomes a Level 1 Asphalt Technician. INDOT specifications require that a Level 1 Asphalt Technician perform or supervise all sampling and testing of HMA materials produced by a Certified Asphalt Producer.

However, it is possible to be either Qualified or Certified only:

- A Qualified Technician can perform sampling and testing, but the work must be performed under the direct supervision of a Level 1 or Certified Technician.
- A Certified Technician cannot perform sampling and testing, but can directly supervise Qualified Technicians.

Both of these situations fulfill INDOT specification requirements.

A technician must be Qualified in the following test methods to become a Qualified Asphalt Technician:

AASHTO T 166 -- Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
AASHTO T 209 -- Theoretical Maximum Specific Gravity (G_{mm}) and Density of Hot Mix Asphalt (HMA)
AASHTO T 312 -- Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
AASHTO T 331 -- Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method (if applicable)
*ITM 571 -- Quantitative Extraction of Asphalt and Gradation of Extracted Aggregate from HMA Mixtures
ITM 572 -- Drying HMA Mixtures
ITM 580 -- Sampling HMA
*ITM 586 -- Asphalt Content by Ignition
ITM 587 -- Reducing HMA Samples to Testing Size

*At least one Test Method required

A technician may become a Qualified Technician in all of the designated sampling, sample reduction and test procedures before or after becoming Certified. Please contact District Testing to become Qualified.

If the technician is not Qualified at the time of becoming Certified, the technician is required to contact INDOT after becoming Qualified to be granted Level 1 status. Please contact:

Jason Galetka
Indiana Department of
Transportation Division of Materials
and Tests 120 S. Shortridge Rd.
Indianapolis, IN 46219
317-522-9673
email: jgaletka@indot.in.gov

Certification Examination

The examination time is limited to a maximum duration of 4 hours and the examination is open book/open note. There are 2 parts of the examination. Part I consists of multiple choice and fill in the blank questions, and Part II consists of word problems and other numerical calculations. A minimum score of 70 percent is required on each part to pass the examination.

A technician that has failed the certification examination will be allowed one retake of the exam. Only the part(s) failed are required to be retaken. A duration of 2 hours for Part I and 2 hours for Part II are allowed. The retake examination will be open book/open note and consist of a format similar to the original examination. The retake examination will be given at the INDOT Division of Materials and Tests within 45 days of notification of the technician's results of the original examination. A minimum score of 70 percent on each part is required to pass the retake examination. Technicians failing either part of the retake examination will be required to participate in the training course the following year and pass the examination to become certified.

The examinations will be retained by INDOT for a period of 1 year after such time the examinations will be destroyed. Technicians may review their examinations in the presence of an INDOT representative within 1 year of the examination date. Arrangements for review of the examination shall be made with INDOT.

Maintaining Status

Once a Technician passes the Certification Examination, they are Certified. There are no Recertification requirements.

Level 1 Asphalt Technicians will retain that status as long as they stay current as a Qualified Technician.

The certified technician will be notified of the recertification procedures prior to the expiration of the certification. The technician is responsible for applying for certification renewal. A current address is required to be maintained on file with INDOT. Address revisions are required to be sent to:

Jason Galetka
Indiana Department of Transportation
Division of Materials and Tests
120 S. Shortridge Rd.
Indianapolis, IN 46219
317-522-9673
email: jgaletka@indot.in.gov

Fees

The fee for attending the certification training course will be established by the Program Committee. The fee will cover a training manual, course materials, and refreshments

The refund policy for the certification course fee is as follows:

1. An administration fee of $100 will be charged for cancellation by the technician within 7 days of the course.

2. Lack of attendance of the course will result in no refund of fees.

3. Unforeseen emergencies that result in absences during the course will result in a refund of the course fee.

The fee for attending the Recertification Course will be established by the Program Committee. The fee will cover a training manual, course materials, refreshments, and lunch. No refunds will be given for the Recertification Course; however, unforeseen emergencies that result in absence of the course will result in a refund of the course fee.

Failure to pay the training course or examination fees will result in suspension of the certification.

Cancellation Policy

If a scheduled certification course or recertification refresher course is cancelled because of insufficient class size, the technicians will be notified 1 week prior to the start of the course. The technicians will be reimbursed the course fee.

Revocation or Suspension of Certification

Certifications awarded may be revoked or suspended at any time by the Certification Committee for just cause. The procedure that will be taken to revoke or suspend a technician's certification is as follows:

1. The technician will be sent written notification of the intent to revoke or suspend the certification by a registered letter. A copy of the written notification will be sent to the technician's employer. The letter will state the grounds for the revocation or suspension, request a written response, and establish a hearing date.

2. The technician will be allowed 60 days from the date of the notification to respond by letter. The response shall include an explanation of why the technician disagrees with the decision to revoke or suspend the certification.

3. After the 60 day time period has elapsed or upon receipt of the response, the case will be reviewed by the Certification Committee on the hearing date. The technician's response letter will be considered and the technician may appear before the Certification Committee.

4. The Certification Committee will issue a decision within 1 week of the hearing.

5. If the technician does not send a response letter, or fails to appear before the Certification Committee, a default judgement will be issued by the Certification Committee based on the evidence available. The revocation or suspension may be affirmed, modified, or vacated following the hearing.

The reasons that a technician's certification may be revoked or suspended include:

1. Cheating on recertification examinations

2. Falsification of quality control test results and/or records

3. Not meeting the requirements of the Qualified Laboratory and Technician Program for the required sampling, sample reduction, and testing procedures

The Certification Committee may decide to revoke or suspend the certification depending upon the seriousness of the violation. Violations deemed as unintentional will result in a penalty of a letter of reprimand to the technician and the technician's employer. Subsequent violations will result in suspension of certification for a designated period as determined by the Certification Committee. The certification will return to good standing after the period of suspension expires.

Intentional violations will result in a 1 year suspension of the certification. Subsequent violations will result in permanent revocation of the certification. If the technician wishes to become recertified after the period of suspension, the technician will be required to complete all steps as if they were a brand new technician.

Appendix A
Level 1 Asphalt Technician
Qualification Credit Form

Name: ____

I verify that the above-noted person has successfully demonstrated the following test methods:

[ ] AASHTO T 166 -- Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens

[ ] AASHTO T 209 -- Theoretical Maximum Specific Gravity (G_{mm}) and Density of Hot Mix Asphalt (HMA)

[ ] AASHTO T 312 -- Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

[ ] AASHTO T 331 -- Bulk Specific Gravity (G_{mb}) of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method (if applicable)

[ ] ITM 571 -- Quantitative Extraction of Asphalt and Gradation of Extracted Aggregate from HMA Mixtures

[ ] ITM 572 -- Drying HMA Mixtures

[ ] ITM 580 -- Sampling HMA

[ ] ITM 586 -- Asphalt Content by Ignition

[ ] ITM 587 -- Reducing HMA Samples to Testing Size

___________________________________ ____________________

Independent Assurance Technician Date

Send To: Jason Galetka
Indiana Department of
Transportation Division of Materials
and Tests 120 S. Shortridge Rd.
Indianapolis, IN 46219
317-522-9673
email: jgaletka@indot.in.gov

ICAT Program Acronyms

AASHTO - American Association of State Highway and Transportation Officials
AC - Asphalt Cement
ACBF - Air Cooled Blast Furnace Slag
ASC - Asphalt Supplier Certification Program
ASTM - American Society for testing and Materials
BBR - Bending Beam Rheometer
DMF - Design Mix Formula
DSR - Dynamic Shear Rheometer
ESAL - Equivalent Single Axle Load
FAA - Fine Aggregate Angularity
GSB - Bulk Specific Gravity
HMA - Hot Mix Asphalt
IA - Independent Assurance
ICAT - Indiana Certified Asphalt Technician
IDEM - Indiana Department of Environmental Management
INDOT - Indiana Department of Transportation
ITM - Indiana Test Method
LCPF - Lot Composite Pay Factor
MAF - Mixture Adjustment Factor
MAS - Maximum Aggregate Size
N_{des} - design number of gyrations
N_{ini} - initial number of gyrations
N_{max} - maximum number of gyrations
NIST - National Institute of Standards and Technology
NMAS - Nominal Maximum Aggregate Size
OG - Open Grade
PAV - Pressure Aging Vessel
PCS - Primary Control Sieve
PF - Pay Factor
PG - Performance Grade
PRA - Polish Resistant Aggregate
QA - Quality Assurance
QC - Quality Control
QCP – Quality Control Plan
RAP - Reclaimed Asphalt Pavement
RAS - Reclaimed Asphalt Shingles
RTFO - Rolling Thin Film Oven
SCPF - Sublot Composite Pay Factor
VFA - Voids Filled with Asphalt
VMA - Voids in Mineral Aggregate
SBR - styrene-butadiene rubber
SF - Steel Furnace Slag
SGC - Superpave Gyratory Compactor
SMA - Stone Matrix Asphalt
WMA - Warm Mix Asphalt

Measure of:	**x:**	**y:**
Percent **(P)** or Volume **(V)** Concentration: P_{xy} or V_{xy}	b = binder s = stone (i.e. aggregate) a = air	e = effective a = absorbed
Specific Gravity **(G)**: G_{xy}	b = binder s = stone (i.e. aggregate) m = mixture	b = bulk e = effective a = apparent m = maximum

INDOT Specification Quick Reference

Section 401 - QC/QA HMA Pavement
Section 402 - HMA Pavement
Section 410 - QC/QA HMA - SMA Pavement
Section 902 - Asphalt Materials
Section 904 - Aggregates

TERMINOLOGY PAGE

Absorption - The increase in the mass of aggregate due to water in the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass

Actual Binder Content - The binder content determined in accordance with ITM 586 or the total of the binder content determined in accordance with ITM 571 and the binder absorption percent from the DMF

Aggregate Base - A layer of aggregate placed on a subgrade or subbase to support a surface course

Air-Cooled Blast Furnace Slag (ACBF) - Material resulting from solidification of molten blast-furnace slag under atmospheric conditions

Apparent Specific Gravity - The ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature

Air Voids - Internal spaces in a compacted mix surrounded by asphalt-coated particles, expressed as a percentage by volume of the total compacted mix

Asphalt Emulsion – An emulsion of asphalt and water that contains a small amount of an emulsifying agent. Emulsified asphalt droplets may be either anionic (negative charge), cationic (positive charge), or nonionic (neutral).

ASTM - American Society for Testing and Materials

Base Course – The layer in the pavement system immediately below the binder and surface courses. The base course consists of crushed aggregate or other stabilized material.

Binder – Asphalt that is classified according to the Standard specifications for Performance Graded Asphalt Binder, AASHTO Designation MP1. The binder may be either unmodified or modified asphalt.

Bulk Specific Gravity - The ratio of the weight in air of a unit volume of material (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight of an equal volume of gas-free distilled water at a stated temperature

Bulk Specific Gravity Saturated Surface Dry (SSD) - The ratio of the mass in air of a unit volume of material, including the mass of water within the voids filled to the extent achieved by submerging in water for a specified time (but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature

Certified Aggregate Producer - A Plant/Redistribution Terminal that meets the requirements of ITM 211 and is approved by the Department.

Certified Asphalt Technician – The Certified Asphalt Technician may supervise all sampling and testing of materials, the maintenance of control charts, and the maintenance of the diary, however, the Certified Asphalt Technician shall not conduct sampling and testing.

Certified HMA Producer - An asphalt mixture plant that meets the requirements of ITM 583 and is approved by the Department

Coarse Aggregate - Aggregate that has a minimum of 20 percent retained on the No. 4 (4.75 mm) sieve

Decant - A test utilizing water to determine the amount of material that is passing the No. 200 sieve. The decantation test is conducted on both fine and coarse aggregate and is usually done in conjunction with the sieve analysis test.

Deleterious - Undesirable aggregate material

Density - The weight per unit volume of a substance

Dolomite - Carbonite rock containing at least 10.3% elemental magnesium when tested in accordance with ITM 205

Equivalent Single Axle Load (ESAL) – The effect on pavement performance of any combination of axle loads of varying magnitude equated to the number of 80-kN (18,000-lb.) single-axle loads that are required to produce an equivalent effect.

Fine Aggregate - Aggregate that is 100 percent passing the 3/8 in. (9.5 mm) sieve and a minimum of 80 percent passing the No. 4 (4.75 mm) sieve

Independent Assurance (IA) – Independent Assurance testing is conducted by INDOT personnel to verify the reliability of the results obtained in acceptance sampling and testing. Certified Asphalt Technicians are checked annually by Independent Assurance Technicians for the sampling and testing procedures that are conducted at the asphalt mixture plant.

Intermediate Course – The hot mix asphalt course immediately below the surface course, generally consisting of larger aggregates and less asphalt (by weight) than the surface course.

Level 1 Asphalt Technician – The Contractor personnel that conducts or supervises all sampling and testing of materials, the maintenance of control charts, and the maintenance of the diary.

Leveling Course – A course of hot mix asphalt of variable thickness used to eliminate irregularities in the contour of an existing surface prior to placing the subsequent course.

Management Representative – The Contractor personnel responsible for all aspects of mixture production and control at the asphalt plant and on the pavement as required by the Program on ITM 583.

Maximum Particle Size (MPS) - The sieve on which 100 percent of the material will pass

Mineral Filler - Dust produced by crushing stone, portland cement, or other inert mineral matter having similar characteristics. Mineral filler is required to be in accordance with the gradation requirements for size No.16.

National Institute of Standards and Technology (NIST) - A federal technology agency that develops and applies technology, measurements, and standards for testing equipment

Nominal Maximum Aggregate Size (NMAS)/Mixture Designation - One sieve size larger than the first sieve to retain more than 10 percent.

Nominal Maximum Particle Size – An individual aggregate term for the smallest sieve opening through which the entire amount of the aggregate is permitted to pass.

Performance Grade (PG) – Asphalt binder grade designation used in Superpave that is based on the binder's mechanical performance at critical temperatures and aging conditions.

Polish Resistant Aggregates (PRA) - Dolomite containing less than 10.3% elemental magnesium, crushed limestone, or gravel meeting the requirements of ITM 214. Aggregates meeting these requirements are maintained on the INDOT Qualified Product List for *Polish Resistant Aggregate Sources*.

Prime Coat – An application of asphalt primer to an absorbent surface. The prime coat is used to prepare an untreated base for an asphalt surface. The prime penetrates or is mixed into the surface of the base and plugs the voids, hardens the top and helps bind the mixture to the overlying course.

Quality Assurance Materials - Certified aggregate materials controlled by gradations determined by the Certified Aggregate Producer.

Quality Control Plan (QCP) - A document written by the Producer that is plant-specific and includes the methods of sampling, testing, calibration, verification, inspection and anticipated frequencies used by the Producer.

Qualified Technician - An individual who has successfully completed the written and testing requirements of the Department's Independent Assurance and Qualified Acceptance Personnel Program outlined in Directive 107.

Reclaimed Asphalt Pavement (RAP) – Asphalt pavement that has been pulverized, usually by milling, and is used like an aggregate in the recycling of asphalt pavements.

Reclaimed Asphalt Shingles (RAS) – Pre-consumer asphalt shingles that are a waste from a shingle manufacturing facility or post-consumer asphalt shingles that are tear-off materials from roofs.

Specific Gravity - The ratio of the mass of a unit volume of a material to the mass of the same volume of gas-free distilled water at a stated temperature.

Standard Specification Materials - Certified materials controlled by aggregate gradations as defined in the Department Standard Specifications and the construction contract documents.

Steel Furnace Slag (SF) - A material derived from the further refinement of iron to steel.

Subbase – The course in the asphalt pavement structure immediately below the base course. If the subgrade soil has adequate support, this course may serve as the subbase.

Subgrade – The soil prepared to support a pavement structure or a pavement system. The subgrade is the foundation of the pavement structure.

Superpave – Short for "Superior Performing Asphalt Pavement", a performance-based system for selecting and specifying asphalt binders and for designing asphalt mixtures.

Tack Coat – An application of asphalt material applied to an existing asphalt or concrete pavement surface at a prescribed rate. Tack coat is used to form a bond between an existing surface and the new overlying course.

Water-Injection Foaming - Water-Injection Foaming is a process that allows a reduction in the temperature at which asphalt mixtures are produced and placed.

Chapter One

Why Are We Here?
Course Purpose and Overview

INDOT Certified Asphalt Technician Course

Chapter One

Presented by: Matt Beeson, INDOT

Asphalt Mixtures

- INDOT spends between $300-$400M annually on asphalt
- Vast majority of pavement in Indiana is asphalt
- INDOT needs a way to validate the properties of asphalt met the specifications

INDOT Specifications

- How does a specification become a specification?
  - Standard Specifications
  - RSP – Recurring Special Provisions
  - USP – Unique Special Provisions
  - CM – Construction Memorandums
  - TM – Testing Memorandums

INDOT Specifications

In INDOT documentation, typically it is defined what is a Contractor duty and what is an INDOT duty.

- “Will” refers something INDOT or their representative is to perform
- “Shall” refers to something the Contractor is to do

Asphalt Mixture Testing

- Why is testing important?
  - INDOT (customer) buys asphalt
  - Asphalt mixture for INDOT projects need to be from a Certified Hot Mix Asphalt Producer
  - Testing ensures consistency of the mix, testing procedures, and production process
  - Important to maintain, calibrate, and verify equipment for accuracy in test results

Types of Testing

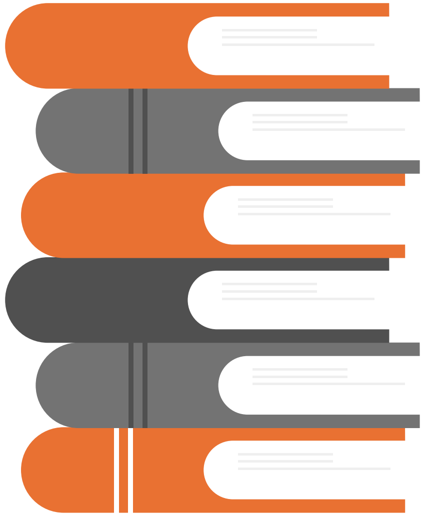
- Quality Control (QC)
  - Contractor testing
  - Contractor performs testing to *control* mixture during production

- Quality Assurance (QA)
  - INDOT testing
  - INDOT performs testing to *assure* the material meets specifications

QC/QA balances the responsibility for quality between the Contractor and INDOT

Testing Methods

- AASHTO - American Association of State Highway and Transportation Officials
- ASTM – American Society for Testing and Materials
- ITM – Indiana Test Method
- INDOT Directives



Certified Hot Mix Asphalt Producer Program

- General program requirements outlined in ITM 583
  - Documentation
  - Laboratory and Equipment Calibration
  - Materials Sampling and Testing
  - Diary
  - Quality Control Plan

Certified Hot Mix Asphalt Producer Program

Contractor Personnel Responsibilities

Management Representative: responsible for all aspects of mixture production and quality control at the asphalt plant and on the pavement as required by ITM 583

Certified Asphalt Technician: supervises all sampling and testing of materials, the maintenance of control charts, and the maintenance of the diary, however, the Certified Asphalt Technician shall not conduct sampling and testing.

Level 1 Asphalt Technician: conducts or supervises all sampling and testing of materials, the maintenance of control charts, and the maintenance of the diary.

Qualified Technician: an individual who has successfully completed the written and testing requirements of the Department's Independent Assurance and Qualified Acceptance Personnel Program.

Certified Hot Mix Asphalt Producer Program

Contractor Personnel Requirements

Certified Asphalt Technician: Successfully passed the ICAT course

Level 1 Asphalt Technician: Successfully passed the ICAT course and the requirements of a qualified technician (Certified and Qualified)

Qualified Technician: an individual who has successfully completed the written and testing requirements of the Department's IA Program

Certified Hot Mix Asphalt Producer Program

Maintaining Your Status

Certified Asphalt Technician: Once a technician passes the certification exam, they are certified. No recertification requirements.

Level 1 Asphalt Technician: Maintains their status as long as they stay current as a Qualified Technician. Any questions can be directed to District Testing.

Qualified Technician: an individual who has successfully completed the written and testing requirements of the Department's IA Program

ITM 583 Testing Methods (AASHTO)

A technician must be Qualified in at least the following methods to become a Qualified Asphalt Technician:

Reference	Brief Description
AASHTO T 166	Bulk Specific Gravity of HMA using SSD Specimens
AASHOT T 209	Maximum Specific Gravity and Density of HMA Paving Mixtures
AASHTO T 312	Preparing and Determining the Density of HMA by means of Superpave Gyratory Compactor
AASHTO T 331	Bulk Specific Gravity and Density of Compacted Asphalt Mixtures Using Vacuum Sealing
ITM 571*	Quantitative Extraction of Asphalt and Gradation of Extracted Aggregate from HMA Mixtures
ITM 572	Drying HMA Mixtures
ITM 580	Sampling HMA
ITM 586*	Asphalt Content by Ignition
ITM 587	Reducing HMA Samples to Testing Size

* At least one method required

Overview of course

Day 1 - Aggregates

- Welcome and Introduction
- Asphalt Technician Safety
- Aggregate Fundamentals for Asphalt Mixtures
- Aggregate Gradation
- Recycled Materials
- Aggregate Lab Demonstration
- Optional Help Session

Overview of course

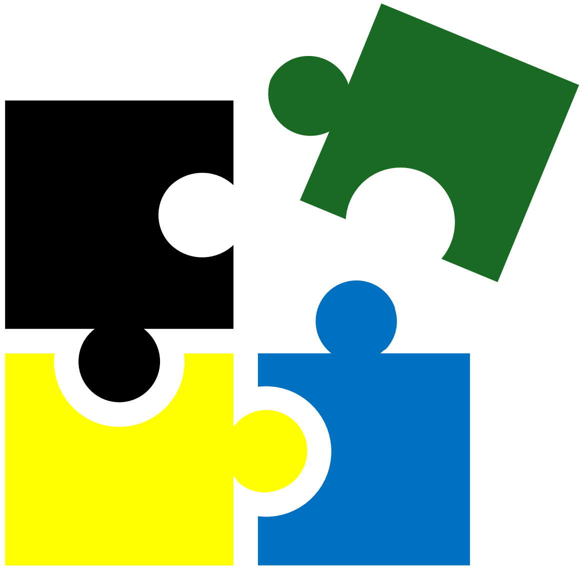
Day 2 – Asphalt Mixtures

- Volumetrics
- Asphalt Mixture Troubleshooting
- Liquid Asphalt Binder
- Plants
- Asphalt Lab Demonstration
- Optional Help Session

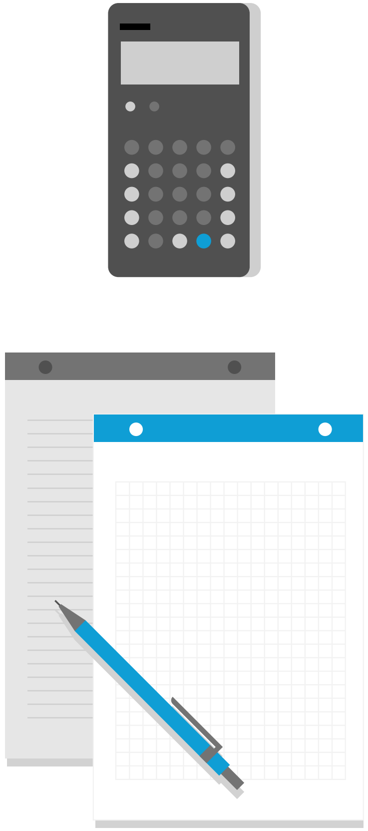
Overview of course

Day 3 – Quality Control/Quality Assurance

- Ethics
- Quality Control/Quality Assurance
- INDOT Pay Items
- ITAP and Data Entry
- Exam Preparation
- Optional Help Session



Certification Exam



Day 4 – Exam

- The exam is 4 hours and is open book/open notes.
- There are 2 parts:
  - Part I – multiple choice and fill in the blank questions
  - Part II – mathematics including word problems and numeric calculations
- A minimum of 70% on each part is required to pass the course.
- A technician that gets less than 70% will be allowed one retake of the exam. Only the part(s) that are failed need to be retaken.
- Retakes must be taken within 45 days of notification of the technician's results of the original exam.

Questions?

Good Luck!

Chapter Two

Asphalt Technician Safety

INDOT Certified Asphalt Technician Course

Presented by: Dan Livingston and Brian Carlson, Rieth-Riley Construction

Safety

The contents of this presentation may not meet all requirements of your company's safety policies or procedures.

Please be sure to follow your company's safety protocol

Always wear the proper PPE

- Gloves
- Hard hats
- Hearing protection
- Reflective vest
- Safety glasses
- Burn sleeves
- Quality firm leather boots
- Respirator
- Dust masks

Stretch and Flex

Muscle strains and sprains are the leading cause of injury in our industry.

ASPHALT PAVEMENT ASSOCIATION of INDIANA

Asphalt Binder Sampling

- Wear proper PPE
  - Safety glasses, face shield, gloves, burn sleeves, hard hat
- Have a proper sampling valve
  - Straham valves or Safe Sampler are the best.
- Do not heat unless absolutely necessary.
- Make sure the sample cans or drain off buckets do not have moisture or other foreign substances in them.

INDIANA DEPARTMENT OF TRANSPORTATION INDOT

APAI ASPHALT PAVEMENT ASSOCIATION of INDIANA

Asphalt Safety

There are two main types of safety hazards in the Asphalt and Paving Industry:

1. **Fire including explosion hazards**
2. **Health hazards including eye contact, skin contact, or inhalation of fumes**

The Asphalt Institute Binder Safety Video:

https://www.youtube.com/watch?v=ia28Y3fR0yk

Fire Hazard

- Fire prevention is extremely important since asphalt products are at high temperatures.
- Control possible ignition sources around asphalt operations are a safety priority. Some sources include:
  - Sparks
  - Electricity
  - Incandescent material
  - Open flames
  - Lighted Cigarettes
  - Other sources

Asphalt Safety Reminders

- Avoid working with any prolonged contact with asphaltic materials and skin.
- Excessive breathing of asphalt materials should be avoided
- Wear PPE to protect against asphalt splatters.
- When chipping or chiseling old asphalt, wear eye protection. Use proper tools to remove old asphalt. Don't chisel with a carpenter's hammer.
- Store all asphalt materials away from high heat. Keep solvent-tinned materials away from open flames.
- Close containers after each use. Make sure all containers are properly marked.
- Always follow the manufacturer's recommendations for the product being used.

Aggregate Sampling Safety

- Wear proper PPE – gloves, hard hat, vest, boots
- Make sure the plant and loader operator know you will be sampling stockpiles
- Watch for undercut stockpiles
- Turn on proper vehicle lighting
- Park in a manner that protects you from traffic
- Follow proper sampling procedures
- Do not climb any stockpile

There is no reason to lift 80-100 lbs of aggregate. Use multiple buckets/bags/pans to reduce risk of injury

Belt Sampling

- Wear proper PPE – gloves, hard hat, vest, safety lock
- If you must obtain a sample from the belt, please be sure to follow company's lock out tag out procedures prior to sampling

Truck Sampling Safety

- Wear proper PPE – gloves, safety vest, hard hat, safety glasses
- Sampling Rack Safety:
  - Have a sample rack that is an adequate height for your needs. Note: single axles are not the same height as triaxles
  - Do not get on the rack until the truck is parked
  - Have a proper railing or chain to keep you from falling off the rack
  - Do not get in the truck bed
  - Use caution when descending ladders or stairs on the sample rack with the mix sample.

Field Sampling Safety - Cores

- Wear proper PPE – gloves, safety vest, hard hat, safety glasses
- **Always be aware of your surroundings!**
- Don’t walk between vehicles and equipment.
- Make contact with the truck driver so they are aware you will be there. Do not assume they see you.
- Make sure the core rig is rated for the size of cores that need to be cut.
- Let the core machine do the cutting for you.
- When coring, watch your foot placement. If the bit gets in a bind the machine can take off spinning on its own.

Field Sampling Safety – Plates

- Wear proper PPE – gloves, safety vest, hard hat, safety glasses
- **Always be aware of your surroundings!**
- Don't walk between vehicles and equipment.
- Make contact with the truck driver and operators in the area so they are aware you will be there. Do not assume they see you.

Pulling plates is a team effort!

Laboratory Safety

Wear proper PPE for the task you will perform.

- Gyratory samples are put into molds that can be taller than some gloves. Be sure to wear long sleeves or arm protection to prevent burns.

- Shaking aggregates can cause a lot of dust. Wear a dust mask to help prevent silica exposure.

ASPHALT PAVEMENT ASSOCIATION of INDIANA

Laboratory Safety

- Asphalt binder content can be obtained by performing one of two methods in Indiana, ignition furnace and chemical extraction.

  - Ignition furnaces can burn around 1,000°F (538°C) and vary but is typically between 392°F (200°C) and 1,202°F (650°C).

  - Extractions should be performed in well-ventilated areas and care should be taken with chemicals.

  - Follow your lab safety procedures according to the method you are using

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Extraction Solvent Safety - Trichlorethylene

Hazard Statements
Causes skin irritation
Causes serious eye irritation
May cause an allergic skin reaction
May cause drowsiness or dizziness
Suspected of causing genetic defects
May cause cancer
May cause damage to organs through prolonged or repeated exposure

Precautionary Statements
Prevention
Obtain special instructions before use
Do not handle until all safety precautions have been read and understood
Use personal protective equipment as required
Wash face, hands and any exposed skin thoroughly after handling
Contaminated work clothing should not be allowed out of the workplace
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Response
IF exposed or concerned: Get medical attention/advice
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN: Wash with plenty of soap and water
Take off contaminated clothing and wash before reuse
If skin irritation or rash occurs: Get medical advice/attention
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Harmful to aquatic life with long lasting effects
WARNING. Cancer and Reproductive Harm - https://www.p65warnings.ca.gov/.

Extraction Solvent Safety – Citrus Based Solvents

DANGER!

Graphical Indications of Hazards

Indication of Principle Danger:
F – Flammable
N – Dangerous to the Environment
Xn – Harmful

Most Important Hazards (R Phrases):
R10 – Flammable
R38 – Irritating Skin
R43 – May Cause sensitization by skin contact
R50/53 – Very toxic to aquatic organisms; may cause long term adverse effects in the aquatic environment
R65 – Harmful: may cause lung damage if swallowed

Hazard Statements:
H226 – Flammable liquid and vapor
H304 – May be fatal if swallowed and enters airways
H315 – Causes skin irritation
H317 – May cause an allergic skin reaction
H400 – Very toxic to aquatic life
H410 – Very toxic to aquatic life with long lasting effects

Precautionary Statements:
P210 – Keep away from heat/sparks/open flames/hot surfaces. — No smoking
P233 – Keep container tightly closed
P240 – Ground/bond container and receiving equipment
P241 – Use explosion-proof electrical/ventilating/lighting/equipment
P242 – Use only non-sparking tools
P243 – Take precautionary measures against static discharge
P261 – Avoid breathing dust/fume/gas/mist/vapours/spray
P264 – Wash contaminated items thoroughly after handling
P272 – Contaminated work clothing should not be allowed out of the workplace
P273 – Avoid release to the environment
P280 – Wear protective gloves/protective clothing/eye protection/face protection
P301 + P310 – IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician
P302 + P352 – IF ON SKIN: Wash with plenty of soap and water
P303 + P361 +P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P321 - Specific treatment. See first aid instructions.
P331 – Do NOT induce vomiting
P332 + P313 – If skin irritation occurs: Get medical advice/attention
P362 – Take off contaminated clothing and wash before reuse
P363 – Wash contaminated clothing before reuse
P370 + P378 – In case of fire: Use carbon dioxide, foam or dry chemical for extinction
P391 – Collect spillage
P403 + P235 - Store in a well-ventilated place. Keep cool.
P405 – Store locked up
501 – Dispose of contents/container in accordance with local/regional/national/international regulations.

Questions?

Chapter Three

Aggregate Fundamentals for Asphalt Mixtures

INDOT Certified Asphalt Technician Course

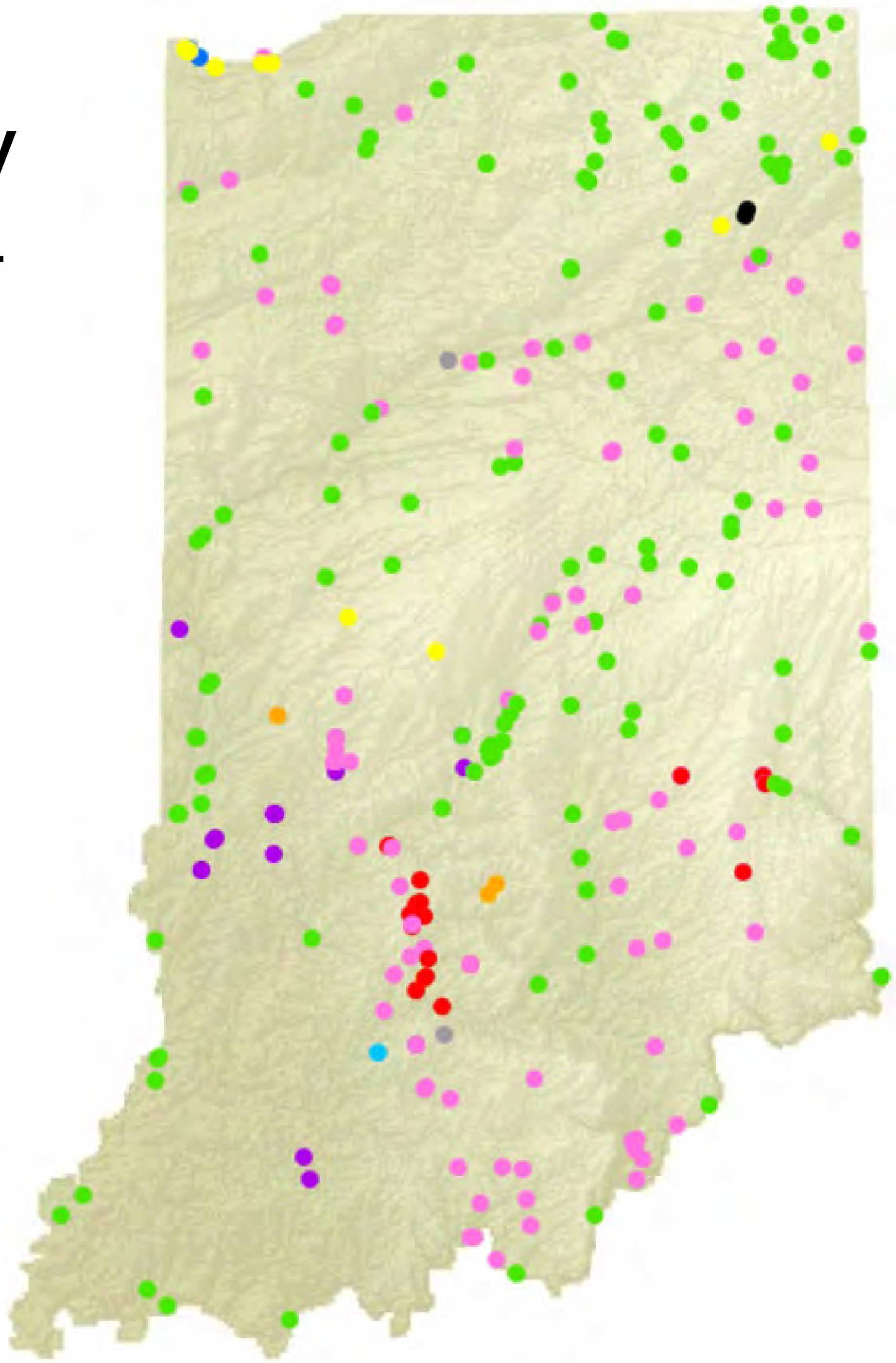
Presented by: Matt Beeson, INDOT and Erick Patton, Brooks Construction

Overview

- Types of aggregates in Indiana
- Aggregate properties and why they are important to asphalt mixtures
- Aggregate stockpiling and best practices
- Sampling aggregates

Indiana Geology

Differences in geology in Indiana means differences in aggregate physical properties and variation in product type



Active Industrial Mineral Operations (2016)

Industrial Minerals (Active 2016)

- Cement
- Clay and Shale
- Crushed Stone
- Dimension Limestone
- Dimension Sandstone
- Gypsum
- Lime
- Peat
- Sand & Gravel (Construction)
- Slag

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Aggregate Types

The aggregates used in highway construction are mineral aggregates. There are two distinct types: natural and artificial.

Natural aggregates are rock, or stone used in their natural state. These include crushed stone, sand, and gravel.

Artificial aggregates are processed materials, like blast furnace slag or steel slag.

Sand

Gravel

Crushed Stone

Slag

Natural Sand and Gravel

Natural sand and gravels are mined from water filled pits, sand bars, and gravel banks.

Crushed Stone

Crushed stone is mined in quarries.

Bedrock is blasted and trucked to the primary crusher.

Indiana bedrock primarily consists of limestone and dolostone (dolomite).

Crushed Stone

Stone is processed by crushing, screening, and washing to produce desired size and gradation.

These aggregates are angular in shape and all faces of the fragments are created by the crushing operation.

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Slag

Slag is a by-product of the manufacturing of steel. It is a recycled, man-made material used as an aggregate in asphalt mixtures. There are two types of slag used in Indiana:

1. Blast Furnace Slag – a non-metallic material removed in the molten state of iron production. These can result in air cooled slag, expanded slag, or granulated slag.
2. Steel Slag – a material derived from the further refinement of iron to steel.

Classification of Aggregates

Aggregates are separated into two classifications: coarse and fine aggregates.

The No. 4 sieve generally determines the difference between coarse aggregates and fine aggregates.

Sieve Size Definition

Aggregate sizes are based off the gradation of the aggregates.

Gradation is determined by a sieve or gradation analysis. A sieve analysis requires passing the sample through a series of sieves, each of which has opening of specific sizes.

Sieve openings are defined in ASTM using the size of the openings for ¼" or larger.

Finer sieves are determined by the number of openings per linear inch.

For example, a No. 4 sieve has four openings every linear inch.

ASTM E11 Test Sieves

	Standard	U.S. Alternative
Coarse Series	100.0mm	4in
Coarse Series	90.0mm	3-1/2in
Coarse Series	75.0mm	3in
Coarse Series	63.0mm	2-1/2in
Coarse Series	50.0mm	2in
Coarse Series	37.5mm	1-1/2in
Coarse Series	25.0mm	1in
Coarse Series	19.0mm	3/4in
Coarse Series	12.5mm	1/2in
Coarse Series	9.5mm	3/8in
Coarse Series	4.75mm	No.4
Fine Series	2.36mm	No.8
Fine Series	1.18mm	No.16
Fine Series	600µm	No.30
Fine Series	300µm	No.50
Fine Series	150µm	No.100
Fine Series	75µm	No.200

https://www.globalgilson.com/blog/sieve-sizes

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Classification of Aggregates

- Coarse Aggregate: an aggregate that has a minimum of 20% retained on the No. 4 sieve (4.75 mm)
  - Section 904.03 defines the acceptable limits for coarse aggregate classes
  - Divided into classes based on test result limits

- Fine Aggregate: an aggregate that is 100% passing the 3/8 in.
  - Section 904.02 outlines specification requirements for fine aggregates

Sieve Analysis

- Sieve analysis is used to detmine the particle-size distribution of materials. This test is conduced on both fine and coarse aggregates in accordance with AASHTO T27, with exception in 904.06.
- The procedure is as follows:

1. The dried sample is placed in the top of the nested sieves.
2. The shaking time is to be sufficient to ensure the sample is divided into fractional sizes. The actual shaking time is required to be in accordance with ITM 906. Minimum shaking times are:

Coarse Aggregate, Size 9 or larger	5 minutes
Coarse Aggregate, Smaller than Size 9	10 minutes
Fine Aggregates	15 minutes

Sieve Analysis

3. At the end of sieving, the material retained on each sieve is carefully transferred to a weigh pan and weighed. The weight retained on each sieve is recorded on a gradation analysis sheet. The weight may not exceed the allowable amount on each sieve as indicated in this table.

APPROXIMATE SIEVE SIZE OVERLOAD				
SCREEN SIZE	STANDARD 15 in x 23 in	STANDARD 14 in x 14 in	12 in DIAMETER	8 in DIAMETER
3 in	40.5 kg	23.0 kg	12.6 kg	---
2 in	27.0 kg	15.3 kg	8.4 kg	3.6 kg
1-1/2 in	20.2 kg	11.5 kg	6.3 kg	2.7 kg
1 in	13.5 kg	7.7 kg	4.2 kg	1.8 kg
¾ in	10.2 kg	5.8 kg	3.2 kg	1.4 kg
½ in	6.7 kg	3.8 kg	2.1 kg	890 g
3/8 in	5.1 kg	2.9 kg	1.6 kg	670 g
No. 4	2.6 kg	1.5 kg	800 g	330 g
8 in diameter sieves, No. 8 to No. 200 shall not exceed 200 g/sieve				
12 in diameter sieves, No. 8 to No. 200 shall not exceed 469 g/sieve				

Aggregate Classifications

Coarse Aggregates

- Assigned to quality classes
- Based on physical quality properties, graded size, and eventual end use of the material

Fine Aggregates

- Not divided into classes
- Quality ratings on fine aggregate no longer included on INDOT reports

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Classes of Coarse Aggregates

TYPE OF CONSTRUCTION	REQUIRED QUALITY CLASS
Aggregate Base	Class A, B, C, or D
Subbase	Class A or B (No. 8) Class A, B, C, or D (No. 53)
Aggregate Pavements or shoulders	Class A, B, C, or D
HMA Base Course	Class A, B, C, or D
HMA Intermediate Course	Class A, B, or C
HMA Surface Course	Class A or B
SMA Surface Course	Class AS
Asphalt Seal Coat	Class A or B
Portland Cement concrete pavement	Class AP
Portland Cement concrete structural-exposed	Class A or AP
Portland Cement concrete structural-non-exposed	Class A or B
Cover (choke) aggregates coarse aggregate	Class A or B

Class AS Requirements

- Order of Classes from highest quality down:
  - AS
  - A
  - B
  - C
  - D
- Class AS: **A** for **S**MA (Stone Matrix/Mastic Asphalt) pavements

Sizes of Coarse Aggregates 904.03(e)

(e) Sizes of Coarse Aggregates

Sieve Sizes	Coarse Aggregate Sizes (Percent Passing)											
	Coarse Graded										Dense Graded	
	2	**5**	**8**	**9**	**11, SC 11[5]**	**12, SC 12[5]**	**SC 16[5]**	**43[1]**	**91**	**93PG[6]**	**53[1]**	**73[1]**
4 in. (100 mm)												
3 1/2 in. (90 mm)												
2 1/2 in. (63 mm)	100											
2 in. (50 mm)	80 - 100											
1 1/2 in. (37.5 mm)		100						100			100	
1 in. (25 mm)	0 - 25	85 - 98	100					70 - 90	100		80 - 100	100
3/4 in. (19 mm)	0 - 10	60 - 85	75 - 95	100				50 - 70			70 - 90	90 - 100
1/2 in. (12.5 mm)	0 - 7	30 - 60	40 - 70	60 - 85	100	100	100	35 - 50		98 - 100	55 - 80	60 - 90
3/8 in. (9.5 mm)		15 - 45	20 - 50	30 - 60	75 - 95	95 - 100	94 - 100			75 - 100		
No. 4 (4.75 mm)		0 - 15	0 - 15	0 - 15	10 - 30	50 - 80	15 - 45	20 - 40		10 - 60	35 - 60	35 - 60
No. 8 (2.36 mm)		0 - 10	0 - 10	0 - 10	0 - 10	0 - 35		15 - 35		0 - 15	25 - 50	
No. 16 (1.18 mm)							0 - 4					
No. 30 (600 µm)						0 - 4		5 - 20		0 - 5	12 - 30	12 - 30
No. 200 (75 µm)[2]								0 - 6.0			5.0 - 13.0[4]	5.0 - 12.0
Decant (PCC)[3]		0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5			0 - 1.5			
Decant (Non-PCC)	0 - 2.5	0 - 2.5	0 - 3.0	0 - 2.5	0 - 2.5	0 - 2.0			0 - 2.5	0 -2.0		
Decant (SC)					0 - 1.5	0 - 1.5	0 - 1.5					

Sizes of Fine Aggregates – 904.02(h)

(h) Sizes of Fine Aggregates

	Sizes (Percent Passing)					
Sieve Sizes	**23**	**24**	**15**	**16**	**PP**	**S&I**
3/8 in. (9.5 mm)	100	100				100
No. 4 (4.75 mm)	95 - 100	95 - 100			100	
No. 6 (3.35 mm)			100			
No. 8 (2.36 mm)	80 - 100	70 - 100	90 - 100		85 - 95	
No. 16 (1.18 mm)	50 - 85	40 - 80				
No. 30 (600 µm)	25 - 60	20 - 60	50 - 75	100	50 - 65	
No. 50 (300 µm)	5 - 30	7 - 40	15 - 40		15 - 25	0 - 30
No. 80 (180 µm)				95 - 100		
No. 100 (150 µm)	0 - 10	1 - 20	0 - 10		0 - 10	
No. 200 (75 µm)	0 - 3	0 - 6	0 - 3	65 - 100		0 - 7

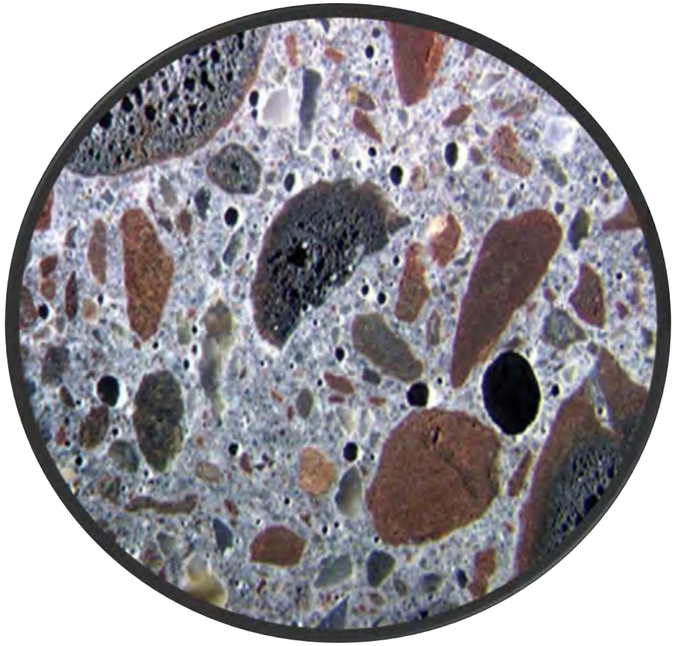
Physical Properties

Physical properties are those that refer to the physical structure of the particles that make up the aggregate. These are specific properties to the geologic makeup of the quarry or pit.

- Absorption
- Specific Gravity
- Surface Texture
- Abrasion Resistance
- Soundness
- Particle Shape
- Deleterious Materials

Absorption

- Aggregates with very high absorption are not desirable in most asphalt applications because they will have an increased liquid asphalt binder demand.
- Some aggregates with very high absorption may continue to absorb binder after initial mixing.
- Absorption is a particle's ability to take in a liquid.
- Permeability is a particle's ability to allow liquid to pass through.

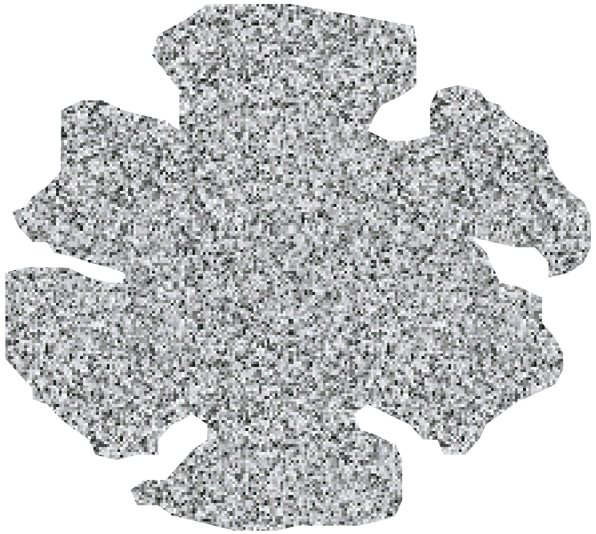


The size, number and continuity of the pores affect other properties

Specific Gravity

- Specific gravity is the ratio of the density of the substance to the density of water.
- This should not be confused with density.
- Density is the weight per unit of volume of a substance.
- There are different types of specific gravity.

Specific Gravity



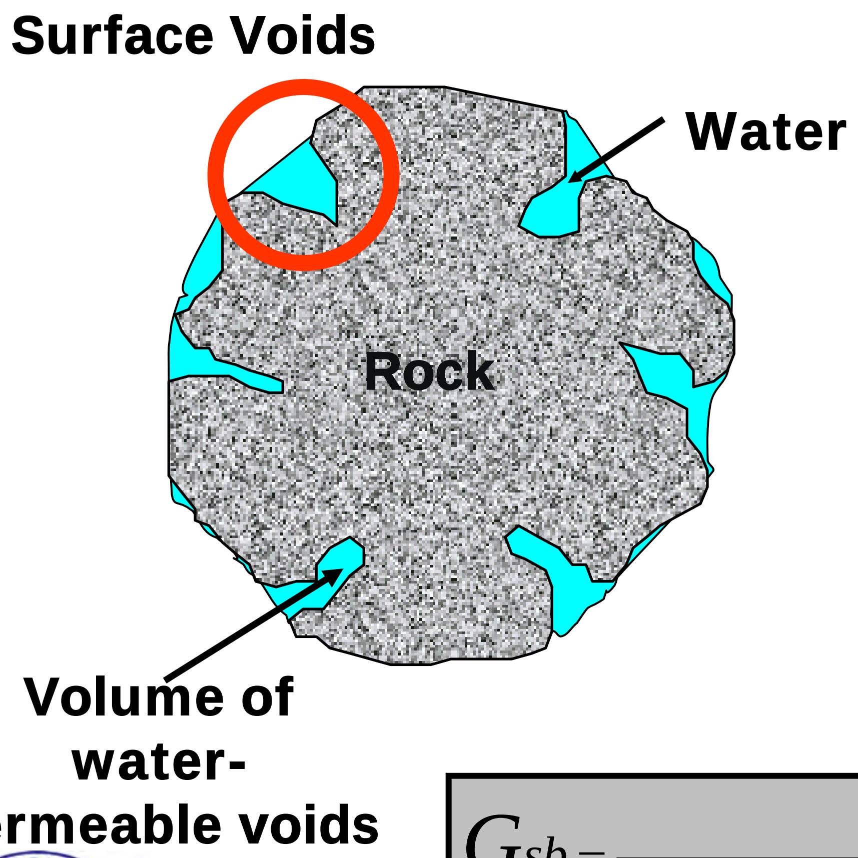
Apparent Specific Gravity: The ratio of a volume of the impermeable portion of the aggregate to the weight of an equal volume of water.

Considerations:

- Mass of oven dry rock
- Volume of solid rock only

$$G_{sa} = \frac{Mass\ of\ Oven\ Dry\ Aggregate}{(Volume\ of\ Oven\ Dry\ Aggregate)\ x\ (Unit\ Weight\ of\ Water)}$$

Specific Gravity



Bulk Specific Gravity: The ratio the weight of a volume of aggregate to the weight of an equal volume of water.

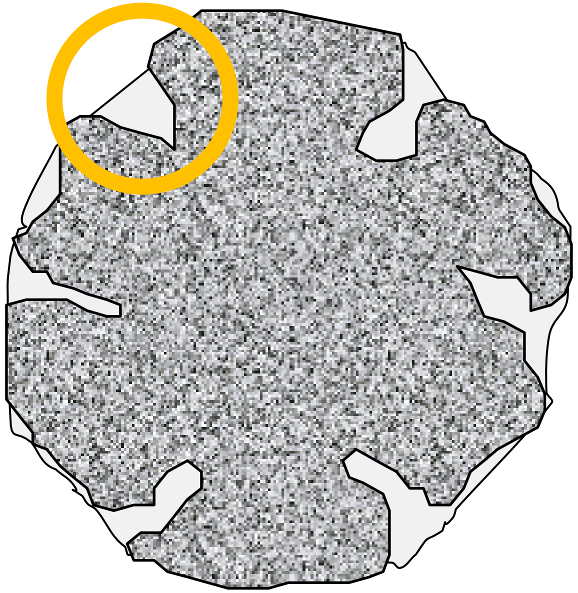
Considerations:

- Mass of oven dry rock
- Volume of solid rock
- Volume of external voids

$$G_{sb} = \frac{Mass\ of\ Oven\ Dry\ Aggregate}{(Volume\ of\ Aggregate + Volume\ of\ Voids)\ x\ (Unit\ Weight\ of\ Water)}$$

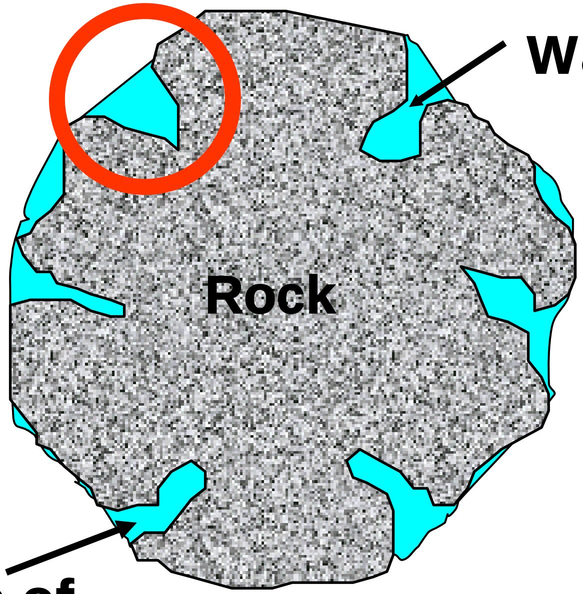
Absorption

Surface Voids



Absorption: The increase in mass due to water in the pores of material.

SSD



Saturated, Surface Dry (SSD): The condition in which the aggregate has been soaked in water and has absorbed water into its pore spaces. The excess, free surface moisture has been removed so that the particles are still saturated, but the surface of the particle is essentially dry.

Considerations:

- Mass of oven dry rock
- Mass of absorbed water
- Volume of solid rock
- Volume of external voids

$$G_{SSD} = \frac{Mass\ of\ Oven\ Dry\ Aggregate + Mass\ of\ Absorbed\ Water}{(Volume\ of\ Aggregate + Volume\ of\ Voids)\ x\ (Unit\ Weight\ of\ Water)}$$

Specific Gravity Calculation

Bulk Specific Gravity (G_{sb})

$$G_{sb} = \frac{A}{(B - C)}$$

Bulk SSD Specific Gravity (G_{sb} SSD)

$$G_{sb}\ SSD = \frac{B}{(B - C)}$$

Apparent Specific Gravity (G_{sa})

$$G_{sa} = \frac{A}{(A - C)}$$

Absorption (% Abs)

$$\%\ Abs = \frac{B - A}{A} \times 100$$

A = Oven Dry Weight in air, g

B = Saturated Surface-Dry (SSD) Weight in air , g

C = Weight in Water, g

Specific Gravity of Common Materials

Substance	Specific Gravity
Wood (Oak)	0.7
Water	1.0
Coal	1.6
Blast Furnace Slag	2.4
Limestone	2.6
Quartz	2.6
Shale	2.6
Gravel	2.7
Trap Rock	2.9
Steel Slag	3.5
Iron	7.9
Lead	11.4
Gold	19.3

Specific Gravity

- Specific gravity is very important in asphalt mixtures.
- This property, along with absorption, can help determine the amount of liquid asphalt binder is needed to meet the specifications.
- Mixtures are measured and specified using volumes but are tested with weights. Specific gravity allows us to convert between weight and volume.
- The Specific Gravity test is measured with AASHTO T85 for coarse aggregate and AASHTO T84 for fine aggregate.

Specific Gravity

- Specification and Reporting
  - Report all specific gravity value to the nearest 0.001
  - Report absorption to the nearest 0.1%
  - Absorption for use in asphalt < 5.0%

<u>NOTE</u>: $G_{sb} > G_{se} > G_{sa}$

Surface Texture

- Surface texture is the pattern and relative roughness or smoothness of the aggregate particle.
- This plays a big role in developing the bond between and aggregate particle and liquid asphalt binder. A rough surface texture gives the liquid asphalt binder something to grip for a stronger bond.
- Some aggregates may have good surface texture initially but polish later under traffic. These aggregates are unacceptable for final surface mixtures.

Abrasion Resistance

- This is an aggregate’s ability to resist destruction by mechanical means. These means include the process of mixing at the asphalt plant, rolling of the mat during the paving process, and under traffic through the service life of the pavement.
- The Los Angles (LA) Abrasion test, in accordance with AASHTO T96, provides a percent loss value. Different classifications of aggregates have different maximum LA Abrasion values dependent on the mixture application.
- This is a value provided to you by the CAPP source on coarse aggregates.

Abrasion Resistance

- Material is placed in a revolving steel drum
- 6-12 steel balls are used, depending on top size of aggregate
- 500 revolutions @ 32 RPMs
- Calculate the percent of material lost through a No. 12 sieve

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Abrasion Resistance

- Class AS requirements are the same quality requirements as Class A except the LA Abrasion is no more than 30% and designed in accordance with ITM 220.
- ITM 220 has a requirement for Class AS aggregates to be tested for Micro-Deval abrasion.
- Micro-Deval is a test on coarse aggregates for abrasion loss in the presence of water. The aggregate sample is separated into different size fractions and soaked for at least one hour. Smaller sized balls than the LA test are put in the apparatus and rotated 100 RPMs for up to 2 hours.
- Like the LA Abrasion test, the sample is washed dried, and a percent loss by mass is calculated.

Soundness

- Extreme weather conditions can cause aggregate breakdown, especially in asphalt surface mixtures.
- Testing is performed to measure the aggregate's ability to resist these harsh conditions, such as freeze-thaw cycles and exposure to salts.
- INDOT subjects aggregates to different types of test methods to evaluate soundness:
  - Sodium sulfate AASHTO T 104
  - Brine freezing and thawing test ITM 209
  - Freezing and thawing test AASHTO T103

Soundness

- Material is immersed in water and subjected to 50 cycles of freeze and thaw.
- After completion, the material is dried to a constant weight
- The percent of material lost during the process and calculated for each sieve fraction.

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Particle Shape

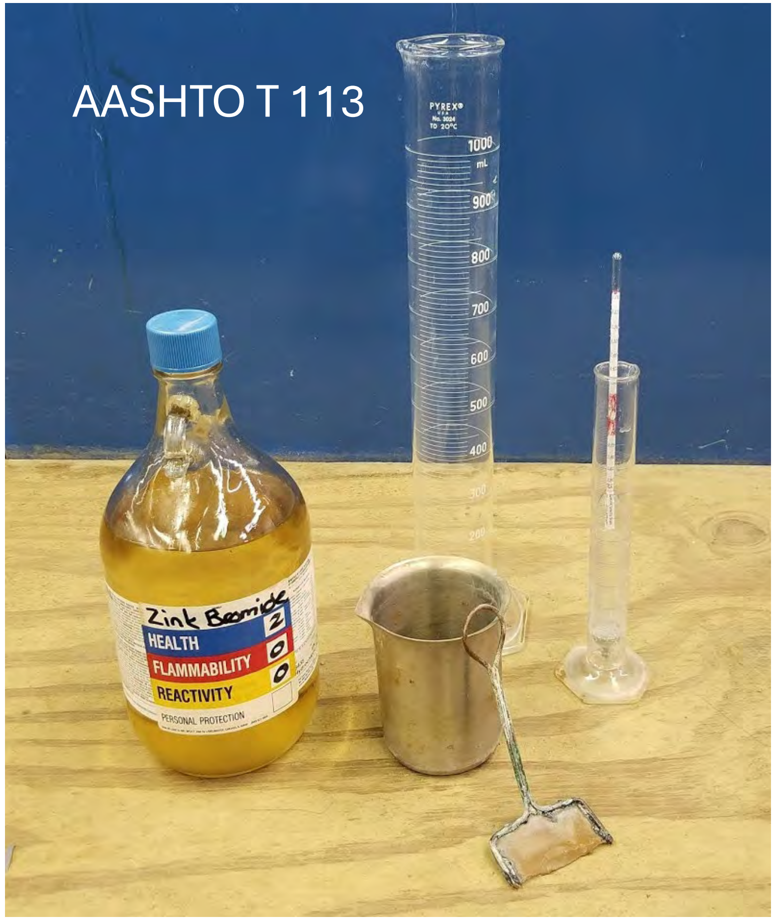
- Aggregates for asphalt mixture are generally grouped into two broad categories: rounded or angular
- Angular particles are newly broken like a crushed stone or crushed gravel.
- Rounded particles come from stream sediments and glacial till in Indiana. These are most commonly natural sands and gravels.
- The shape can greatly affect the workability and the strength of mix.
- Irregular shapes found in crushed materials interlock and are optimal for strength. Rounded particles help workability of the mix. Specifications outline the crushed aggregate requirements for different asphalt mixture application.

Deleterious Materials

- Deleterious materials are materials which are undesirable for use in asphalt mixtures.
- Specifications limit the amount of deleterious material in the final aggregate product.
- Some examples of deleterious include:
  - Chert
  - Shale
  - Wood
  - Trash
  - Coal
  - Limonite
  - Ochre

Chert

- Chert is a rock comprised of microcrystalline silica.
- When lightweight chert (less than 2.450 specific gravity) is present, the chert may undergo expansion enough to cause pop-outs when located close to the surface.
- The binder may also not coat chert particles which can cause raveling of the pavement.
- Limited to 3% maximum in Class A applications.



Consensus Properties

- Consensus properties are properties that are dependent on the supplier and their operating equipment and process.
- These include:
  - Coarse Aggregate Angularity
  - Fine Aggregate Angularity
  - Flat and Elongated particles

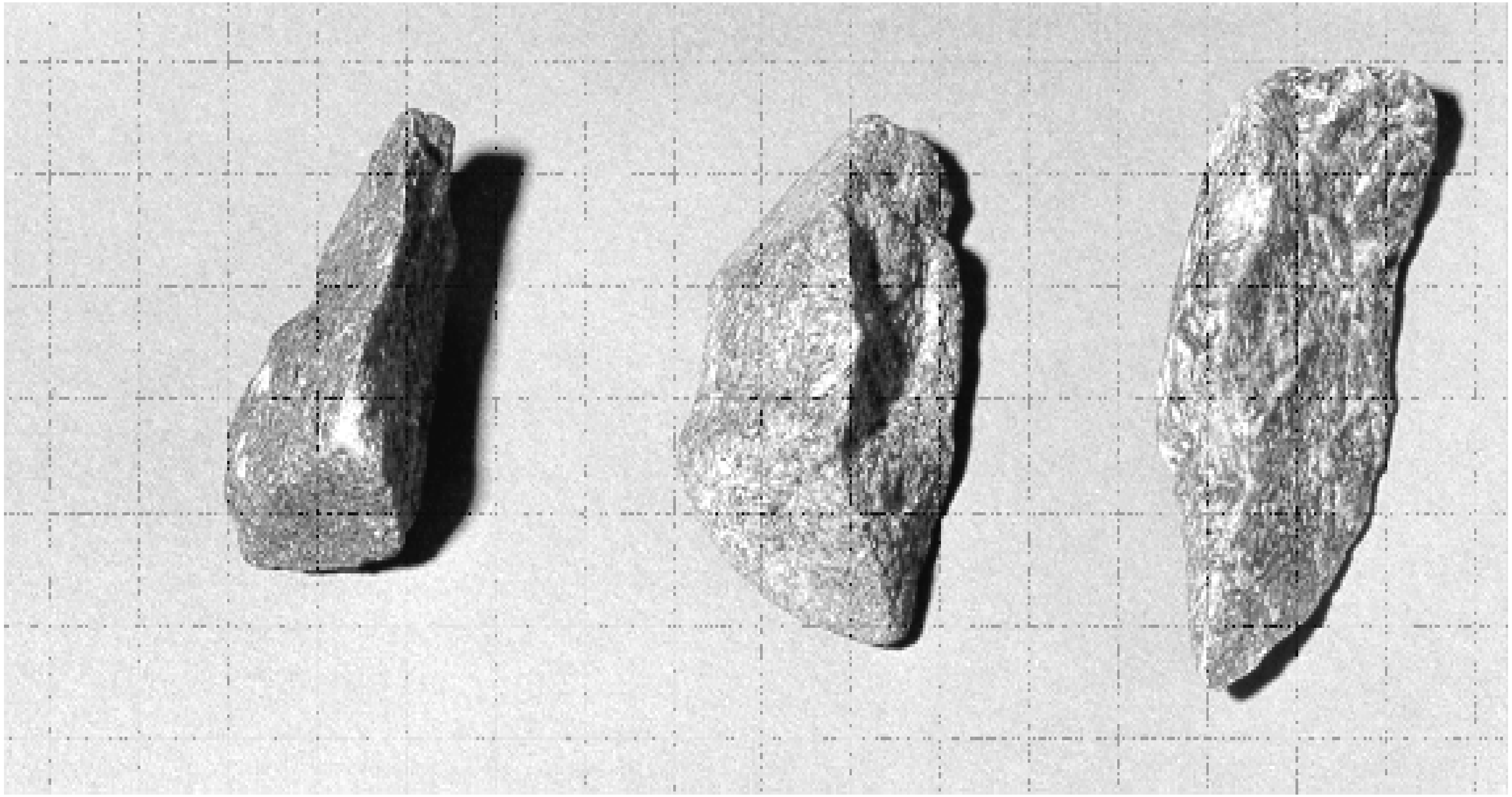
Coarse Aggregate Angularity

- Crushed particles (coarse aggregate angularity) are necessary in asphalt mixtures to assist in resistance to shoving and rutting under traffic.
- The internal friction among the crushed aggregate particles prevents the aggregates from being moved past each other to provide for a stable mix.
- Coarse Aggregate Angularity is performed in accordance with ASTM D5821.

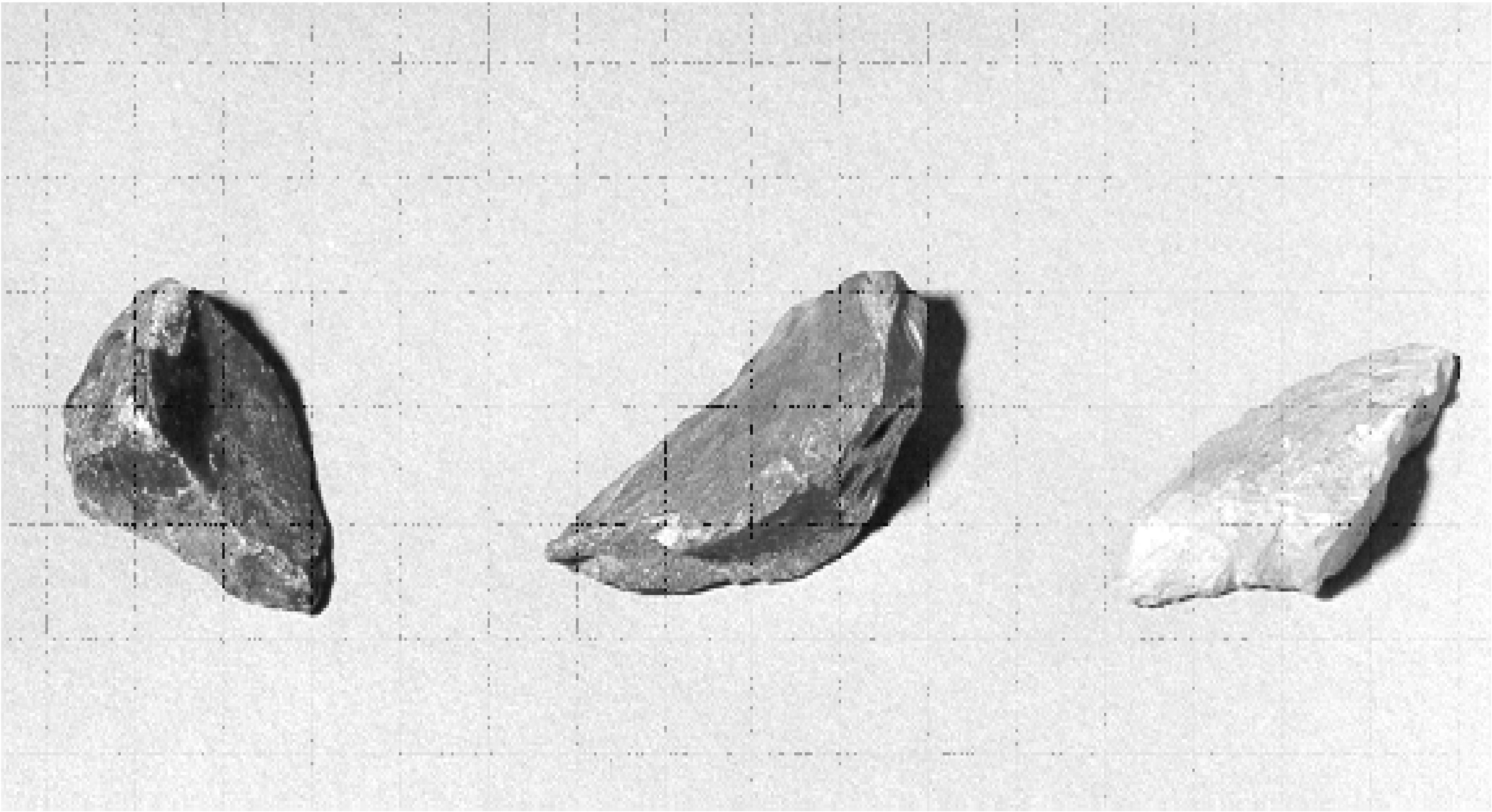
Coarse Aggregate Angularity

- Fractured faces that have an area < 25% of the maximum cross-sectional area of the particle are not considered crushed.
- Stone is defined as being 100% crushed. Crushed particles are defined as having one or more sharp, or slightly blunt edges.
- Coarse Aggregate Angularity is a requirement for asphalt mixtures with gravel.
- This test is performed during the mix design process and in the field labs when testing RAP samples.

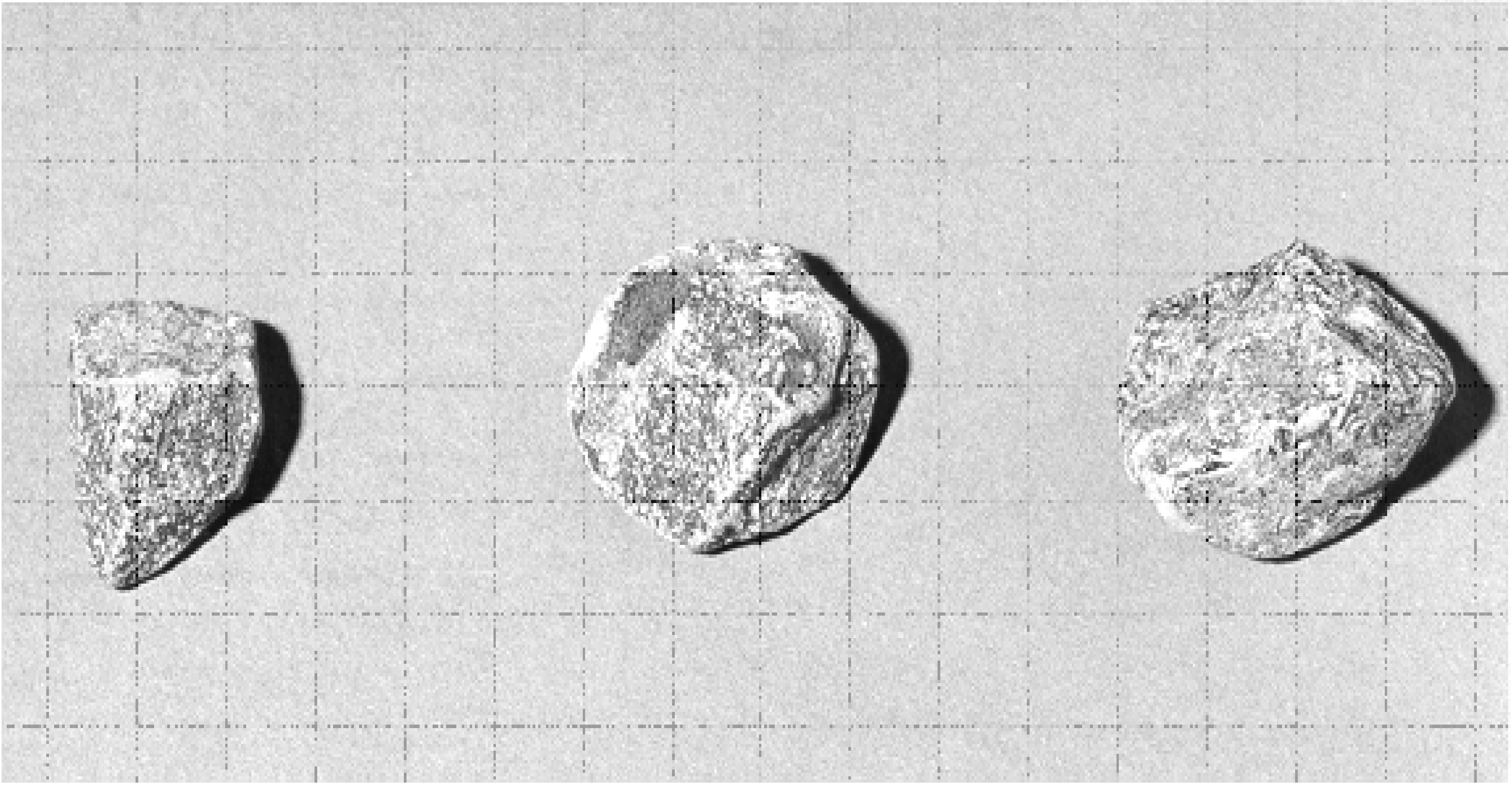
Fractured particle (sharp edges, rough surfaces)



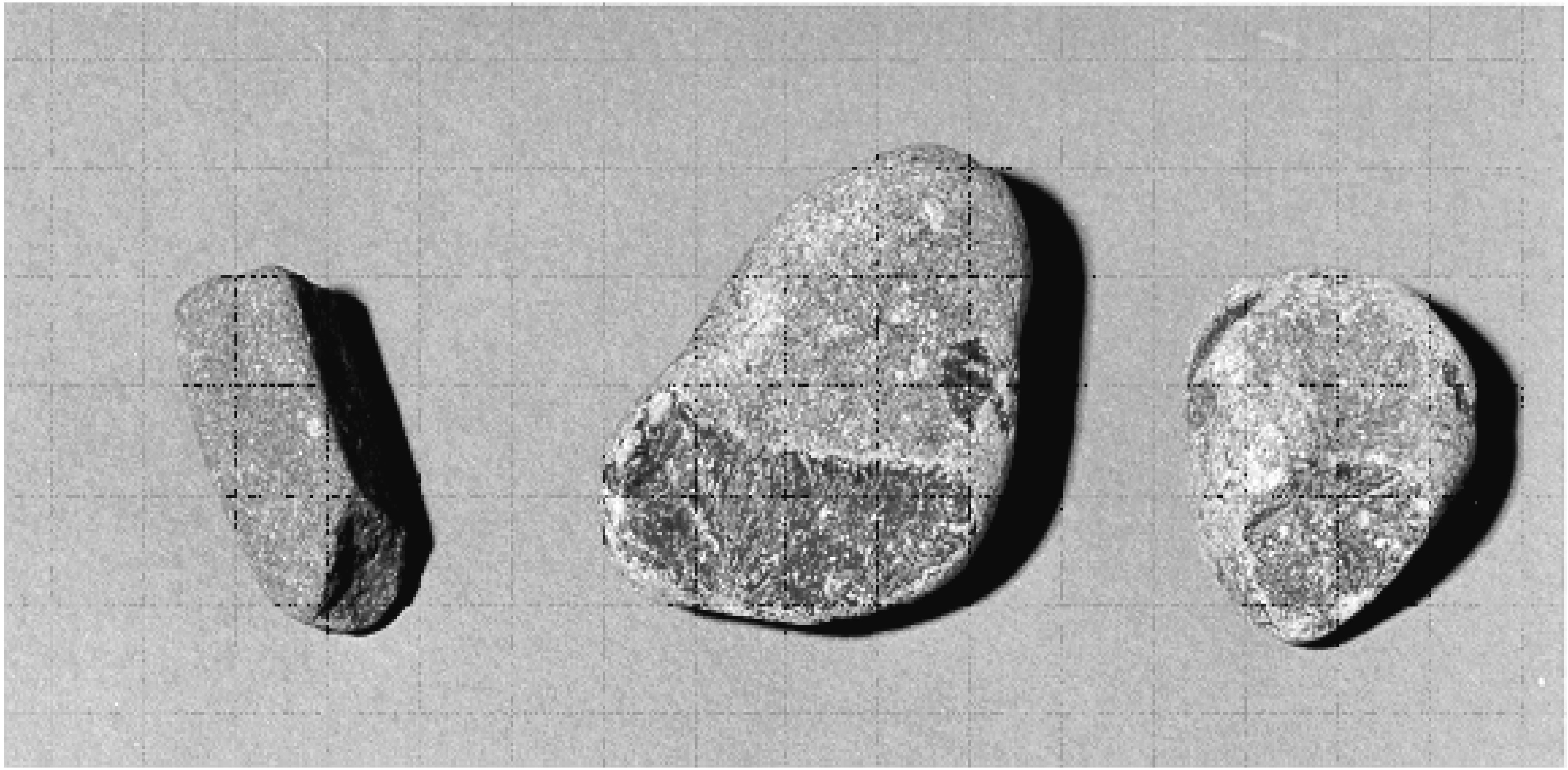
Fractured particle (sharp edges, smooth surfaces)



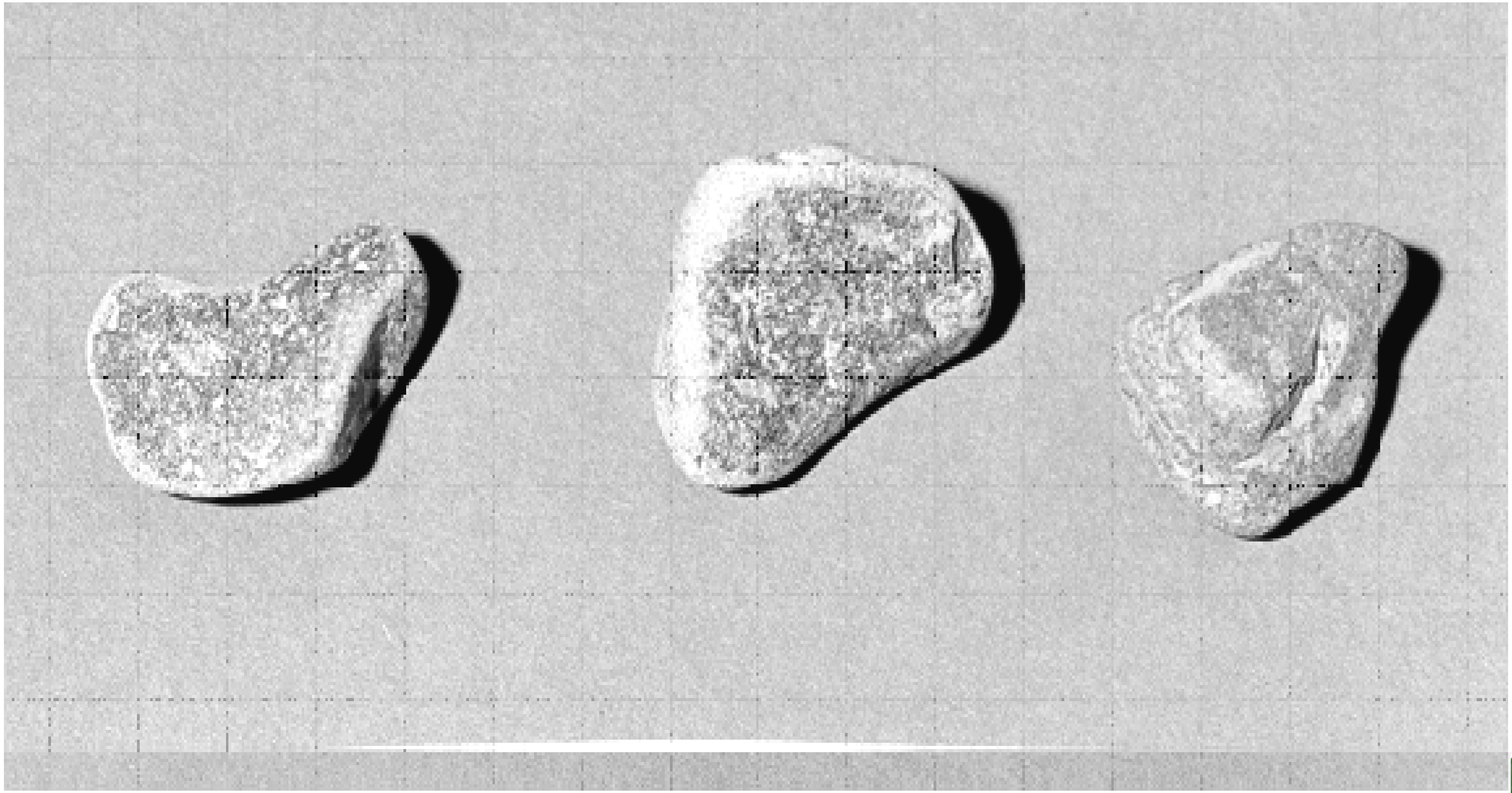
Fractured particle (round edges, rough surfaces)



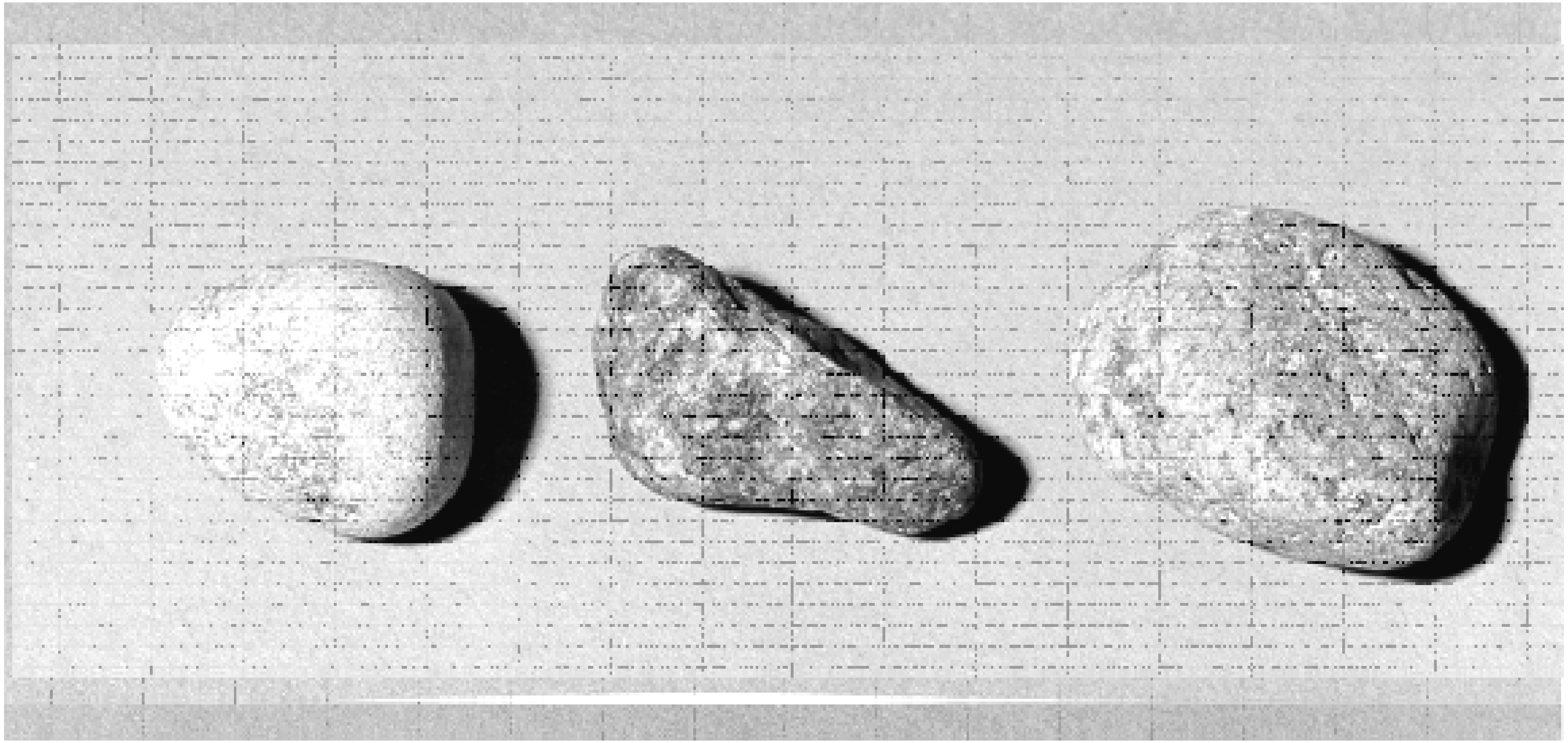
Fractured particle (center) flanked by two non-fractured particles (chipped only)



Non-Fractured particle (round edges, smooth surfaces)



Non-Fractured particle (rounded particles, smooth surfaces).



Calculation

Calculate the percentage of crushed particles with specified number of fractured faces as follows:

$$P = \frac{F}{F + N} \times 100$$

P = percentage of particles with the specified number of faces

F = mass of fractured particles with at least specified number of faces

N = mass of non-fractured particles

Specification Requirement

Section 904.03 (b)

Coarse Aggregate Angularity		
Traffic, ESAL	Depth from Surface	
	≤ 4 in.	> 4 in.
< 3,000,000	75	50
3,000,000 to < 10,000,000	85/80*	60
≥ 10,000,000	95/90*	95/90*
* Denotes two faced crush requirements.		

Fine Aggregate Angularity

- Like the crushed content of coarse aggregate, it is necessary to achieve a high degree of internal friction and high shear strength for rutting resistance within the fine material of the asphalt mixture.
- Fine Aggregate Angularity (FAA) is defined as the percent air voids present in loosely compacted aggregates finer than the No. 8 sieve.
- FAA is determined with the Uncompacted Void Content of Fine Aggregate Test AASHTO T 304.
- This test is performed during the mix design process, but it is important to understand the limits of FAA in a mixture when making mix changes during production.

Fine Aggregate Angularity Calculation

$$U = \frac{V - (F/G)}{V} \times 100$$

U = % Uncompacted Voids in the material

V = Volume of cylindrical measure, mL

F = net mass (g) of fine aggregate in measure (gross mass – mass of empty measure)

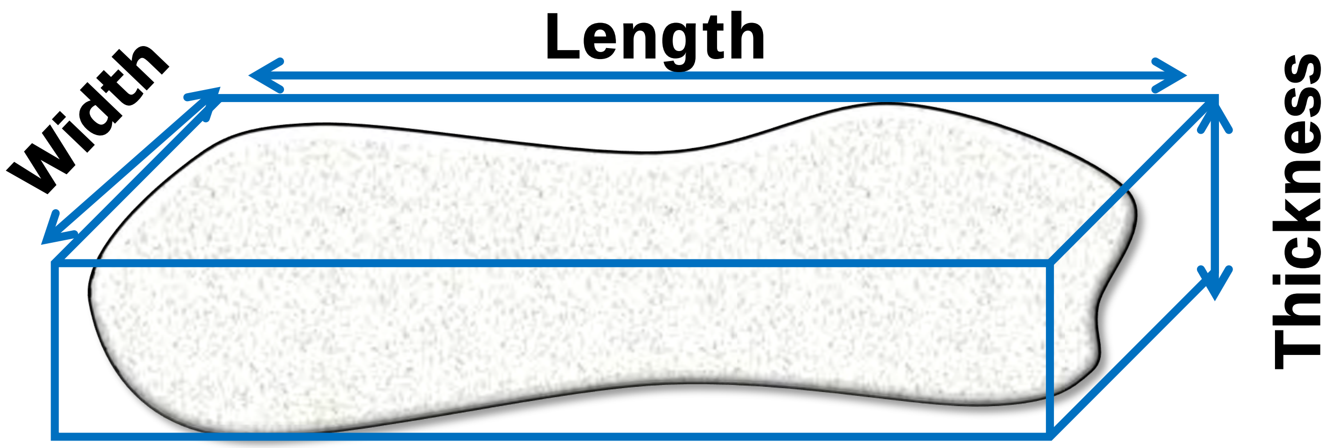
G = bulk dry specific gravity of fine aggregate

Flat and Elongated Particles

- Flat and Elongated particles are undesirable because they tend to break during construction and under traffic. This characteristic is defined as the percentage by weight of coarse aggregates to have a length more than five times its width with ASTM D 4791.

- INDOT specifies < 10% of particles may have a ratio of 5:1.
- Note that some specifications may have a flat, elongated, and/or flat and elongated requirements.

Flat and Elongated Particles



Length = the maximum dimension

Thickness = the maximum dimension perpendicular to the length and width

Width = the maximum dimension in the plane perpendicular to the length

Question: When does segregation/degradation occur?

Segregation

Answer: **Every** time you handle the aggregate!

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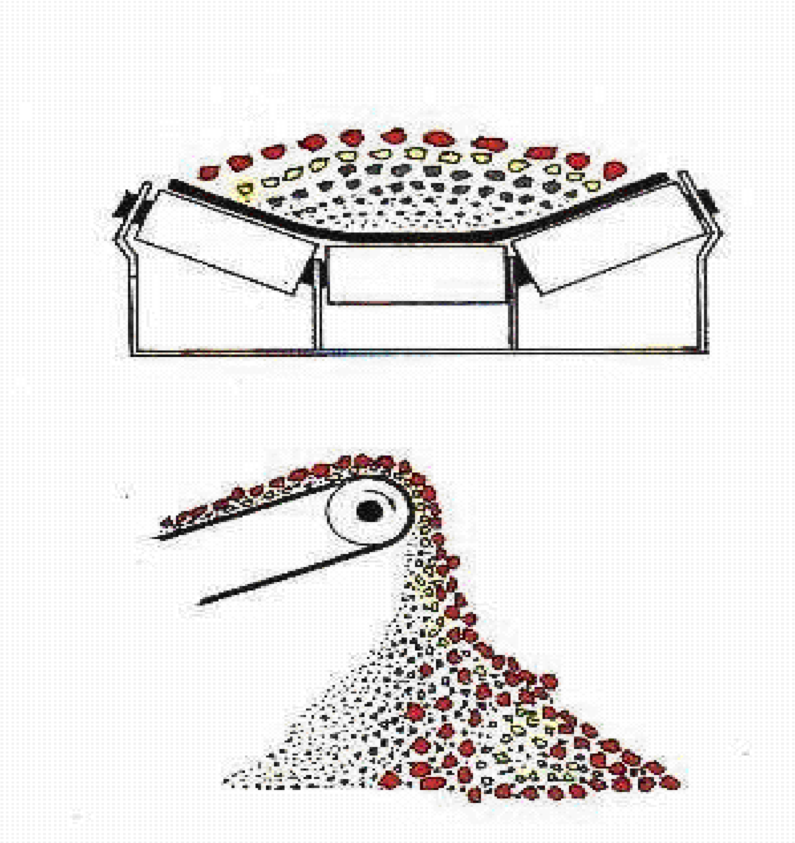
Segregation

- Conveyor Belt Segregation
  - Begins on the belt where the fines vibrate to the bottom and the coarse material remains on the top.
  - At the end of the conveyor if left un-deflected, the coarse materials are thrown out and away. The fine particles drop down or adhere to the belt. Higher speeds increase this affect.



Segregation

- High conveyor drop can cause:
  - Segregation
  - Degradation
  - Loss of fines

Segregation

- Stockpile segregation is the separation of a well graded aggregate into individual sizes due to gravity.
- Segregation is one of the greatest issues of material handling and stockpiling.

Segregation

- Techniques to reduce stockpile segregation may include:
  - Construct truck-built stockpiles one dump high to reduce the amount of roll-down segregation.
  - The one dump high method requires a lot of area in the yard so it may not be practical in some yards. One method you could use is to restock truck dumps on top of other dumps with a front-end loader.
  - The more a stockpile is moved, more fine material is created.
  - Do not drive equipment or vehicles on stockpiles as this will breakdown underlying material.
  - Reduce contamination from other piles or undesirable materials.
  - Label stockpiles to prevent improper stockpiling from incoming trucks.

Sampling Aggregate Stockpiles

Aggregate sampling should be in accordance with ITM 207.

https://youtu.be/5dJw9ld7NPE

Be consistent and uniform with your sampling procedures.

Obtain the most representative sample as possible.

Coarse Aggregate Sampling

1. Locate the area of the stockpile from which plant loading begins.
2. Using a front end-loader, dig into the stockpile and set aside a small pile of 10-15 ton of material. This is required to be done in the same manner as the plant being loaded. When forming the small pile, the loader bucket is required to be as low as possible and the operator is required to roll the material from the bucket rather than dumping. Reducing the distance the material is allowed to free-fall reduces segregation. Each additional bucket load of material is required to be taken and dumped in the same manner above and is required to be placed uniformly over the preceding one.

Coarse Aggregate Sampling

3. Thoroughly mix the small pile. Using the loader bucket, go to the end of the oblong pile and roll over the material. Keep the loader bucket as low as possible, push the bucket into the material until the front of the bucket passes the midpoint of the original pile. The loader bucket is required to then be slowly raised and rolled forward producing a smooth mixing of the material. Go to the opposite end of the pile and repeat.
4. The pile is now ready for sampling. The sampling is taken at the center of the volume which is approximately one-third of the height of the pile. The sample consists of not less than six full shovels of material taken at equal increments around the pile. The shovel is inserted full-depth horizontally into the matier and raised vertically. Care is to be taken to retain as much material on the shove as possible.

Fine Aggregate Sampling

- Fine aggregate is sampled using the same technique as coarse aggregate sampling, except a sampling tube or fire shovel is used instead of the large shovel.

Sample Sizes from Stockpiles

MATERIAL	SAMPLE SIZE
No. 2 Coarse Aggregate	220 lb
No. 5 Coarse Aggregate	110 lb
No. 8 Coarse Aggregate	55 lb
No. 9 Coarse Aggregate	35 lb
No. 11 and No. 12 Coarse Aggregate	25 lb
All Sands	25 lb

The weight of the sample depends on the maximum particle size of the material being tested. As a rule, a larger top size material requires a larger sample. The size of sample for materials that do not meet a specific INDOT size are required to be the same as the INDOT size the aggregate gradation is comparable to.

Reducing to Sample Size

The total sample is required to be recduced to a sample size that may be continually tested. The key to sample reduction is to ensure that the sample remains representative of the material in the stockpile.

AASHTO R 75 details three methods for splitting to the proper test size.

Reducing to Sample Size

1. Using a mechanical splitter is the most accepted method of reducing to test size all coarse aggregate material smaller than a No. 2 gradation.
2. Using a sand splitter is the accepted method for fine aggregate that is drier than the saturated-surface-dry(SSD) condition. As a quick check to determine this condition, if the sand retains the shape molded in the hand, the sand is considered wetter than SSD.
3. The miniature stockpile is the method used for fine aggregate that has free moisture on the particle surfaces.
4. Quartering may be used when a mechanical splitter is not available.

Reducing to Sample Size

AGGREGATE SIZE	MINIMUM (Suggested)	MAXIMUM (Suggested)
No. 2	11,300 g	---
No. 5 and No. 8	6,000 g	8,000 g
No. 9	4,000 g	6,000 g
No. 11	2,000 g	---
No. 12	1,000 g	---
Fine Aggregate	300 g	---

Remember, only lift to your capability.

Split the minimum amount into multiple bags/buckets as needed.

Chapter 4

Gradation Calculation

INDOT Certified Asphalt Technician Course

Presented by: Mike Isaacs, Howard Companies

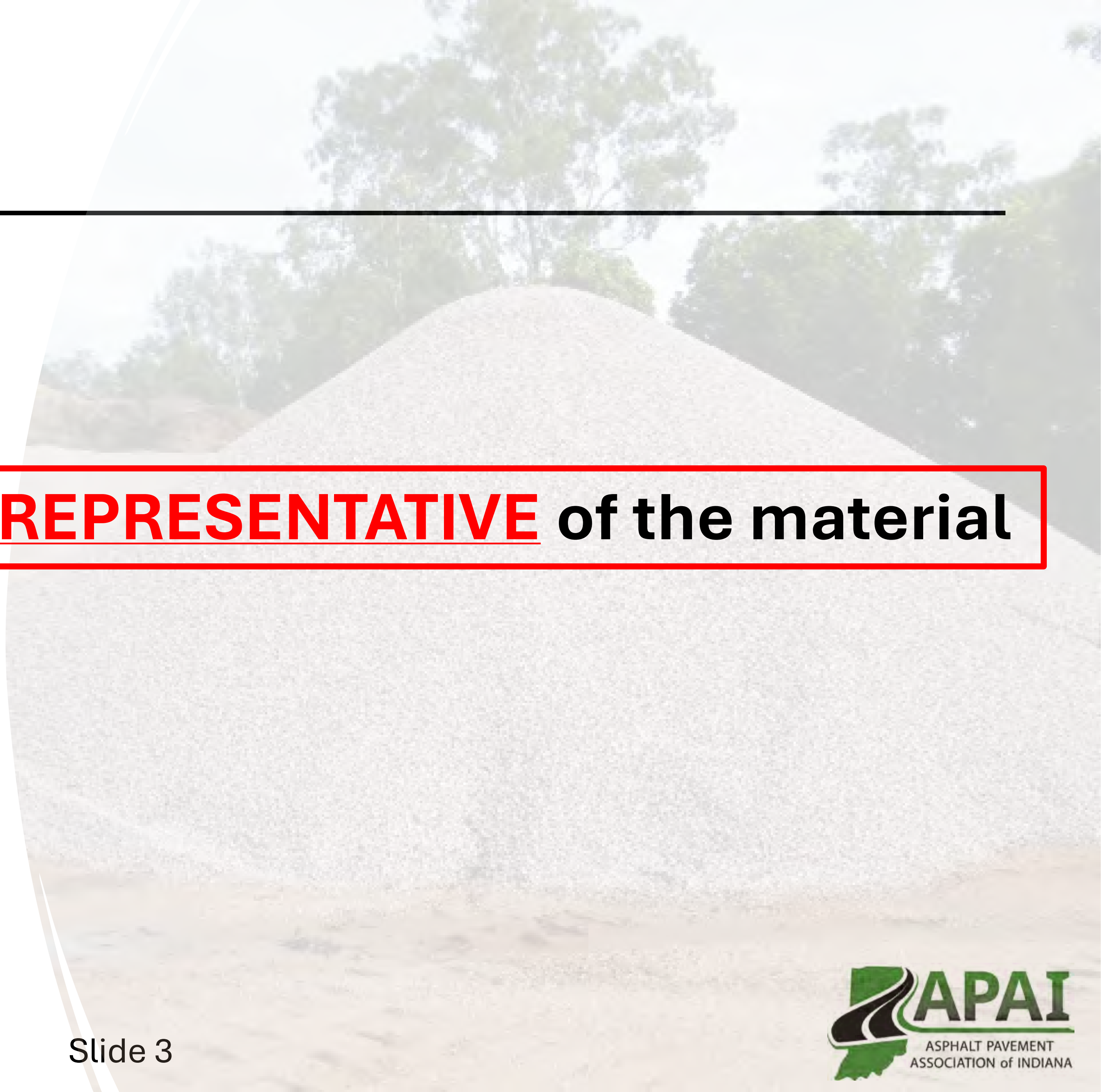
Gradation

- Aggregate Stockpiles
- Recycle material stockpiles (RAP and RAS)
- Asphalt mixture blended aggregates

Gradation

- Aggregate Stockpiles
- Recycle material stockpiles (RAP and RAS)
- Asphalt mixture blended aggregates

Make sure the sample is <u>REPRESENTATIVE</u> of the material



Gradation

- The size of aggregates are dependent on their gradation
- These can be found in section 904 of the INDOT Standard Specifications.
- Note that other projects, like airports, might have different names for the aggregates with different gradations.
- *It is always important to verify the specification requirements for each project you are working on.*

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(e) Sizes of Coarse Aggregates

Sieve Sizes	Coarse Aggregate Sizes (Percent Passing)											
	Coarse Graded										Dense Graded	
	2	**5**	**8**	**9**	**11, SC 11**[5]	**12, SC 12**[5]	**SC 16**[5]	**43**[1]	**91**	**93PG**[6]	**53**[1]	**73**[1]
4 in. (100 mm)												
3 1/2 in. (90 mm)												
2 1/2 in. (63 mm)	100											
2 in. (50 mm)	80 - 100											
1 1/2 in. (37.5 mm)		100						100			100	
1 in. (25 mm)	0 - 25	85 - 98	100					70 - 90	100		80 - 100	100
3/4 in. (19 mm)	0 - 10	60 - 85	75 - 95	100				50 - 70			70 - 90	90 - 100
1/2 in. (12.5 mm)	0 - 7	30 - 60	40 - 70	60 - 85	100	100	100	35 - 50		98 - 100	55 - 80	60 - 90
3/8 in. (9.5 mm)		15 - 45	20 - 50	30 - 60	75 - 95	95 - 100	94 - 100			75 - 100		
No. 4 (4.75 mm)		0 - 15	0 - 15	0 - 15	10 - 30	50 - 80	15 - 45	20 - 40		10 - 60	35 - 60	35 - 60
No. 8 (2.36 mm)		0 - 10	0 - 10	0 - 10	0 - 10	0 - 35		15 - 35		0 - 15	25 - 50	
No. 16 (1.18 mm)							0 - 4					
No. 30 (600 µm)						0 - 4		5 - 20		0 - 5	12 - 30	12 - 30
No. 200 (75 µm)[2]								0 - 6.0			5.0 - 13.0[4]	5.0 - 12.0
Decant (PCC)[3]		0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5			0 - 1.5			
Decant (Non-PCC)	0 - 2.5	0 - 2.5	0 - 3.0	0 - 2.5	0 - 2.5	0 - 2.0			0 - 2.5	0 -2.0		
Decant (SC)					0 - 1.5	0 - 1.5	0 - 1.5					

(1) The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be determined in accordance with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90.

(2) Includes the total amount passing the No. 200 (75 µm) sieve as determined by AASHTO T 11 and AASHTO T 27.

(3) Decant may be from 0 to 2.5 for stone and slag.

(4) When slag is used for separation layers as defined in 302.01, the total amount passing the No. 200 (75 µm) sieve shall be 10.0 to 12.0.

(5) Seal coat (SC) aggregates shall be 85% one face and 80% two face crushed. The Flakiness Index in accordance with ITM 224 shall be a maximum of 25%.

(6) Pea gravel shall be generally uncrushed gravel, with a maximum of 20% crushed particles, and shall meet the gradation requirements of 93PG. Determination of crushed particles shall be made from the weight (mass) of material retained on the No. 4 (4.75 mm) sieve in accordance with ASTM D5821.

Where an AASHTO coarse aggregate is specified as an option, gradation shall be in accordance with AASHTO M 43. All other aggregate properties shall be in accordance with 904.

INDOT Standard Specifications 904.03 (e)

(e) Sizes of Coarse Aggregates

Sieve Sizes	Coarse Aggregate Sizes (Percent Passing)									
	Coarse Graded									
	2	**5**	**8**	**9**	**11, SC 11[(5)]**	**12, SC 12[(5)]**	**SC 16[(5)]**	**43[(1)]**	**91**	**93PG[(6)]**
4 in. (100 mm)										
3 1/2 in. (90 mm)										
2 1/2 in. (63 mm)	100									
2 in. (50 mm)	80 - 100									
1 1/2 in. (37.5 mm)		100						100		
1 in. (25 mm)	0 - 25	85 - 98	100					70 - 90	100	
3/4 in. (19 mm)	0 - 10	60 - 85	75 - 95	100				50 - 70		
1/2 in. (12.5 mm)	0 - 7	30 - 60	40 - 70	60 - 85	100	100	100	35 - 50		98 - 100
3/8 in. (9.5 mm)		15 - 45	20 - 50	30 - 60	75 - 95	95 - 100	94 - 100			75 - 100
No. 4 (4.75 mm)		0 - 15	0 - 15	0 - 15	10 - 30	50 - 80	15 - 45	20 - 40		10 - 60
No. 8 (2.36 mm)		0 - 10	0 - 10	0 - 10	0 - 10	0 - 35		15 - 35		0 - 15
No. 16 (1.18 mm)							0 - 4			
No. 30 (600 µm)						0 - 4		5 - 20		0 - 5
No. 200 (75 µm)[(2)]								0 - 6.0		
Decant (PCC)[(3)]		0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5			0 - 1.5	
Decant (Non-PCC)	0 - 2.5	0 - 2.5	0 - 3.0	0 - 2.5	0 - 2.5	0 - 2.0			0 - 2.5	0 -2.0
Decant (SC)					0 - 1.5	0 - 1.5	0 - 1.5			

(1) The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90.

(2) Includes the total amount passing the No. 200 (75 µm) sieve as determined by AASHTO T 11 and AASHTO T 27.

(3) Decant may be from 0 to 2.5 for stone and slag.

Note the decant requirements for aggregates. Asphalt requirements use the "Non-PCC" ranges. This test is run to determine the amount of material passing the No. 200 (75 µm) sieve. The decantation test is performed on coarse and fine aggregates.

(h) Sizes of Fine Aggregates

Sizes (Percent Passing)						
Sieve Sizes	**23**	**24**	**15**	**16**	**PP**	**S&I**
3/8 in. (9.5 mm)	100	100				100
No. 4 (4.75 mm)	95 - 100	95 - 100			100	
No. 6 (3.35 mm)			100			
No. 8 (2.36 mm)	80 - 100	70 - 100	90 - 100		85 - 95	
No. 16 (1.18 mm)	50 - 85	40 - 80				
No. 30 (600 µm)	25 - 60	20 - 60	50 - 75	100	50 - 65	
No. 50 (300 µm)	5 - 30	7 - 40	15 - 40		15 - 25	0 - 30
No. 80 (180 µm)				95 - 100		
No. 100 (150 µm)	0 - 10	1 - 20	0 - 10		0 - 10	
No. 200 (75 µm)	0 - 3	0 - 6	0 - 3	65 - 100		0 - 7

INDOT Standard Specifications 904.02 (h)

Rounding

- Rounding – "5" up Procedure
  - When the first digit discarded is ***<u>less</u>*** than 5, the last digit retained should not be changed.
  - Examples:
    - Nearest (0): 2.4 becomes ____
    - Nearest (0.1): 2.43 becomes____
    - Nearest (0.01): 2.434 becomes____
    - Nearest (0.001): 2.4341 becomes____

Rounding

- Rounding – “5” up Procedure
  - When the first digit discarded is ***<u>less</u>*** than 5, the last digit retained should not be changed.
  - Examples:
    - Nearest (0): 2.4 becomes 2
    - Nearest (0.1): 2.43 becomes 2.4
    - Nearest (0.01): 2.434 becomes 2.43
    - Nearest (0.001): 2.4341 becomes 2.434

Rounding

- Rounding – “5” up Procedure
  - When the first digit discarded is ***greater*** than 5, the last digit retained should not be changed.
  - Examples:
    - Nearest (0): 2.6 becomes ____
    - Nearest (0.1): 2.56 becomes____
    - Nearest (0.01): 2.416 becomes____
    - Nearest (0.001): 2.4157 becomes____

Rounding

- Rounding – “5” up Procedure
  - When the first digit discarded is ***<u>greater</u>*** than 5, the last digit retained should not be changed.
  - Examples:
    - Nearest (0): 2.6 becomes 3
    - Nearest (0.1): 2.56 becomes 2.6
    - Nearest (0.01): 2.416 becomes 2.42
    - Nearest (0.001): 2.4157 becomes 2.416

Moisture Example Problem

Calculate the percent of moisture for the No. 8 gravel if the original wet weight was 6731.5 g. The Total Dry Weight is 6678.1 g. (Report to nearest 0.1)

$$\% \, Moisture = \frac{(Weight\ Wet - Weight\ Dry)}{Weight\ Dry} \text{ x } 100$$

Moisture Example Problem

Calculate the percent of moisture for the No. 8 gravel if the original wet weight was 6580.5 g. The Total Dry Weight is 6491.8 g. (Report to the nearest 0.1)

$$\% \, Moisture = \frac{(Weight\ Wet - Weight\ Dry)}{Weight\ Dry} \text{ x } 100$$

$$\% \, Moisture = \frac{(6580.5 - 6491.8)}{6580.5} \text{ x } 100 = 1.3\%$$

Round moisture to the nearest 0.1%

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0			
1" (25.0 mm)	0.0			100.0
3/4" (19.0 mm)	0.0			75-95
1/2" (12.5 mm)	1201.4			40-70
3/8" (9.5 mm)	1950.9			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0			
1" (25.0 mm)	0.0			100.0
3/4" (19.0 mm)	0.0			75-95
1/2" (12.5 mm)	1201.4			40-70
3/8" (9.5 mm)	1950.9			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			

When Weight Retained = 0.0, the weight passing is the total weight.

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4			40-70
3/8" (9.5 mm)	1950.9			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 µm)	20.0			
No. 50 (300µm)	10.0			
No. 100 (150 µm)	2.0			
No. 200 (75 µm)	1.0			

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	**4510.8**		75-95
1/2" (12.5 mm)	**1201.4**			40-70
3/8" (9.5 mm)	1950.9			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			

Now we have some weight retained on the ½" (12.5 mm). Take the Weight Passing the sieve above, 3/4" (19.0 mm), and subtract the weight retained on the ½" (12.5 mm) sieve.

So, for the Weight Passing on the ½" (12.5 mm) sieve, you will have:

4510.8 g – 1201.4 g = 3309.4 g

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	**3309.4**		40-70
3/8" (9.5 mm)	1950.9			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			
Pan	1.5			

Now we have some weight retained. Take the Weight Passing the sieve above and subtract the weight retained on that sieve.

For the Weight Passing on the ½" (12.5 mm) sieve, you will have:

4510.8 g – 1201.4 g = 3309.4 g

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	**3309.4**		40-70
3/8" (9.5 mm)	**1950.9**			20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			

Let's try the 3/8" (9.5 mm) sieve. Take the Weight Passing from the ½" (12.5 mm) sieve and subtract the weight retained on the 3/8" (9.5 mm) sieve.

For the Weight Passing on the 3/8" (9.5 mm) sieve, you will have:

3309.4 g – 1950.9 g = 1358.5 g

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	**1358.5**		20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 µm)	20.0			
No. 50 (300µm)	10.0			
No. 100 (150 µm)	2.0			
No. 200 (75 µm)	1.0			

Let's try the 3/8" (9.5 mm) sieve. Take the Weight Passing from the ½" (12.5 mm) sieve and subtract the weight retained on the 3/8" (9.5 mm) sieve.

For the Weight Passing on the 3/8" (9.5 mm) sieve, you will have:

3309.4 g – 1950.9 g = 1358.5 g

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0			0-15
No. 8 (2.36 mm)	92.2			0-10
No. 16 (1.18 mm)	56.3			
No. 30 (600 μm)	20.0			
No. 50 (300μm)	10.0			
No. 100 (150 μm)	2.0			
No. 200 (75 μm)	1.0			

Now, do the same calculation for all the remaining sieve sizes.

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 µm)	20.0	15.0		
No. 50 (300µm)	10.0	5.0		
No. 100 (150 µm)	2.0	3.0		
No. 200 (75 µm)	1.0	2.0		

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 μm)	20.0	15.0		
No. 50 (300μm)	10.0	5.0		
No. 100 (150 μm)	2.0	3.0		
No. 200 (75 μm)	1.0	2.0		

The next step is to determine the % Passing for each sieve.

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 μm)	20.0	15.0		
No. 50 (300μm)	10.0	5.0		
No. 100 (150 μm)	2.0	3.0		
No. 200 (75 μm)	1.0	2.0		

The % Passing for each sieve is calculated by taking the Weight Passing and dividing it by the Total Weight and multiplying it by 100.

$$\% \ Passing = \frac{\textbf{Weight Passing}}{\textbf{Total Weight}} \times \mathbf{100}$$

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8		
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 μm)	20.0	15.0		
No. 50 (300μm)	10.0	5.0		
No. 100 (150 μm)	2.0	3.0		
No. 200 (75 μm)	1.0	2.0		

The % Passing for each sieve is calculated by taking the Weight Passing and dividing it by the Total Weight and multiplying it by 100.

$$\%\ Passing = \frac{4510.8}{4510.8} \times 100 = 100.0$$

Round to the nearest 0.1

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8	100.0	
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 µm)	20.0	15.0		
No. 50 (300µm)	10.0	5.0		
No. 100 (150 µm)	2.0	3.0		
No. 200 (75 µm)	1.0	2.0		

The % Passing for each sieve is calculated by taking the Weight Passing and dividing it by the Total Weight and multiplying it by 100.

$$\%\ Passing = \frac{4510.8}{4510.8} \times 100 = 100.0$$

Round to the nearest 0.1

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8	100.0	
1" (25.0 mm)	0.0	4510.8		100.0
3/4" (19.0 mm)	0.0	4510.8		75-95
1/2" (12.5 mm)	1201.4	3309.4		40-70
3/8" (9.5 mm)	1950.9	1358.5		20-50
No. 4 (4.75 mm)	1175.0	183.5		0-15
No. 8 (2.36 mm)	92.2	91.3		0-10
No. 16 (1.18 mm)	56.3	35.0		
No. 30 (600 µm)	20.0	15.0		
No. 50 (300µm)	10.0	5.0		
No. 100 (150 µm)	2.0	3.0		
No. 200 (75 µm)	1.0	2.0		

Perform this calculation for the rest of the sieves.

$$\%\ Passing = \frac{Weight\ Passing}{Total\ Weight} \times 100$$

Example Problem #1

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8	100.0	
1" (25.0 mm)	0.0	4510.8	100.0	100.0
3/4" (19.0 mm)	0.0	4510.8	100.0	75-95
1/2" (12.5 mm)	1201.4	3309.4	73.4	40-70
3/8" (9.5 mm)	1950.9	1358.5	30.1	20-50
No. 4 (4.75 mm)	1175.0	183.5	4.1	0-15
No. 8 (2.36 mm)	92.2	91.3	2.0	0-10
No. 16 (1.18 mm)	56.3	35.0	0.8	
No. 30 (600 µm)	20.0	15.0	0.3	
No. 50 (300µm)	10.0	5.0	0.1	
No. 100 (150 µm)	2.0	3.0	0.1	
No. 200 (75 µm)	1.0	2.0	0.0	

Example Problem

Material	#8 Stone			
Total Weight (g)	4510.8			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	4510.8	100.0	
1" (25.0 mm)	0.0	4510.8	100.0	100.0
3/4" (19.0 mm)	0.0	4510.8	100.0	75-95
1/2" (12.5 mm)	1201.4	3309.4	**73.4**	40-70
3/8" (9.5 mm)	1950.9	1358.5	30.1	20-50
No. 4 (4.75 mm)	1175.0	183.5	4.1	0-15
No. 8 (2.36 mm)	92.2	91.3	2.0	0-10
No. 16 (1.18 mm)	56.3	35.0	0.8	
No. 30 (600 µm)	20.0	15.0	0.3	
No. 50 (300µm)	10.0	5.0	0.1	
No. 100 (150 µm)	2.0	3.0	0.1	
No. 200 (75 µm)	1.0	2.0	0.0	

- CAPP Suppliers are required to grade coarse aggregate material to the No. 8 sieve. Asphalt lab technician typically look at the full nest of sieves for blended aggregate purposes.
- If this were a standard No. 8 material, it would be out of tolerance for the ½" (12.5 mm) sieve. However, if this were a "QA No. 8" then the CAPP source indicates the gradation bands for that material.

You need to communicate with your quarry so you understand the material you are using.

| Decant (Non-PCC) | 0 - 2.5 | 0 - 2.5 | 0 - 3.0 | 0 - 2.5 | 0 - 2.5 | 0 - 2.0 | | | 0 - 2.5 | 0 -2.0 |

(e) Sizes of Coarse Aggregates

Sieve Sizes	Coarse Aggregate Sizes (Percent Passing)											
	Coarse Graded										Dense Graded	
	2	**5**	**8**	**9**	**11, SC 11**[5]	**12, SC 12**[5]	**SC 16**[5]	**43**[1]	**91**	**93PG**[6]	**53**[1]	**73**[1]
4 in. (100 mm)												
3 1/2 in. (90 mm)												
2 1/2 in. (63 mm)	100											
2 in. (50 mm)	80 - 100											
1 1/2 in. (37.5 mm)		100						100			100	
1 in. (25 mm)	0 - 25	85 - 98	100					70 - 90	100		80 – 100	100
3/4 in. (19 mm)	0 - 10	60 - 85	7[illegible] - 95	100				50 - 70			70 - 90	90 - 100
1/2 in. (12.5 mm)	0 - 7	30 - 60	40 - 70	60 - 85	100	100	100	35 - 50		98 - 100	55 - 80	60 - 90
3/8 in. (9.5 mm)		15 - 45	20 - 50	30 - 60	75 - 95	95 - 100	94 - 100			75 - 100		
No. 4 (4.75 mm)		0 - 15	0 - 15	0 - 15	10 - 30	50 - 80	15 - 45	20 - 40		10 - 60	35 - 60	35 - 60
No. 8 (2.36 mm)		0 - 10	0 - 10	0 - 10	0 - 10	0 - 35		15 - 35		0 - 15	25 - 50	
No. 16 (1.18 mm)							0 - 4					
No. 30 (600 µm)						0 - 4		5 - 20		0 - 5	12 - 30	12 - 30
No. 200 (75 µm)[2]								0 - 6.0			5.0 - 13.0[4]	5.0 - 12.0
Decant (PCC)[3]		0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5	0 - 1.5			0 - 1.5			
Decant (Non-PCC)	0 - 2.5	0 - 2.5	0 - 3.0	0 - 2.5	0 - 2.5	0 - 2.0			0 - 2.5	0 -2.0		
Decant (SC)					0 - 1.5	0 - 1.5	0 - 1.5					

(1) The liquid limit shall not exceed 25 (35 if slag) and the plasticity index shall not exceed 5. The liquid limit shall be determined in accordance with AASHTO T 89 and the plasticity index in accordance with AASHTO T 90.

(2) Includes the total amount passing the No. 200 (75 µm) sieve as determined by AASHTO T 11 and AASHTO T 27.

(3) Decant may be from 0 to 2.5 for stone and slag.

Note the decant requirements for aggregates. Asphalt requirements use the "Non-PCC" ranges. This test is run to determine the amount of material passing the No. 200 (75 µm) sieve. The decantation test is performed on coarse and fine aggregates.

To Decant or Not to Decant…

With asphalt mixtures, the decant process is to separate the liquid components from solid components. Decanting is a critical step to ensure accurate measurements and results in asphalt testing. It involves carefully pouring off the liquid without disturbing the solids. This process can be used when:

- Solvent Extraction Testing: To determine the asphalt binder content per ITM 571 of a sample, a liquid solvent is used to dissolve the binder and leave the blended aggregate. After the solvent is used, the mixture can be decanted to separate liquid from the remaining solid aggregates.
- Moisture Content Determination: In some tests, especially when determining the moisture content of aggregates, water is added to the sample. This excess water may need to be decanted to accurately measure the moisture content.
- Rinsing and Cleaning Aggregates: When cleaning aggregates to determine gradation after an extraction test, technicians might rinse aggregates with water or another liquid. Decanting is used to remove the excess liquid before weighing the aggregates.

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0			
1" (25.0 mm)	0.0			100.0
3/4" (19.0 mm)	720.9			75-95
1/2" (12.5 mm)	3169.1			40-70
3/8" (9.5 mm)	1280.2			20-50
No. 4 (4.75 mm)	1094.5			0-15
No. 8 (2.36 mm)	223.8			0-10
No. 16 (1.18 mm)	150.4			
No. 30 (600 µm)	15.0			
No. 50 (300µm)	10.1			
No. 100 (150 µm)	5.2			
No. 200 (75 µm)	2.4			
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight	Gram Loss	% Loss	
6678.1				

Determine the Weight Passing for each sieve

$$Weight\ Passing = Weight\ Passing\ previous\ sieve - Weight\ Retained$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1		
1" (25.0 mm)	0.0	6678.1		100.0
3/4" (19.0 mm)	720.9	5957.2		75-95
1/2" (12.5 mm)	3169.1	2788.1		40-70
3/8" (9.5 mm)	1280.2	1507.9		20-50
No. 4 (4.75 mm)	1094.5	413.4		0-15
No. 8 (2.36 mm)	223.8	189.6		0-10
No. 16 (1.18 mm)	150.4	39.2		
No. 30 (600 µm)	15.0	24.2		
No. 50 (300µm)	10.1	14.1		
No. 100 (150 µm)	5.2	8.9		
No. 200 (75 µm)	2.4	6.5		
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight	Gram Loss	% Loss	
6678.1				

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1		
1" (25.0 mm)	0.0	6678.1		100.0
3/4" (19.0 mm)	720.9	5957.2		75-95
1/2" (12.5 mm)	3169.1	2788.1		40-70
3/8" (9.5 mm)	1280.2	1507.9		20-50
No. 4 (4.75 mm)	1094.5	413.4		0-15
No. 8 (2.36 mm)	223.8	189.6		0-10
No. 16 (1.18 mm)	150.4	39.2		
No. 30 (600 μm)	15.0	24.2		
No. 50 (300μm)	10.1	14.1		
No. 100 (150 μm)	5.2	8.9		
No. 200 (75 μm)	2.4	6.5		
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight	Gram Loss	% Loss	
6678.1				

Next, calculate the % Passing each sieve

$$\% \, Passing = \frac{Weight \, Passing}{Total \, Weight} \times 100$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight	Gram Loss	% Loss	
6678.1				

Next, calculate the % Passing each sieve

$$\% \; Passing = \frac{Weight \; Passing}{Total \; Weight} \times 100$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	**0.0**	6678.1	100.0	
1" (25.0 mm)	**0.0**	6678.1	100.0	100.0
3/4" (19.0 mm)	**720.9**	5957.2	89.2	75-95
1/2" (12.5 mm)	**3169.1**	2788.1	41.7	40-70
3/8" (9.5 mm)	**1280.2**	1507.9	22.6	20-50
No. 4 (4.75 mm)	**1094.5**	413.4	6.2	0-15
No. 8 (2.36 mm)	**223.8**	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	**64.7**			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1				

Now we will determine the decant for the sample. First, add all the Weight Retained on each sieve up to the No. 8 (2.36 mm) and add the pan weight retained.

$$Final\ Weight = 720.9 + 3169.1 + 1280.2 + 1094.5 + 223.8 + 64.7$$

$$Final\ Weight = 6553.2\ g$$

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 μm)	15.0	24.2	0.4	
No. 50 (300μm)	10.1	14.1	0.2	
No. 100 (150 μm)	5.2	8.9	0.1	
No. 200 (75 μm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2			

Now we will determine the decant for the sample. First, add all the Weight Retained on each sieve up to the No. 8 (2.36 mm) and add the pan weight retained.

$$Final\ Weight = 720.9 + 3169.1 + 1280.2 + 1094.5 + 223.8 + 64.7$$

$$Final\ Weight = 6553.2\ g$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 μm)	15.0	24.2	0.4	
No. 50 (300μm)	10.1	14.1	0.2	
No. 100 (150 μm)	5.2	8.9	0.1	
No. 200 (75 μm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2			

Next, determine the grams lost by subtracting the final weight from the original total weight.

$$Grams\ Loss = Original\ Total\ Weight\ -\ Final\ Weight$$

$$Grams\ Loss = 124.9\ g$$

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9		

Next, determine the grams lost by subtracting the final weight from the original total weight.

$$Grams\ Loss = Original\ Total\ Weight - Final\ Weight$$

$$Grams\ Loss = 6678.1 - 6553.2 = 124.9$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9		

Finally, to calculate the % loss by decant,

$$\% \, Loss = \frac{Gram\ Loss}{Original\ Total\ Weight} \times 100$$

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9	1.9	0.0-3.0

Finally, to calculate the % loss by decant,

$$\% \, Loss = \frac{Gram \, Loss}{Original \, Total \, Weight} \times 100$$

$$\% \, Loss = \frac{124.9}{6678.1} \times 100 = 1.9\%$$

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9	1.9	0.0-3.0

Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 μm)	15.0	24.2	0.4	
No. 50 (300μm)	10.1	14.1	0.2	
No. 100 (150 μm)	5.2	8.9	0.1	
No. 200 (75 μm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9	1.9	0.0-3.0

Only one more check: We need to make sure the sieve analysis has been done accurately and is considered a valid test:

$$\frac{Original\ Total\ Weight - (Final\ Weight + Gram\ Loss)}{Original\ Total\ Weight} \times 100$$

$$\frac{6678.1 - (6553.2 + 124.9)}{6678.1} \times 100 = 0.0\%$$

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Example Problem #2

Material	#8 Stone			
Total/Dry Weight	6678.1			
Sieve Size	Weight Retained (g)	Weight Passing (g)	% Passing	Specification Limit
1 1/2" (37.5 mm)	0.0	6678.1	100.0	
1" (25.0 mm)	0.0	6678.1	100.0	100.0
3/4" (19.0 mm)	720.9	5957.2	89.2	75-95
1/2" (12.5 mm)	3169.1	2788.1	41.7	40-70
3/8" (9.5 mm)	1280.2	1507.9	22.6	20-50
No. 4 (4.75 mm)	1094.5	413.4	6.2	0-15
No. 8 (2.36 mm)	223.8	189.6	2.8	0-10
No. 16 (1.18 mm)	150.4	39.2	0.6	
No. 30 (600 µm)	15.0	24.2	0.4	
No. 50 (300µm)	10.1	14.1	0.2	
No. 100 (150 µm)	5.2	8.9	0.1	
No. 200 (75 µm)	2.4	6.5	0.1	
Pan	64.7			
Decant				
Original Total/Dry Weight	Final Weight (g)	Gram Loss	% Loss	
6678.1	6553.2	124.9	1.9	0.0-3.0

Only one more check: We need to make sure the sieve analysis has been done accurately and is considered a valid test:

$$\frac{Original\ Total\ Weight - (Final\ Weight + Gram\ Loss)}{Original\ Total\ Weight} \times 100$$

$$\frac{6678.1 - (6553.2 + 124.9)}{6678.1} \times 100 = 0.0\%$$

$$0.0\% < 0.3\%$$ ✓

This is a valid test!

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Chapter 5

Recycled Materials

INDOT Certified Asphalt Technician Course

Presented by: Nathan Awwad, INDOT

Outline

- Sustainability
- Best practices for handling – keep SMA RAP separate
- Testing on recycled materials
- Specifications
- Binder replacement – change homework problem
- ITM 590
- What Gsb value do you use or when to call INDOT
- Aggregate blending problem (Kirsten Fowler)

Definitions

- RAP – Reclaimed Asphalt Pavement
  - RAP shall be the product resulting from the cold milling or crushing of an existing HMA pavement

- RAS – Reclaimed Asphalt Shingles
  - RAS may be obtained from either pre-consumer or post-consumer asphalt shingles

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Why Mill to Create RAP?

- Asphalt is **100% recyclable** and is considered the most recycled material in the United States.
- Provides a rough texture on existing pavement to enhance the bonding (with tack coat) between existing pavement and the new asphalt layer(s)
- Corrects cross slopes, drainage, and maintenance of curb lines
- Removes deteriorated pavement layers to ensure the longevity of the pavement structure
- Allows for the reuse of existing pavement materials

Is It Economical to Use RAP?

- RAP reduces the need for new materials in the mix design. On average, using RAP saves approximately $3.3 billion annually*
- Reusing pavement materials reduces the cost associated with disposing of waste material and having to obtain new material. Depends on Virgin binder cost, aggregate cost, asphalt content in the RAP, and percentage of RAP used.
- Reduces trucking costs of hauling in new material, potentially over long distances
- Example: 30,000 tons of RAP = 70 - 6,000 gallon transport trailers and 28,200 tons of clean aggregates!
- Properly designed mixtures with RAP can meet or exceed the performance of a virgin mixture.

*Source Hey NAPA 2024

Environmental Benefits of RAP

- Conserves natural resources by reducing the demand of virgin aggregate and asphalt materials
- Conserves the petroleum products by reusing asphalt binder and reduces the need for mining new aggregate materials
- Reduces the amount of material that ends up in landfills
- Reduces the energy consumption and greenhouse gas emissions associated with the production of new asphalt materials.

Sustainability

Climate challenge, etc. continuing to advance technologies such as WMA and recycling agents

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Sustainability

- Asphalt's recyclability makes it sustainable, an opportunity for cost savings, and environmental conservation
- The industry continues to improve and innovate ways in which asphalt is recycled to increase the use of RAP in asphalt mixtures. This includes:
  - High RAP mixtures (>30% Binder Replacement) designed with a recycling agent if needed
- Warm mix technologies allow the asphalt industry to produce asphalt mix at a lower temperature at the asphalt plant (Typically < 280°F). This reduces the Green House Gas and carbon emissions and can use less fuel and decrease energy use at the plant.

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Sources of RAP

- Milling
- Pavement Removal
- Reject Materials
- Start up waste materials
- Laboratory materials

Best Practices for handling

- Clean and separate stockpiles
- Consistent materials

Example language from a QCP:

MATERIAL STOCKPILES

Stockpiling of aggregates and RAP is done by unloading dump truck loads side by side and then stacking the material only as high as the front-end loader can place the material. Stockpiles will be sufficiently separated to avoid contamination. The size and type of aggregate of each stockpile will be identified by signs placed in the area of the stockpiles.

The entire front face of each stockpile will be worked by a front-end loader from side to side when charging the plant. The sides of the face will be mixed with the center of the face and the existing yard material will not be included in the bucket. The cold bins shall be loaded such that material from one bin will not contaminate another bin.

RAP Management

- Good material management practices should always be part of a QC program for any asphalt mix production operation

- As RAP content increases, it is even more important to determine and understand the pile’s properties and control its consistency the best way possible

RAP Management

- Some milled RAP materials can be used “as is” in an asphalt mixture without further crushing.
- Multi-source piles can be a combination of milled materials, plant waste, pavement rubble and laboratory mixture.
- Do not dump undesirable, deleterious materials in the RAP piles. This can include project waste like concrete chunks, rebar, trash, etc.
- Incoming millings should be monitored for quality and origin of material. If the characteristics are significantly different, like SMA RAP versus a dense graded RAP, these materials should be stockpiled separately.

Processing RAP

- Some contractors may choose to process RAP piles for consistency.
- Avoid contaminating the RAP piles from the beginning.
- Mix RAP from different sources going into the screen or crusher. Have the loader pull across the entire face of the pile and not just eat into one side.
- Don't over crush the material as it will generate excess fines and will result in a lot of uncoated particle faces
- Watch the weather when processing. The cooler it is, the less likely the pile will clump together.
- Blend the material again when moving RAP stockpiles.

Fractionating RAP

- Fractionating RAP is different than processing RAP. Fractionating screens the RAP into two or more different sizes.
- It is up to the contractor if they choose to fractionate their RAP piles and what size they choose to make during the operation.
- This makes the RAP more desirable to mix designs and allows RAP to be used in any mix type.

	Coarse RAP	Fine RAP
Asphalt Content %	4.1	7.4
% Pass 9.5 mm	96.8	100.0
% Pass 4.75 mm	66.5	100.0
% Pass 1.18 mm	25.9	84.3
% Pass 0.30 mm	18.7	48.2
% Pass 75 µm	8.3	17.5

Fractionating RAP

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% Pass 4.75 mm	66.5	100.0
% Pass 1.18 mm	25.9	84.3
% Pass 0.30 mm	18.7	48.2
% Pass 75 µm	8.3	17.5

Document references

- Standard Specifications 401.06 – “HMA Recycled Materials”
- Standard Specifications 410.06 – “SMA Recycled Materials”
- Testing memo (TM19-01) - “Gsb List Instructions”
- ITM 590 – “Total Aggregate Gsb Determination from Extracted HMA or SMA Mixture”
- ITM 583 – “Certified HMA Producer Program”
- ITM 571 – “Quantitative Extraction of Asphalt and Gradation of Extracted Aggregate from HMA Mixtures”
- ITM 586 – “Asphalt Content by Ignition”

Testing Recycled Materials

- As part of ITM 583 and the QCP, the Contractor establishes a testing frequency in their QCP for the following:
  - Binder Content
  - Gradation
  - Moisture Content
  - Coarse Aggregate Angularity (if gravel)
  - G_{sb} of recycled Aggregate
- For example, the QCP may state that these tests will be conducted for every 2,000 tons processed
- As processed vs as used

Specifications – HMA 401.06

- May be RAP or RAS, or a blend of both
- RAP
  - Before entering the plant, shall be processed so that 100% will pass the 2 in. (50mm) sieve
  - RAP coarse aggregate shall pass the max size sieve for mixture type
  - RAP for ESAL 3 and 4 <u>surface</u> mixtures:
    - shall be a fine RAP; 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve
    - Coarse RAP, use up to a max of 20% by volume retained on the No. 4 for Cat 4 mixtures

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Specifications – HMA 401.06

- RAS
  - Before entering the plant, shall be processed so that 100% will pass the 3/8 in. (9.5 mm) sieve
  - Can be pre-consumer or post-consumer, but shall not be blended
  - Post-consumer requirements:
    - Minimize metallic materials (nails). ≤ 0.5% by mass on the No. 4
    - Minimize non-metallic materials (glass, rubber, plastic, etc). ≤ 1.5% by mass on the No. 4
    - Processing company shall have a IDEM Legitimate Use Approval letter

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Specifications – HMA 401.06

- How much can you use?
- All mixes are limited to 25% binder replacement
- RAS shall be ≤ 3.0% by total mass of the mixture and ≤ 15% binder replacement

$$\text{Binder Replacement, \%} = \frac{(A \times B) + (C \times D)}{E}$$

where:

A = RAP, % Binder Content by Mass of RAP
B = RAP, % by Total Mass of Mixture
C = RAS, % Binder Content by Mass of RAS
D = RAS, % by Total Mass of Mixture
E = Total, % Binder Content by Total Mass of Mixture.

Binder Replacement Example

You are running a 9.5 mm Surface Category 2 on an INDOT project and the plant operator tells you that you are going to be out of the RAP by the end of the day. You still have more Surface mix to run tomorrow and the next week to finish the project. There is another pile of RAP (named Pile F) that has been tested and ready to use in a 9.5 mm Surface mixture. Determine the Binder Replacement if you were to switch from the RAP pile you are currently using to the new RAP pile with the following properties:

$$\% \textit{ Binder Content of Pile F} = 7.1\%$$

$$\% \textit{ RAP in the mixture being used} = 22.0\%$$

$$\textit{Total } \% \textit{ Binder Content of the Mix} = 5.8\%$$

$$\textit{Binder Replacement} = \frac{(7.1 \times 22.0)}{5.8}$$

$$\textit{Binder Replacement} = 26.9\%$$

$$\text{Binder Replacement, } \% = \frac{(A \times B)+(C \times D)}{E}$$

A = RAP, % Binder Content by Mass of RAP
B = RAP, % by Total Mass of Mixture
C = RAS, % Binder Content by Mass of RAS
D = RAS, % by Total Mass of Mixture
E = Total, % Binder Content by Total Mass of Mixture.

Binder Replacement Example

$$\% \; Binder \; Content \; of \; RAP \; B = 7.0\%$$
$$\% \; RAP \; in \; the \; mixture = 21.0\%$$
$$Total \; \% \; Binder \; Content \; of \; the \; Mix = 5.8\%$$

$$Binder \; Replacement = \frac{(7.1 \times 22.0)}{5.8}$$

$Binder \; Replacement = 26.9\%$ > 25.0% allowed by INDOT Specifications!

Can we use this RAP?

Binder Replacement Example

Can we use this RAP - YES!

$$\begin{aligned}\% \text{ Binder Content of RAP B} &= 7.1\% \\ \% \text{ RAP in the mixture} &= \underline{22.0\%} \\ \text{Total } \% \text{ Binder Content of the Mix} &= 5.8\%\end{aligned}$$

$$Binder\ Replacement = \frac{(7.1 \times 22.0)}{5.8}$$

$$Binder\ Replacement = 26.9\%$$

$$\begin{aligned}\% \text{ Binder Content of RAP B} &= 7.1\% \\ \% \text{ RAP in the mixture} &= \underline{18.0\%} \\ \text{Total } \% \text{ Binder Content of the Mix} &= 5.8\%\end{aligned}$$

$$Binder\ Replacement = \frac{(7.1 \times 18.0)}{5.8}$$

$$Binder\ Replacement = 22.0\% < 25.0\%\ max$$

Specifications – SMA 410.06

- SMA is a premium product and SMA recycled materials have special requirements.
- Up to 25% binder replacement by RAP. **RAS is not allowed**
- Non-SMA RAP shall be 100% passing the 3/8 in. (9.5 mm) sieve and 95 to 100% passing the No. 4 (4.75 mm) sieve
  - Use is limited by aggregate requirements in 904
- SMA RAP comes from milling SMA pavement only and shall be 95 to 100% passing the max sieve size of mixture type be produced
- Separate Stockpiles

SMA RAP GRADATION, %						
Sieve Size	Mixture Designation					
	9.5 mm		12.5 mm		19.0 mm	
	Lower	Upper	Lower	Upper	Lower	Upper
1 1/2 in. (37.5 mm)					100.0	100.0
1 in. (25.0 mm)			100.0	100.0	95.0	100.0
3/4 in. (19.0 mm)	100.0	100.0	95.0	100.0	---	---
1/2 in. (12.5 mm)	95.0	100.0	---	---	---	---

G_{sb} of recycled materials

- TM 19-01
- Bulk specific gravity of RAS material shall be 2.500
- Bulk specific gravity value of HMA RAP shall be 2.640.
- When to call INDOT District Testing:
  - If a Producer has a RAP stockpile with a bulk specific gravity value greater than or equal to 2.660 or less than 2.620, INDOT will obtain a sample from a RAP stockpile and determine Gsb
- SMA RAP must always be stockpiled separately and the Gsb is determined by INDOT for specific stockpiles

Determining the G_{sb} of RAP

- ITM 590 – “Total Aggregate Gsb Determination from Extracted HMA or SMA Mixture”
  - Sample size large enough to produce minimum coarse aggregate
  - Extract binder (ITM 571, T164)

ITM 571 Method A – Centrifuge Extraction

For purposes in this course, we will work through an example calculation for the extracted asphalt binder content in accordance with ITM 571 method A.

A centrifuge extractor was used to determine the asphalt binder content given the following:

Weight of sample, g = 4954.7
Weight of extracted aggregate, g = 4681.3
Weight of fines in extracted solvent and water rinse, g = 15.1

ITM 571 Method A – Centrifuge Extraction

For purposes in this course, we will work through an example calculation for the extracted asphalt binder content in accordance with ITM 571 method A.

A centrifuge extractor was used to determine the asphalt binder content given the following:

Weight of sample, g = 4954.7
Weight of extracted aggregate, g = 4681.3
Weight of fines in extracted solvent and water rinse, g = 15.1

$$\%\ Binder = \frac{W_1 - (W_2 + W_3)}{W_1} \times 100$$

W_1 = weight of sample, g
W_2 = weight of extracted aggregate, g
W_3 = weight of fines in extracted solvent (cup and filter fines), g

ITM 571 Method A – Centrifuge Extraction

For purposes in this course, we will work through an example calculation for the extracted asphalt binder content in accordance with ITM 571 method A.

A centrifuge extractor was used to determine the asphalt binder content given the following:

Weight of sample, g = 4954.7
Weight of extracted aggregate, g = 4681.3
Weight of fines in extracted solvent and water rinse, g = 15.1

$$\% \, Binder = \frac{4954.7 - (4681.3 + 15.1)}{4954.7} \times 100 = 5.21\%$$

Determining the G_{sb} of RAP

- ITM 590 – “Total Aggregate Gsb Determination from Extracted HMA or SMA Mixture”
  - Sample size large enough to produce minimum coarse aggregate
  - Extract binder (ITM 571, T164)
  - Gradation per T30 and split +4 /-4 material
  - Gsb of coarse aggregate per T85, Gsb of fine aggregate per T84

7.8 Combine the $(Gsb)_{CA}$ determined in 7.5 and the $(Gsb)_{FA}$ determined in 7.7 to achieve the $(Gsb)_{TOTAL}$ of the aggregate blend as follows:

7.8.1 $$(Gsb)_{TOTAL} = \frac{100}{\left[\frac{(100 - A)}{(Gsb)_{CA}}\right] + \left[\frac{(A)}{(Gsb)_{FA}}\right]}$$

Where:

A = % passing the 4.75 mm sieve as determined in 7.5.

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G_{sb} of RAP

Combine the $(Gsb)_{CA}$ and $(Gsb)_{FA}$ to achieve the $(Gsb)_{TOTAL}$ of the aggregate blend:

$$(Gsb)_{TOTAL} = \frac{100}{\left[\frac{(100 - A)}{(Gsb)_{CA}}\right] + \left[\frac{(A)}{(Gsb)_{FA}}\right]}$$

Where A = % passing the No. 4 (4.75 mm) sieve

Report $(Gsb)_{TOTAL}$ to the nearest 0.001

Aggregate blending

Material	#8 Stone		Sand		RAP		Combined Gradation %
Percent Used	60%		25%		15%		
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix	
1 ½”	100.0		100.0		100.0		
1"	100.0		100.0		100.0		
3/4"	100.0		100.0		100.0		
1/2"	73.4		100.0		100.0		
3/8"	30.1		100.0		99.6		
No. 4	4.1		99.0		53.3		
No. 8	2.0		88.4		7.2		
No. 16	0.8		64.7		2.6		
No. 30	0.3		34.8		1.6		
No. 50	0.0		19.0		0.9		
No. 100	0.0		8.7		0.4		
No. 200	0.0		2.4		0.2		
Pan	0.0		0.1		0.0		

Aggregate Blending

Material	#8 Stone	
Percent Used	60%	
Sieves	% Passing	% for Mix
1 ½”	100.0	
1"	100.0	
3/4"	100.0	
1/2"	73.4	
3/8"	30.1	
No. 4	4.1	
No. 8	2.0	
No. 16	0.8	
No. 30	0.3	
No. 50	0.0	
No. 100	0.0	
No. 200	0.0	
Pan	0.0	

$$\%\ for\ Mix = \%\ Passing \times \frac{Percent\ Used}{100}$$

Figure this value for all sieves

Aggregate Blending

Material	#8 Stone	
Percent Used	60%	
Sieves	% Passing	% for Mix
1 ½”	100.0	
1"	100.0	
3/4"	100.0	
1/2"	73.4	
3/8"	30.1	
No. 4	4.1	
No. 8	2.0	
No. 16	0.8	
No. 30	0.3	
No. 50	0.0	
No. 100	0.0	
No. 200	0.0	
Pan	0.0	

$$\%\ for\ Mix = \%\ Passing\ \times \frac{Percent\ Used}{100}$$

Figure this value for all sieves

Aggregate Blending

Material	#8 Stone	
Percent Used	**60%**	
Sieves	% Passing	% for Mix
1 ½"	**100.0**	60.0
1"	100.0	
3/4"	100.0	
1/2"	73.4	
3/8"	30.1	
No. 4	4.1	
No. 8	2.0	
No. 16	0.8	
No. 30	0.3	
No. 50	0.0	
No. 100	0.0	
No. 200	0.0	
Pan	0.0	

$$\%\ for\ Mix = \%\ Passing \times \frac{Percent\ Used}{100}$$

% for Mix 1.5" Sieve = **100.0** X $\frac{60}{100}$ = 60.0

Figure this value for all sieves

Aggregate Blending

Material	#8 Stone	
Percent Used	60%	
Sieves	% Passing	% for Mix
1 ½”	100.0	60.0
1"	100.0	60.0
3/4"	100.0	60.0
1/2"	73.4	44.0
3/8"	30.1	18.1
No. 4	4.1	2.4
No. 8	2.0	1.2
No. 16	0.8	0.5
No. 30	0.3	0.2
No. 50	0.0	0.0
No. 100	0.0	0.0
No. 200	0.0	0.0
Pan	0.0	0.0

% for Mix 1/2” Sieve = $73.4 \times \frac{60}{100} = 44.04$

% for Mix 3/8” Sieve = $30.1 \times \frac{60}{100} = 18.06$

Final rounding to 0.1%

Aggregate Blending

Material	#8 Stone		Sand	
Percent Used	60%		25%	
Sieves	% Passing	% for Mix	% Passing	% for Mix
1 1/2"	100.0	60.0	100.0	
1"	100.0	60.0	100.0	
3/4"	100.0	60.0	100.0	
1/2"	73.4	44.0	100.0	
3/8"	30.1	18.1	100.0	
No. 4	4.1	2.4	99.0	
No. 8	2.0	1.2	88.4	
No. 16	0.8	0.5	64.7	
No. 30	0.3	0.2	34.8	
No. 50	0.0	0.0	19.0	
No. 100	0.0	0.0	8.7	
No. 200	0.0	0.0	2.4	
Pan	0.0	0.0	0.1	

Next, calculate the % Mix for the second material just like you did for the first material

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Aggregate Blending

Material	#8 Stone		Sand	
Percent Used	60%		25%	
Sieves	% Passing	% for Mix	% Passing	% for Mix
1 1/2"	100.0	60.0	100.0	25.0
1"	100.0	60.0	100.0	25.0
3/4"	100.0	60.0	100.0	25.0
1/2"	73.4	44.0	100.0	25.0
3/8"	30.1	18.1	100.0	25.0
No. 4	4.1	2.4	99.0	24.8
No. 8	2.0	1.2	88.4	22.1
No. 16	0.8	0.5	64.7	16.2
No. 30	0.3	0.2	34.8	8.7
No. 50	0.0	0.0	19.0	4.7
No. 100	0.0	0.0	8.7	2.2
No. 200	0.0	0.0	2.4	0.6
Pan	0.0	0.0	0.1	0.0

Aggregate Blending

Material	#8 Stone		Sand		RAP	
Percent Used	60%		25%		15%	
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix
1 1/2"	100.0	60.0	100.0	25.0	100.0	
1"	100.0	60.0	100.0	25.0	100.0	
3/4"	100.0	60.0	100.0	25.0	100.0	
1/2"	73.4	44.0	100.0	25.0	100.0	
3/8"	30.1	18.1	100.0	25.0	99.6	
No. 4	4.1	2.4	99.0	24.8	53.3	
No. 8	2.0	1.2	88.4	22.1	7.2	
No. 16	0.8	0.5	64.7	16.2	2.6	
No. 30	0.3	0.2	34.8	8.7	1.6	
No. 50	0.0	0.0	19.0	4.7	0.9	
No. 100	0.0	0.0	8.7	2.2	0.4	
No. 200	0.0	0.0	2.4	0.6	0.2	
Pan	0.0	0.0	0.1	0.0	0.0	

Keep calculating the % Mix for all component materials

Aggregate Blending

Material	#8 Stone		Sand		RAP	
Percent Used	60%		25%		15%	
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix
1 1/2"	100.0	60.0	100.0	25.0	100.0	15.0
1"	100.0	60.0	100.0	25.0	100.0	15.0
3/4"	100.0	60.0	100.0	25.0	100.0	15.0
1/2"	73.4	44.0	100.0	25.0	100.0	15.0
3/8"	30.1	18.1	100.0	25.0	99.6	14.9
No. 4	4.1	2.4	99.0	24.8	53.3	8.0
No. 8	2.0	1.2	88.4	22.1	7.2	1.1
No. 16	0.8	0.5	64.7	16.2	2.6	0.4
No. 30	0.3	0.2	34.8	8.7	1.6	0.2
No. 50	0.0	0.0	19.0	4.7	0.9	0.1
No. 100	0.0	0.0	8.7	2.2	0.4	0.1
No. 200	0.0	0.0	2.4	0.6	0.2	0.0
Pan	0.0	0.0	0.1	0.0	0.0	0.0

Aggregate Blending

Material	#8 Stone		Sand		RAP	
Percent Used	60%		25%		15%	
Sieves						% for Mix
1 1/2"						15.0
1"						15.0
3/4"						15.0
1/2"						15.0
3/8"						14.9
No. 4						8.0
No. 8						1.1
No. 16						0.4
No. 30						0.2
No. 50						0.1
No. 100	0.0	0.0	8.7	2.2	0.4	0.1
No. 200	0.0	0.0	2.4	0.6	0.2	0.0
Pan	0.0	0.0	0.1	0.0	0.0	0.0

Now to determine the combined gradation for the blend of aggregates.

Aggregate Blending

Material	#8 Stone		Sand		RAP		Combined Gradation %
Percent Used	60%		25%		15%		
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix	
1 1/2"	100.0	60.0	100.0	25.0	100.0	15.0	
1"	100.0	60.0	100.0	25.0	100.0	15.0	
3/4"	100.0	60.0	100.0	25.0	100.0	15.0	
1/2"	73.4	44.0	100.0	25.0	100.0	15.0	
3/8"	30.1	18.1	100.0	25.0	99.6	14.9	
No. 4	4.1	2.4	99.0	24.8	53.3	8.0	
No. 8	2.0	1.2	88.4	22.1	7.2	1.1	
No. 16	0.8	0.5	64.7	16.2	2.6	0.4	
No. 30	0.3	0.2	34.8	8.7	1.6	0.2	
No. 50	0.0	0.0	19.0	4.7	0.9	0.1	
No. 100	0.0	0.0	8.7	2.2	0.4	0.1	
No. 200	0.0	0.0	2.4	0.6	0.2	0.0	
Pan	0.0	0.0	0.1	0.0	0.0	0.0	

To determine the combined gradation, add the % for mix of each component material on each sieve.

Aggregate Blending

Material	#8 Stone		Sand		RAP		
Percent Used	60%		25%		15%		
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix	Combined Gradation %
1 1/2"	100.0	60.0	100.0	25.0	100.0	15.0	**100.0**
1"	100.0	60.0	100.0	25.0	100.0	15.0	
3/4"	100.0	60.0	100.0	25.0	100.0	15.0	
1/2"	73.4	44.0	100.0	25.0	100.0	15.0	
3/8"	30.1	18.1	100.0	25.0	99.6	14.9	
No. 4	4.1	2.4	99.0	24.8	53.3	8.0	
No. 8	2.0	1.2	88.4	22.1	7.2	1.1	
No. 16	0.8	0.5	64.7	16.2	2.6	0.4	
No. 30	0.3	0.2	34.8	8.7	1.6	0.2	
No. 50	0.0	0.0	19.0	4.7	0.9	0.1	
No. 100	0.0	0.0	8.7	2.2	0.4	0.1	
No. 200	0.0	0.0	2.4	0.6	0.2	0.0	
Pan	0.0	0.0	0.1	0.0	0.0	0.0	

60.0 + 25.0 + 15.0 = 100.0

Aggregate Blending

Material	#8 Stone		Sand		RAP		Combined Gradation %
Percent Used	60%		25%		15%		
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix	
1 1/2"	100.0	60.0	100.0	25.0	100.0	15.0	100.0
1"	100.0	60.0	100.0	25.0	100.0	15.0	
3/4"	100.0	60.0	100.0	25.0	100.0	15.0	
1/2"	73.4	44.0	100.0	25.0	100.0	15.0	
3/8"	30.1	18.1	100.0	25.0	99.6	14.9	
No. 4	4.1	2.4	99.0	24.8	53.3	8.0	
No. 8	2.0	1.2	88.4	22.1	7.2	1.1	
No. 16	0.8	0.5	64.7	16.2	2.6	0.4	
No. 30	0.3	0.2	34.8	8.7	1.6	0.2	
No. 50	0.0	0.0	19.0	4.7	0.9	0.1	
No. 100	0.0	0.0	8.7	2.2	0.4	0.1	
No. 200	0.0	0.0	2.4	0.6	0.2	0.0	
Pan	0.0	0.0	0.1	0.0	0.0	0.0	

This step is done for all the sieves.

Aggregate Blending

Material	#8 Stone		Sand		RAP		Combined Gradation %
Percent Used	60%		25%		15%		
Sieves	% Passing	% for Mix	% Passing	% for Mix	% Passing	% for Mix	
1 1/2"	100.0	60.0	100.0	25.0	100.0	15.0	100.0
1"	100.0	60.0	100.0	25.0	100.0	15.0	100.0
3/4"	100.0	60.0	100.0	25.0	100.0	15.0	100.0
1/2"	73.4	44.0	100.0	25.0	100.0	15.0	84.0
3/8"	30.1	18.1	100.0	25.0	99.6	14.9	58.0
No. 4	4.1	2.4	99.0	24.8	53.3	8.0	35.2
No. 8	2.0	1.2	88.4	22.1	7.2	1.1	24.4
No. 16	0.8	0.5	64.7	16.2	2.6	0.4	17.0
No. 30	0.3	0.2	34.8	8.7	1.6	0.2	9.1
No. 50	0.0	0.0	19.0	4.7	0.9	0.1	4.9
No. 100	0.0	0.0	8.7	2.2	0.4	0.1	2.2
No. 200	0.0	0.0	2.4	0.6	0.2	0.0	0.6
Pan	0.0	0.0	0.1	0.0	0.0	0.0	0.0

Note: Final rounding is to 0.1

Chapter 6

Asphalt Mixture Volumetrics

INDOT Certified Asphalt Technician Course

Presented by: Gerry Huber, Heritage Research Group

Asphalt Mix Designs

- Based on contract specifications
- Go through a process to select materials
- Perform trial blends to determine an aggregate structure
- Evaluate trial blends batching and compaction
- Select the final aggregate structure
- Select final binder content
- Performed in an INDOT qualified design lab
- Follows AASHTO R 35

Mixture Types

- The mix design follows INDOT specifications for INDOT projects. All contract items are listed in a *Contract Information Book* on INDOT's website.

<u>Example Item Description</u>

QC/QA HMA, ___, 58__, ___, ___mm

ESAL Category (2-4)

Number is the binder high temp. grade. Letter is the traffic loading designation. Low binder temp. is -28

Course

Mix Size (NMAS)

QC/QA HMA, 2, 58S, Intermediate, 19.0 mm

ESAL Category 2

PG 58S-28

Intermediate Course

19.0 mm NMAS

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Mix Aggregate Gradations

- There are important features for an asphalt mix to meet gradation requirements.
  - Maximum Particle Size – One sieve size larger than the nominal maximum aggregate size.
  - Nominal Maximum Aggregate Size – One sieve size larger than the first sieve to retain more than 10 percent.
  - Maximum Density Line – ag gradation in which the aggregate particles fit together in their densest possible arrangement. This is a gradation to avoid because there would be insufficient space between the aggregate for the required volume of asphalt binder.
  - Primary Control Sieve (PCS) Control Point – values that define whether a gradation is coarse or fine graded. A gradation equal to or passing below the PCS Control Point is considered coarse-graded.

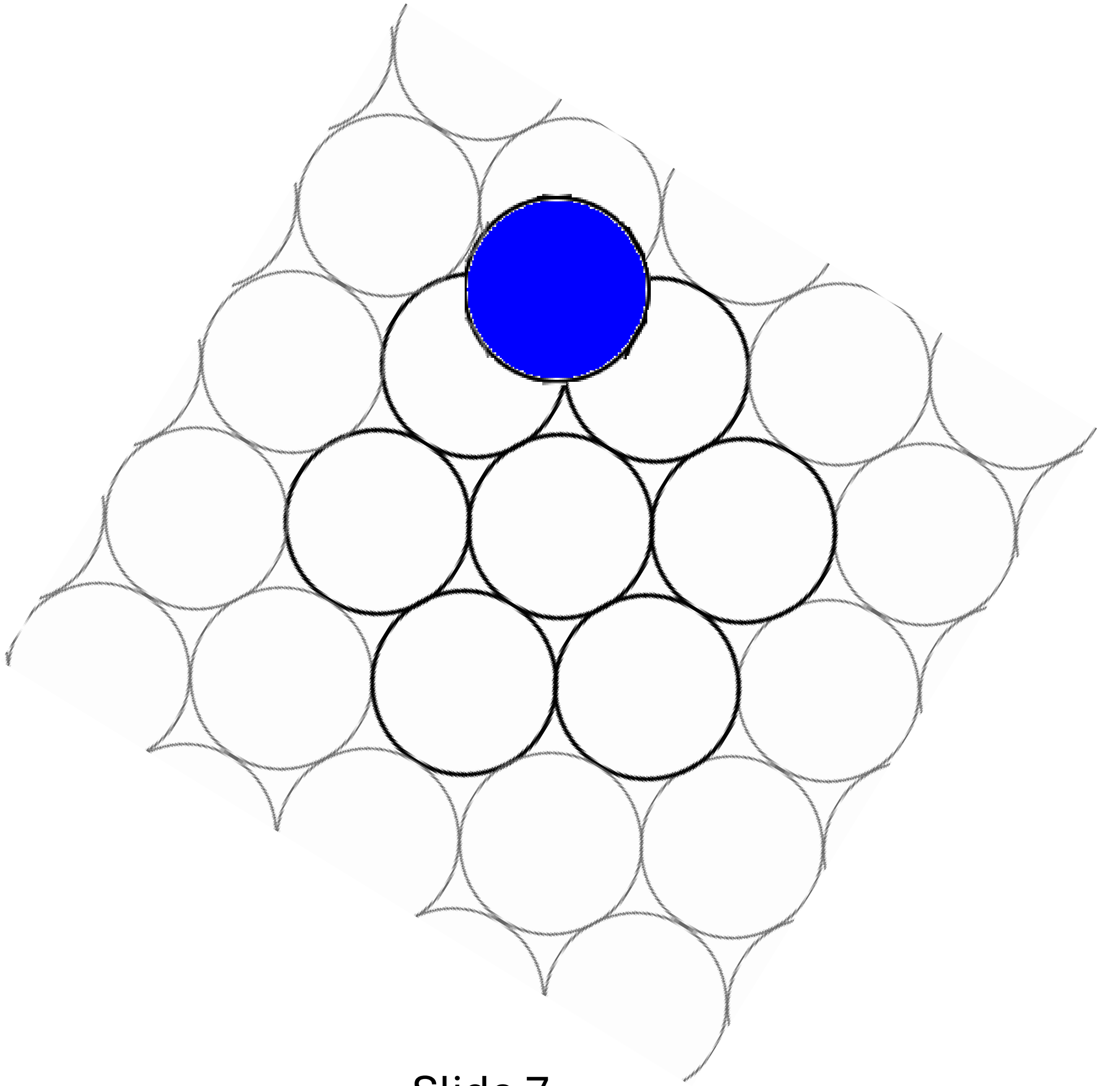
Mix Design – Things to Look For

- Specification and application
- Contract, Item, and Quantity
- Gradation
- Gyratory Compactive Effort
- Voids in the Mineral Aggregate (VMA)
- Voids Filled with Asphalt (VFA)
- Aggregate requirements
- PG Binder Grade

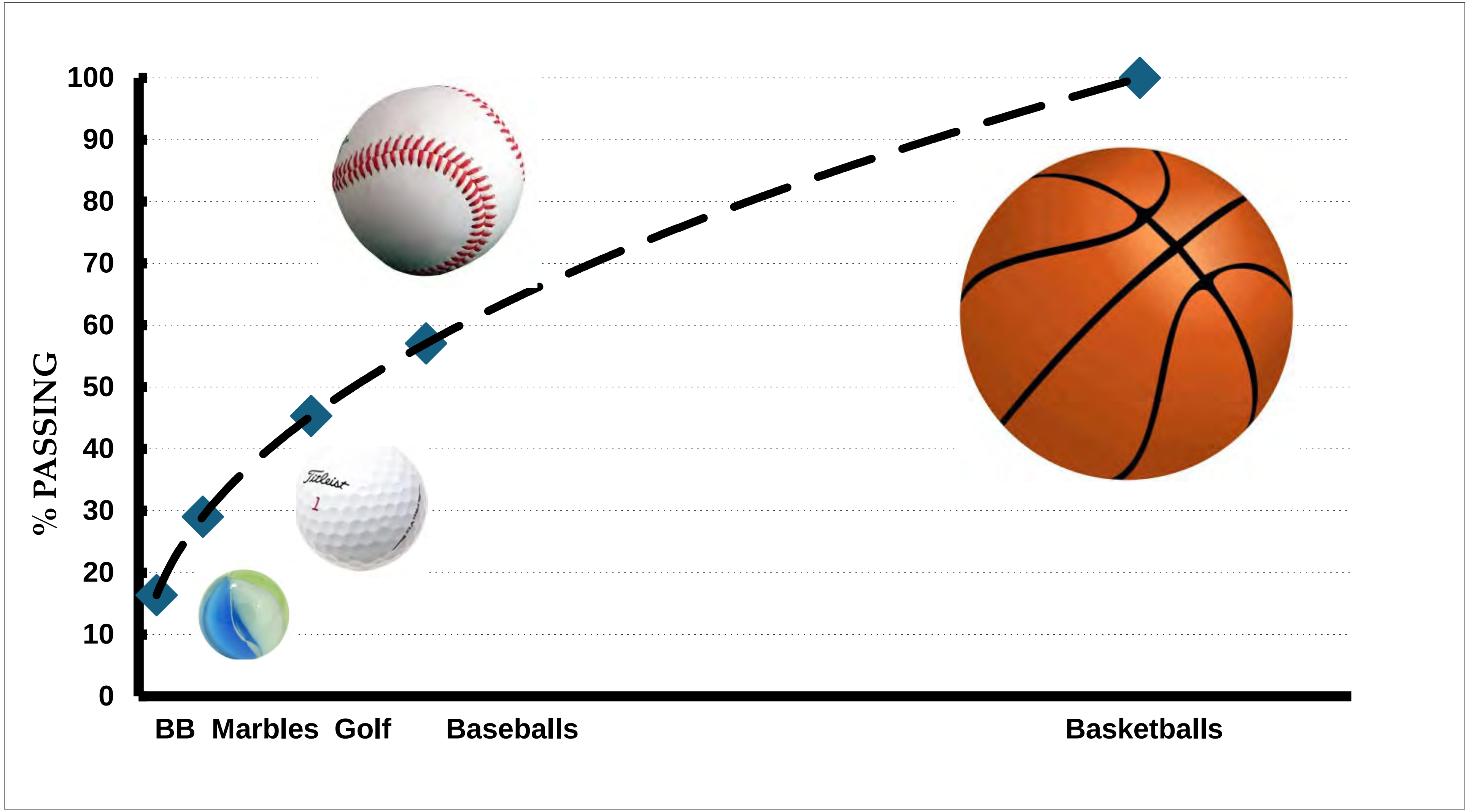
Aggregate Packing

- Gradation
- Shape
- Texture
- Angularity
- Compaction:
  - Type, Amount
- Hardness

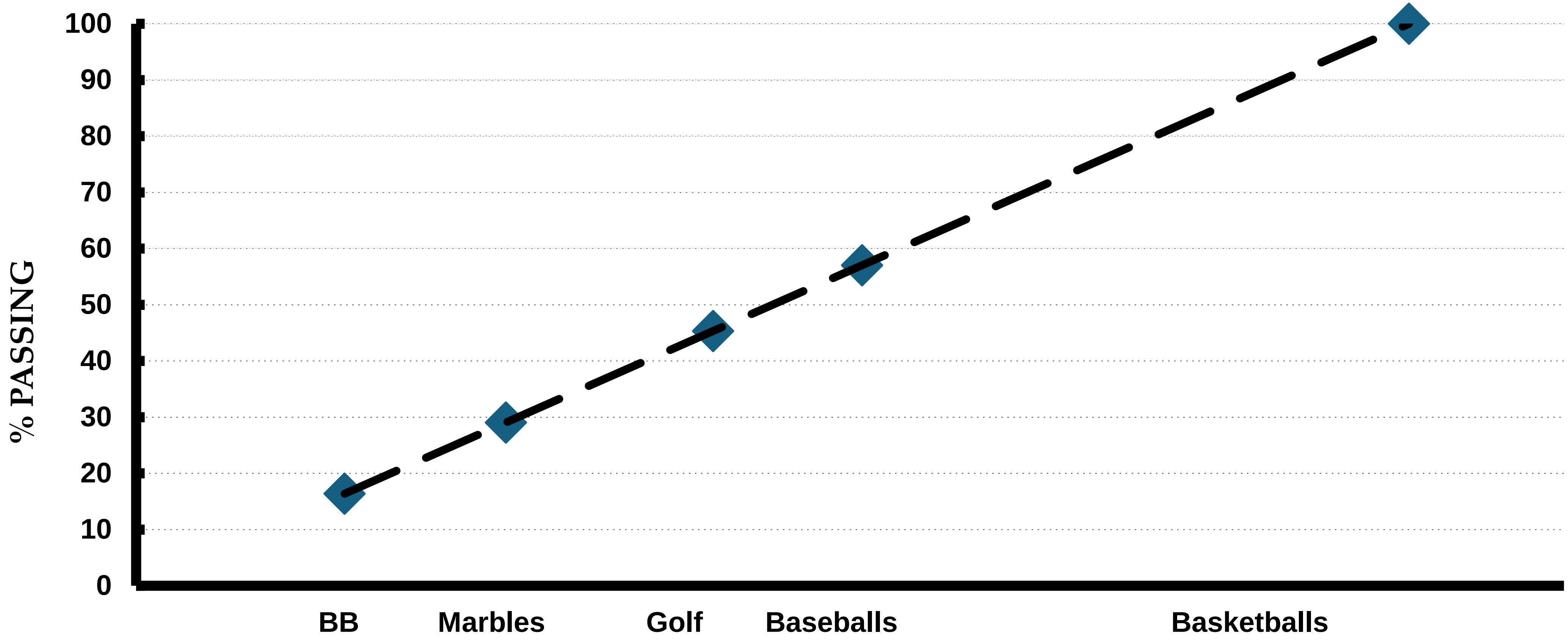
Aggregate Packing



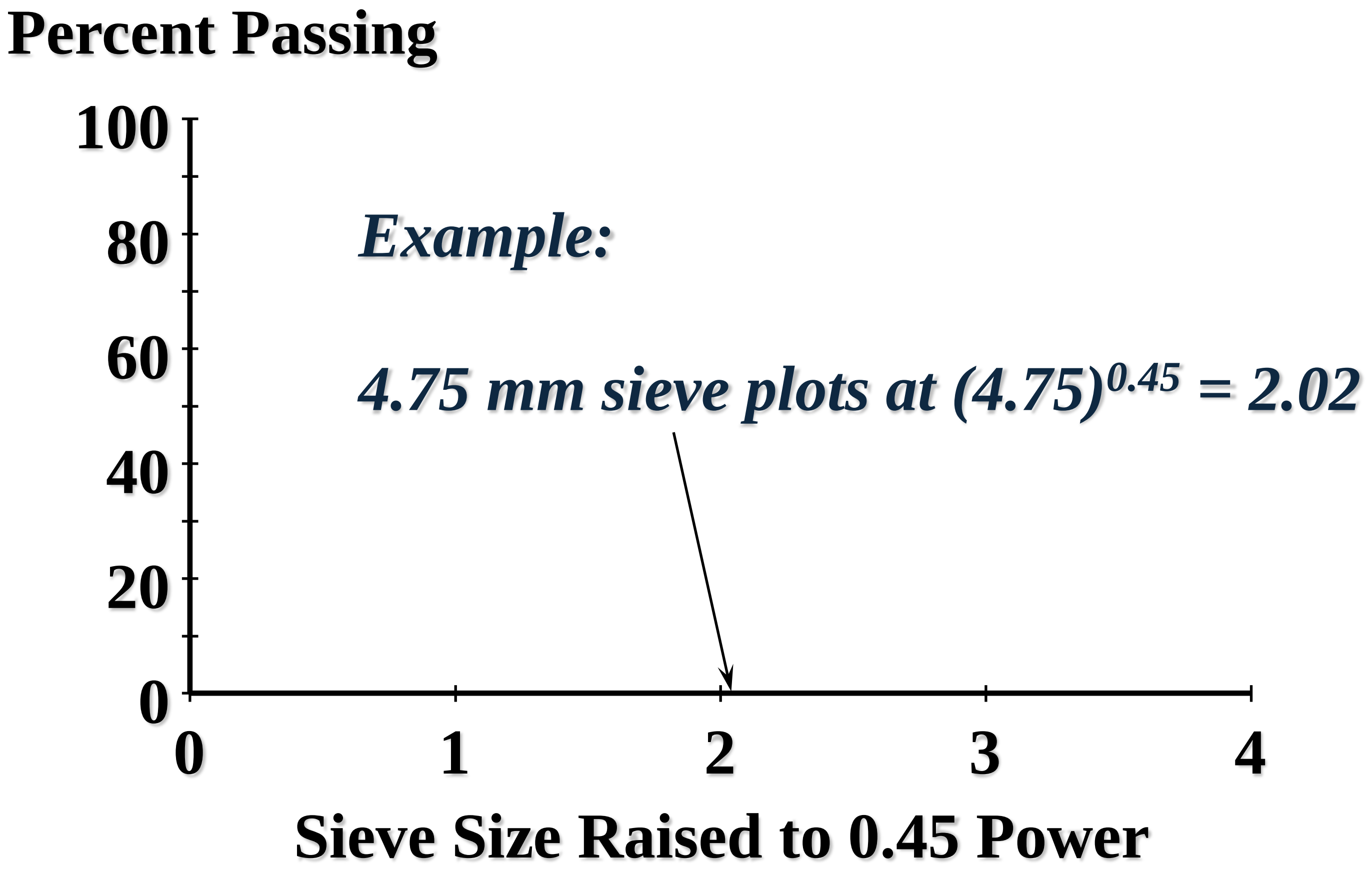
Percent by Diameter



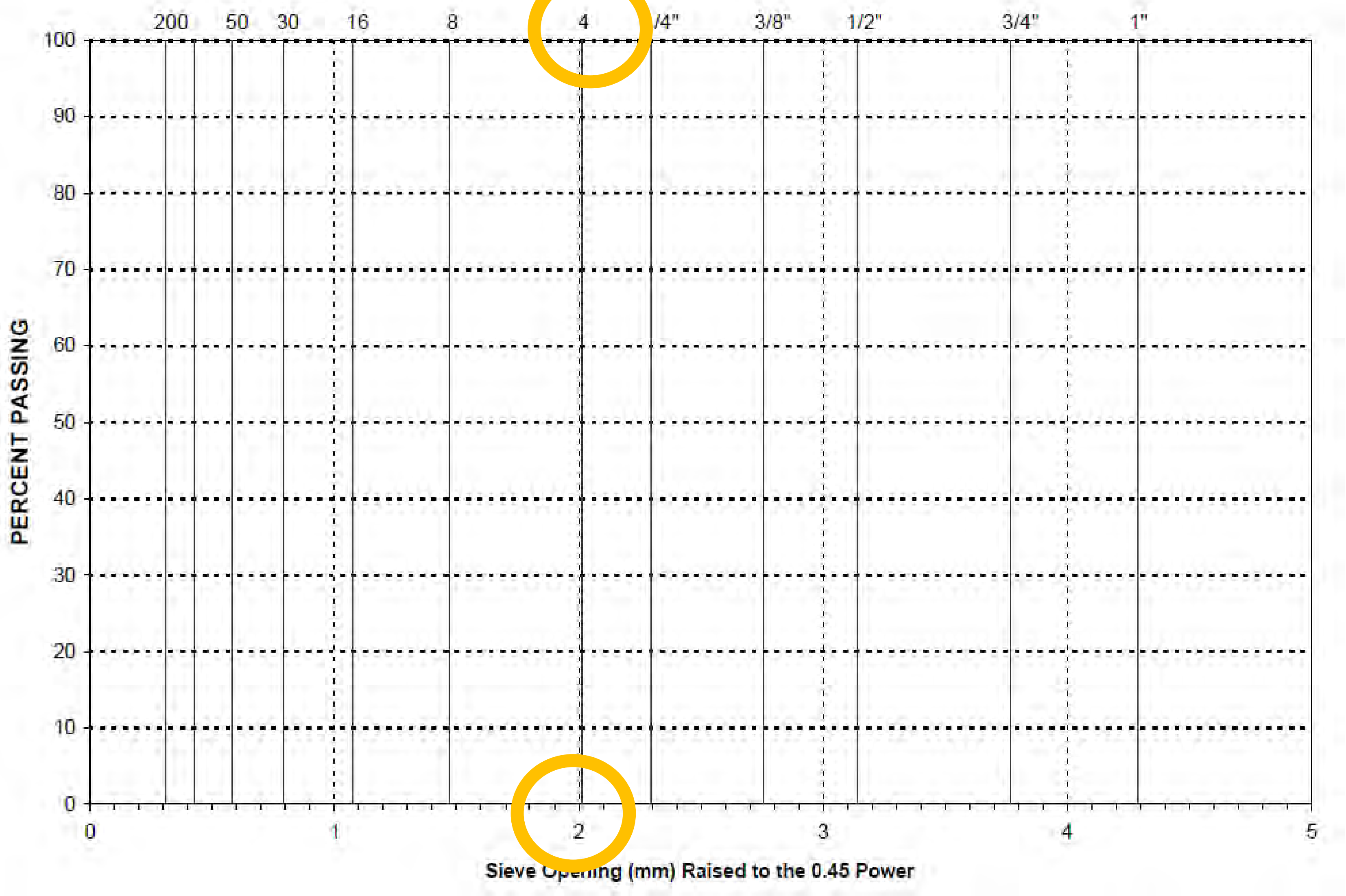
Percent by Square Root Diameter



0.45 Power Grading Chart



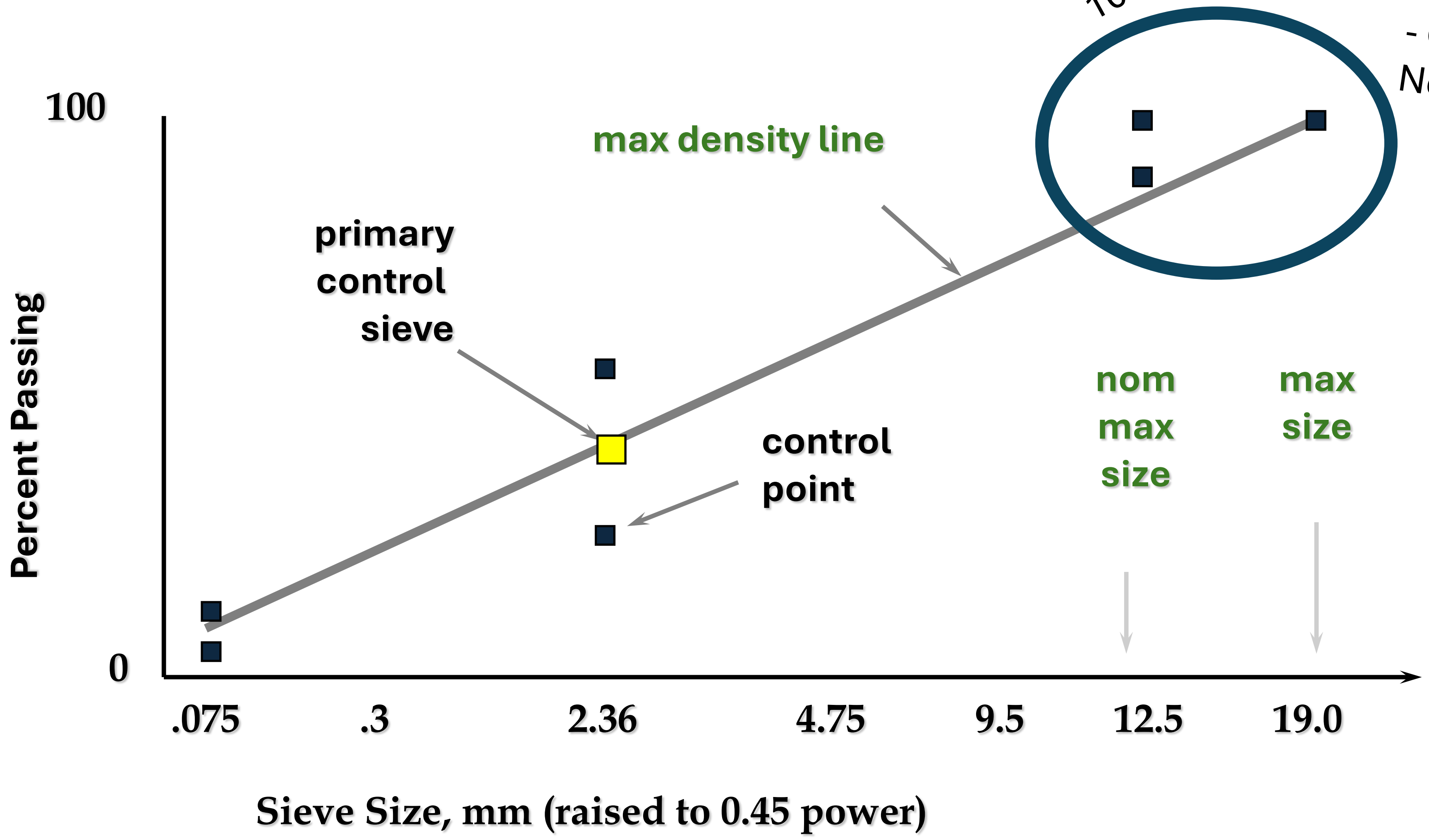
0.45 Power Grading Chart



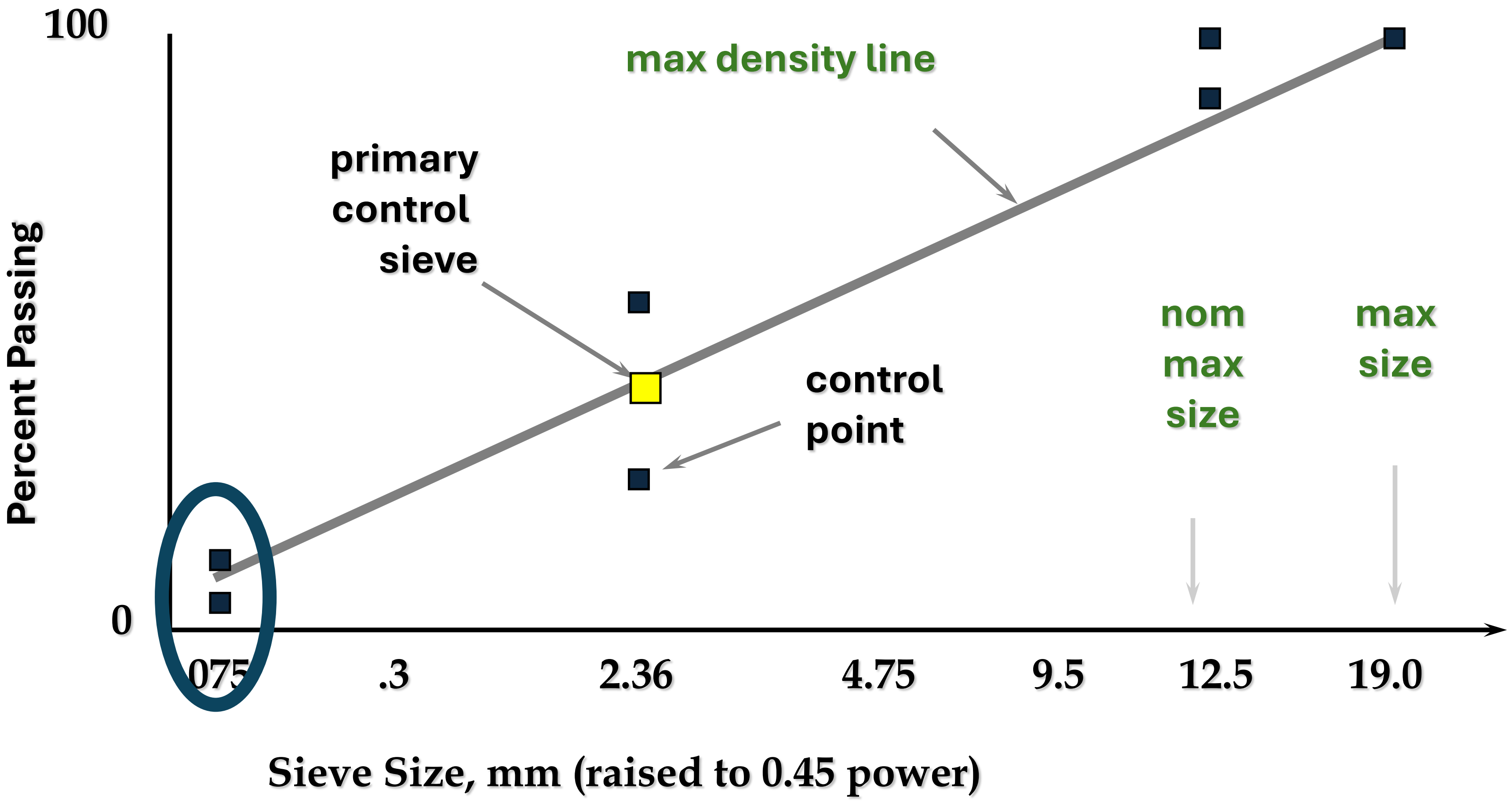
AASHTO M323
Gradation Specifications

Nominal Maximum Size
- One size larger than the first size to retain more than 10%

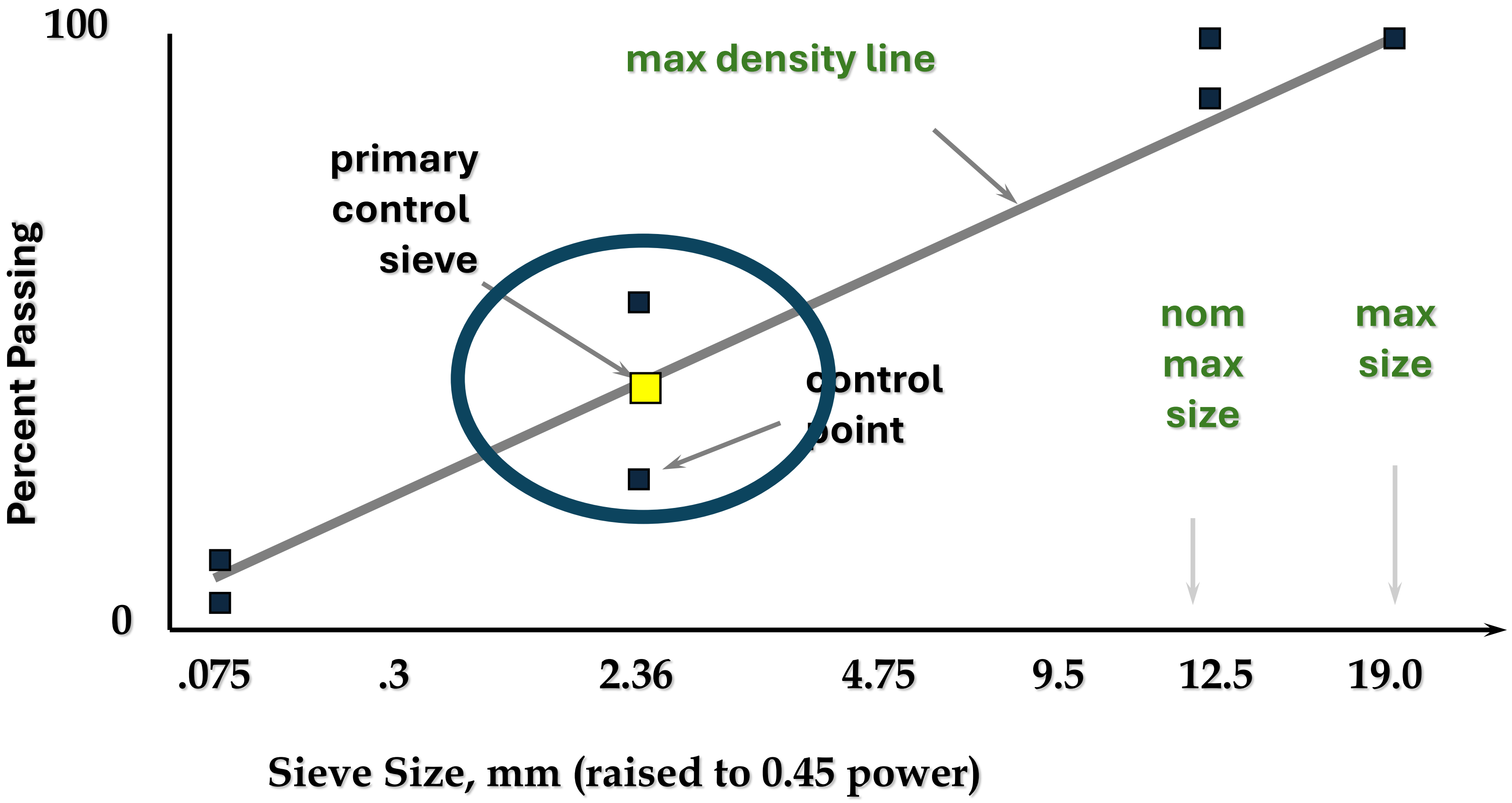
Maximum Size
- One size larger than the Nominal Maximum Size



AASHTO M323
Gradation Specifications



AASHTO M323
Gradation Specifications



19.0-mm NMS Mixture

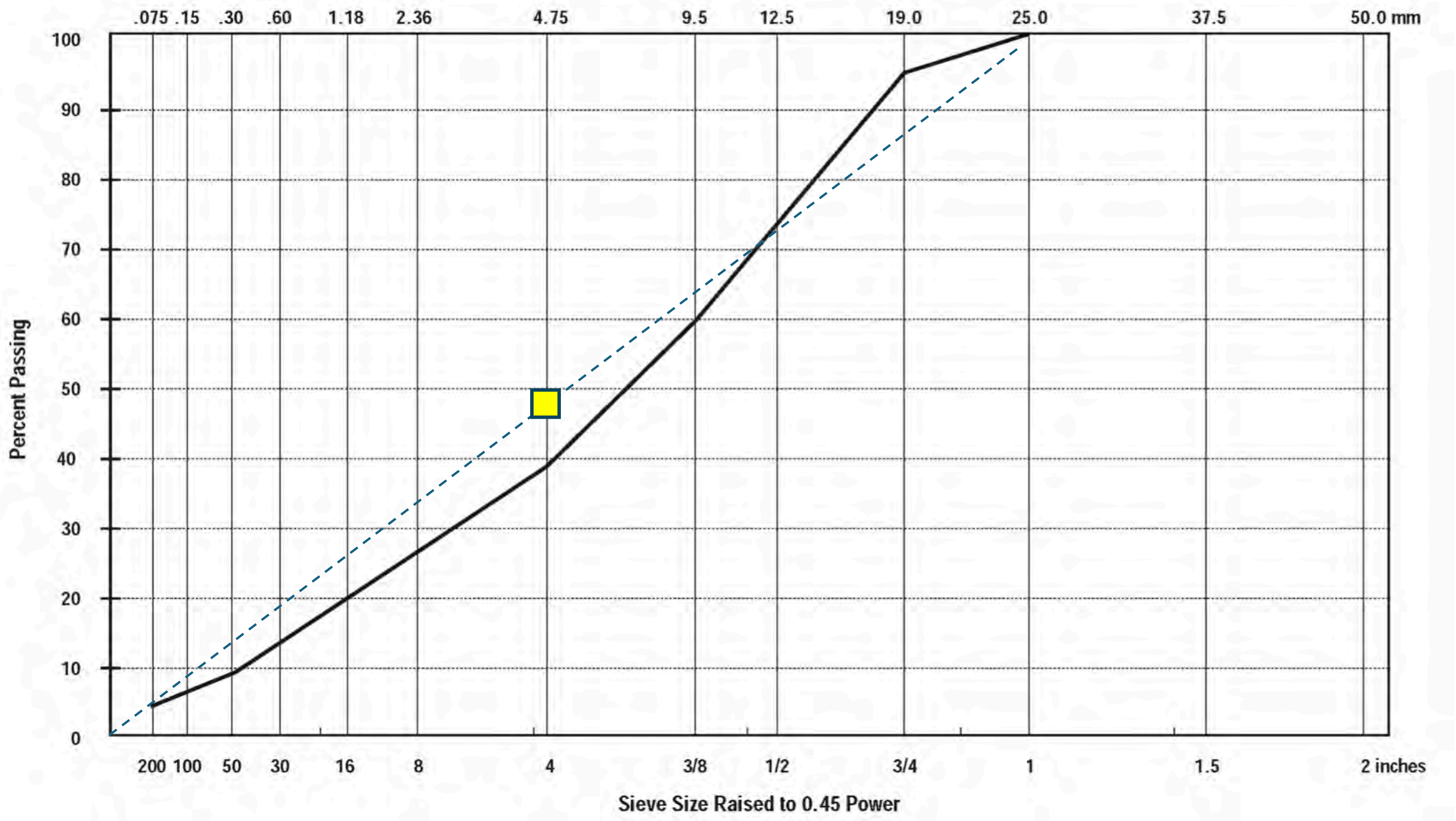
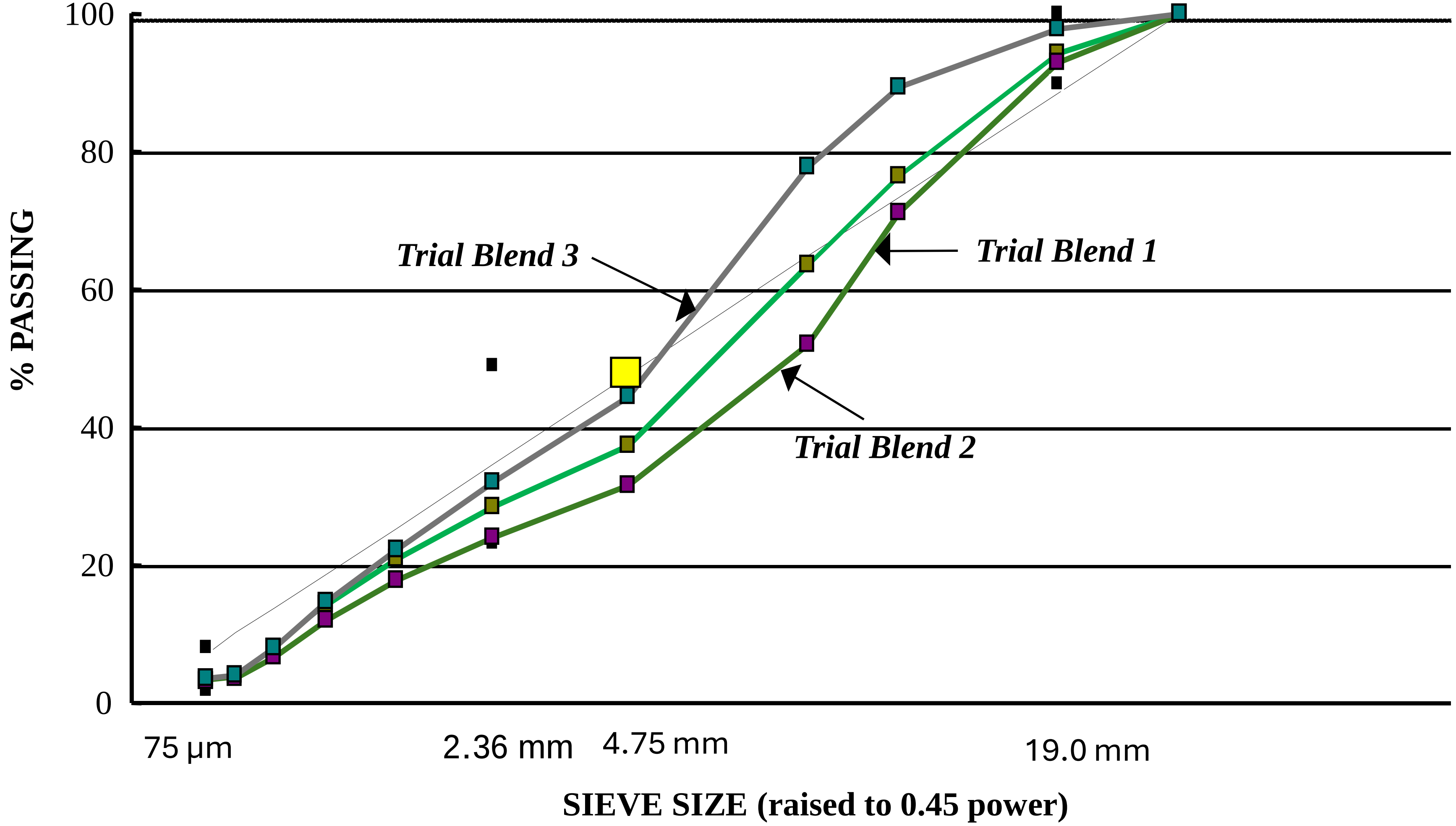


Figure 3.7 0.45 Power Chart

Typical Coarse Superpave Gradations



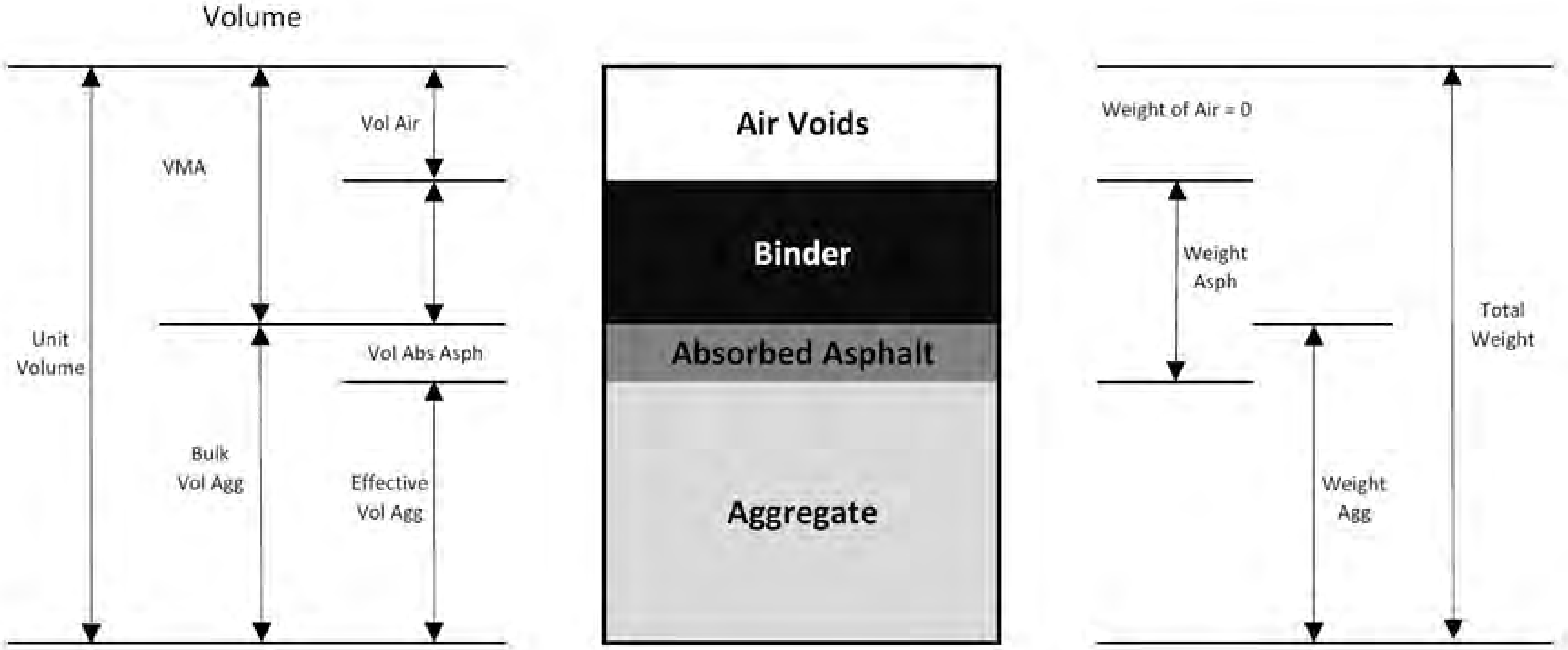
Mix Characteristics

- When a sample of asphalt mix is analyzed, here are at least five things to look at that likely influence behavior:

1. Mix Density
2. Air Voids
3. Voids in Mineral Aggregate (VMA)
4. Voids Filled with Asphalt (VFA)
5. Binder Content

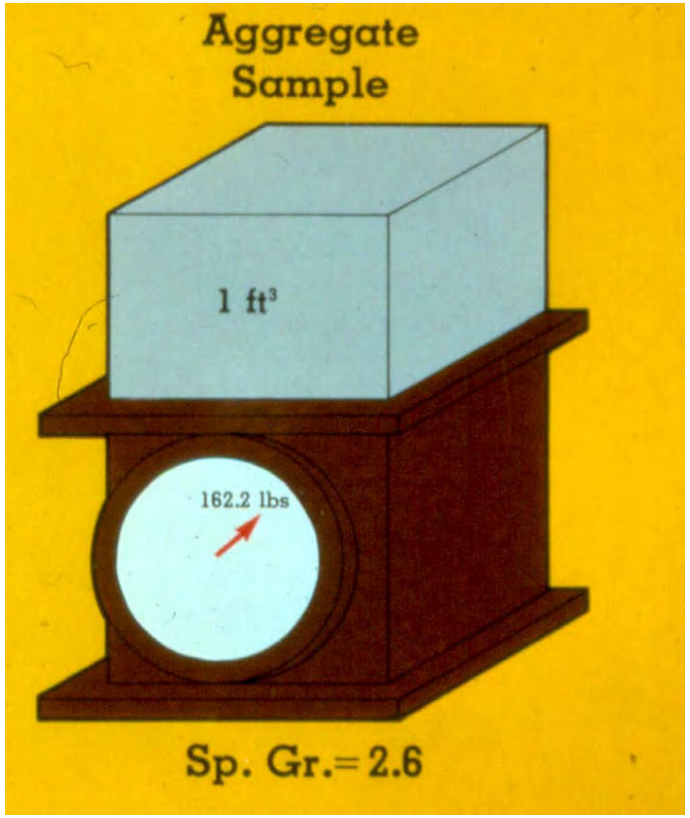
- It is important to understand mix properties are most affected by volume even though production and testing of asphalt are measured using weights.

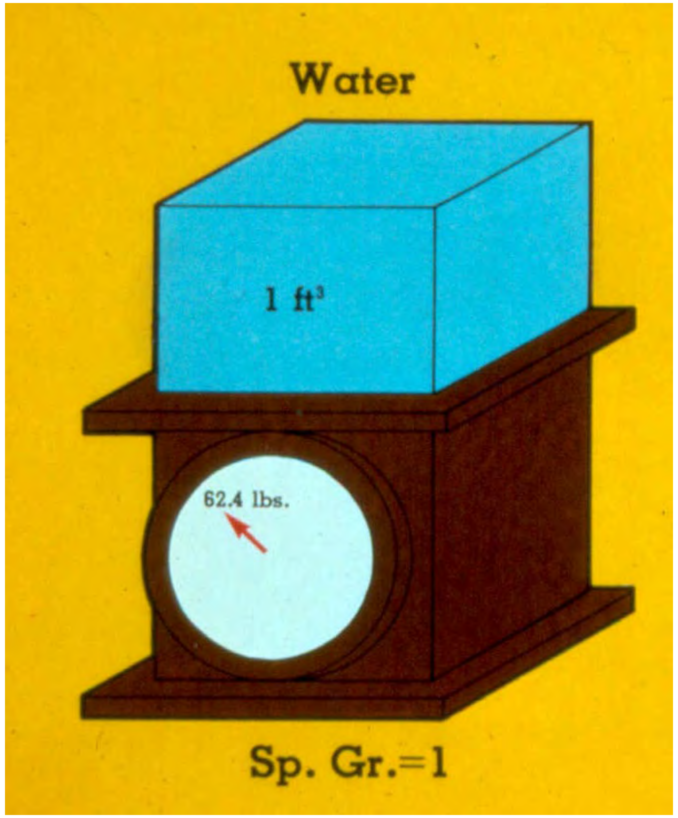
Component Diagram of Compacted Asphalt Sample



Specific Gravity

- Definition
  - Ratio of an object's density to the density of water (water unit wt. = 62.416 lb/ft^3)
- Used as a bridge between the Mass and Volume of objects





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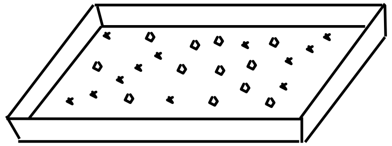
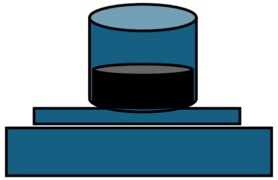
Maximum Specific Gravity

The maximum specific gravity of an asphalt mix (G_{mm}) is determined in accordance with AASHTO T 209.

Maximum Specific Gravity of Mix (Bowl Method)

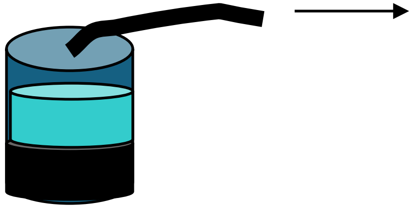


1. Separate fine aggregate to less than 1/4 in.

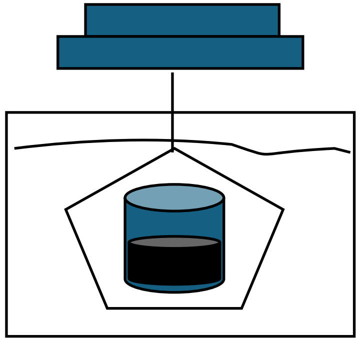


2. Place in bowl and weigh cool

A = mass of dry sample in air, g.

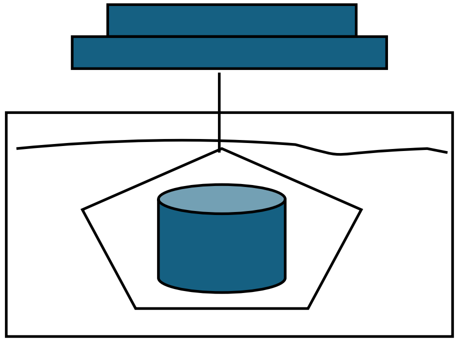


3. Vacuum sample under water @ 25-30 mm. Hg. 15 min. agitation



4. Weigh bowl and sample under water.

C=mass of bowl and mix in water (g)



5. Weigh bowl under water

B=mass of bowl in water (g)

Max. Specific Gravity of Mix

$$G_{mm} = \frac{A}{(A-(C-B))}$$

Separate Fine Aggregate

Determine the Dry Weight of Sample

Sample in Bowl, Cover with Water @ 77°F

Apply vacuum of 25.0 – 30.0 mm Hg to the sample for 15 minutes w/agitation for 15 ± 2 minutes

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Weights Under Water

Bowl weight under water

Bowl and Sample weight under water

Maximum Specific Gravity (bowl method) Example 1

Asphalt Content, %	= 4.9
Weight of Bowl in Water, g (B)	= 1229.2
Weight of Sample, g (A)	= 2215.9
Weight of Bowl + Mix in Water, g (C)	= 2557.0

Determine the Maximum Specific Gravity of Mix.

Maximum Specific Gravity (bowl method) Example 1

Asphalt Content, %	= 4.9
Weight of Bowl in Water, g (B)	= 1229.2
Weight of Sample, g (A)	= 2215.9
Weight of Bowl + Mix in Water, g (C)	= 2557.0

$$\text{Maximum Sp. Gr. of Mix} = \frac{A}{(A-(C-B))}$$

$$= \frac{2215.9}{(2215.9-(2557.0-1229.2))} = 2.495$$

Maximum Specific Gravity of Mix Example 2

Air Voids, %	4.2
Weight of Sample, g	2526.3
Weight of Bowl, g	2399.5
Weight of Bowl in Water, g	1228.2
Weight of Bowl + Mix in Water, g	2753.6

Determine the Maximum Specific Gravity of Mix.

Maximum Specific Gravity of Mix Example 2

Air Voids, %	4.2
Weight of Sample, g	2526.3 (A)
Weight of Bowl, g	2399.5
Weight of Bowl in Water, g	1228.2 (B)
Weight of Bowl + Mix in Water, g	2753.6 (C)

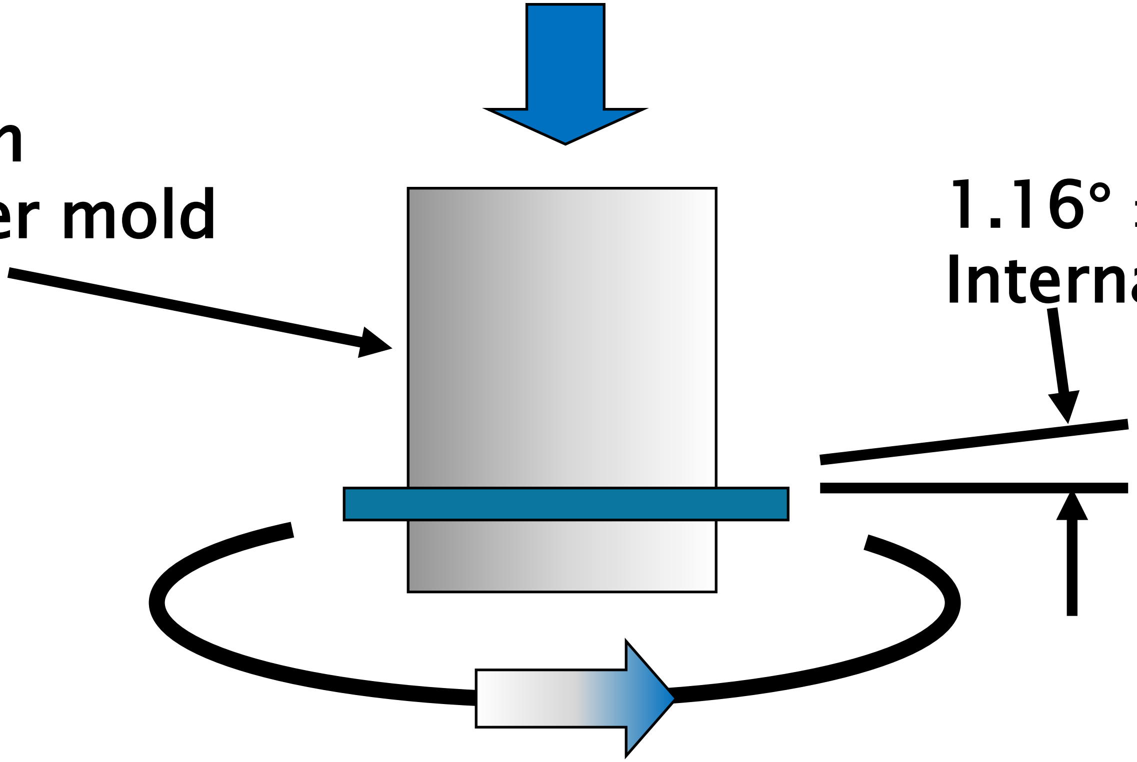
$$\textbf{Maximum Sp. Gr. of Mix} = \frac{2526.3}{2526.3 - (2753.6 - 1228.2)} = 2.524$$

Bulk Specific Gravity

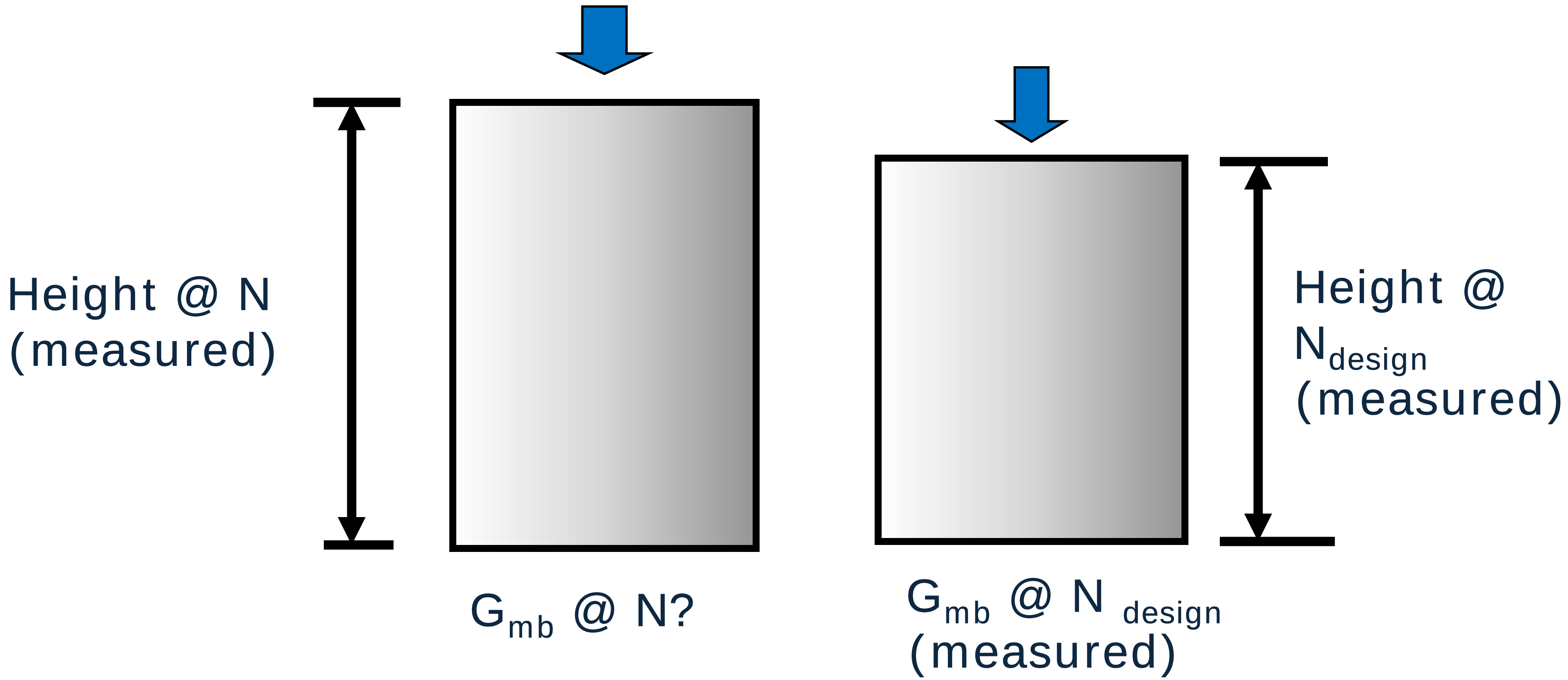
The bulk specific gravity of asphalt mixtures (G_{mb}) is determined in accordance with AASHTO T 166.

This method is run on pills and field cores.

Gyratory Mold Compaction Parameters



Bulk Specific Gravity of Gyratory Specimens



Bulk Specific Gravity of Mix

Weigh in air

Submerge sample in water for 3-5 minutes at 77 ± 1.8°F and determine weight in water.

Bulk Specific Gravity of Mix

Pat with a damp cloth to reach saturated surface dry condition

Bulk Specific Gravity of Mix

Weigh in air with surface water

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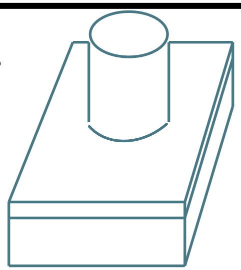
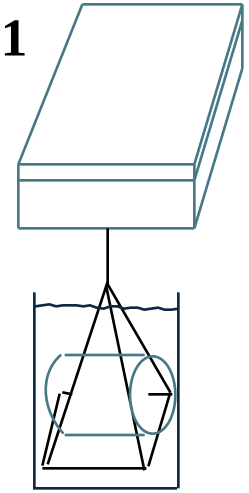
Bulk Specific Gravity Example 1

4649.7



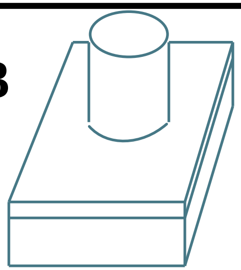
A = Dry Wgt. in grams

2624.1



C = Wgt. in water

4656.3

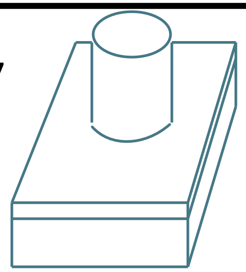


B = Saturated Surface Dry in grams

$$\text{Bulk Specific Gravity of Mixture} = \frac{A}{B - C}$$

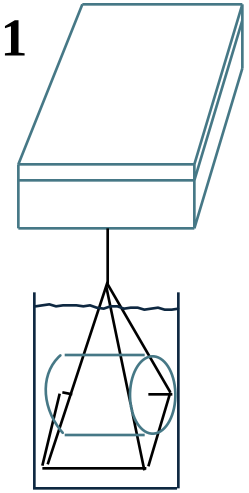
Bulk Specific Gravity Example 1

4649.7



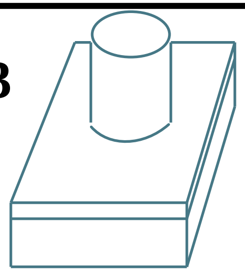
A = Dry Wgt.
in grams

2624.1



C = Wgt. in water

4656.3



B = Saturated Surface Dry
in grams

$$\text{Bulk Specific Gravity of Mixture} = \frac{A}{B - C}$$

$$= \frac{4649.7}{4656.3 - 2624.1}$$

$$= 2.288$$

Bulk Specific Gravity of Mix Using the CoreLok

- CoreLok is an automatic sealing device
- Used where a mixture is too porous for an accurate SSD measurement
  - core density when water absorption > 2.0%
  - pills for open graded asphalt mixtures
- AASHTO T331

G_{mb} with CoreLok Example

Bulk Specific Gravity of Mix Using the Corelok Device

$$G_{mb} = \frac{A}{\left[(B - E) - \left(\frac{(B - A)}{F_T}\right)\right]}$$

Where,

A = Dry Sample Weight (g)

B = Sealed Sample Weight (g)

E = Sealed Sample Weight in Water (g)

F_T = Apparent Specific Gravity of Bag

G_{mb} with CoreLok Example

Sample Dry Weight = 4146.6 g

Sealed Sample in Bag Weight = 4199.5 g

Sealed Sample in Water Weight = 2228.8 g

Apparent Specific Gravity of Bag = 0.7257

G_{mb} = 4146.6 / {(4199.5-2228.8) - [(4199.5-4146.6) / 0.7275]}

G_{mb} = 4146.6 /(1970.7 - 72.7) = 2.185

G_{mb} with CoreLok Example

$$G_{mb} = 4146.6 / (1970.7 - 72.7) = 2.185$$

$$= 2.185 + 0.020 = 2.205$$

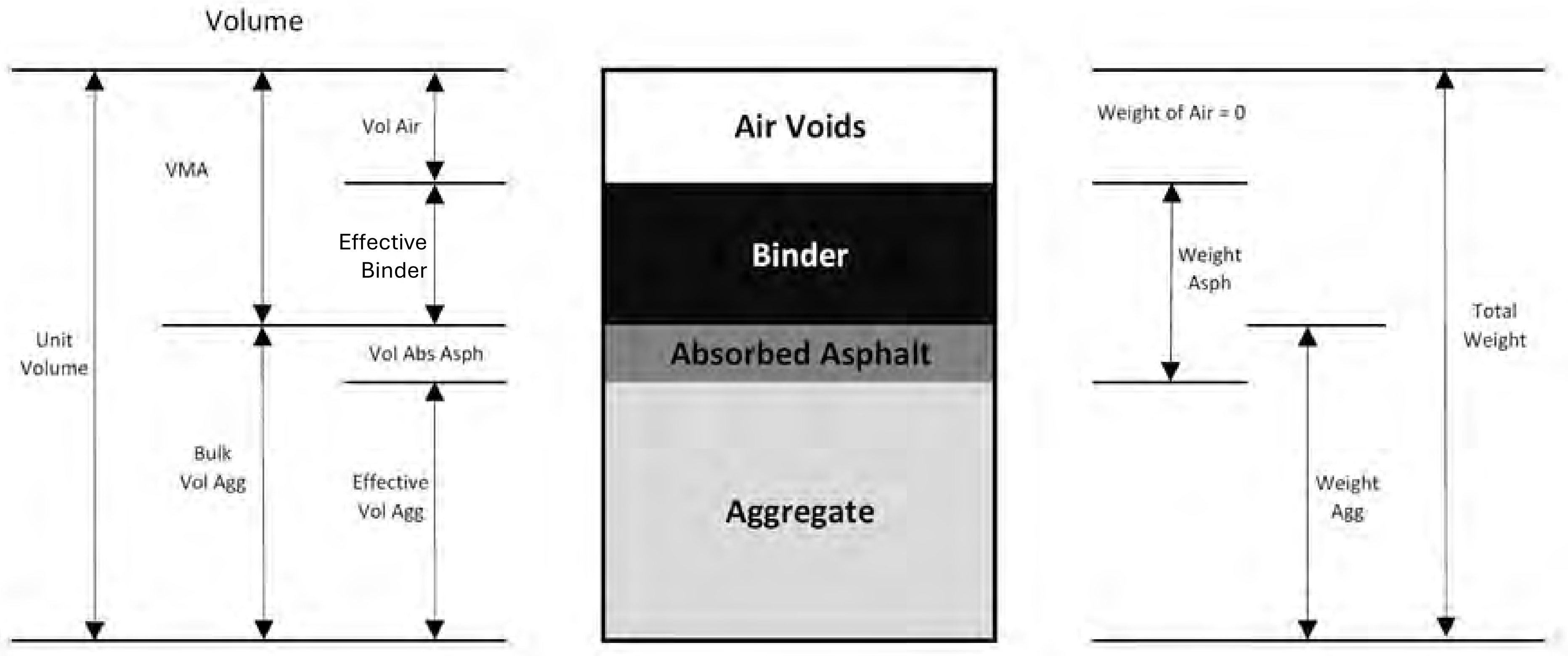
INDOT Directive 304

<u>Corelok offset:</u>

Dense Graded HMA; when core BSG (Gmb) is determined by AASHTO T 331, a value of 0.020 will be added to the core BSG.

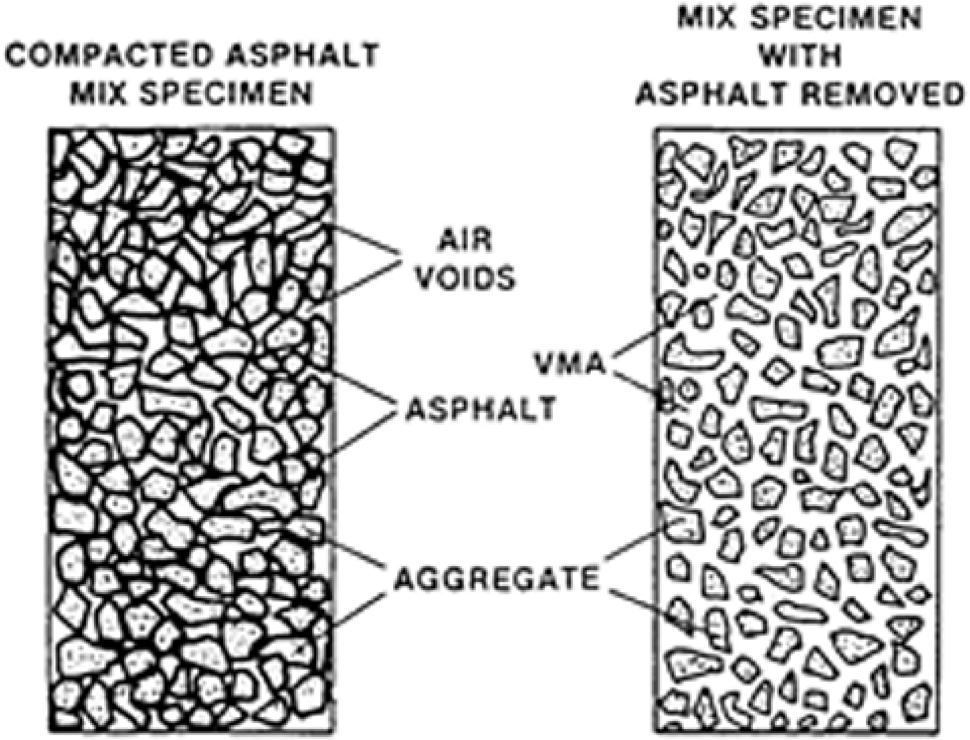
SMA; when core BSG (Gmb) is determined by AASHTO T 331, a value of 0.045 will be added to the core BSG.

Let's go back and look at our Volumetrics



VMA

- VMA are the void spaces between the aggregate particles in the compacted paving mixture.
- This is the space available for the volume of asphalt binder that is not absorbed and the volume of air necessary in the mixture.
- Factors that influence VMA are:
  - Gradation
  - Shape
  - Texture
  - Angularity
  - Hardness
  - Type and Amount of Compaction

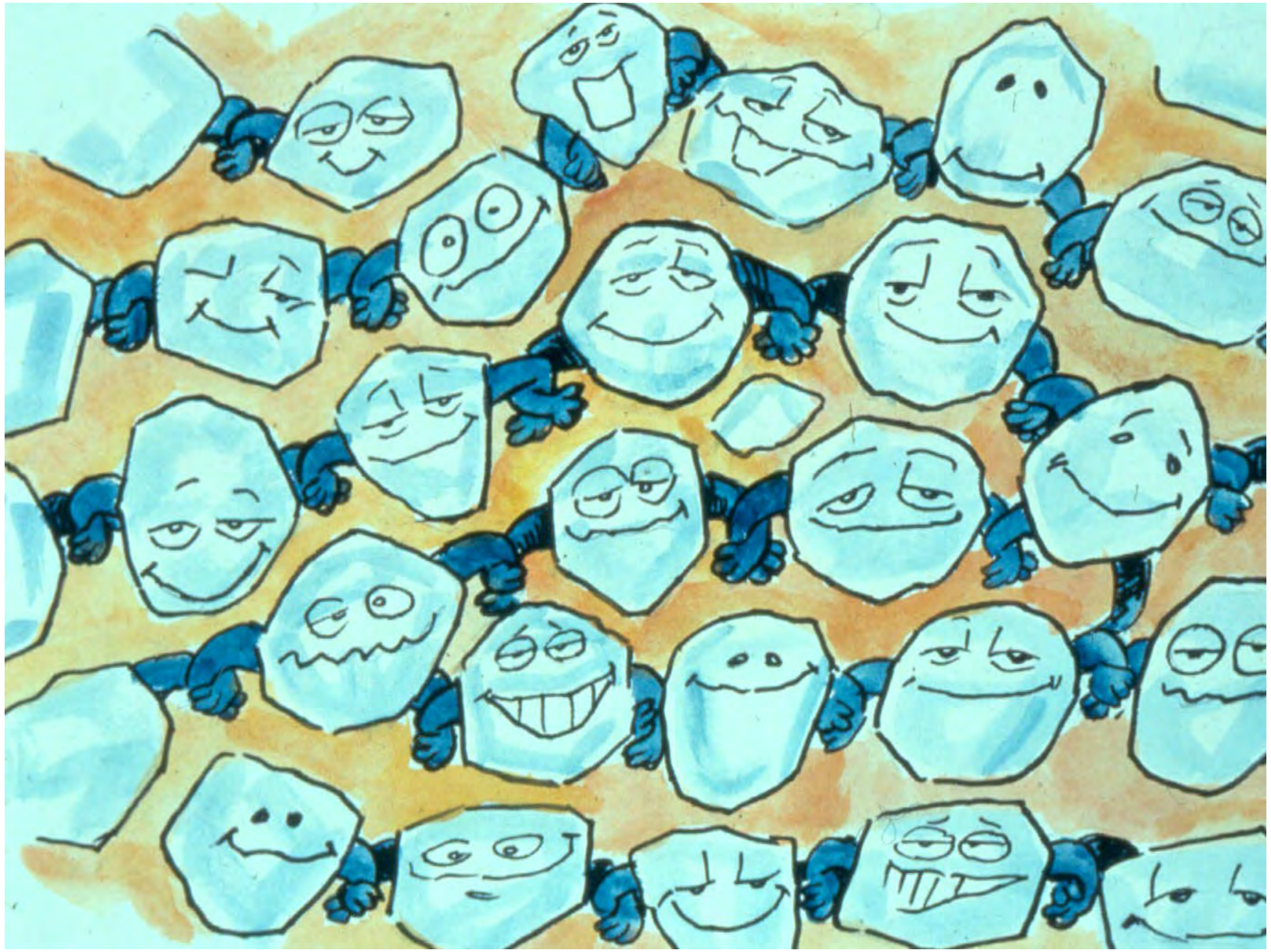


Air Voids

- Air voids are small pockets of air between the coated aggregate particles and the compacted asphalt mixture.
- A minimum parentage of air voids are needed to prevent the pavement from flushing, shoving, and rutting.
- Too high air voids will lead to reduced pavement life due to accelerated aging.
- Air voids act like shock absorbers. Air is very compressible and instead of pressure building up in the binder, the air voids are slightly compressed. As a result, the pavement has the same stiffness when the last axle of the last truck is applied as when the first axle was applied. And the pavement does not rut.
- Air voids are directly related to durability.

Relationships of Mix and Properties of Performance

Rut Resistance



Low Rut Resistance

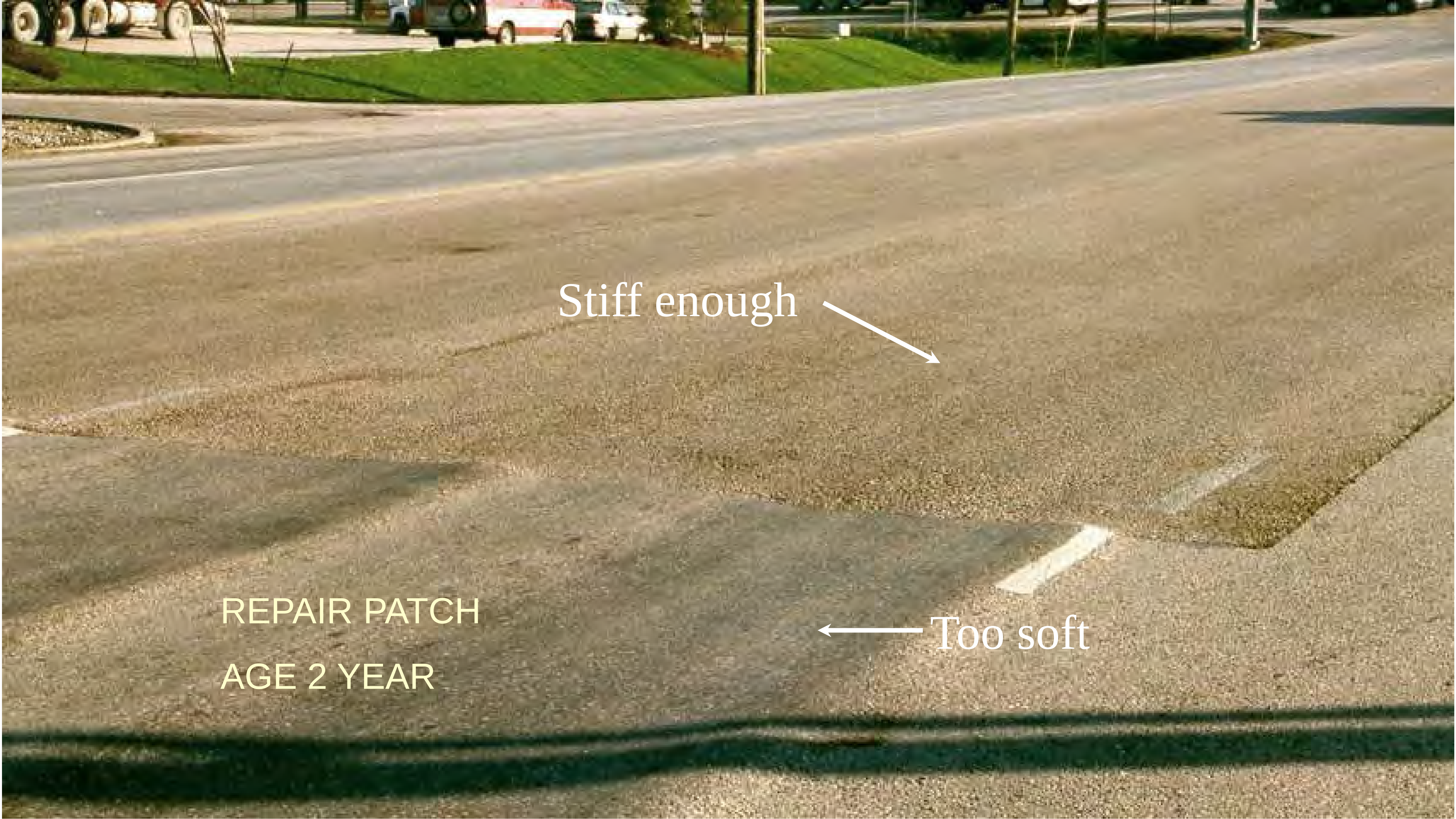
Causes	Effects
Excess asphalt content	Rutting, flushing or bleeding
Excess natural sand	Tenderness during and after rolling Difficult to compact
Rounded aggregate, few or no crushed faces	Rutting

Low Rut Resistance

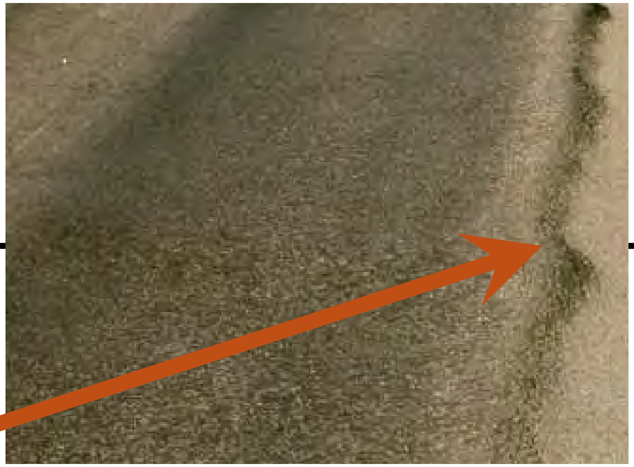
Causes	Effects
Excess asphalt content	Rutting, flushing or bleeding
Excess natural sand	Tenderness during and after rolling Difficult to compact
Rounded aggregate, few or no crushed faces	Rutting

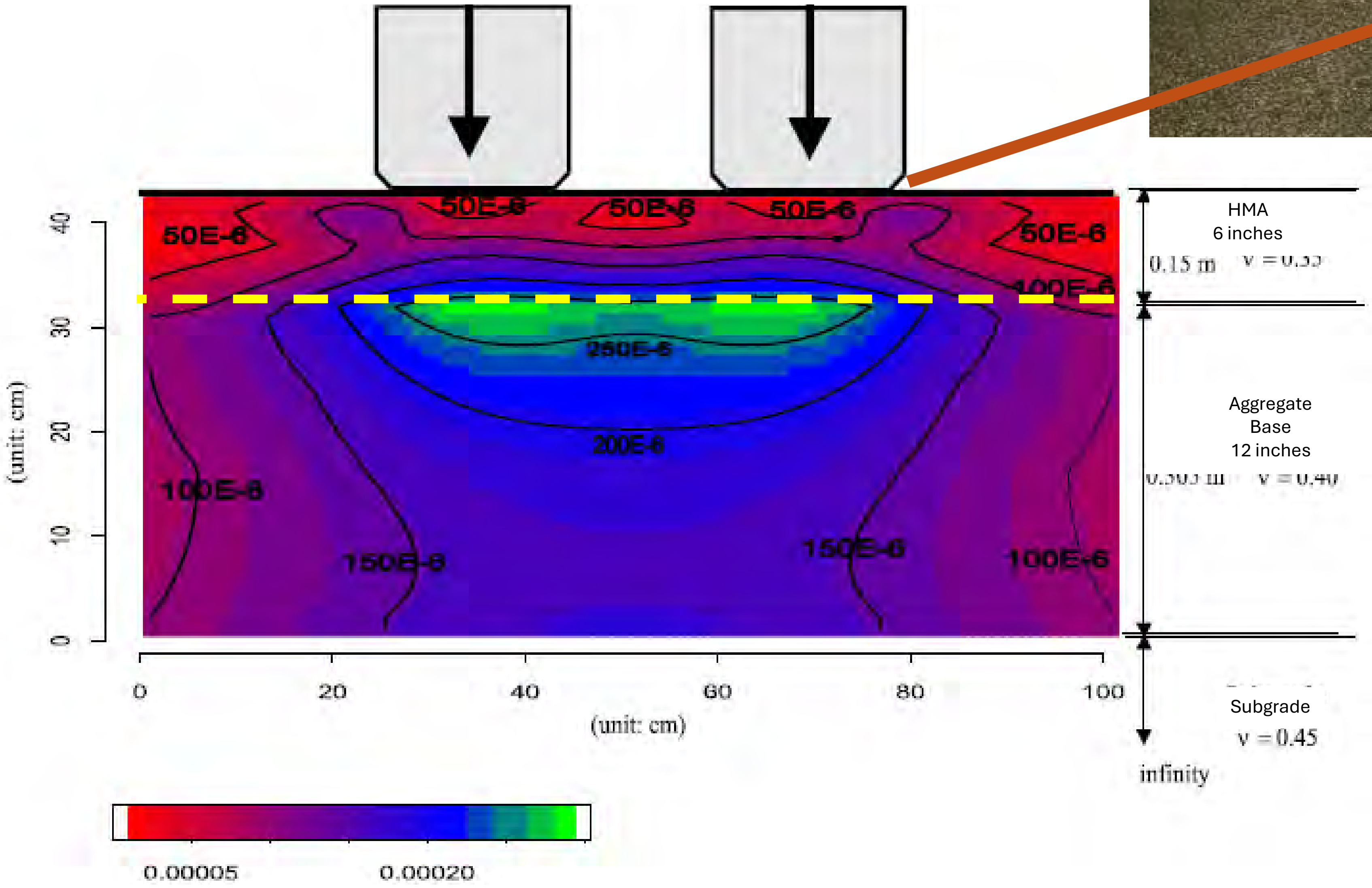
A BUSY INTERSECTION


40
PAVED WITH REGULAR MIX,
AGE 2 YEAR

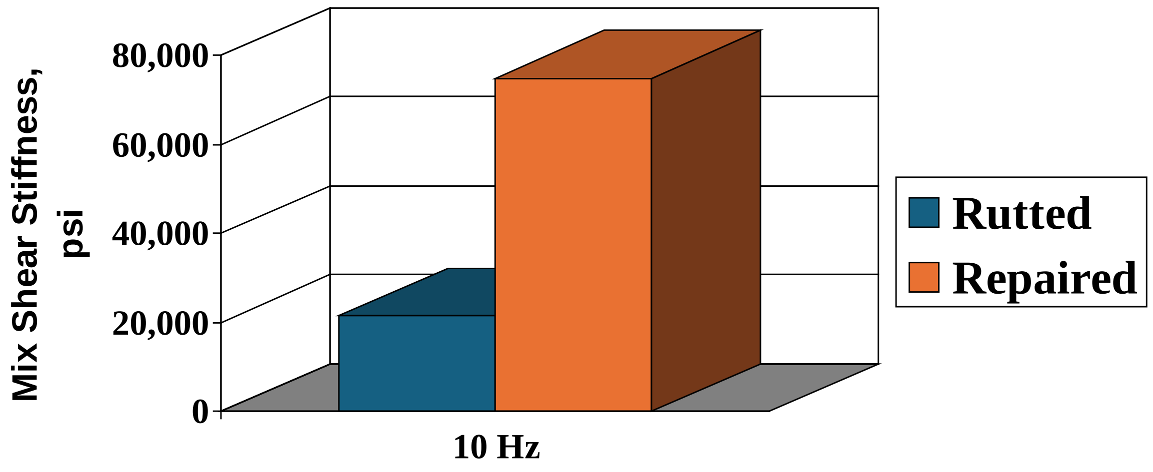

Stiff enough
REPAIR PATCH
AGE 2 YEAR
Too soft

Rutting in Asphalt Layer



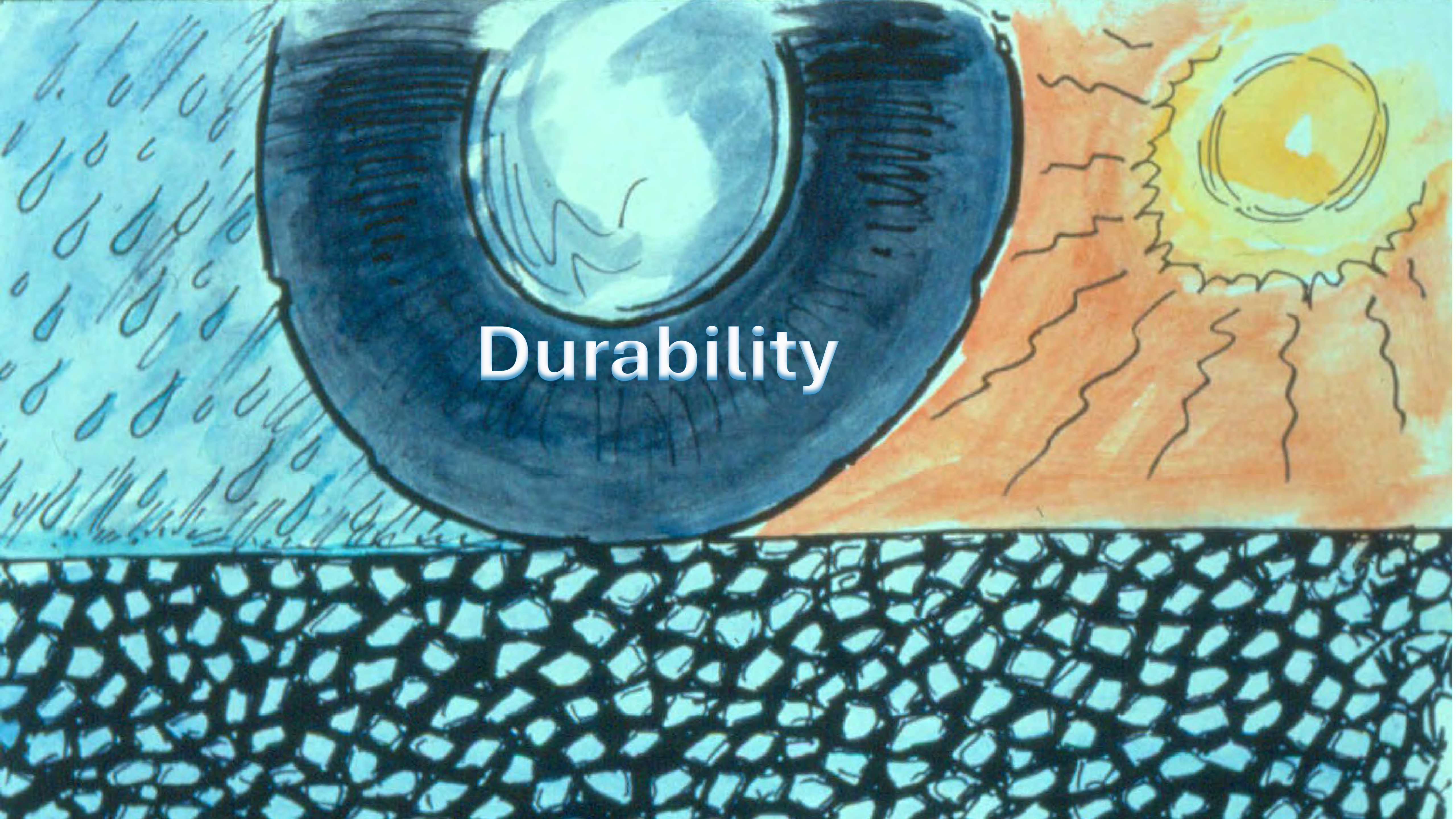


Mixture Stiffness




After 9 years


After 23 years


Durability

Poor Mix Durability

Causes	Effects
Low asphalt content	Dryness, raveling
High voids content	Early hardening of asphalt followed by cracking or disintegration
Water susceptible aggregate	Asphalt strips from aggregate causing raveled, low stiffness pavement


Aging
(Durability)
Raveling

Poor Mix Durability

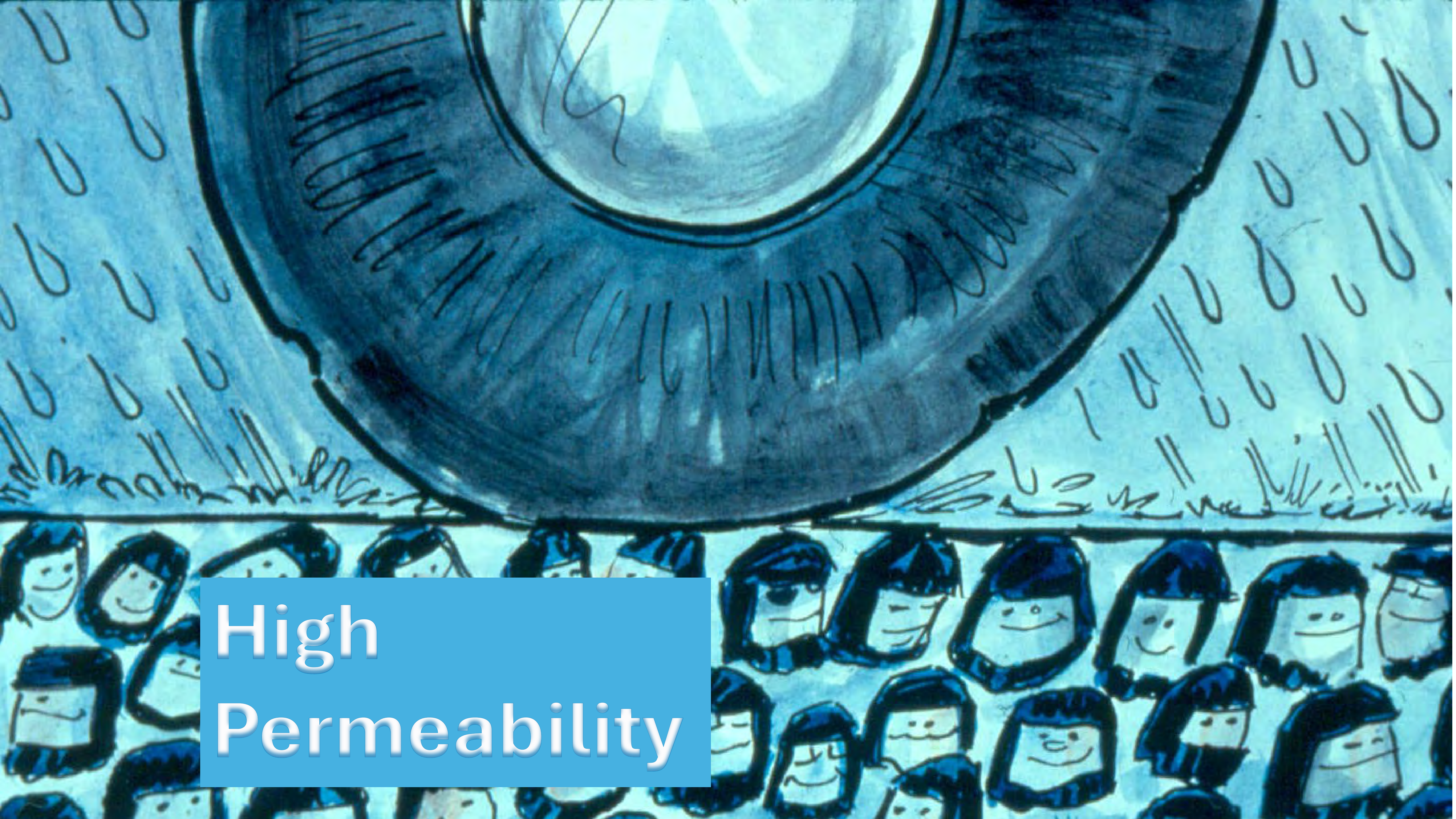
Causes	Effects
Low asphalt content	Dryness, raveling
High voids content	Early hardening of asphalt followed by cracking or disintegration
Water susceptible aggregate	Asphalt strips from aggregate causing raveled, low stiffness pavement


Silo Segregation, 3 yr. old pavement


Silo Segregation, 3 yr. old pavement

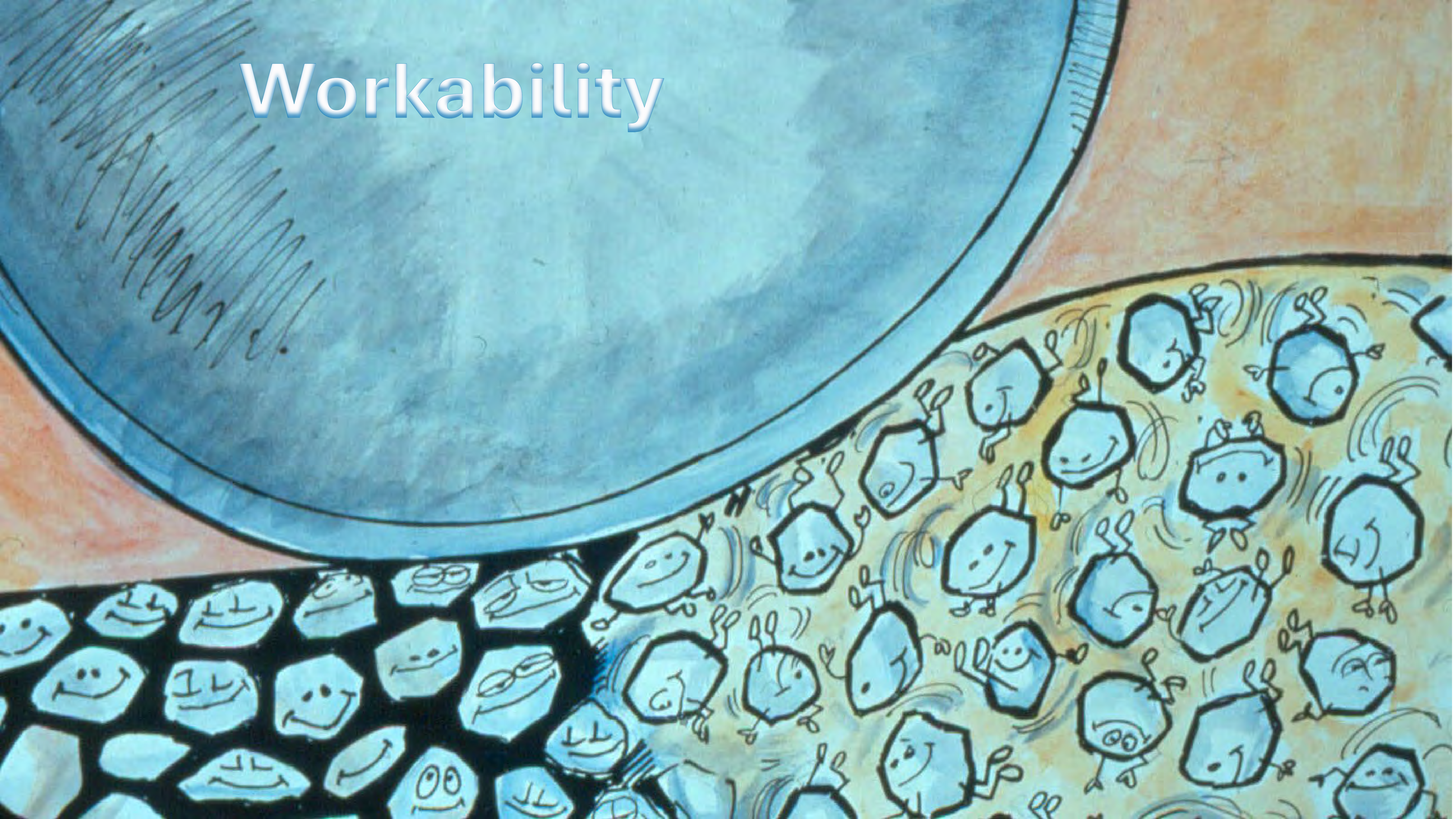
Poor Mix Durability

Causes	Effects
Low asphalt content	Dryness, raveling
High voids content	Early hardening of asphalt followed by cracking or disintegration
Water susceptible aggregate	Asphalt strips from aggregate causing raveled, low stiffness pavement


High
Permeability


H24

Workability



Poor Mix Workability

Causes	Effects
Large maximum size particles	Difficult to place
Excess coarse aggregate	Difficult to compact
Excess natural sand	Tenderness
Low P_{200} (dust)	Tenderness
High P_{200} (dust)	Dryness, gumminess


P-73
INDIANA
1347 R


EC


INGERSOLL-RAND

Poor Mix Workability

Causes	Effects
Large maximum size particles	Difficult to place
Excess coarse aggregate	Difficult to compact
Excess natural sand	Tenderness
Low P_{200} (dust)	Tenderness
High P_{200} (dust)	Dryness, gumminess

Poor Mix Workability

Causes	Effects
Large maximum size particles	Difficult to place
Excess coarse aggregate	Difficult to compact
Excess natural sand	Tenderness
Low P_{200} (dust)	Tenderness
High P_{200} (dust)	Dryness, gumminess


TOLKO
Vanderwell
BRANDS

Poor Mix Workability

Causes	Effects
Large maximum size particles	Difficult to place
Excess coarse aggregate	Difficult to compact
Excess natural sand	Tenderness
Low P_{200} (dust)	Tenderness
High P_{200} (dust)	Dryness, gumminess

Fatigue Resistance

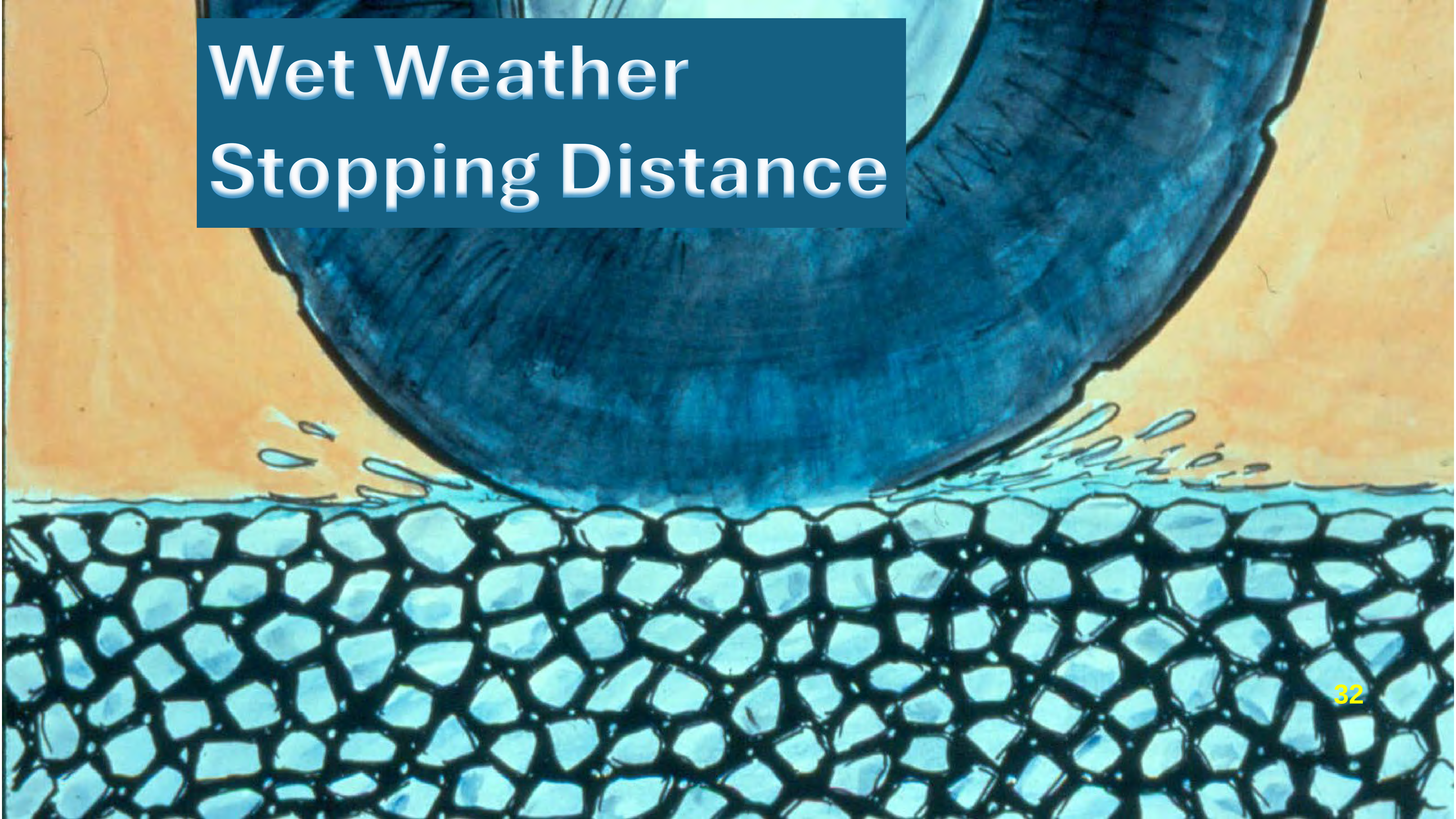
Poor Fatigue Resistance

Causes	Effects
Low asphalt content	Cracking
High voids in-place content	Early aging of asphalt binder followed by cracking
Inadequate pavement thickness	Excessive bending followed by cracking


Advanced Fatigue Cracking

Fatigue Cracking

Wet Weather Stopping Distance



Poor Friction

- Increases Stopping Distance

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INDOT

APAI
ASPHALT PAVEMENT ASSOCIATION of INDIANA

Poor Friction

Causes	Effects
Excess asphalt content	Bleeding, low wet weather friction
Poorly textured (smooth) aggregate	Low wet weather friction
Polishing aggregate	Low wet weather friction


Flushing

Poor Friction

Causes	Effects
Excess asphalt content	Bleeding, low wet weather friction
Poorly textured (smooth) aggregate	Low wet weather friction
Polishing aggregate	Low wet weather friction

Loss of Micro Texture

All Properties Must Be Considered

Relationship of Mixture Properties to Performance

- Rutting
- Fatigue Cracking
- Low Temperature Cracking
- Aging

- PG High Temperature
- PG Low Temperature
- Coarse Aggregate Angularity (CAA)
- Fine Aggregate Angularity (FAA)
- Gradation

- Air Voids in-place (Va_{ip})
- Effective Asphalt Content (Vbe)
- Voids in Mineral Aggregate in-place (VMA_{ip})
- Voids Filled with Asphalt in-place (VFA_{ip})

Relationship of Mixture Properties to Performance

- Rutting
- Fatigue Cracking
- Low Temperature Cracking
- Aging

- PG High Temperature
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- Coarse Aggregate Angularity (CAA)
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Relationship of Mixture Properties to Performance

- Rutting
- Fatigue Cracking
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Relationship of Mixture Properties to Performance

- Rutting
- Fatigue Cracking
- Low Temperature Cracking
- Aging

- PG High Temperature
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- Coarse Aggregate Angularity (CAA)
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ASPHALT PAVEMENT ASSOCIATION of INDIANA

Relationship of Mixture Properties to Performance

- Rutting
- Fatigue Cracking
- Low Temperature Cracking
- Aging

- PG High Temperature
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- Coarse Aggregate Angularity (CAA)
- Fine Aggregate Angularity (FAA)
- Gradation

- Air Voids in-place (Va_{ip})
- Effective Asphalt Content (Vbe)
- Voids in Mineral Aggregate in-place (VMA_{ip})
- Voids Filled with Asphalt in-place (VFA_{ip})

Chapter 7

Volumetric Calculation Practice

INDOT Certified Asphalt Technician Course

Presented by: Nathan Awwad, INDOT

Common Abbreviations

- AV = V_a = Air Voids %
- G_{mb} = Bulk Specific Gravity
- G_{mm} = Maximum Sp. Gravity
- G_{sb} = Specific Gravity of Agg.
- G_{se} = Effective Specific Gravity
- V_{be} = Volume of Effective Binder
- VFA =Voids filled with Asphalt
- VMA =Voids in Mineral Agg. %
- N_{des} = Design number of gyrations
- P_b = Binder % (Actual)
- P_{ba} = Absorbed Binder %
- P_{be} = Effective Binder %
- P_s = Aggregate %
- P_{200} = agg passing No. 200 sieve

REQUIRED DECIMAL PLACES FOR ROUNDING (FOR ACCEPTANCE UNLESS NOTED)				
Property	Nearest Whole Unit (0)	First Decimal Place (0.0)	Second Decimal Place (0.00)	Third Decimal Place (0.000)
CAA	X			
Density (Mix Design)	X			
FAA	X			
Asphalt Mixture Temperature	X			
Tensile Strength	X			
VFA	X			
Control Limits		X		
Dust/Effective Binder		X		
Five-Point Moving Average		X		
Gradation		X		
Target Mean		X		
Air Voids			X	
Binder Content			X	
Density (Pavement)			X	
Draindown			X	
VMA			X	
Volume of Effective Binder (V_{be})			X	
Bulk Specific Gravity				X
Maximum Specific Gravity				X

Bulk Specific Gravity (pill)

$$\text{Bulk Sp. Gr (Gmb)} = \frac{A}{B - C}$$

Where:

A= weight of specimen in air, g

B = weight of surface-dry specimen in air, g

C = weight of specimen in water, g

A: 4846.3

B: 4850.2

C: 2790.6

G_{mb}: ______

Bulk Specific Gravity (pill)

$$\text{Bulk Sp. Gr (Gmb)} = \frac{A}{B - C}$$

Where:

A= weight of specimen in air, g

B = weight of surface-dry specimen in air, g

C = weight of specimen in water, g

A: 4846.3

B: 4850.2

C: 2790.6

$$\text{Bulk Sp. Gr (Gmb)} = \frac{4846.3}{4850.2 - 2790.6}$$

G_{mb}: 2.353

Maximum Specific Gravity

$$\text{Max Sp. Gr. (Gmm)} = \frac{A}{A - (C - B)}$$

Where:

A= weight of oven dry sample in air, g

B = weight of container in water, g

C = weight container and sample in water, g

A: 896.6

B: 1319.5

C: 1850.3

G_{mm}: ______

Maximum Specific Gravity

$$\text{Max Sp. Gr. (Gmm)} = \frac{A}{A - (C - B)}$$

Where:

A= weight of oven dry sample in air, g

B = weight of container in water, g

C = weight container and sample in water, g

A: 896.6

B: 1319.5

C: 1850.3

$$\text{Max Sp. Gr. (Gmm)} = \frac{896.6}{896.6 - (1850.3 - 1319.5)}$$

G_{mm}: 2.451

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV =
VMA =
V_{be} =

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of % Air Voids

$$AV = V_a = 100 \times \frac{(G_{mm} - G_{mb})}{G_{mm}}$$

$$100 \times \frac{(2.451 - 2.353)}{2.451} = 4.00\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
VMA =
V_{be} =

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of VMA

$$VMA = 100 - \frac{(G_{mb} \times P_s)}{G_{sb}}$$

We have to figure P_s since we are not directly given that value.

$$P_s = 100 - Pb$$

Volumetric Calculations

G_{mb} = 2.353	AV = 4.00	VFA =	P_{be} =
G_{mm} = 2.451	P_s =	G_{se} =	Dust/P_{be} =
G_{sb} = 2.609	VMA =	P_{ba} =	Density, lb/ft^3 =
P_b = 6.60%	V_{be} =		Density, % =

Calculation of VMA

$$P_s = 100 - Pb \qquad 100 - 6.6 = 93.4$$

$$\text{VMA} = 100 - \frac{(G_{mb} \times P_s)}{G_{sb}}$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA =
V_{be} =

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of VMA

$$P_s = 100 - Pb \qquad 100 - 6.6 = 93.4$$

$$\text{VMA} = 100 - \frac{(G_{mb} \times P_s)}{G_{sb}}$$

$$\text{VMA} = 100 - \frac{(2.353 \times 93.4)}{2.609} = 15.76\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} =

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of V_{be}

$$V_{be} = VMA - AV$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} =

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of V_{be}

$$V_{be} = VMA - AV$$

$$V_{be} = 15.76 - 4.00 = 11.76\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of VFA

$$\text{VFA} = \frac{(VMA - AV)}{VMA} \times 100$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA =
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of VFA

$$\text{VFA} = \frac{(VMA - AV)}{VMA} \times 100$$

$$\text{VFA} = \frac{(15.76 - 4.00)}{15.76} \times 100 = 74.7 \approx 75\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of G_{se}

$$G_{se} = \frac{(100 - P_b)}{\frac{100}{G_{mm}} - \frac{P_b}{1.03}}$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} =
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of G_{se}

$$G_{se} = \frac{(100 - P_b)}{\frac{100}{G_{mm}} - \frac{P_b}{1.03}}$$

$$G_{se} = \frac{(100-6.6)}{\frac{100}{2.451} - \frac{6.6}{1.03}} = 2.716$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} =

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of Pba

$$P_{ba} = 100 \times \left(\frac{G_{se} - Gs_b}{G_{sb} \times Gse}\right) \times 1.03$$

$$P_{ba} = 100 \times \left(\frac{2.716 - 2.609}{2.609 \times 2.716}\right) \times 1.03 = 1.6\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of Pbe

$$\mathrm{P_{be}} = Pb - \left(\frac{P_{ba}}{100} \times P_s\right)$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} =
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of Pbe

$$\mathrm{P_{be}} = Pb - \left(\frac{P_{ba}}{100} \times P_s\right)$$

$$\mathrm{P_{be}} = 6.60 - \left(\frac{1.6}{100} \times 93.4\right) = 5.1\%$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} = 5.1
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of Dust/P_{be} Ratio

Given P_{200} = 5.3%

$$\text{Dust}/P_{be} = \left(\frac{P_{200}}{P_{be}}\right)$$

Volumetric Calculations

G_{mb} = 2.353
G_{mm} = 2.451
G_{sb} = 2.609
P_b = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} = 5.1
Dust/P_{be} =
Density, lb/ft^3 =
Density, % =

Calculation of Dust/P_{be} Ratio

Given P_{200} = 5.3%

$$\text{Dust}/P_{be} = \left(\frac{P_{200}}{P_{be}}\right) = \left(\frac{5.3}{5.1}\right) = 1.0\%$$

Volumetric Calculations

Gmb = 2.353	AV = 4.0%	VFA = 75	P_{be} = 5.1
Gmm = 2.451	P_s = 93.4%	G_{se} = 2.716	Dust/P_{be} = 1.0
Gsb = 2.609	VMA = 15.8%	P_{ba} = 1.6	Density, lb/ft^3 =
Pb = 6.60%	Vbe = 11.8%		Density, % =

Calculation of Density by weight

$$D = \text{Gmb}_{\text{core}} \text{ x } 62.416 \text{ lb/ft}^3$$

Given $\text{Gmb}_{\text{core}} = 2.292$

Calculation of Density in % Gmm

$$D = \frac{Gmb_{core}}{G_{mm}} \text{ x } 100$$

Volumetric Calculations

Gmb = 2.353
Gmm = 2.451
Gsb = 2.609
Pb = 6.60%

AV = 4.0%
P_s = 93.4%
VMA = 15.8%
Vbe = 11.8%

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} = 5.1
Dust/P_{be} = 1.0
Density, lb/ft^3 =
Density, % =

Calculation of Density by weight

$$D = Gmb_{core} \text{ x } 62.416 \text{ lb/ft}^3$$

Given $Gmb_{core} = 2.292$

$$2.292 \text{ x } 62.416 = 143.1\ lb/ft^3$$

Calculation of Density in % Gmm

$$D = \frac{Gmb_{core}}{G_{mm}} \text{ x } 100$$

$$\frac{2.292}{2.451} \text{ x } 100 = \quad 93.51\%$$

Volumetric Calculations

Gmb = 2.353
Gmm = 2.451
Gsb = 2.609
Pb = 6.60%

AV = 4.00
P_s = 93.4
VMA = 15.76
V_{be} = 11.76

VFA = 75
G_{se} = 2.716
P_{ba} = 1.6

P_{be} = 5.1
Dust/P_{be} = 1.0
Core Density, lb/ft^3 = 143.1
Core Density, %G_{mm} = 93.51

Chapter 8

Quality Control Troubleshooting

INDOT Certified Asphalt Technician Course

Presented by: Brad Cruea, Milestone Contractors

What is Quality Control Testing?

Quality Control (QC) is a set of procedures and tests performed to ***continuously monitor*** and ***control*** a manufactured product, like asphalt mix, to ensure it meets or exceeds the required specifications outlined by the owner/customer.

QC activities include sampling, testing, inspection, and taking corrective actions to maintain control over the production or placement process.

What is Quality Assurance Testing?

Quality Assurance (QA) is the owner/customer performing their own tests to confirm that the manufactured product with within the specification limits.

QC vs. QA

What is QC/QA?

- The interaction, policies, and testing between the contractor and INDOT to ensure the taxpayers of Indiana are getting what they paid for.

- Both QC and QA are essential to ensuring the performance and durability of asphalt pavements. Together, they help in identifying any deviations from the desired standards and facilitate necessary adjustments to uphold quality throughout the construction process.

QC Testing (Per ITM 583)

- Aggregates
  - Stockpiled
  - Blended Aggregates in the asphalt mixture
- Asphalt Binder
  - Sampling per INDOT
- Recycled Materials
  - Binder Content
  - Gradation
  - Moisture Content
  - Coarse Aggregate Angularity
  - Bulk Specific Gravity of the recycled aggregates

QC Testing (Per ITM 583)

- Mixture Sampled at the Plant (Truck Samples)
  - Binder Content
  - Gradation
  - Aggregate degradation (for SMA mixtures) – once per lot
  - Moisture Content
  - Temperature
  - Draindown (for OG and SMA mixtures)

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QC Testing (Per ITM 583)

- Mixture Sampled from the Pavement (Plate Samples)
  - Air Voids
  - VMA
  - Binder Content
  - Gradation
  - Dust/calculated effective binder ratio
  - Moisture Content (for surface mixtures)
  - Bulk Specific Gravity
  - Maximum Specific Gravity
  - Volume of Effective Binder, V_{be}

QC Testing

- Controlling gradation will control your mix
  - Stockpiles
  - Mixture
  - Recycle Materials

- Make sure you get a ***representative sample***, no matter what property you are testing

- Your EYES are one of the most important QC Tools!
  - If something doesn't look right, it probably isn't!

ITM 583 QC Control Limits

This table outlines the Quality Control limits per ITM 583. Any value outside of these limits are to be documented in the Daily Diary.

10.2 Control limits for single test values shall be as follows:

Parameter	Maximum % Passing, Control Limits (±)		
	Aggregate Stockpiles	Blended Aggregate Base and Intermediate Mixtures	Blended Aggregate Surface Mixture
3/4 in	10.0	10.0	
1/2 in.	10.0	10.0	10.0
No.4	10.0	10.0	10.0
No.8	10.0	10.0	8.0
No.16	8.0	8.0	8.0
No.30	6.0	6.0	4.0
No.50	6.0	6.0	4.0
No.100	6.0	6.0	3.0
No.200	2.0	2.0	2.0

Parameter	Control Limits
Binder Content of Mixture and RAP, %	± 0.7
Binder Content of RAS, %	± 3.0
Vbe, %, above design minimum (QC/QA HMA, SMA)	+ 2.0
VMA @ Ndes, % (QC/QA HMA)	± 1.0
VMA @ N_{75}, Minimum % (9.5 mm SMA)	17.0
VMA @ N_{75}, Minimum % (12.5 mm SMA)	16.0
Target Air Voids % (Dense Graded Mixtures, SMA)	± 1.0
Target Air Voids % (Open Graded Mixtures)	± 3.0
2.36mm (No. 8) sieve % passing (9.5mm Surface Mixtures Only)	+ 4.0

Common Scenarios

What if?	Probable effect on Acceptance Properties	Probable cause(s)
G_{mb} ↑ & G_{mm} √	VMA↓ AV↓ Binder√	Aggr. Structure
G_{mb} ↓ & G_{mm} √	VMA? AV? Binder?	
G_{mb} ↑ & G_{mm} ↑	VMA? AV? Binder?	
G_{mb} ↓ & G_{mm} ↓	VMA? AV? Binder?	
G_{mb} ↓ & G_{mm} ↓	VMA? AV? Binder?	
G_{mb} > G_{mm}		

What if? (compared to DMF)	Probable effect on Acceptance Properties	Probable cause(s)
G_{mb} ↑ & G_{mm} √	VMA↓ AV↓ Binder√	Aggr. Structure
G_{mb} ↓ & G_{mm} √	VMA↑ AV↑ Binder√	Aggr. Structure
G_{mb} ↑ & G_{mm} ↑	VMA? AV? Binder?	
G_{mb} ↓ & G_{mm} ↓	VMA? AV? Binder?	
G_{mb} > G_{mm}		

Common Scenarios

What if? (compared to DMF)	Probable effect on Acceptance Properties	Probable cause(s)
G_{mb} ↑ & G_{mm} ↑	VMA↓ AV? Binder↓	Aggr. Structure/ composition G_{sb} change ↑ ? Low binder Absorption (low effective binder)

What if? (compared to DMF)	Probable effect on Acceptance Properties	Probable cause(s)
G_{MB} ↓ & G_{MM} ↓	VMA↑ AV? Binder↑	Aggr. Structure/ composition G_{sb} change ? high binder Absorption (effective binder)

Common Scenarios

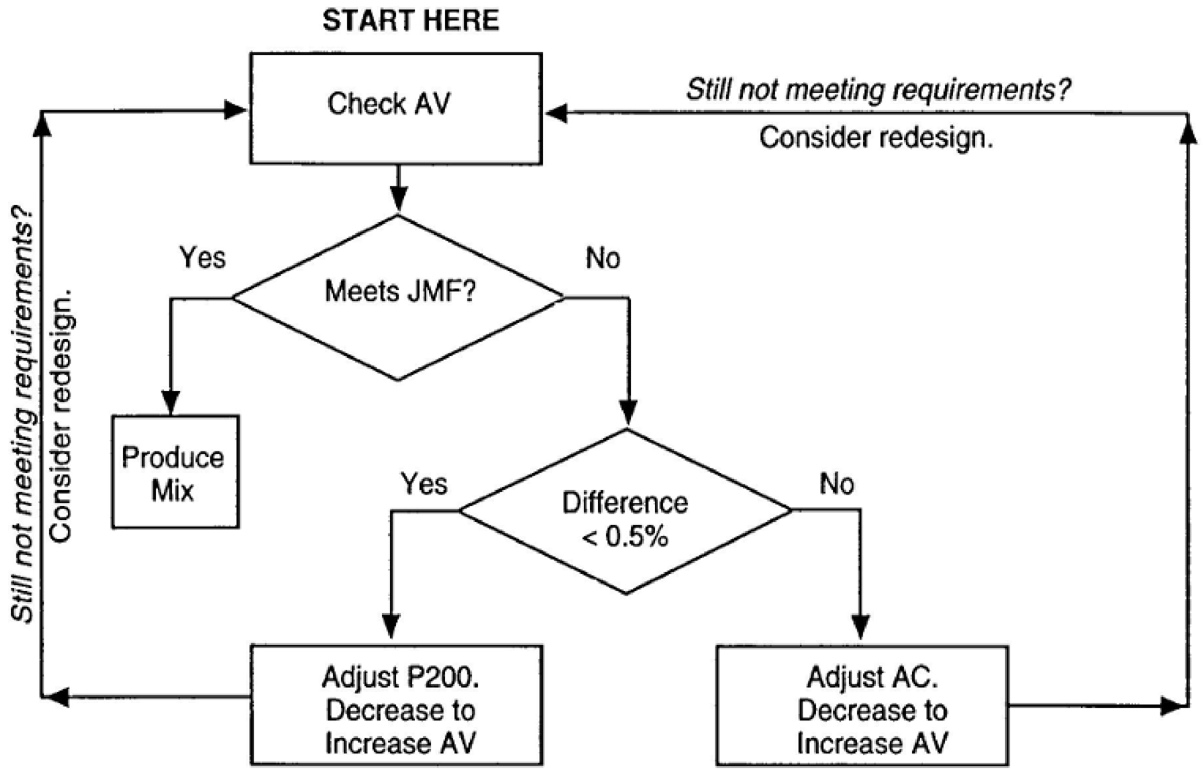
What if? (compared to DMF)	Probable effect on Acceptance Properties	Probable cause(s)
G_{MB} > G_{MM}	PANIC	TEST ERROR

General Relationships

Property – Air Voids	Applicable Test(s)	Function of…	Impact
$\frac{(G_{mm} - Gmb)}{G_{mm}} \times 100$	G_{mm}	asphalt binder content	moderate
		aggregate absorption	high
		gradation	slight
		aggregate specific gravity (G_{sb})	high
	G_{mb}	asphalt binder content	slight

- Air Voids are influenced by a combination of VMA, percent passing the No. 200 sieve, and the binder content.
- Adjustments are dependent on the magnitude of variance between the production and DMF values.
- Comparisons of the G_{mb} and G_{mm} values to the DMF and production values should also be done.
  - Different G_{mb} values may be caused by an aggregate gradation change, especially the P_{200} or particle shape change from aggregate breakdown.
  - Different G_{mm} values may be caused by a binder content, aggregate absorption, or aggregate specific gravity change.

Air Void Adjustment Process



VMA = Voids in Mineral Aggregate
AV = Air Voids
P200 = Percent passing 0.075 mm (#200) sieve

NOTE: This flow chart is intended to provide guidance for adjustment of AV. Due to differences in properties of specific mixes, the effect of the adjustments may be variable.

General Relationships

Property – VMA	Applicable Test(s)	Function of…	Impact
$100 - \frac{(G_{mb} \times Ps)}{G_{sb}}$ Where: $P_s = 100 - P_b$	$G_{mb}\ (Gsb)$	gradation, especially % passing No. 200	Very high
		particle shape	high
		compactive effort	moderate
		aggregate strength	moderate
	P_b	asphalt binder content	slight

- A loss of VMA is a common problem during mix production. Gradation changes may be caused by a mechanical problem with the plant. Compare the blended aggregate and extracted aggregate gradations is a good technique to see if this problem exists.
- There may be some "rounding" of the coarse aggregate edges as they pass through the drum. This rounding lowers VMA.
- Dust variation in the mix may be caused by variations in the minus No. 200 sieve material of the aggregates; however, a change in the dust is more likely the result of inconsistent fine return from the plant baghouse.

General Relationships

- Air Voids, as with VMA, may need to be increased in most cases with the specifications are not being met. Procedures for increasing air voids include:

1. Reduce the binder content
2. Reduce the amount passing the No. 200 sieve
3. Change the relative proportion of coarse and fine aggregate

General Relationships

- Adjusting for low VMA is the more common problem a lab technician needs to correct. Procedures to increase VMA may include some of the following:

  1. Reduce the amount of material passing the No. 200 sieve
  2. Reduce the amount of natural sand in the mixture
  3. Adjust the aggregate gradation away from the maximum density line

Things to think about VMA

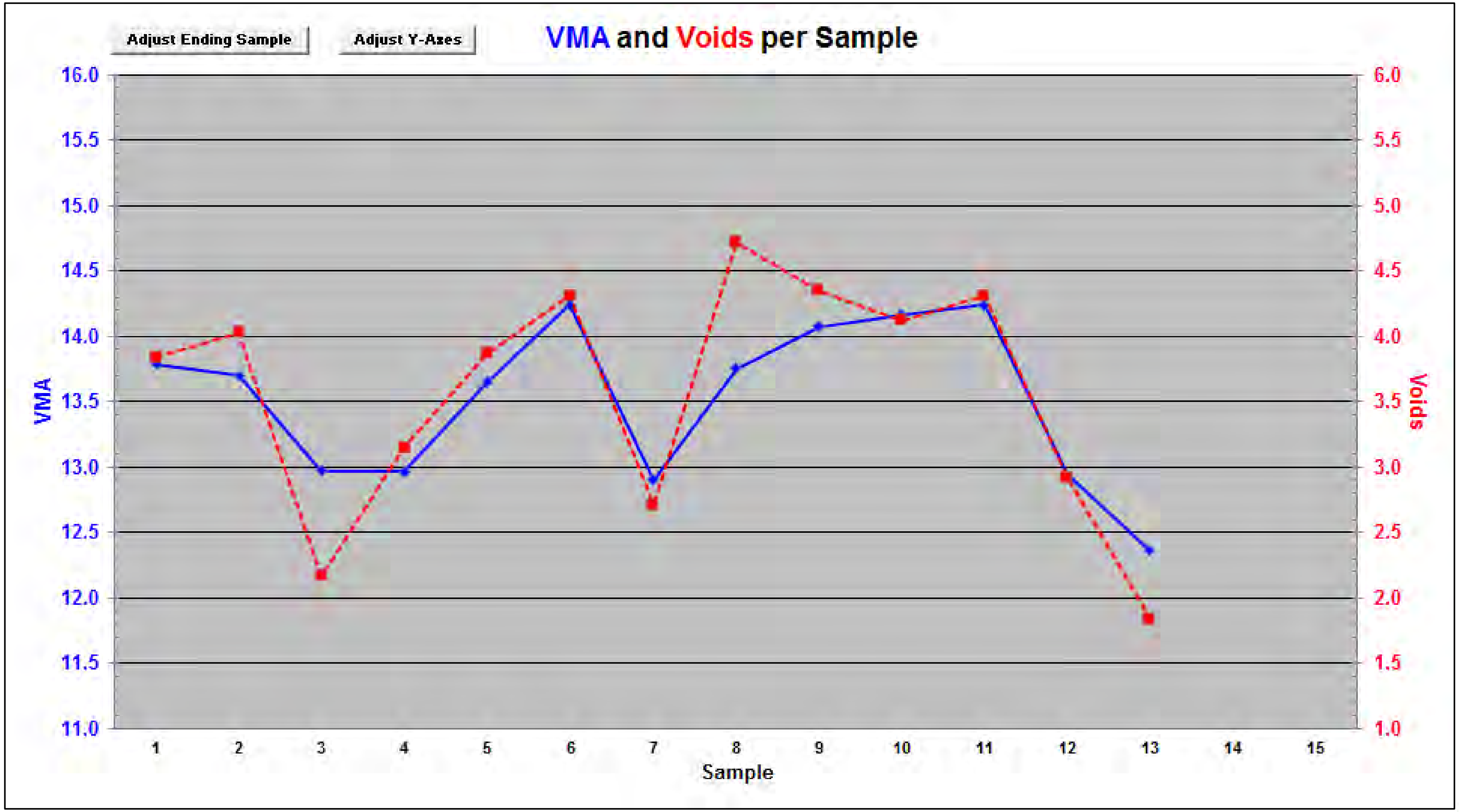
VMA is mainly a result of gradation.

There are **5** things that effect VMA:

Shape
Texture
Strength
Gradation
Type and Amount of Compaction

Remember: If you can control VMA, you can control the Air Voids

VMA Drives the Air Voids



General Relationships

Property – V_{be}	Function of…	Impact
VMA – Air Voids	gradation	Very high
	asphalt binder content	slight
	absorption	high
	Low V_{be}	If VMA and Air Voids are both low, make gradation change If VMA is low and Vir Voids are high, make gradation and binder content change
	High V_{be}	If VMA is high and Air Voids are low, make gradation and binder content change

Gradation Control

- Aggregate stockpiles
- Recycle materials stockpiles
- Cold feed system at the plant
- Mixing and load-out systems
- Dust control systems

Gradation – Stockpile Control

- Segregation
- Handling from supplier to yard to mixture
- Contamination

Gradation – Cold Feed

- Improperly calibrated bins

- Bins run empty
- Overflow from adjacent cold feed bin
- Wrong material was fed in the bin
- Incorrect proportional set-up

Gradation – Load Out

Truck

Silo Segregation

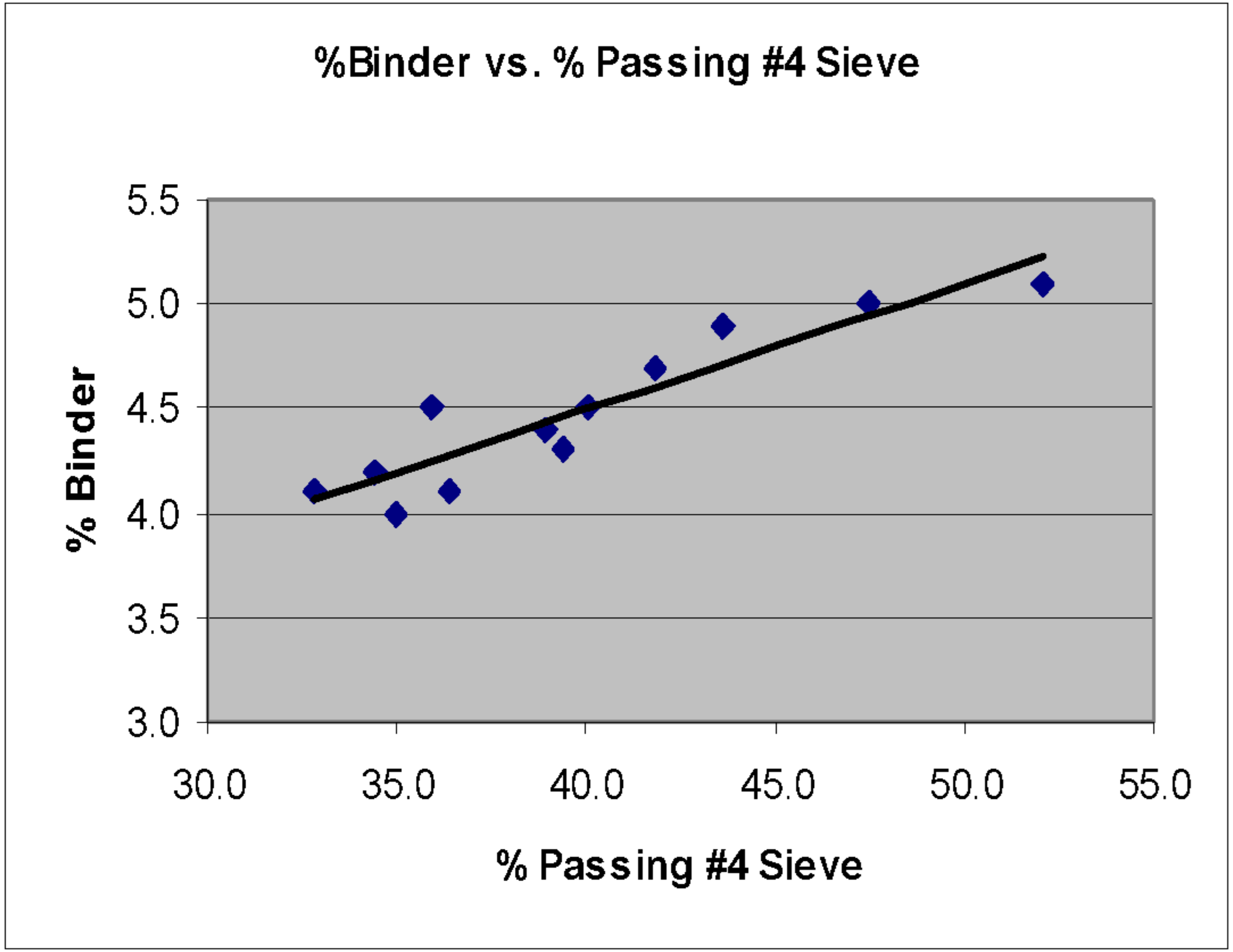
Gradation – Dust System

- Primary Collector
  - Knock-out box
  - Feed system into plant
- Secondary Collector
  - Baghouse
  - Pod with vane feeder
- Mineral Filler Bin
  - Weigh hopper

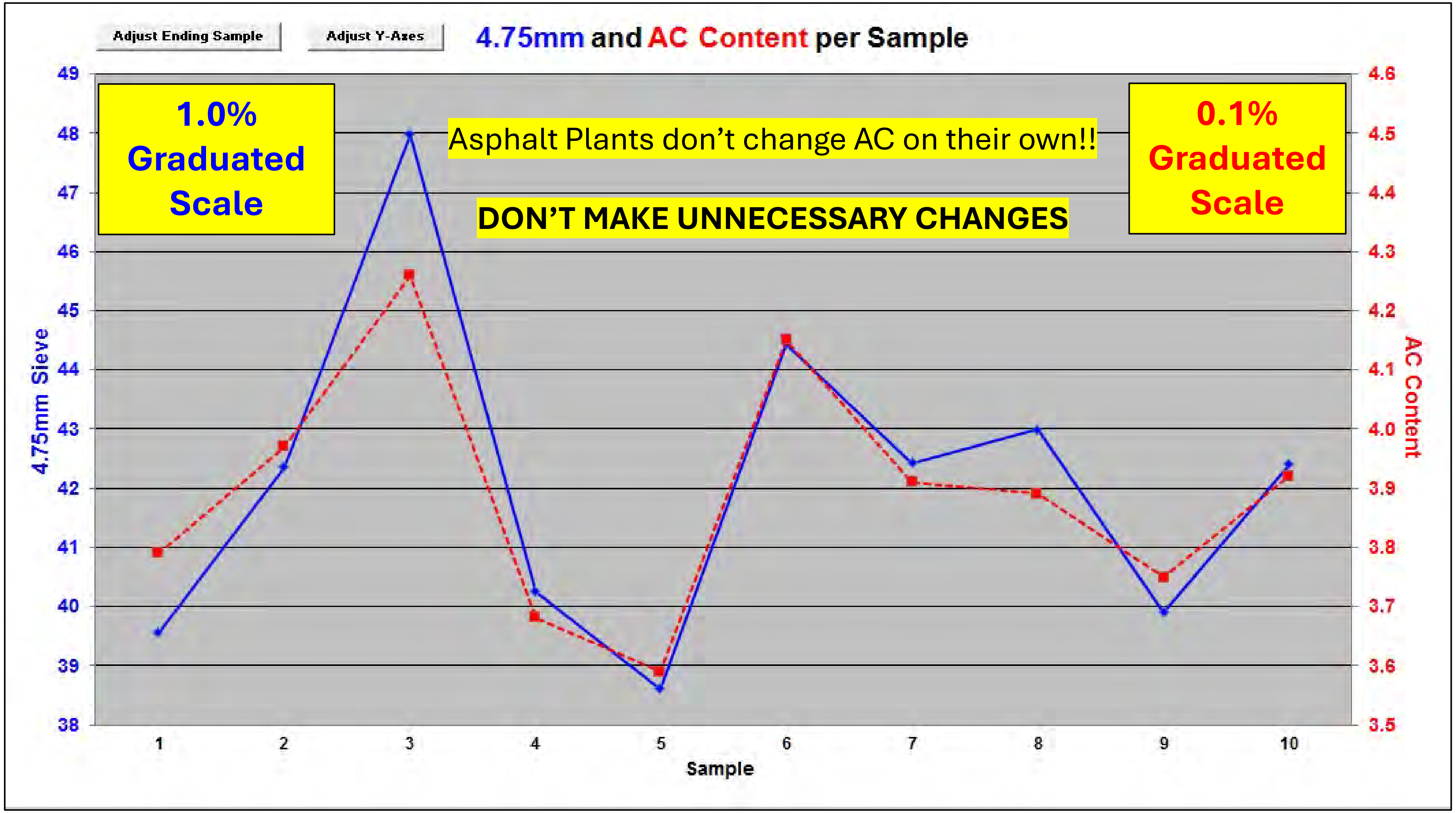
Binder Content Control

- Monitor mix segregation
  - Plot percent binder vs. percent passing the No. 8 or No. 4 sieves
- Ensure proper flow meter calibration
- Aggregate moisture correction (slight impact)
- Appropriate aggregate or RAP weigh bridge calibration
- Verify the RAP binder content is correct at the plant
- Check the RAP aggregate type (dolomite/burn off)
- Watch out for impact on the start-up, shut-down, and switching of mixes

	% P #4	%Binder
1	47.5	5.0
2	38.9	4.4
3	35.0	4.0
4	39.4	4.3
5	52.1	5.1
6	43.6	4.9
7	36.4	4.1
8	32.8	4.1
9	41.8	4.7
10	34.4	4.2
11	40.1	4.5
12	35.9	4.5
Minimum	32.8	4.0
Maximum	52.1	5.1
Average	39.8	4.5



Segregated Mix



Asphalt Plant

Start Out on the Right Foot

- Before you start production, check:
  - Stockpiles, ***know what's in your piles!***
  - Verify the correct mix design set up is inputted in the plant
  - Maintain plant and lab equipment calibrations and verifications
  - Ensure test equipment is in good working order
- Keep constant communication with your plant operator through the day

Tips and Tricks

- Retest to verify results as needed
- Eliminate the obvious first
- Be careful not to overreact
- Keep track of all your changes to find patterns

  Where you've been helps you determine where to go

- Gather as much data as you can before making decisions

Chapter 9

Liquid Asphalt Binders

INDOT Certified Asphalt Technician Course

Presented by: Kit Peregrine, Asphalt Materials and Jon Holland, Rieth-Riley Construction

Liquid Asphalt

Asphalt is a black, cementing material varying from solid to semi-solid at room temperature.

Virtually all asphalts used in roads are produced in petroleum refineries.

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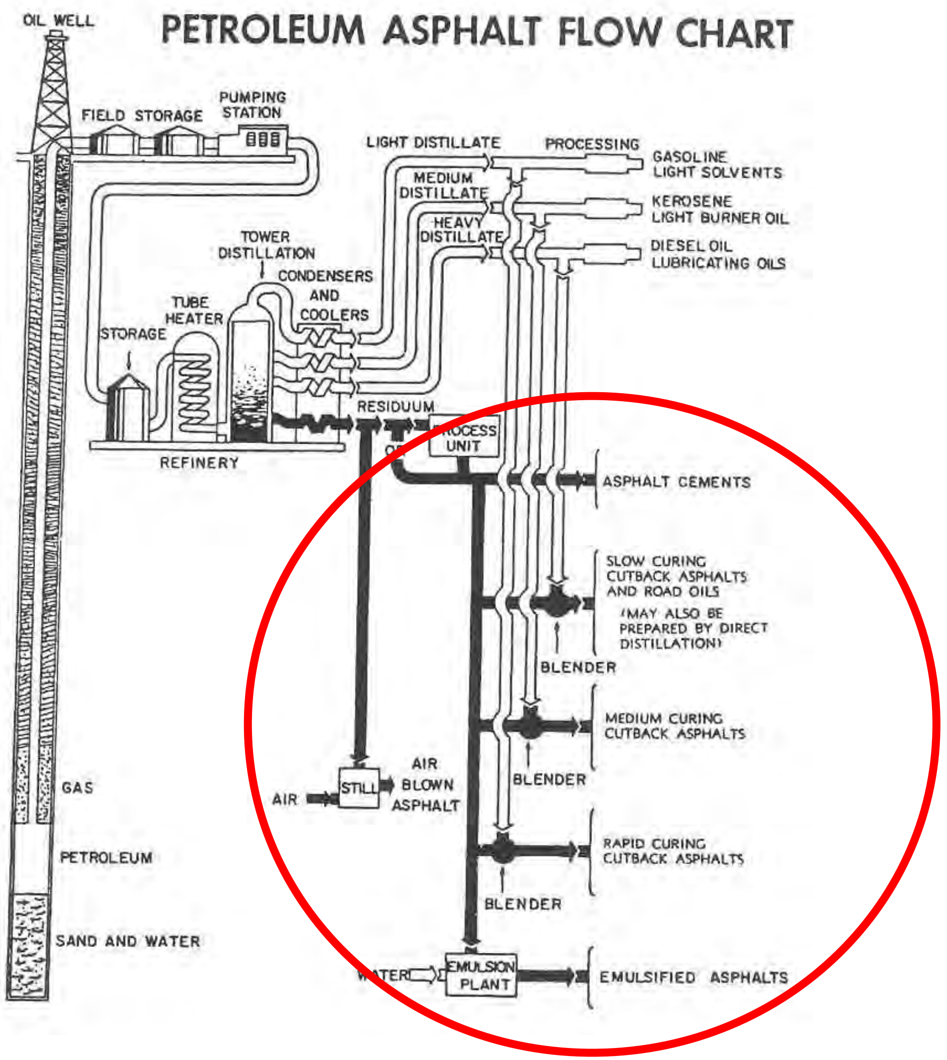
Liquid Asphalt Binders



Liquid Asphalt Binders

Asphalt binder behavior is dependent on:

Temperature

Time of Loading

Aging

Liquid Asphalt Binders

- Temperature:
  - If asphalt binder is heated, it becomes soft
  - If asphalt binder is heated enough, it will turn to a liquid
  - When asphalt cools, it becomes more of a solid
- Time of Loading:
  - Asphalt binders will react with a different stiffness depending on how fast the load is applied.
  - Trucks moving at highway speed puts a load on the pavement differently than trucks coming to a stop at a red light.
- Aging:
  - As asphalt binder ages, it becomes harder and more brittle. The rate of aging depends on the length of time it is exposed to high temperatures and the access to oxygen during the life of the pavement (oxidation).

Performance Graded Binder

- In 1987, the Strategic Highway Research Program (SHRP) developed an improved method for specifying binder and mineral aggregates for mix designs called **Superpave** (Superior Performing Asphalt Pavements) to analyze and establish pavement performance prediction.
- SHRP specifications for Superpave asphalt binders are known as **Performance Graded** specifications.
  - An asphalt binder is graded by an upper temperature (in °C) above which the binder becomes too soft and a lower temperature (in °C) in which the asphalt binder becomes too stiff.

Performance Graded Binder

- Grades in 6-degree increments
- The higher the high temperature, the more rut resistant at high temperatures
- The lower the low temperature, the more resistant to thermal cracking at low temperatures

147°F -7°F

Performance Grade → **PG 64 - 22**

Maximum Pavement Design Temperature

Meets all requirements up to this temperature (°C)

Minimum Pavement Design Temperature

Meets all requirements down to this temperature (°C)

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Performance Graded Binder

Grade Bumping (AASHTO M320)

- To accommodate for higher traffic levels, the PG binder needs to be "bumped" up.

64°C → 70°C → 76°C

- The testing is done at these different high temperatures: 64°C, 70 °C, or 76 °C.

Performance Graded Binder

Performance graded testing (AASHTO M320)

- Measures physical properties in terms of rutting, fatigue cracking and low temperature cracking
- Tested at the binder's high temperature.
- Puts an oscillatory load on the material at relatively low shear strain which doesn't accurately represent the ability of some polymer modified binders to resist rutting. Under these low levels of stress and strain, the polymer network is not activated.
- Shortcoming for polymer modified asphalt (PMA) and limitations of the PG system to characterize PMA.
- Other agencies adopted additional "PG-plus" tests to verify the presence of polymer and/or guarantee a minimum elastic response provide by polymer modifications. These tests may include elastic recovery, forced ductility, toughness and tenacity and phase angle tests.

Performance Graded Binder

Beginning with INDOT contracts let on or after 9/1/2024:

- The base grade performance graded asphalt binders in Indiana went from **PG 64-22** to **PG 58-28**
- The testing for asphalt binders went from AASHTO M320 to AASHTO M332 with AASHTO R92.
- Asphalt binder nomenclature and grade “bumping”
- Contractors can use the new asphalt binders and testing in contracts prior to 9/1/2024 with approved change order per Construction Memo No. 24-08.

New Asphalt Binder Testing

MSCR graded testing (AASHTO M 332) with Elastic Response (AASHTO R92)

- Multiple Stress Creek Recovery (MSCR) is the latest improvement to Superpave PG binder specifications. Higher levels of stress and strain are applied to the binder, better representing what occurs in the pavement. With these higher levels, the response of the asphalt binder shows the stiffening effects of the polymer and the elastic effects.
- Tested at the binder’s high temperature for non-recoverable creep-compliance (Jnr) and percent recovery indicating elastic behavior during each loading cycle.
- Elastic Response is the asphalt’s ability to recover its original shape after loading, or the elastic component at a given temperature and stress level. A high elastic response indicates high elastic component at the test temperature.

MSCR and Elastic Response Terminology

- As mentioned, the Jnr value represents the non-recoverable creep compliance of an asphalt binder, measuring the permanent deformation under stress.
- A lower Jnr value means the binder recovers more readily from deformation, therefore indicating better rutting resistance.
- Elastic response refers to the asphalt binder's ability to recover its shape after deformation from applied stress. Like a rubber band, it measures the "percent recovery" from deformation. A higher percentage indicates greater elastic response and better resistance to permanent deformation (rutting).
  - Adding polymers or other modifiers to asphalt binders can significantly enhance their elastic response, leading to higher percent recovery values.

MSCR and Elastic Response

- Percent recovery is the primary indicator of elastic response.
- The non-recoverable creep compliance (Jnr) is also important to provide information about the binder’s overall stiffness and potential for permanent deformation.
- Binders and the elastic response are highly temperature-dependent. MSCR testing should be conducted at temperatures relevant to the intended pavement application.

New Asphalt Binder Nomenclature

147°F -7°F

PG 64-22

136°F -18°F

PG 58S-28

Performance Grade

High Temperature ∘C

highest 7-day average pavement temperature

Low Temperature ∘C

lowest historical yearly pavement temperature

MSCR Traffic Designation
"S" = Standard
"H" = Heavy
"E" = Extremely Heavy

PG high temperature grade is based on climate, but due to heavy traffic, you would bump up the high grade for stiffer binder.
MSCR binders are stiffer with traffic designation change, not high temperature.

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New Asphalt Binder Performance Grades

- PG testing and nomenclature
- Current asphalt binder base grade PG 64-22
- One binder “bump” PG 70-22
- Two binder “bump” PG 76-22

- MSCR testing and nomenclature
- New asphalt binder base grade PG 58-28
- Traffic levels designated by letters
- Neat binder PG 58S-28
- One binder “bump” PG 58H-28
- Two binder “bump” PG 58E-28

Current PG Binder	New PG Binder	Traffic Designation
PG 64-22	**PG 58S-28**	S – Standard
PG 70-22	**PG 58H-28**	H – Heavy
PG 76-22	**PG 58E-28**	E – Extremely Heavy

Asphalt Binder Storage & Handling

- Contamination hazard
  - Change in volume of the asphalt binder material when heated or cooled.
  - Materials such as hot oil or fuel oil can leak in the system and can cause softening or loss of stiffness of the binder.
- Extended Storage Consequences
  - When binder is heated, it slowly increases in stiffness and can cause the material to go out of specification
  - The rate of change in viscosity is dependent on size of tank, surface area, amount of circulation, temperature, etc.
- Improper Storage
  - Modified binders include additives and may be required to be stored under special conditions.

Refer to the material supplier's storage and handling procedures for each asphalt binder grade requirements

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Asphalt Binder Storage & Handling Safety

- Be aware of burn hazard locations
- Use designated walk areas
- Notify plant operator you will be around the tanks sampling
- Verify the proper tank and asphalt binder to sample
- Look out for construction traffic
- Avoid tank vent openings for H_2S build-up
- Stay upwind of asphalt fumes if possible
- When sampling, wear long sleeve shirt, pants, gloves, eye protection
- Always follow established safety procedures

Asphalt Binder Safety

- Burns
  - Apply cold water to affected area
  - Do not remove the asphalt binder
  - Have a physician examine
- H_2S (Hydrogen Sulfide)
  - Builds up in vapor space of asphalt binder tank (rotten egg smell)
  - Modified binders have higher levels
  - Keep face out of man-ways (1/2 meter)
  - Stay upwind of hatch and avoid breathing fumes
  - If overexposure occurs, move to fresh air
  - Administer oxygen if breathing is difficult
  - Start artificial respiration if breathing stops
  - Have exposed person see physician immediately

Asphalt Materials

- Categorized as paving grades and non-paving grade asphalt.
  - **Paving grade**: Performance graded (PG) asphalt binders
  - **Non-Paving grade**: asphalt emulsions, utility asphalts, and asphalts for coating corrugated metal pipe
- All asphalt PG binders used on INDOT projects, or those that reference INDOT specifications, shall come from the INDOT Qualified Product list for *Performance-Graded Asphalt Binder Suppliers*

Asphalt Materials Verification Sampling and Acceptance

- **Paving Grades**: 2 verification samples per year per certified plant per grade. Type A certification from material supplier.
- **PG Asphalt Binder for crack sealing or tack coat**: Type A certification.
- **Non-Paving grade asphalt emulsions**: From QPL of Asphalt Emulsion Suppliers. Type C Certification.
- **Utility Asphalt**: Type A certification. Tested by supplier every 14 days in storage and every 14 days after delivery of material.
- **Asphalt for Coating Corrugated Metal**: Type A certification. Verification sample from tank in production after replenishment and every 30 days after.

(Per INDOT's Frequency Manual)

Asphalt PG Binder Sampling

- Proper sampling is important to obtain a representative sample
- Avoid sampling from the top of the tank if possible
- Use only clean containers
- Allow 4 quarts of asphalt binder to drain out of the tank before sampling
- Seal the container immediately
- Clean the outside of the container if spilled asphalt is present.

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Asphalt PG Binder Sampling

- Sampling per AASHTO R 66 and exceptions in 902.02(a)
- Taken by the Contractor’s Level I Asphalt Technician or Qualified Technician, witnessed by a Department representative.
- 2 1-qt (1.0L) samples shall be obtained
- Containers supplied by the HMA production facility and shall be metal cans with air-tight covers

Asphalt PG Binder Sampling

<u>Sampling Containers:</u>

Sample Date

HMA Plant No.

PG Supplier No.

Asphalt Binder Grade

PG Tank No.

SiteManager ID No.

<u>Acceptance Criteria:</u>

1. Verification testing in accordance with specification, Type A certification will be considered as acceptable.
2. Verification testing not in accordance with specifications, back-up will be run to confirm results. If back up is within specification, Type A is acceptable.
3. Verification and back-up not within specification, material goes to the DTE to be addressed as a Failed Material.

Conclusions

- Specifications, sampling, and testing of asphalt binders are to ensure a long-lasting, quality product.
- In QC, it is important to verify the materials being used are for the right mixture and/or application, proper documentation is being received, and the required tests meet specifications.
- Checking the storage and handling temperatures and methods from the manufacturer with the plant operator are key to ensuring the asphalt binder is not contaminated or stored in a manner that the properties of the asphalt binder is compromised. These are specific to the asphalt binder source and grade.
- Understanding the asphalt materials and their overall properties can help ensure proper use for the design and construction of asphalt mixtures and applications.

Chapter 10

Asphalt Plants

INDOT Certified Asphalt Technician Course

Presented by: Jon Holland, Rieth-Riley Construction

Asphalt Plants

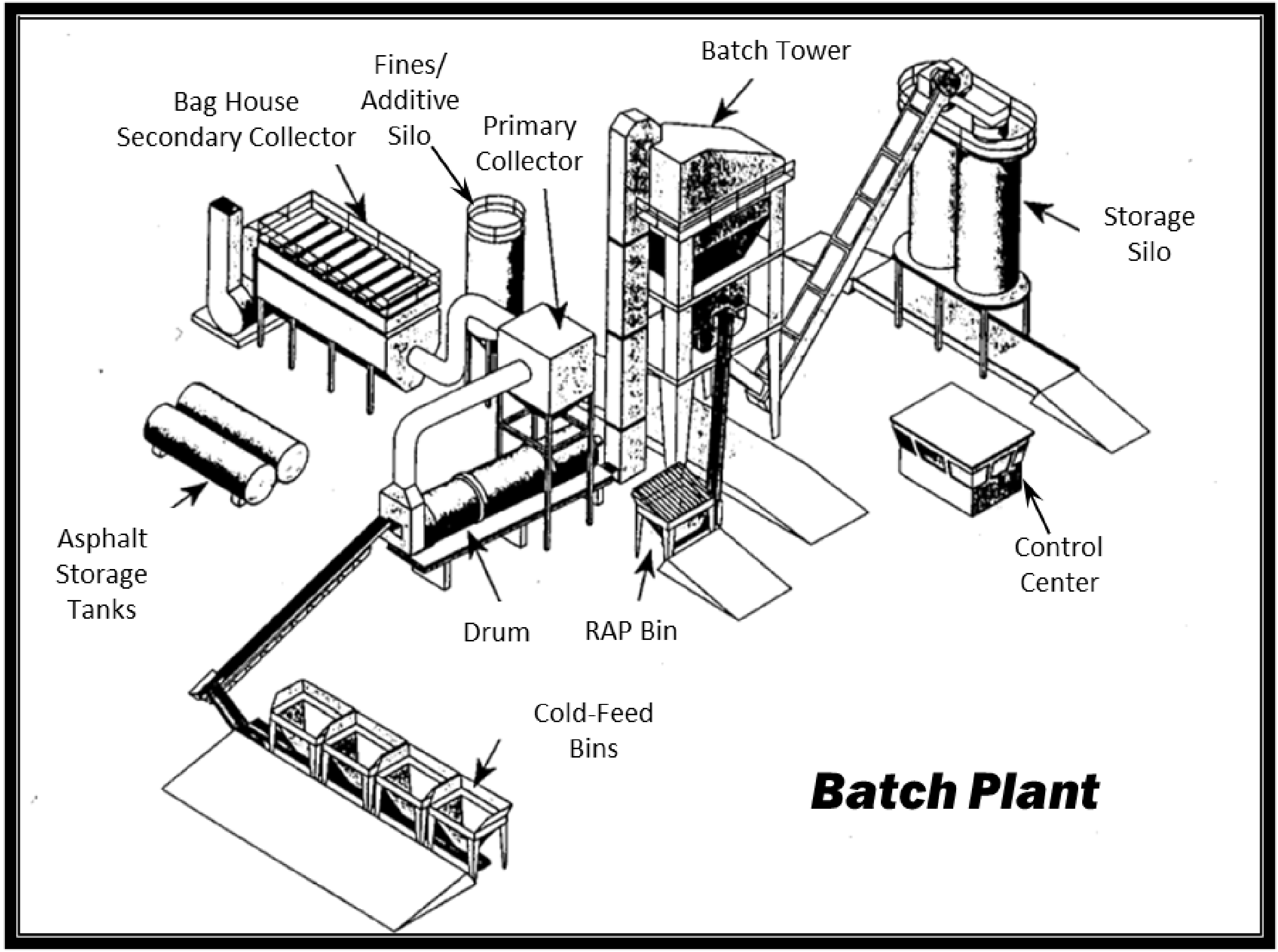
An assembly of mechanical and electronic equipment where aggregates, recycled materials, or other additives are blended, heated, dried, and mixed with liquid asphalt binder to produce asphalt mixture.

Types of Asphalt Plants

- An asphalt plant can be at a stationary, in a permanent location, or portable, moved to different locations based on contract demands.
- Basically, an asphalt plant can be either a batch plant or drum plant.
- However, there are several different types of these plants:
  - Batch
  - Continuous
  - Parallel-flow drum
  - Counter-flow drum
  - Double barrel drum

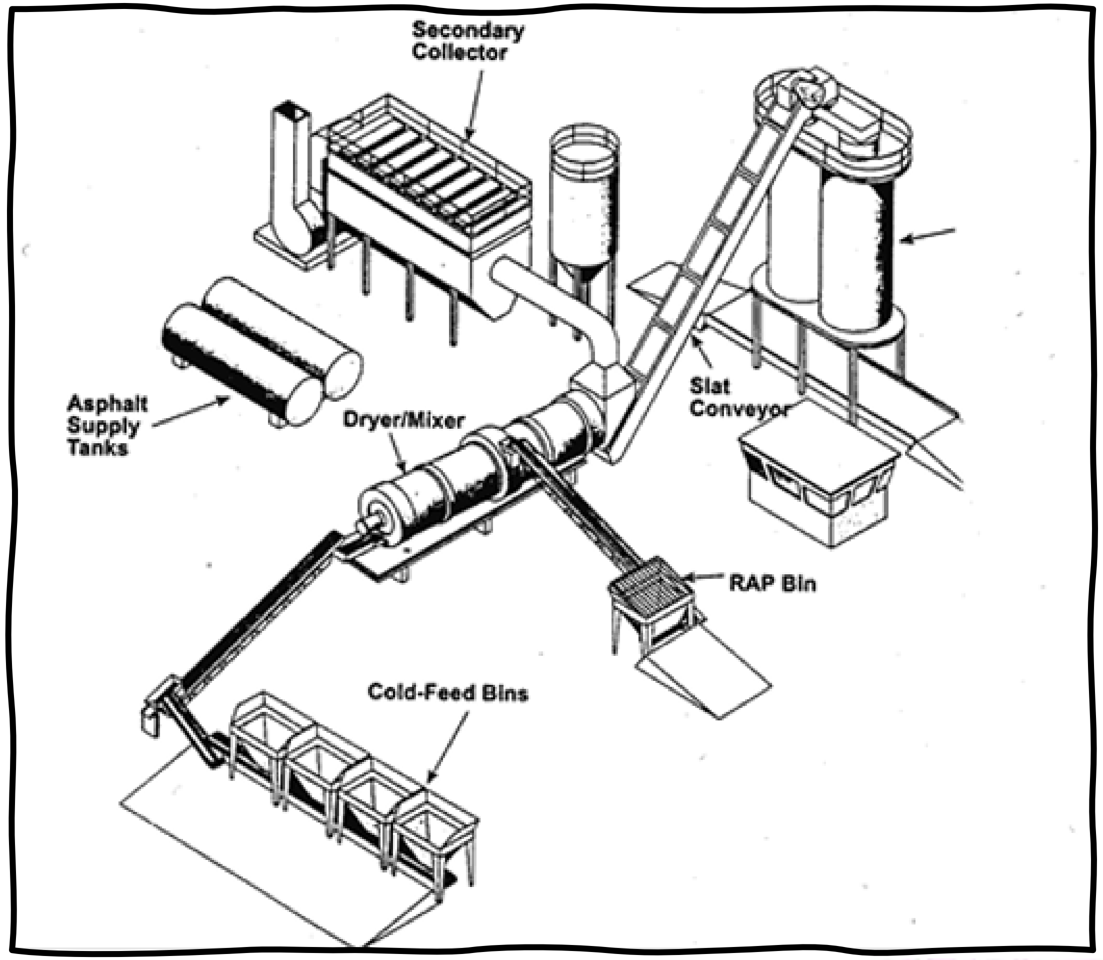
Batch Plants

- In a batch plant, the hot aggregate, recycled materials, and asphalt binder are added into designated amounts to make up one batch.
- After mixing, the asphalt mixture is discharged from the pugmill in one batch increments.



Drum Plant

- In a drum plant, the aggregate and other materials are dried, heated, and mixed with the liquid asphalt binder in the drum in a continuous process.



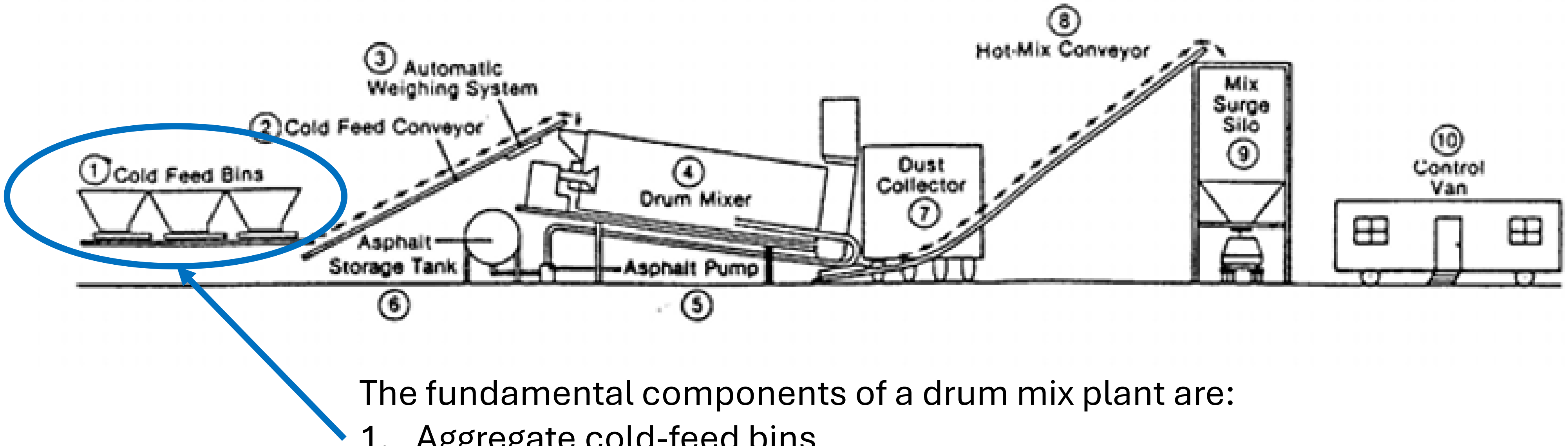
Asphalt Plants

- Regardless of the type of mixing plant, the purpose is the same: to produce an asphalt mixture containing proportions of liquid asphalt binder and aggregate that meets all the specification requirements.
- There are very few batch plants in Indiana, so this chapter will focus on drum plants and their operations. These operations include, cold aggregate storage and feeding, dust control and collection system, mix storage, and recycled material storage and feeding.

Asphalt Plants

- The basic difference between a batch plant and drum plant is that in drum plants, the aggregate is not only dried and heated within the drum, but also mixed with the liquid asphalt binder. There are no gradation screens, hot bins, weigh hoppers, or pugmills in a drum mix plant. The aggregate gradation is controlled at the cold feed.

Drum Mix Plant Components



The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins

Cold Feed Bins

When charging cold feed bins, segregation and degradation of the aggregate may occur. These can be prevented by proper stockpiling, ensuring enough material is in each bin for uniform flow without contaminating the adjacent bin(s).

Cold Feed Bins

The most common type of cold feeder used is the continuous belt.

Openings at the bottom of the bins deposit different aggregates on a belt conveyor which carries all aggregates to the drum.

Feeder controls regulate the amount of aggregate flowing from each bin, providing a continuous, uniform flow of properly graded aggregate to the plant.

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Cold Feed Bins

- It is key to control and regulate the flow of material from each bin. Typical control variations are:

Gate Opening	Belt
Fixed	One Speed (on or off)
Adjustable	Adjustable

- The cold aggregate feeders are calibrated by the Producer for each type and size of aggregate. These are to be accurate to the nearest 0.5%.
- Calibration charts for each aggregate are used specific to the asphalt mixture.
- Calibration is determined by using the “flow rate” of a material against the “control” used by the system. Each material is calibrated for three to four control settings across the working production range anticipated for the material.

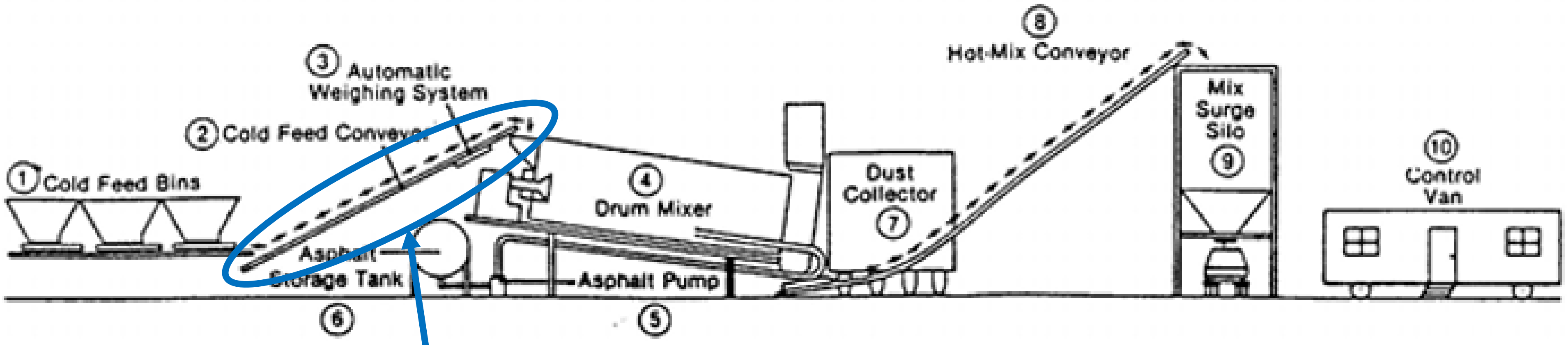
Cold Feed Calibration

- The “Control”
  - Each manufacturer has a method to control the flow of material and can be done by adjusting the RPM of the belt from the control tower
  - The vibrator may be adjusted from the control tower and expressed as a maximum vibration potential
  - The gate height is measured by the height of the opening. This cannot change when using variable speed control.
- The “flow rate”
  - Pre-determined by the configuration of the plant. The most common method is to physically weight the material delivered at a specific control setting over a measured period.
  - The flow rate is converted to tons per hour with moisture content considered.
  - The degree of accuracy is only as good as the method used to determine the flow rate for each control setting.

Sample Calibration Chart

Gross Weight	Tare Weight	**Net Weight**	Gross Comp.	Tare Comp.	Net Comp.	% Error
79,140	36,700		42,720	0		
81,040	36,700		87,210	42,720		
80,290	36,700		130,670	87,210		
78,620	36,700		172,660	130,670		

Drum Mix Plant Components



The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor

Aggregate Conveyor and Cold-Feed Weigh System

Uniformity and balance are best ensured by careful preparation. Materials are required to be sampled and tested and plant components carefully inspected and calibrated before production begins.

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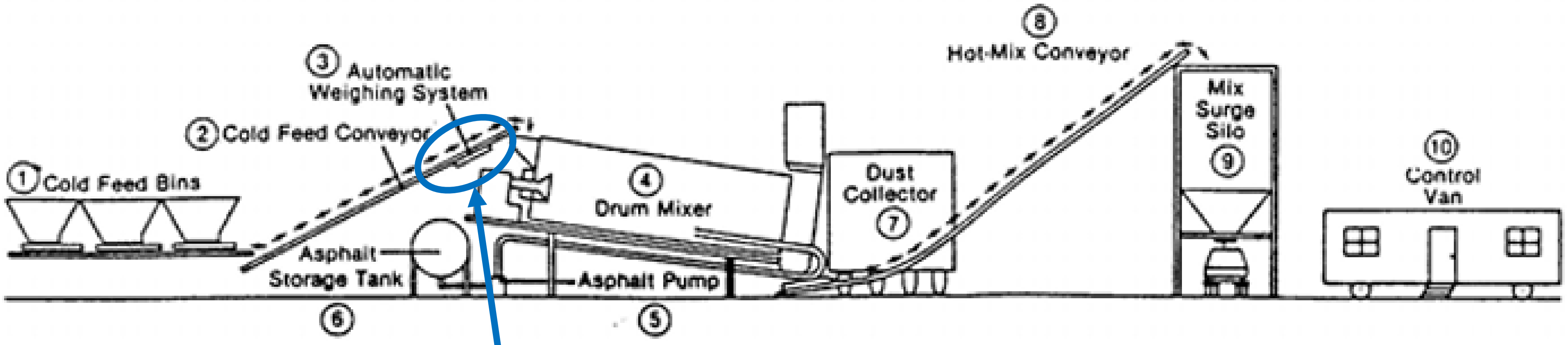
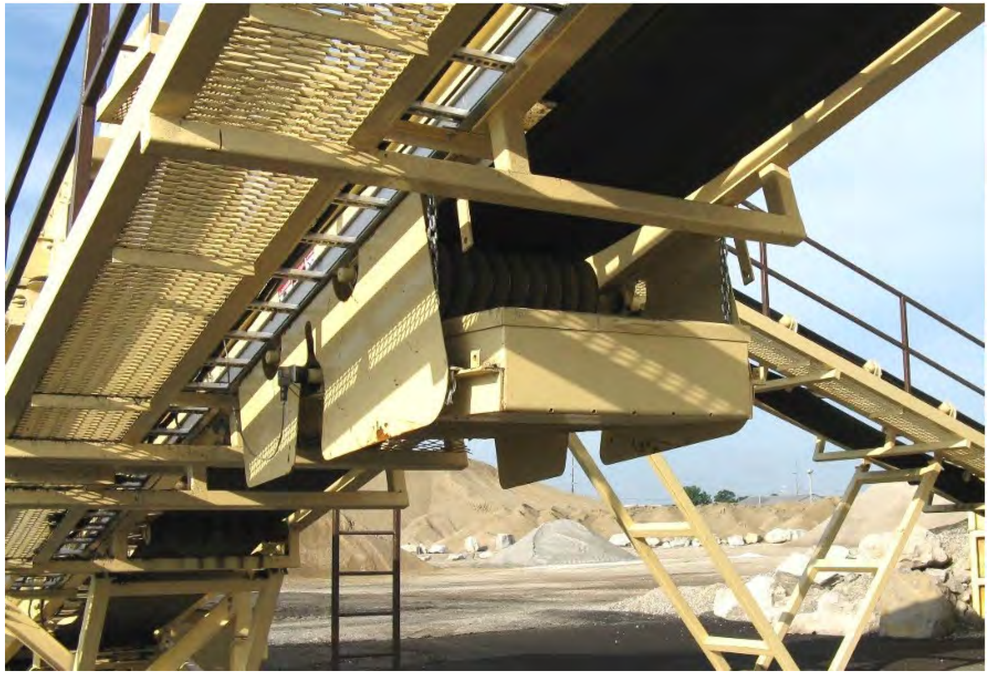
Drum Mix Plant Components



The fundamental components of a drum mix plant are:

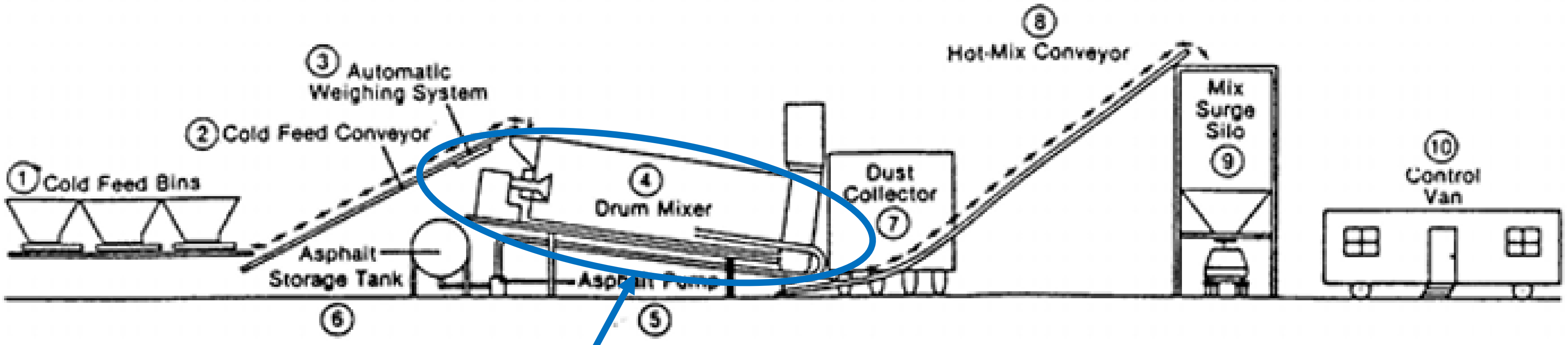
1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system

In-Line Aggregate Weigher



- The in-line belt weigher is usually located midway between the head and tail pulley of the cold feed belt conveyor.
- The device is required to be within ± 0.5% accuracy.
- In drum mix plants, the aggregate is weighed before drying. Since the undried material may contain moisture that may influence the weight of the aggregate, **an accurate measure of the moisture content is important**.
- From the moisture content measurement, adjustments may be made to the automatic liquid asphalt binder metering system to ensure the amount of liquid asphalt binder delivered to the drum is proportionate to the amount of aggregate minus the aggregate moisture content.

Drum Mix Plant Components



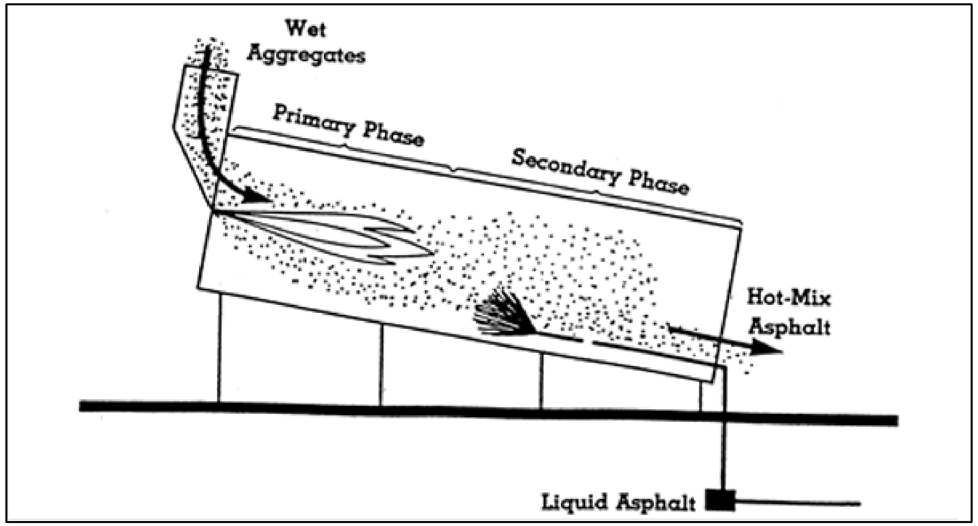
The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum Mixer

Drum Mixer

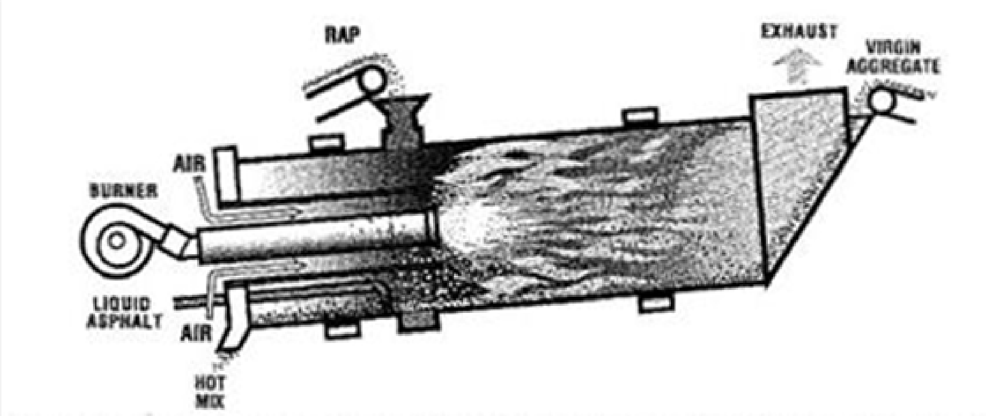
- This is the heart of the drum mix plant.
- It dries the aggregate and blends the aggregate and liquid asphalt binder together.
- Mix temperatures are monitored continuously by a sensor located at the discharge of the drum mixer.
- There are two main variations: parallel-flow and counterflow
- Counterflow drums can use more RAP without higher emissions and less damage to the virgin liquid asphalt binder.
- The liquid asphalt binder in counterflow drums are not exposed to the open flame and hot exhaust gas streams like they do in parallel-flow.

Parallel-Flow Drum

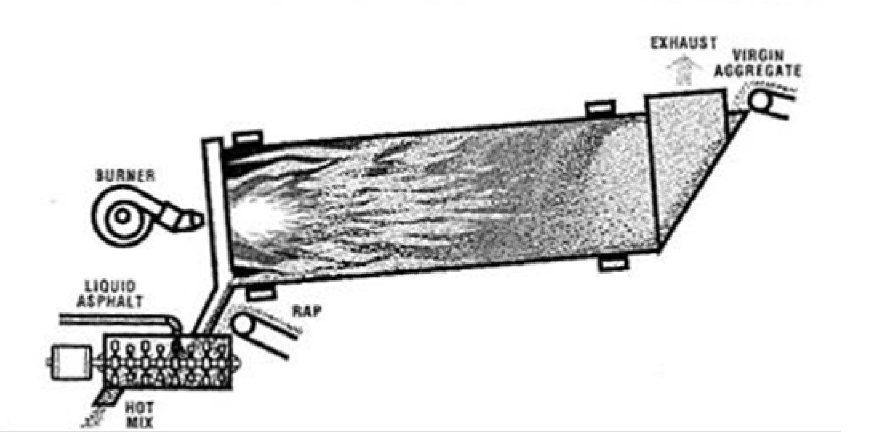


- Wet aggregates enter the primary zone where the heat from the burner dries and heats them. Spiral flights aid in directing the wet aggregate into the drum to attain uniform loading.
- Tapered lifting flights pick up the aggregates and drop them in an even veil through the burner flame. Subsequent flights direct aggregate through the drum and continue to drop in a veil across the cross-section of the drum.
- Recycled material gets added as the aggregate continues to the secondary zone, where liquid asphalt binder is added and blended with the aggregates.
- The mixture of hot liquid binder and moisture released from the aggregate produces a foaming mass that traps dust and aids in coating larger particles.

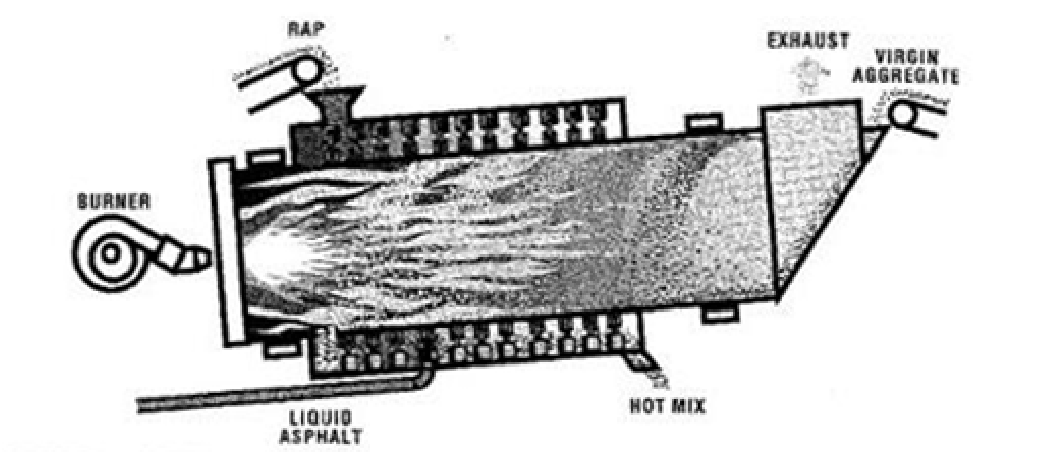
Counter Flow Drums



COUNTERFLOW DRUM-MIXER FLOW

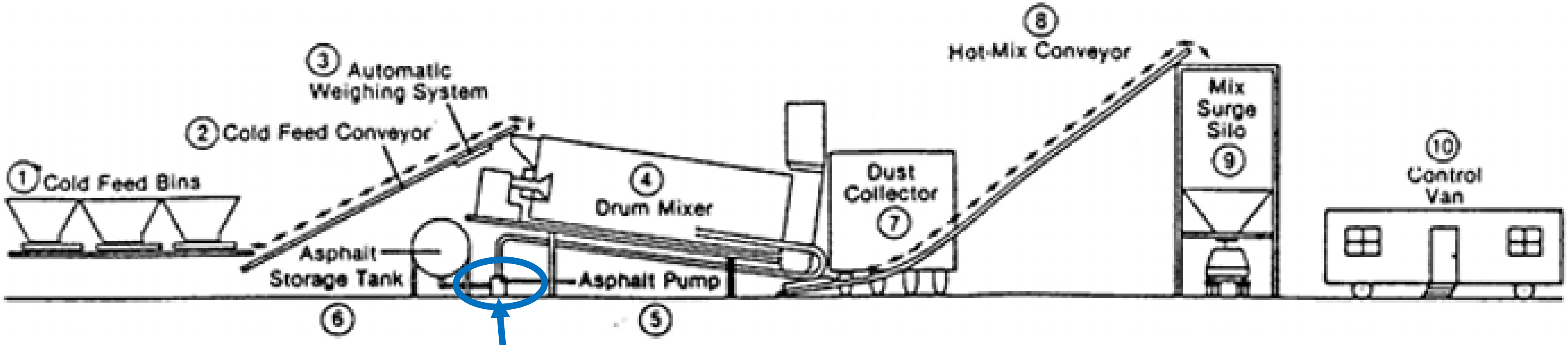


SEPARATE DRYER AND MIXER FLOW



DOUBLE-BARREL UNITIZED DRYER/MIXER FLOW

Drum Mix Plant Components



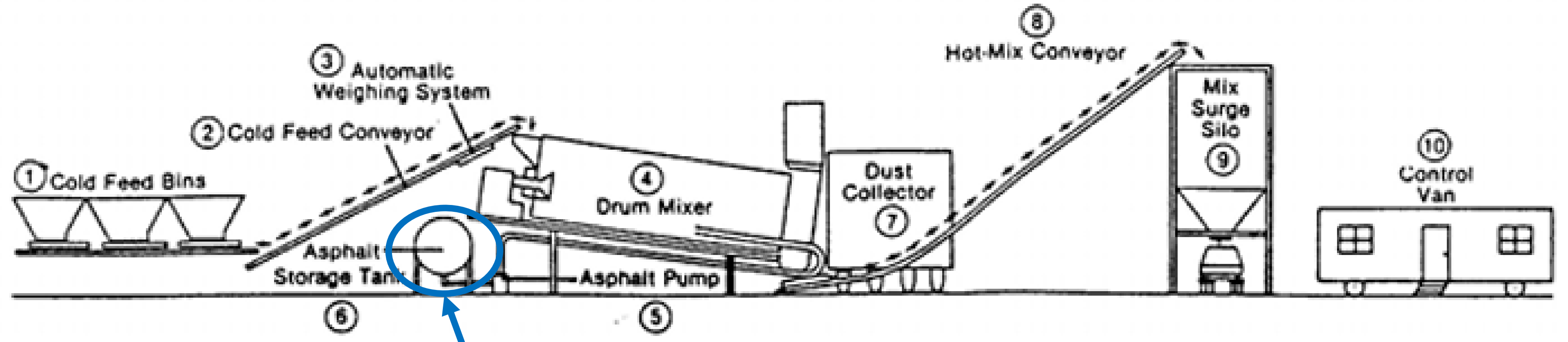
The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump

Liquid Asphalt Binder Pump/Metering

- The metering system is required to be calibrated and accurate to the nearest 0.5%.
- The weight of aggregate going into the drum, as measured by the weigh belt, is the basis for determining the quantity of liquid asphalt binder delivered into the drum.
- Proportioning is done by establishing a rate of binder delivery in gallons per minute to match the aggregate delivery in tons of dry aggregate per hour.
- Delivery rate is increased or decreased proportionality to the corrected dry weight measurement of aggregate passing over the belt scale.
- The rate of asphalt binder delivery is indicated on a rate meter at the control tower.

Drum Mix Plant Components



The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump
6. Liquid Asphalt Binder Storage Tank

Liquid Asphalt Binder Storage Tank

Liquid asphalt binder storage tanks are used to store and maintain asphalt binder at the right temperature for paving and asphalt production.

Temperature – Proper storage temperatures are provided by the liquid asphalt binder supplier. Insulation helps keep the heat in the tank and reduce energy costs.

Agitation – Agitation may be required to keep additives suspended or to mix emulsified asphalts.

Grades – Different grades of liquid asphalt binder have different properties and should be stored separately. If you must switch the grade in the tank, the tank should be emptied as much as possible from the existing material before switching grades.

Safety – Always follow proper safety storage protocol if sampling or you are around liquid asphalt binder tanks.

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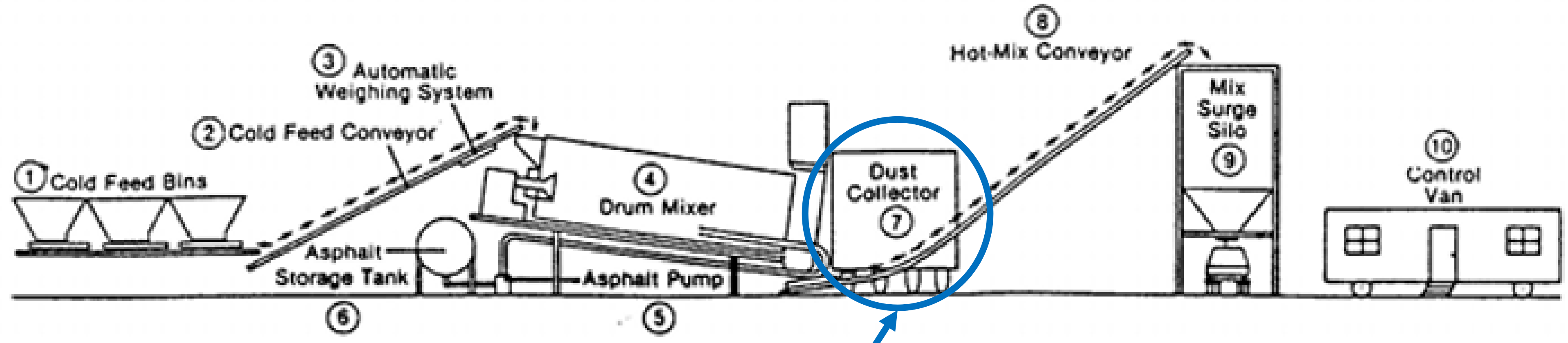
Drum Mix Plant Components



The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump
6. Liquid Asphalt Binder Storage Tank
7. Dust Collector

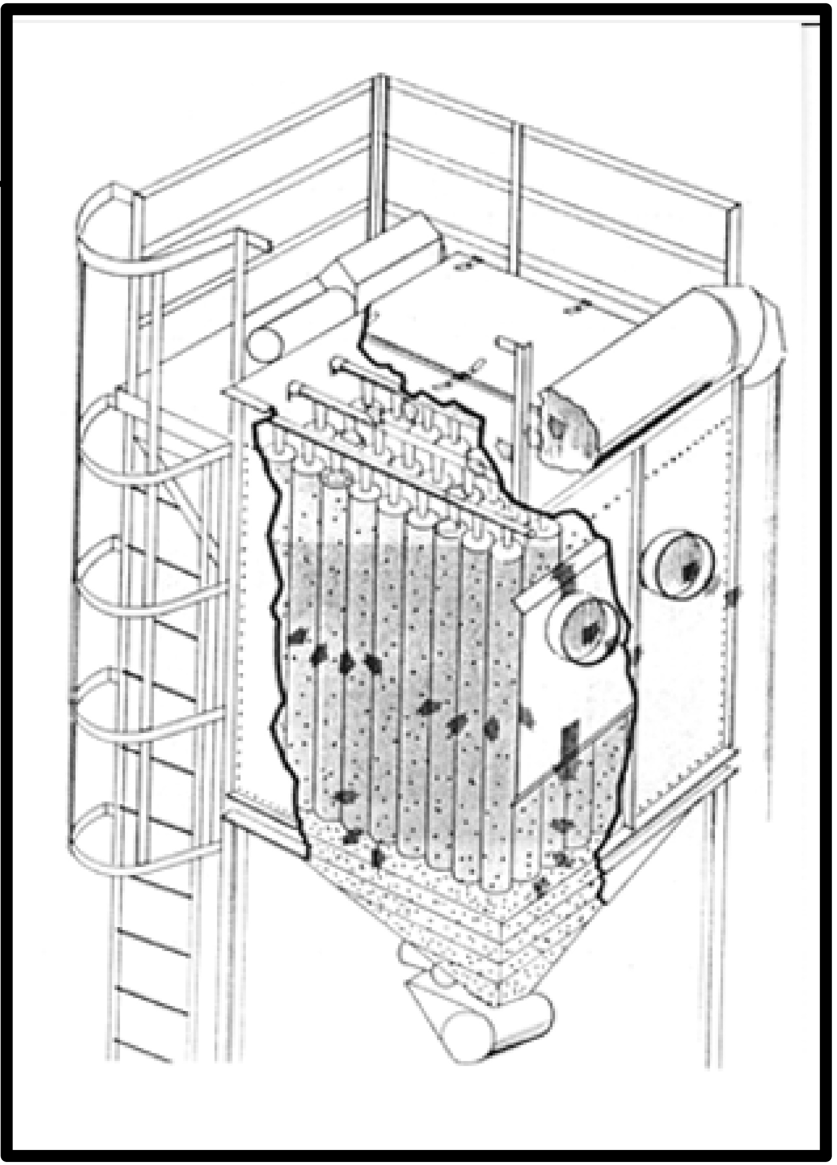
Dust Collector

This part of the plant is critical to manage and control air pollution during the production of asphalt mixtures.

The purpose is to minimize the emission of dust particles into the atmosphere, ensuring compliance with environmental regulations and maintaining air quality around the plant.

Dust Collector

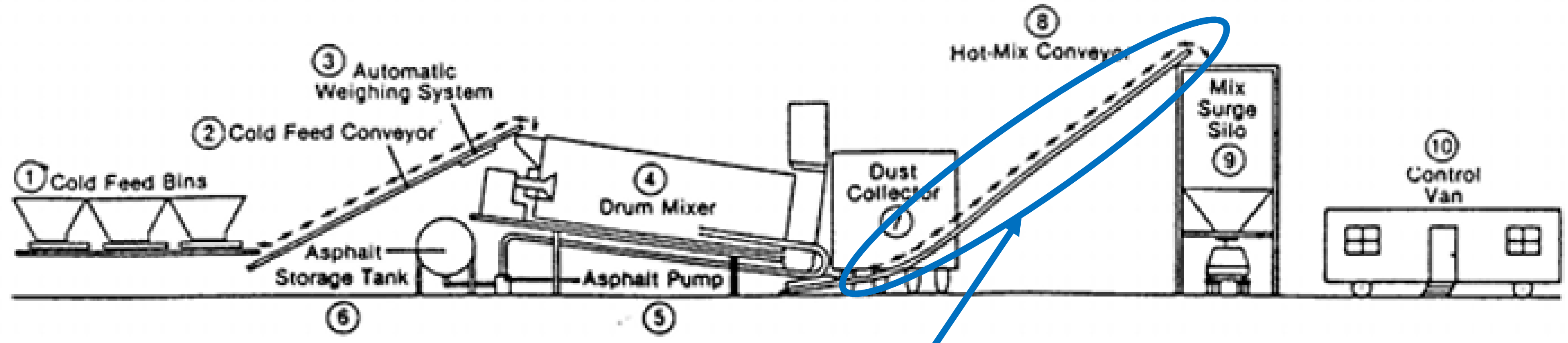
Primary Dry Collector:	**Secondary Collector**:
Typically include knockout boxes or centrifugal collectors (cyclones) to capture larger dust particles by reducing the velocity of exhaust gas.	Include wet scrubbers or baghouse (fabric filters). Wet scrubbers move dust through a water mist to capture dust particles. Baghouses use filter bags to trap fine dust particles as the exhaust gases pass through them.



Dust Collector

- Baghouses are highly efficient, capturing about 99.9% of dust particles.
- The type of dust collection system and management of the fines collected can affect the asphalt mixture properties.
- Some dust can be metered at a specified amount back into the mixture to help maintain consistency in volumetric asphalt mixture properties like VMA.

Drum Mix Plant Components

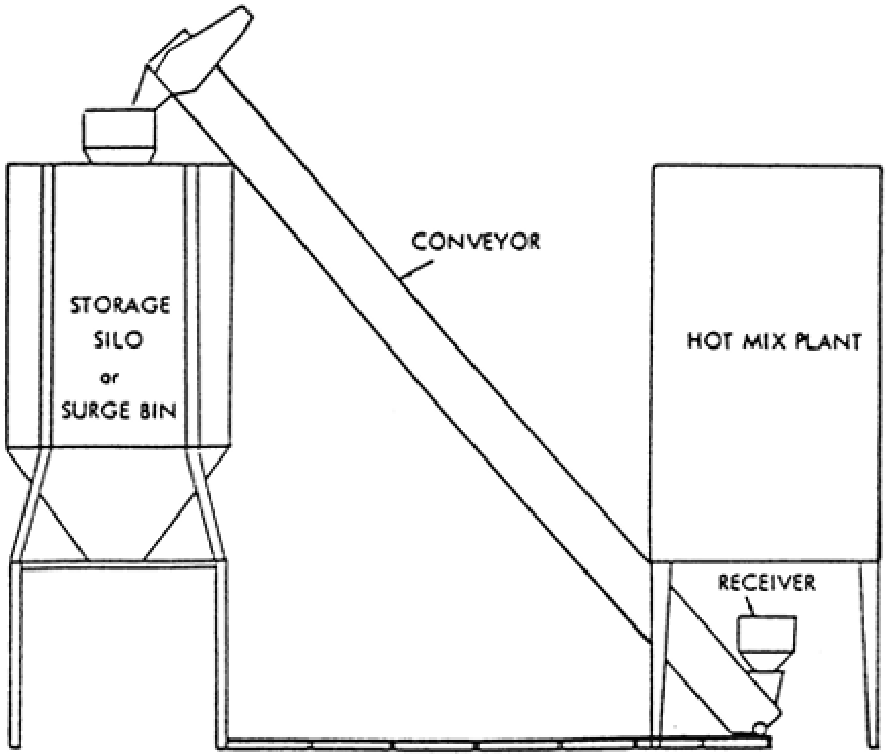


The fundamental components of a drum mix plant are:

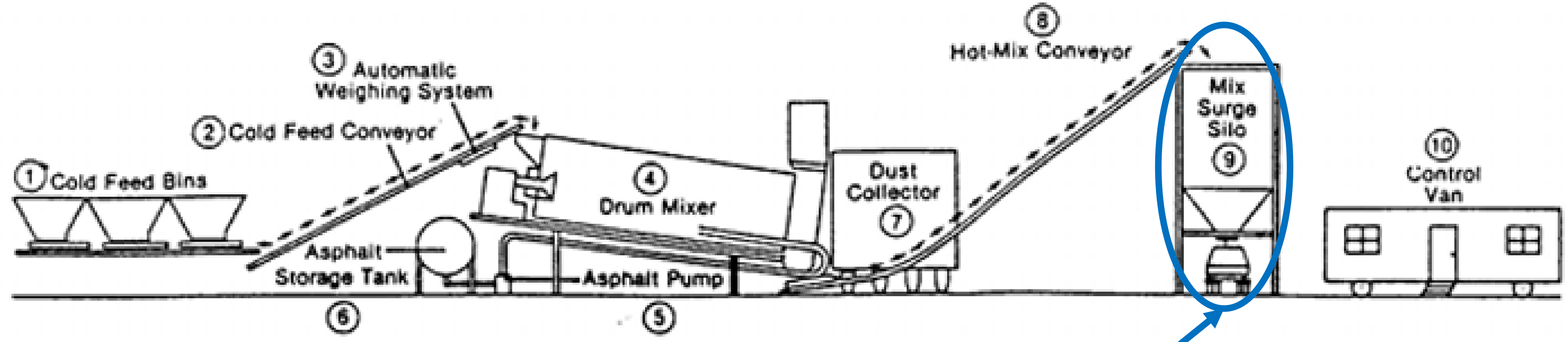
1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump
6. Liquid Asphalt Binder Storage Tank
7. Dust Collector
8. Hot Mix Conveyor

Hot Mix Conveyor

- This conveyor is used to transport hot asphalt mixture to the heated bins.
- On some asphalt plants, these can be "slat" conveyors. A slat conveyor is similar to a belt conveyor but with slats replacing the belt. The smooth surface of the slats prevents damage to items being moved and can be rugged, with little maintenance, and can carry material with minimal heat loss.



Drum Mix Plant Components



The fundamental components of a drum mix plant are:

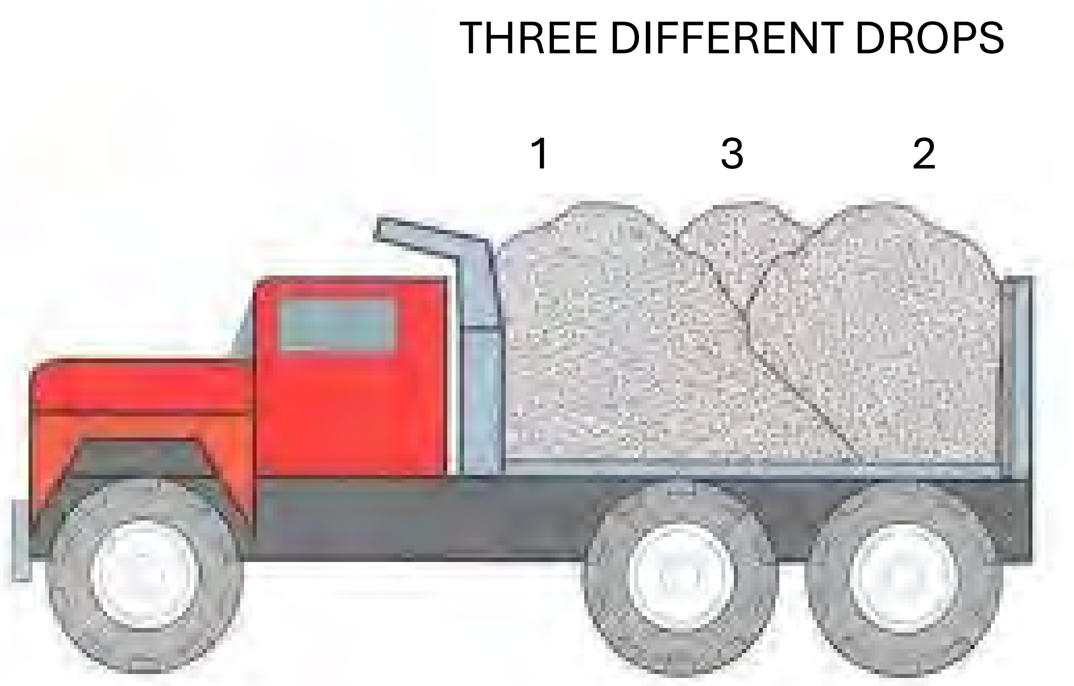
1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump
6. Liquid Asphalt Binder Storage Tank
7. Dust Collector
8. Hot Mix Conveyor
9. Mix Surge Silo

Mix Surge Silo

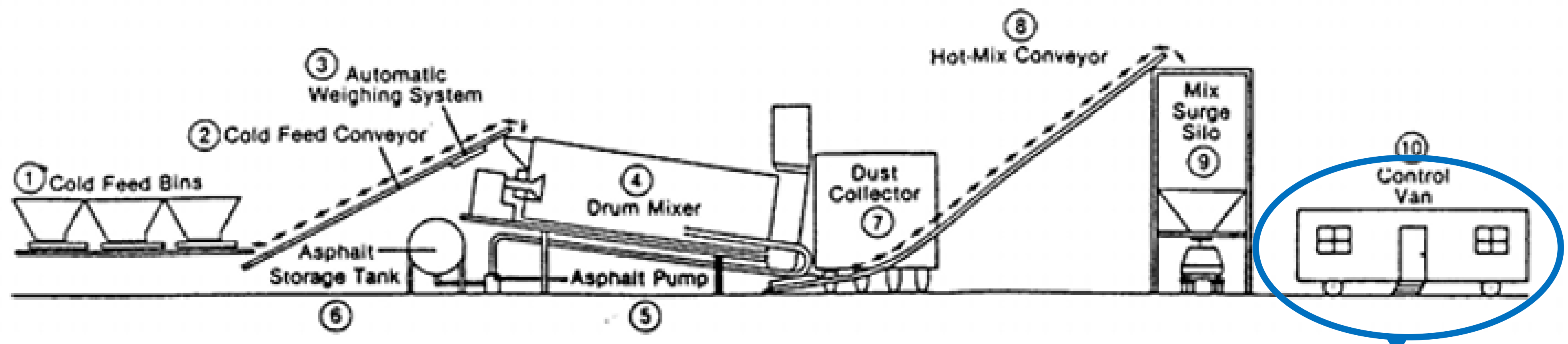
- To prevent shutdowns due to interruptions in paving operations or shortages of trucks to haul mix from the plant to jobsite, most plants are equipped with surge bins (storage silos).
- The asphalt mixture is deposited from the conveyor to the top of the bin and discharged into trucks from the bottom.
- To prevent segregation, good practice is to use a baffle plate or similar device at the discharge end as the mixture drops into the surge bins.
- It is also good practice to keep the hopper at least one-third full to avoid segregation as the hopper empties and to help keep the mix hot.
- Some surge bins can hold mix for long term storage.

Load Out

- During load out, issues can occur with silo segregation and truck segregation.
- In a silo, high absorption or length of time in the silo can cause mix and/or workability issues.
- To reduce segregation while loading trucks at the plant, the trucks should be loaded using a three-dump method.
- A high peak in the load may indicate the asphalt binder is too low.
- A mix that slumps in the truck may indicate the binder content is too high or there may be excessive moisture.



Drum Mix Plant Components



The fundamental components of a drum mix plant are:

1. Aggregate cold-feed bins
2. Cold-feed Conveyor
3. Aggregate weighing system
4. Drum mixer
5. Liquid Asphalt Binder Pump
6. Liquid Asphalt Binder Storage Tank
7. Dust Collector
8. Hot Mix Conveyor
9. Mix Surge Silo
10. Control Tower

Control Tower

- This is where the plant operator monitor and manage all aspects of the asphalt mixing process. This includes the flow of materials, temperatures, and production rates.
- The Control Panel essentially acts as the command center for the entire plant operation with touch screen interfaces with various controls to adjust settings and view critical data in real-time.
- Each panel and tower set up is unique to that plant.

QC Techs and Plant Operations

- One critical part of QC is to use your ***eyes***!
- Drive through the plant daily to monitor all stockpiles, aggregates and recycled materials, for contamination and use.
- Communicate with the plant operator what mixes are going to which project and when.
- Test for moisture content of your aggregates and let the plant operator know to ensure the proper settings are used for plant inputs of each mix design. *This is especially critical after a rain event.*
- Determine the sampling and testing schedule and set up your Daily Diary, prepare Type D certifications, or other documentation required by the project specifications.
- **Maintain communication with your plant operator throughout the paving operation!** Report any test data or adjustments to the mix that should be made to ensure mixes are running within the specified tolerances.

Chapter 11

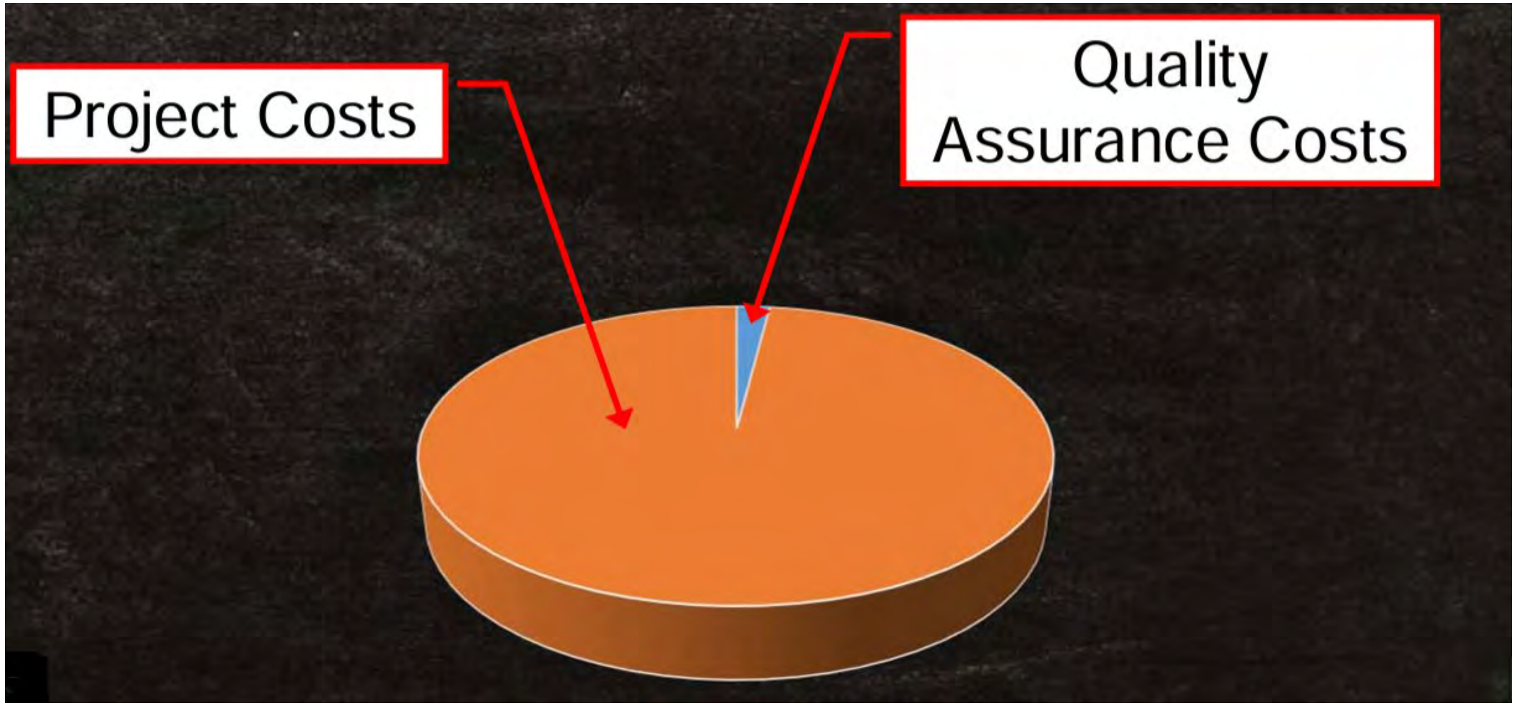
Quality Control and Quality Assurance

INDOT Certified Asphalt Technician Course

Presented by: Nathan Awwad, INDOT and Cody Fowler, Rieth-Riley Construction

Why QC/QA?

Quality Assurance costs are small, but they critically impact the overall quality of the entire project



What is QC and QA?

- Quality Control
  - The system used by the Contractor to monitor, assess and adjust their production of placement processes to ensure that the final product will meet the specified level of quality
  - Includes sampling, testing, inspection and corrective action to maintain continuous control of a production or placement process

- Quality Assurance
  - QA addresses the overall program of obtaining the quality of a service, product or facility in the most efficient, economical and satisfactory manner possible
  - Includes elements of QC, independent assurance, acceptance, dispute resolution, laboratory accreditation and personnel certification

What is QC and QA?

- Quality Control (QC)
  - CONTRACTOR
- Quality Assurance (QA)
  - AGENCY
- QC/QA is ***both*** Contractor and the Agency

INDOT Certified Plant Program Requirements

- ITM 583: Certified Hot Mix Asphalt Producer Program
  - Required documents on site
  - Laboratory and equipment calibration
  - Diary
  - Materials Sampling and testing
  - Control Limits
  - Response to test results
  - Quality Control Plan

INDOT Certified Plant Program Requirements

14.0 DEPARTMENT RESPONSIBILITIES.

14.1 The Department will conduct annual audits on a random basis of each HMA Plant.

14.2 The Department will maintain the List of Certified Hot Mix Asphalt Producers.

14.3 The Department will administer a Certified Asphalt Technician Training Program (ICAT). Certification of the Technicians will be provided by the Department upon passing a certification test. The Department will maintain a list of test methods requiring Qualification in the ICAT Policies and Procedures Manual.

14.4 The removal of a Producer from the Department's List of Certified Hot Mix Asphalt Producers will be the responsibility of the Division of Materials and Tests. The Producer shall have the right to appeal the removal from the Department's List of Certified Hot Mix Asphalt Producers to the Director, Construction Management Division.

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INDOT Audits

- Full Audit
  - Conducted once per year on INDOT produced mix
  - Documents
  - Control limits/diary
  - Sampling and testing requirements
    - (RAP, Aggregates, Binder, Truck and plate samples, 402 mix)
  - HMA plant equipment and stockpiles
  - Laboratory calibrations and verifications

INDOT Audits

- Partial Audit
  - Optional, in addition to a full audit
  - Reduced review of Documents
  - Generic review of Control limits/diary
  - Focus on current week of Sampling and testing requirements
    - (RAP, Aggregates, Binder, Truck and plate samples, 402 mix)

INDOT Audits

- No Production Audit
  - Documents
  - Control limits/diary
  - HMA plant equipment and stockpiles
  - Laboratory calibrations and verifications

INDOT Audits

2023 STATEWIDE COMPILATION OF CORRECTIVE ACTIONS		# of Gigs
3.3	AASHTO's not up to date	12
2.2	QCP needs to be updated	11
7.18	Stockpiles aren't adequately spaced	11
8.23	Weights need to be calibrated	11
8.17	Corelok needs to be verified	6
8.22	Vacuum gauge needs to be calibrated	6
2.8	Level 1 techs not current	5
8.19	Master ring needs to be calibrated	5
7.16	Stockpile is missing signs	4
7.20	Binder tanks missing signs	4
8.16	Thermometers needs to be verified	4
8.21	Proving ring and Gage blocks need to be	4
7.4	Plant scales and meters need to be verified	3
8.7	Balances need to be verified	3
8.12	Ignition oven balance needs to be verified	3

Daily Diary

- The Producer shall maintain a Daily Diary at the HMA Plant. At a minimum, the diary should include:
  - Type of mixture produced and quantity, DMF number, and the contract or purchase order number for each mixture.
  - The time the sample was obtained and the time the test was completed.
  - Non-conforming tests and the resulting corrective action taken.
  - Any significant events or problems.
- The Level I Asphalt Technician, Certified Asphalt Technician, or Management Representative must sign the diary.

Testing Frequencies

3 Main Asphalt Mixture Specifications

- 401 – QC/QA HMA
  - Dense Graded
  - Open Graded
- 402 – HMA
- 410 – QC/QA HMA , SMA
  - **S**tone **M**atrix **A**sphalt, also known as Stone Mastic Asphalt

Testing Frequencies

Lots and sublots: Dense graded 401.07

- Base/Intermediate:
  - Lot = 5,000 tons
  - Sublot = 1,000 tons
- Surface:
  - Lot = 3,000 tons
  - Sublot = 600 tons

Testing Frequencies

Lots and sublots: SMA 410.07

- Intermediate:
  - Lot = 4,000 tons
  - Sublot = 1,000 tons
- Surface:
  - Lot = 2,400 tons
  - Sublot = 600 tons

Testing Frequencies

Lots and sublots: HMA ITM 583

- Base/Intermediate:
  - 1st 250 ton of mix
  - Every 1,000 ton of each DMF in a construction season
  - If the DMF does not reach 250 ton, a minimum of one sample is required for certification.
- Surface:
  - 1st 250 ton of mix
  - Every 600 ton of each DMF in a construction season
  - If the DMF does not reach 250 ton, a minimum of one sample is required for certification.

Testing Frequencies – QC/QA

Different mixes are accepted in different ways:

- 401 mix less than a Lot – Single sublot
- 401 mix by Lot – Percent Within Limits
- 410 SMA – Adjustment Points
- Open Graded – Single Sublot
- 402 mix – Type D Certification

Sampling QC/QA HMA

- An acceptance sample will consist of plate samples and cores obtained in accordance with ITM 802 and ITM 580.
- The Engineer will randomly select the location within each sublot lot for sampling in accordance with ITM 802.
- INDOT will take immediate possession of the sample

Sampling QC/QA HMA

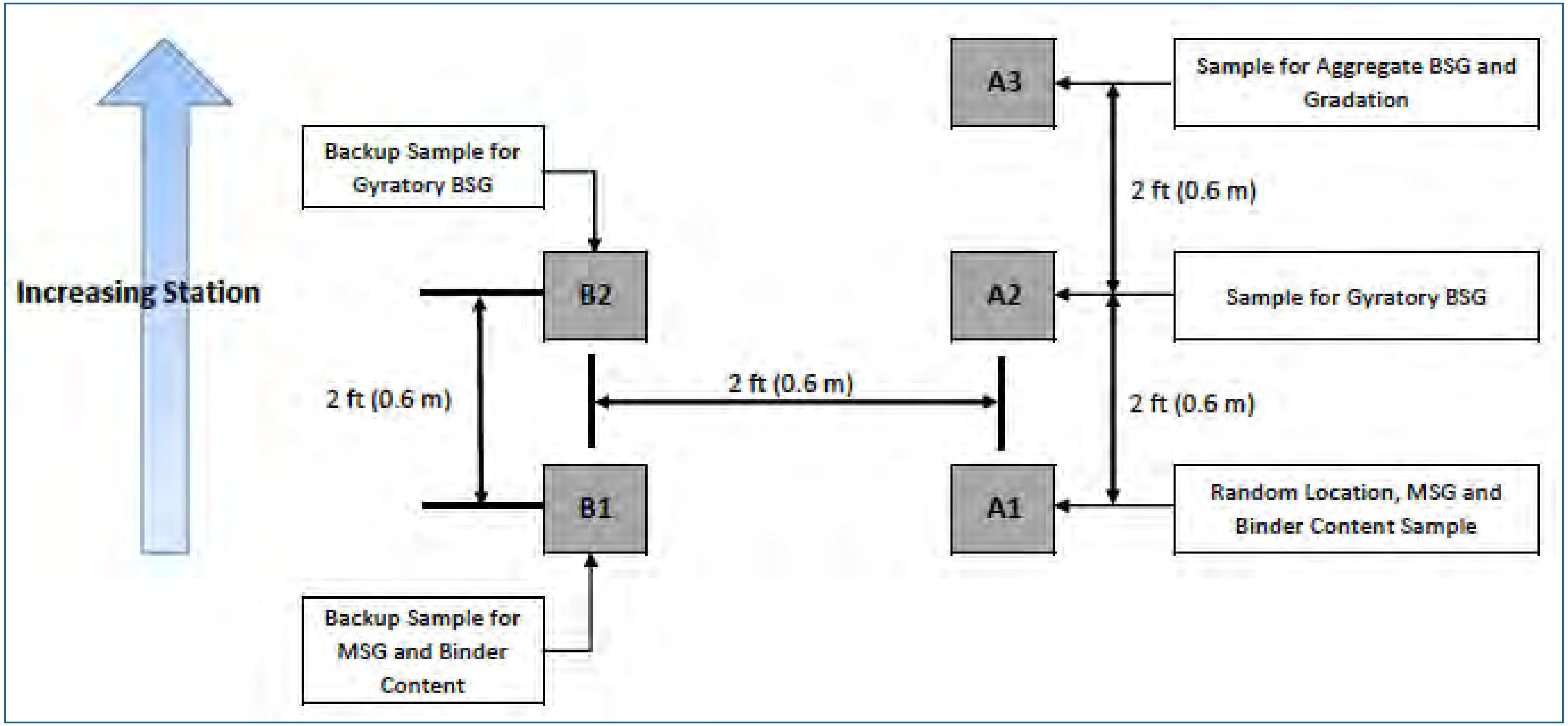
- All samples to be taken by the contractor/producer.
  - Contractor personnel obtaining plate samples must be qualified for ITM 580
- INDOT Project Engineer/ Project Supervisor or their designated representative are required to witness the taking of the sample.
- Road samples taken from random locations IAW ITM 802 and the Indiana GIFE.
  - **NOTE:** New to the GIFE Plate Sampling guidance , the PEMS should provide notice approximately 200 tons, about 10 trucks, in advance for base and intermediate mixtures. For surface mixtures, notice approximately 100 tons, or 5 trucks, should be provide. This has been done to promote a safe working environment during QA roadway sampling.

Sampling Techniques

- Plate Samples without a Mold
- Plate Samples with a Mold
- Cores
- Truck Samples
  - 4.75 mm Mixtures
  - Open Graded Mixtures
  - Dense Graded Mixtures

Plate Sampling

Select random location (Reference, ITM 802 – Random Sampling)



Acceptance (Plate) Sampling SS 401.09

- In the event an acceptance sample is not available to represent the sublot, all test results from the previous sublot will be used for acceptance. If the previous sublot is not available, the subsequent sublot will be used for acceptance.
- Samples shall not be obtained from the following:
  - Mix placed on an approach, taper, gore area, crossover, that is not placed simultaneously with the mainline.
  - Mix placed on a shoulder less than 9 ft wide that is not placed simultaneously with the mainline.
  - Within 25 ft of a transverse construction joint.
  - Areas placed with paving equipment in accordance with a widener or other mechanical devices like specialty paving equipment.

Plate Sampling

A2, B2 Boxes

Minimum Sample Sizes
Effective 2017

Size of Sample				
	Minimum Weight of Sample, g			
Mixture Designation	Moisture	MSG and Binder Content	Gyratory Specimens	Aggregate Bulk Specific Gravity
4.75 mm	1,000	3,000	11,000	N/A
9.5 mm	1,500	11,000	11,000	11,000
12.5 mm	2,000	11,000	11,000	11,000
19.0 mm	3,000	11,000	11,000	11,000
25.0 mm	4,000	11,000	11,000	11,000
OG 19.0 mm	3,000	5,500	11,000	N/A
OG 25.0 mm	4,000	7,000	11,000	N/A

A1, B1 Boxes

Plate Sampling without a Mold

- Apparatus
  - Sampling Plate – 8” square minimum with 3/8” hole
  - No. 18 Mechanics Wire
  - Masonry Nail
  - Pitchfork or Square Bit Shovel
  - Box for Sample with Non-Absorbent Lining
  - Oven bag (for moisture samples)

Plate Sampling without a Mold

- Place plate with wire on pavement.
  - (Use nail if movement is a problem.)
- Wire extended beyond pavement width.

Plate Sampling without a Mold

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Plate Sampling without a Mold

Plate Sampling without a Mold

Producer QC Samples
Typically 2 Plates

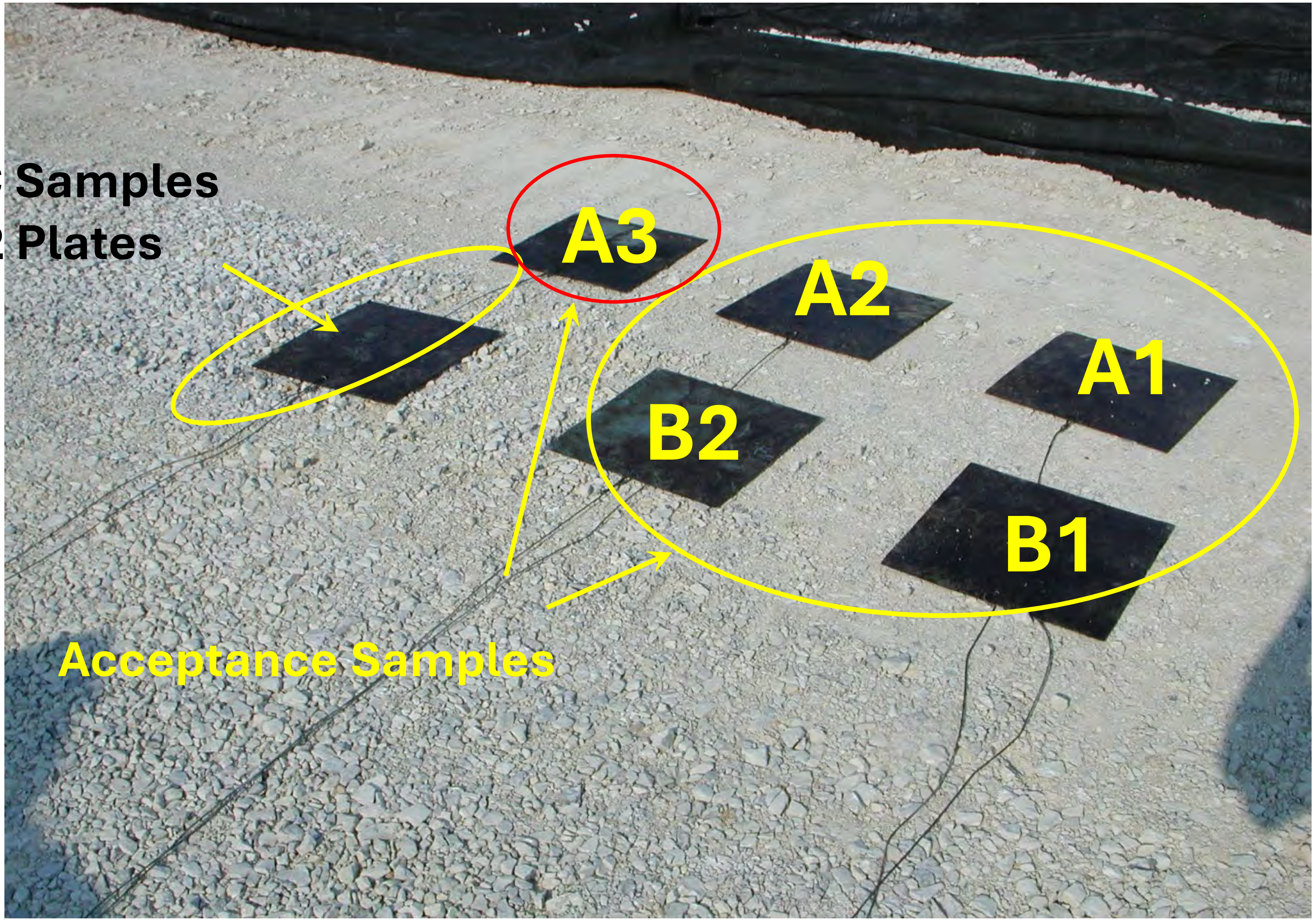

Plate Sampling without a Mold

SAFETY NOTE!

QC Technician (on far left) out of the way of the paving crew.

ALL EMPLOYEES on the project wear PPE (Hi-vis shirt/vest, safety-toe boots, hard hat, eye protection)

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Plate Sampling without a Mold

Plate Sampling without a Mold

Use shovel to lift plate and sample

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Plate Sampling without a Mold

HOT STUFF! = WEAR GLOVES!

Place entire sample in box.

Plate Sampling without a Mold

- **Check sample weight or use tables in ITM-580 to estimate the weight.**
- **Be sure sample is properly identified.**

Plate Sampling without a Mold

Refill sample hole with HMA.

Plate Sampling with a Mold

- Apparatus --
  - Same as sampling without mold plus …
  - Mold, round with height greater than mixture thickness and diameter less than plate width

Plate Sampling with a Mold

Clean mold pushed in a circular motion into mixture directly over the plate.

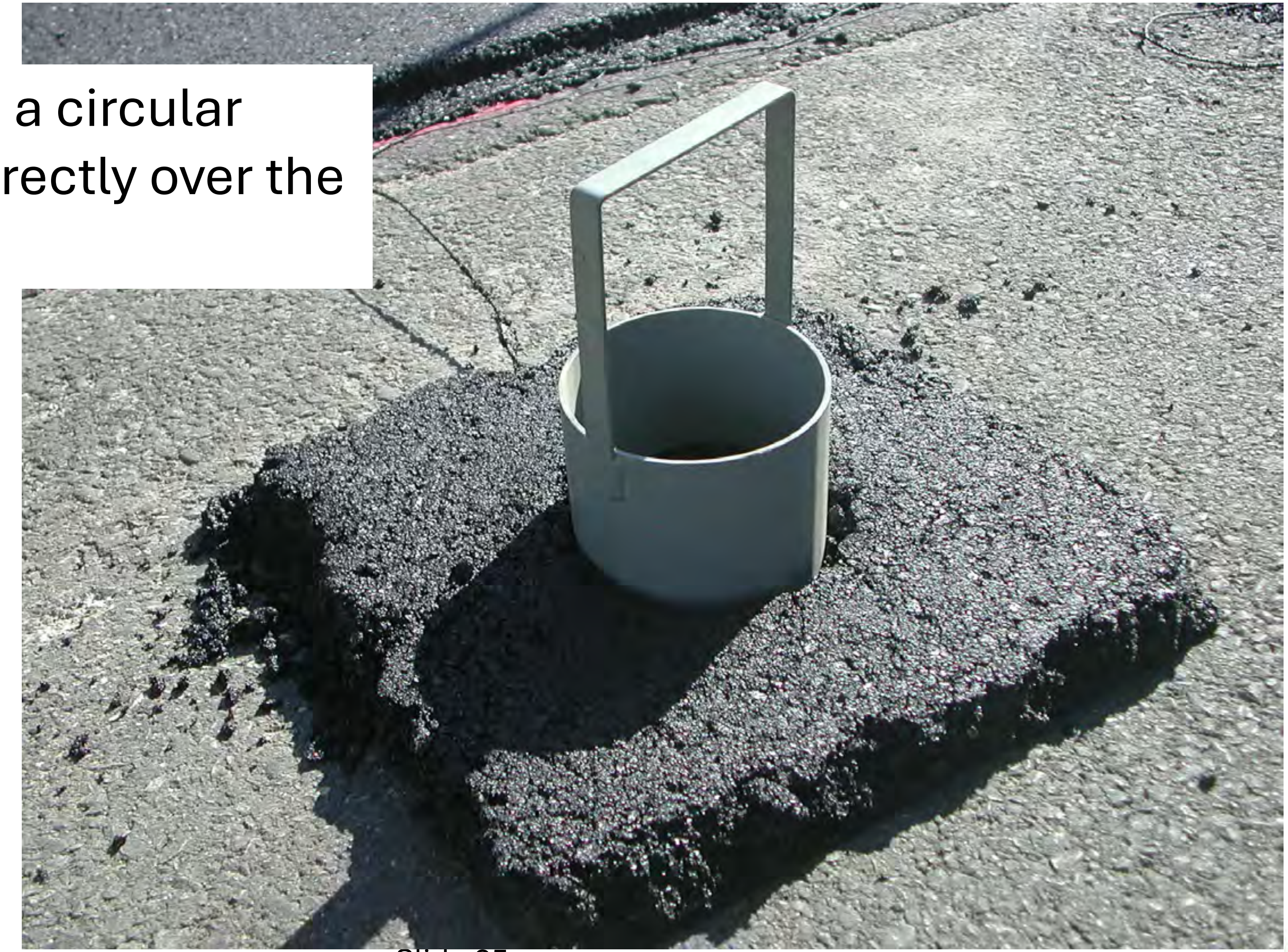


Plate Sampling with a Mold

Scrape away excess outside mold.

Plate Sampling with a Mold

- Place sample inside mold into sample container along with material remaining on the plate.
- Refill hole with HMA.

Cores

Cut a uniform 6” diameter pavement sample, being careful not to damage the core.

Cores

- Mark the layer to be tested.
- Fill the hole with HMA within one work day.

Marking Cores

Make sure the cores are CLEARLY and APPROPRIATELY marked.

The following pictures are examples of actual cores submitted to INDOT for testing.

Marking Cores

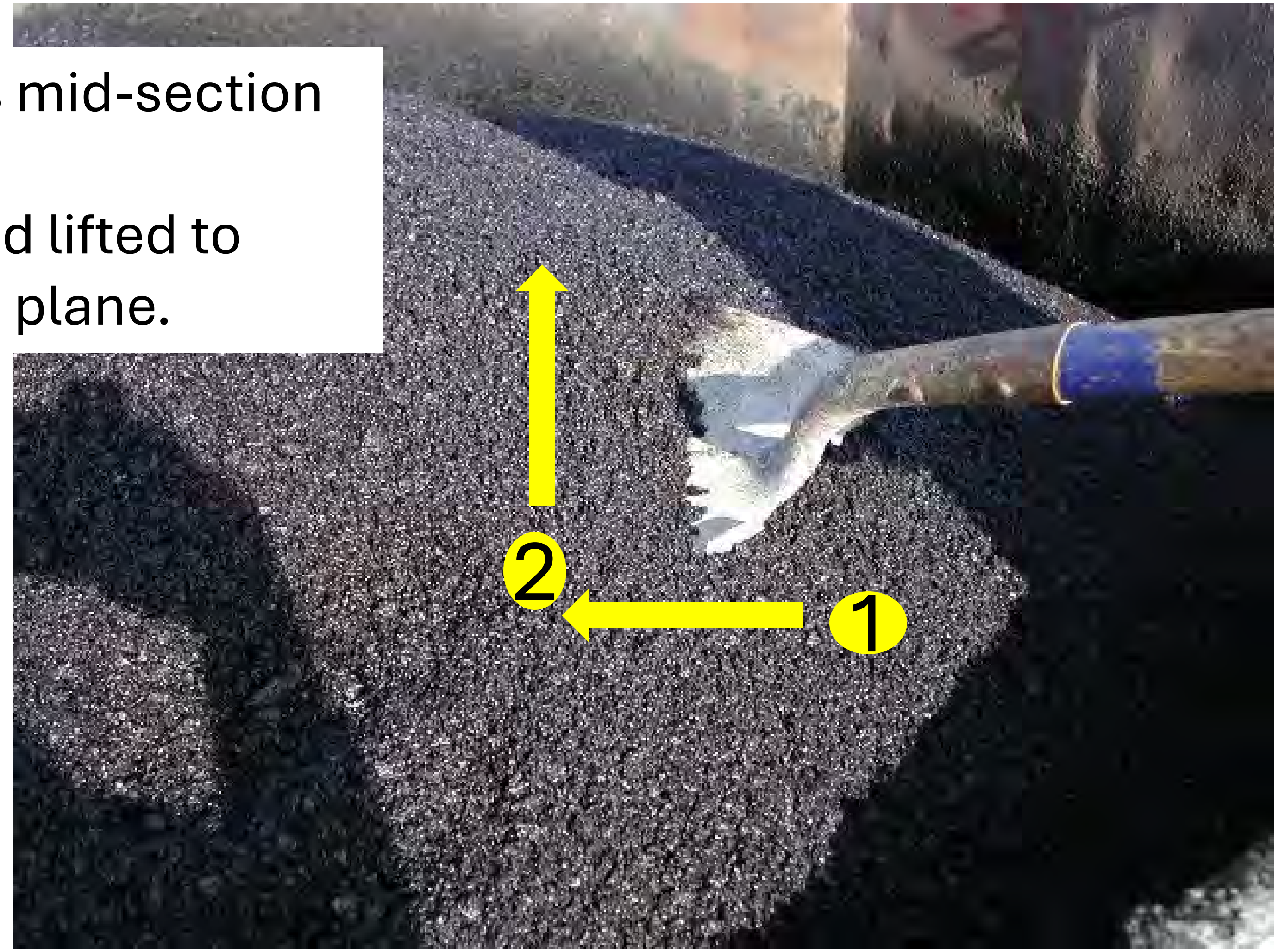


Marking Cores

If cores are not clearly marked or identified, it may result in a discrepancy in testing that can result in significant differences between the final QC and QA core density results.

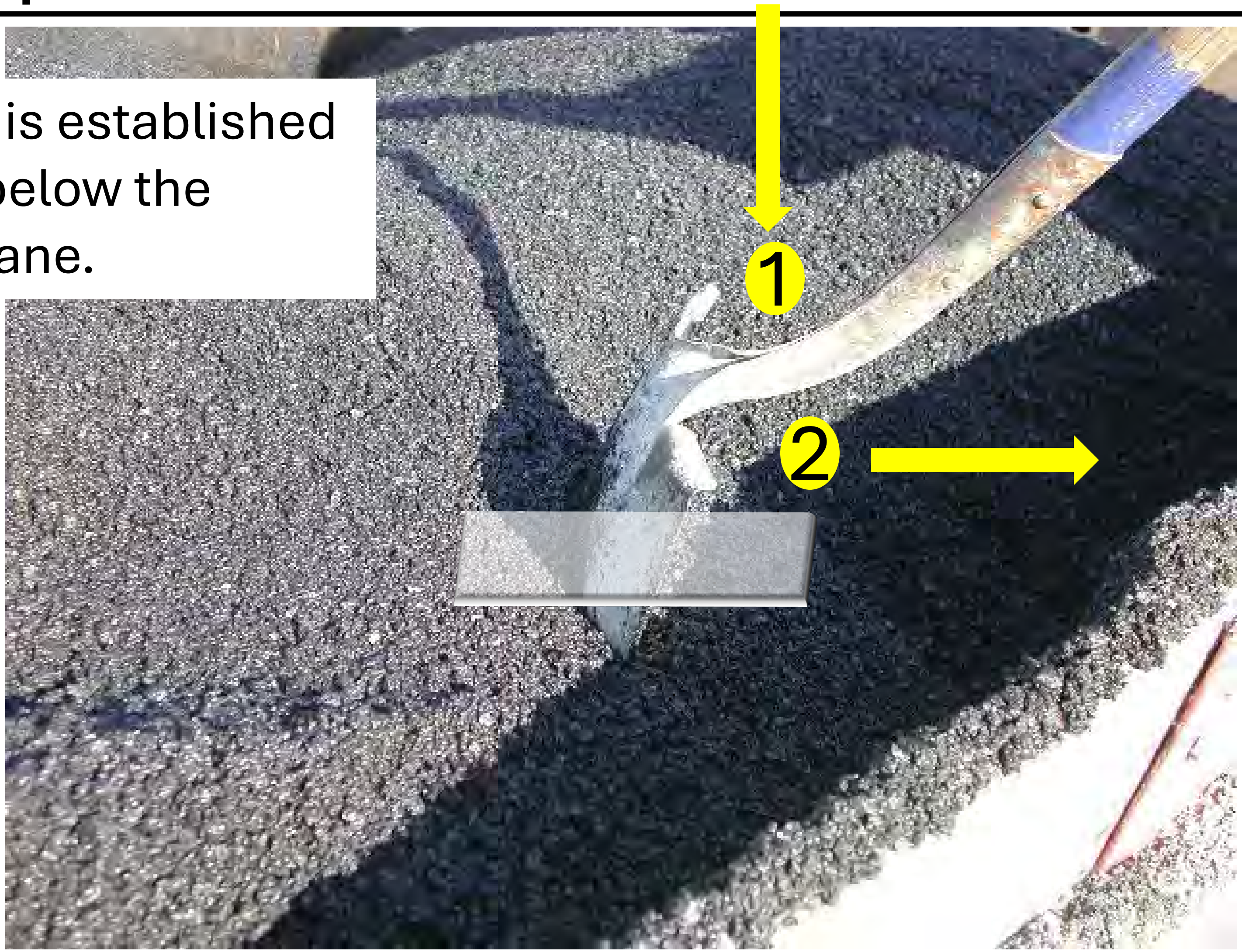
Truck Samples – Dense Graded Mix

- Sample location is mid-section of the truck.
- Shovel inserted and lifted to establish horizontal plane.



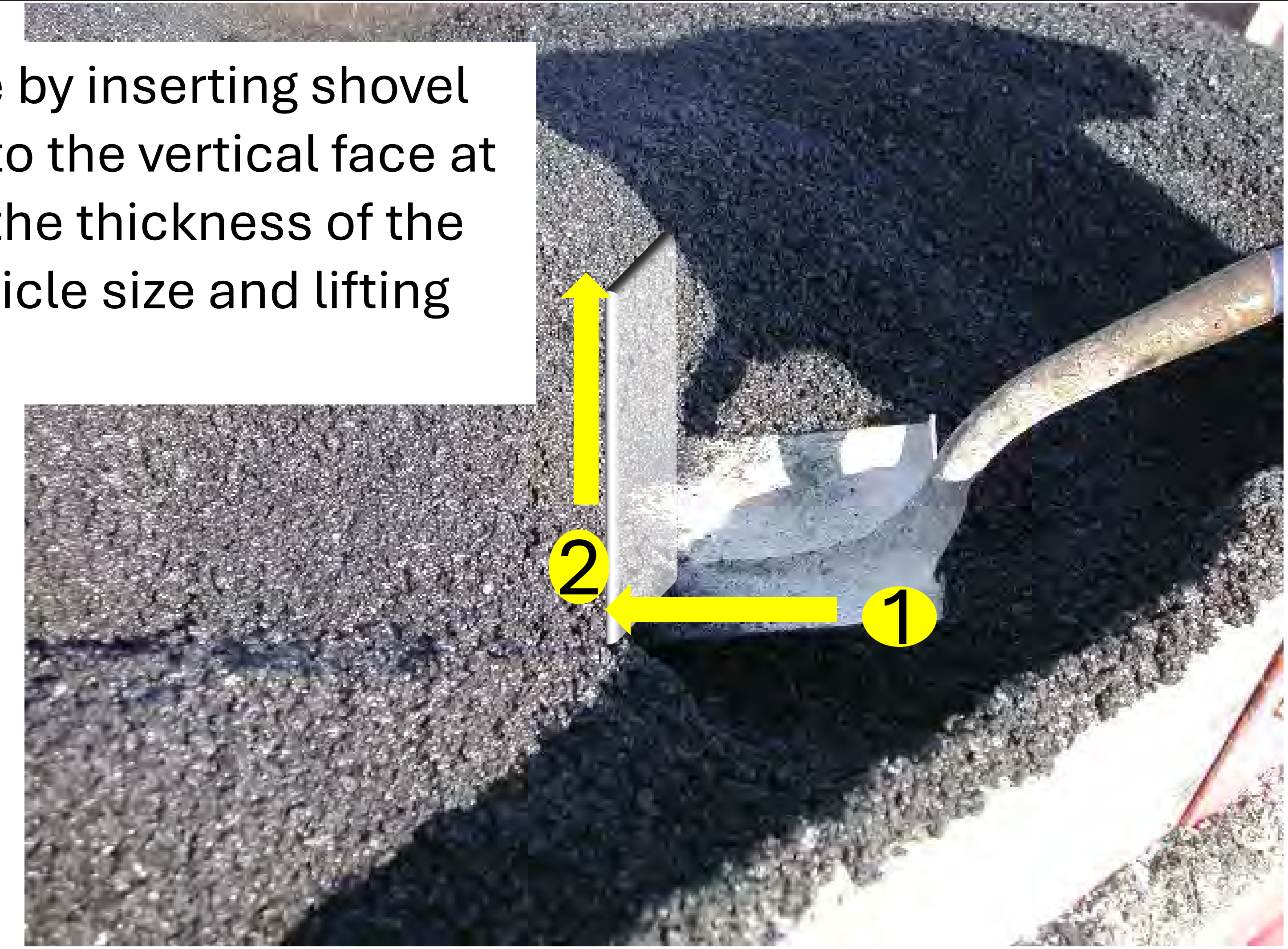
Truck Samples – Dense Graded Mix

Vertical face is established with shovel below the horizontal plane.



Truck Samples – Dense Graded Mix

Obtain sample by inserting shovel horizontally into the vertical face at a depth twice the thickness of the maximum particle size and lifting vertically.



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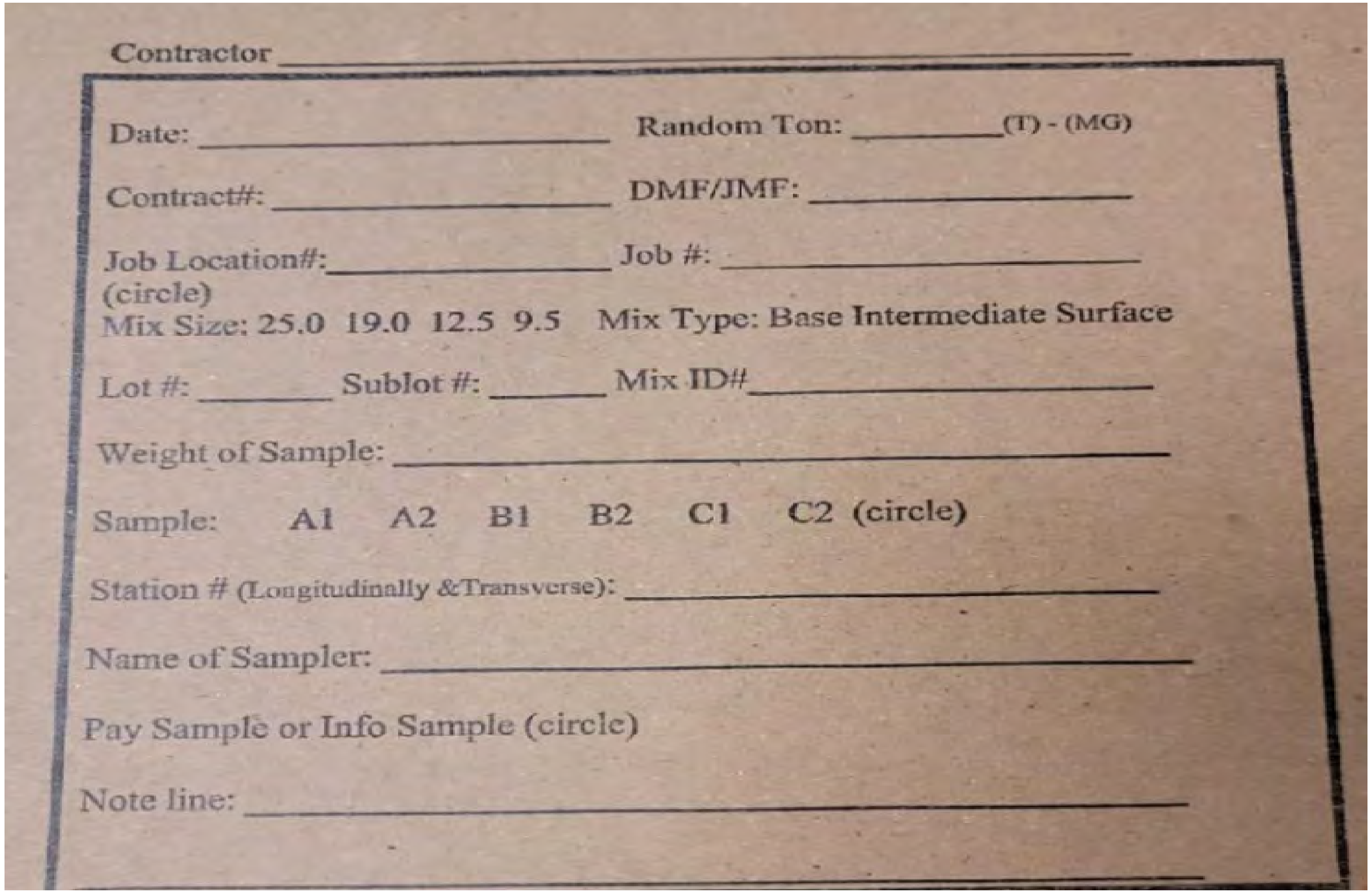
Truck Samples – Dense Graded Mix

Place sample in container.

Sample Labeling: Top



Contractor ______________________________

Date: ____________________ Random Ton: ________(T) - (MG)

Contract#: ____________________ DMF/JMF: ____________________

Job Location#: ____________________ Job #: ____________________

(circle)
Mix Size: 25.0 19.0 12.5 9.5 Mix Type: Base Intermediate Surface

Lot #: ________ Sublot #: ________ Mix ID# ____________________

Weight of Sample: ______________________________

Sample: A1 A2 B1 B2 C1 C2 (circle)

Station # (Longitudinally &Transverse): ____________________

Name of Sampler: ______________________________

Pay Sample or Info Sample (circle)

Note line: ______________________________

Plate Sample: End

The following information shall be on all box ends for plate sampling

- A/B sample (A1, A2, A3, B1, B2)
- Contract Number
- DMF/JMF Number
- Item (CLN) Number
- Lot/Sublot
- Material Description: Size, Course, ESAL Category, PG grade
- Sample Date
- Sitemanager ID number

Plate Sample: End

Date:____________________ Random Ton:______________

Contract #:______________ DMF:_____________________

Job Location:____________ Job #:_____________________

Lot: _________ Sublot #:________ Mix Id:____________________

Sample: A1 A2 B1 B2 C1 C2

Directive 304

- Insufficient Plate Sample Size
  - Original sample
    - If original sample size is insufficient, the backup sample will be used
    - No dispute (appeal) allowed
  - Backup sample
    - If backup sample size is insufficient, previous or subsequent sublot results are used
    - Possibly submitted as failed material

Pavement Smoothness (SS401.18)

- Smoothness of pavement affects
  - Public safety – vehicles are more controllable
  - Ride quality
  - Pavement longevity? Yes! A smooth road does not suffer point-load impacts.
- How do we monitor smoothness?
  - 16 foot or 10 foot straight edge
  - Inertial Profiler

Straight Edge

Inertial Profiler – ITM 917

ASPHALT PAVEMENT ASSOCIATION of INDIANA

Chapter 12

INDOT Pay Factors

INDOT Certified Asphalt Technician Course

Presented by: Nathan Awwad, INDOT

Review of Acceptance Types

3 Main HMA Specifications

- 401 – QC/QA HMA
  - Dense Graded
  - Open Graded
- 402 – HMA
- 410 – QC/QA HMA , SMA

Review of Acceptance Frequencies

Lots and sublots: Dense graded 401.07

- Base/Intermediate:
  - Lot = 5,000 tons
  - Sublot = 1,000 tons
- Surface:
  - Lot = 3,000 tons
  - Sublot = 600 tons

Review of Acceptance Frequencies

Lots and sublots: SMA 410.07

- Intermediate:
  - Lot = 4,000 tons
  - Sublot = 1,000 tons
- Surface:
  - Lot = 2,400 tons
  - Sublot = 600 tons

Acceptance Types

Different mixes are accepted in different ways:

- 401 mix less than a Lot – Single sublot
- 401 mix by Lot – Percent Within Limits
- 410 SMA – Adjustment Points
- Open Graded – Single Sublot
- 402 mix – Certification

401 Mix – Single Sublot 401.19(b)

Air Voids	
Dense Graded Deviation from Spec (±%)	Pay Factor
≤ 0.5	1.05
> 0.5 and ≤ 1.7	1.00
1.8	0.96
1.9	0.90
2.0	0.84
> 2.0	Submitted to the Office of Materials Management*

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

Volume of Effective Binder, Vbe	
Dense Graded Deviation from Spec Minimum	Pay Factors
> +3.0	Submitted to the Office of Materials Management*
≥ +2.5 and ≤ +3.0	1.00 - 0.05 for each 0.1% above +2.5%
≥ +2.0 and < +2.5	1.05 - 0.01 for each 0.1% above +2.0%
> +0.5 and < +2.0	1.05
≥ 0.0 and ≤ +0.5	1.05 - 0.01 for each 0.1% below +0.5%
≥ -0.5 and < 0.0	1.00 - 0.02 for each 0.1% below 0.0%
≥ -2.0 and < -0.5	0.90 - 0.06 for each 0.1% below - 0.5%
< -2.0	Submitted to the Office of Materials Management*

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

Density	
Percentages are based on %MSG Dense Graded	Pay Factors, %
≥ 98.0	Submitted to the Office of Materials Management*
97.0 - 97.9	1.00
96.6 - 96.9	1.05 - 0.01 for each 0.1% above 96.5
95.0 - 96.5	1.05
94.1 - 94.9	1.00 + 0.005 for each 0.1% above 94.0
93.0 - 94.0	1.00
92.0 - 92.9	1.00 - 0.005 for each 0.1% below 93.0
91.0 - 91.9	0.95 - 0.010 for each 0.1% below 92.0
90.0 - 90.9	0.85 - 0.030 for each 0.1% below 91.0
≤ 89.9	Submitted to the Office of Materials Management*

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

401 Mix – Single Sublot 401.19(b)

Air Voids					
AV	PF	**AV**	PF	**AV**	PF
2.9	Fail	**4.3**	1.00	**5.7**	1.00
3.0	0.84	**4.4**	1.00	**5.8**	1.00
3.1	0.90	**4.5**	1.05	**5.9**	1.00
3.2	0.96	**4.6**	1.05	**6.0**	1.00
3.3	1.00	**4.7**	1.05	**6.1**	1.00
3.4	1.00	**4.8**	1.05	**6.2**	1.00
3.5	1.00	**4.9**	1.05	**6.3**	1.00
3.6	1.00	**5.0**	1.05	**6.4**	1.00
3.7	1.00	**5.1**	1.05	**6.5**	1.00
3.8	1.00	**5.2**	1.05	**6.6**	1.00
3.9	1.00	**5.3**	1.05	**6.7**	1.00
4.0	1.00	**5.4**	1.05	**6.8**	0.96
4.1	1.00	**5.5**	1.05	**6.9**	0.90
4.2	1.00	**5.6**	1.00	**7.0**	0.84
				7.1	Fail

401 Mix – Single Sublot 401.19(b)

Vbe					
Deviation*	PF	**Deviation***	PF	**Deviation***	PF
-2.1	fail	**-0.3**	0.94	**1.5**	1.05
-2.0	0.00	**-0.2**	0.96	**1.6**	1.05
-1.9	0.06	**-0.1**	0.98	**1.7**	1.05
-1.8	0.12	**0.0**	1.00	**1.8**	1.05
-1.7	0.18	**0.1**	1.01	**1.9**	1.05
-1.6	0.24	**0.2**	1.02	**2.0**	1.05
-1.5	0.30	**0.3**	1.03	**2.1**	1.04
-1.4	0.36	**0.4**	1.04	**2.2**	1.03
-1.3	0.42	**0.5**	1.05	**2.3**	1.02
-1.2	0.48	**0.6**	1.05	**2.4**	1.01
-1.1	0.54	**0.7**	1.05	**2.5**	1.00
-1.0	0.60	**0.8**	1.05	**2.6**	0.95
-0.9	0.66	**0.9**	1.05	**2.7**	0.90
-0.8	0.72	**1.0**	1.05	**2.8**	0.85
-0.7	0.78	**1.1**	1.05	**2.9**	0.80
-0.6	0.84	**1.2**	1.05	**3.0**	0.75
-0.5	0.90	**1.3**	1.05	**3.1**	fail
-0.4	0.92	**1.4**	1.05		

*Spec minimum

9.5mm @13.2 Vbe?

Vbe, CRITERIA @ N_{des}	
Mixture Designation	Minimum Vbe, %
4.75 mm	12.0
9.5 mm	11.0
12.5 mm	10.0
19.0 mm	9.0
25.0 mm	8.0
OG	n/a

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401 Mix – Single Sublot 401.19(b)

Density							
Density	PF	**Density**	PF	**Density**	PF	**Density**	PF
89.9	Fail	**91.9**	0.940	**93.9**	1.000	**96.0**	1.050
90.0	0.550	**92.0**	0.950	**94.0**	1.000	**96.1**	1.050
90.1	0.580	**92.1**	0.955	**94.1**	1.005	**96.2**	1.050
90.2	0.610	**92.2**	0.960	**94.2**	1.010	**96.3**	1.050
90.3	0.640	**92.3**	0.965	**94.3**	1.015	**96.4**	1.050
90.4	0.670	**92.4**	0.970	**94.4**	1.020	**96.5**	1.050
90.5	0.700	**92.5**	0.975	**94.5**	1.025	**96.6**	1.040
90.6	0.730	**92.6**	0.980	**94.6**	1.030	**96.7**	1.030
90.7	0.760	**92.7**	0.985	**94.7**	1.035	**96.8**	1.020
90.8	0.790	**92.8**	0.990	**94.8**	1.040	**96.9**	1.010
90.9	0.820	**92.9**	0.995	**94.9**	1.045	**97.0**	1.000
91.0	0.850	**93.0**	1.000	**95.0**	1.050	**97.1**	1.000
91.1	0.860	**93.1**	1.000	**95.1**	1.050	**97.2**	1.000
91.2	0.870	**93.2**	1.000	**95.2**	1.050	**97.3**	1.000
91.3	0.880	**93.3**	1.000	**95.3**	1.050	**97.4**	1.000
91.4	0.890	**93.4**	1.000	**95.4**	1.050	**97.5**	1.000
91.5	0.900	**93.5**	1.000	**95.5**	1.050	**97.6**	1.000
91.6	0.910	**93.6**	1.000	**95.6**	1.050	**97.7**	1.000
91.7	0.920	**93.7**	1.000	**95.7**	1.050	**97.8**	1.000
91.8	0.930	**93.8**	1.000	**95.8**	1.050	**97.9**	1.000
				95.9	1.050	**98.0**	Fail

401 Mix – Single Sublot 401.19(b)

Sublot Composite Pay Factor (Dense Graded)

$$SCPF = 0.30\,(PF_{VOIDS}) + 0.35\,(PF_{VBE}) + 0.35\,(PF_{DENSITY})$$

401 Mix – Single Sublot 401.19(b)

9.5 mm Surface	DMF Target	Sublot 1 600 tons	Sublot 2 600 tons	**Sublot 3** **600 tons**	Sublot 4 600 tons
Air Voids	5.00	4.46	4.07	**4.99**	5.25
Vbe Gsb = 2.710	11.2	12.69	12.98	**12.97**	12.56
Density (% Gmm)		94.1	93.8	**93.0**	93.9

401 Mix – Single Sublot 401.19(b)

Sublot Composite Pay Factor Dense Graded

9.5 mm Surface	Sublot 3 600 tons
AV	**4.99**
Vbe	**12.97**
Density %	**93.0**

$SCPF = 0.30\ (PF_{VOIDS}) + 0.35\ (PF_{VBE}) + 0.35\ (PF_{DENSITY})$

$SCPF = 0.30\ (\mathbf{1.05}) + 0.35\ (\mathbf{1.05}) + 0.35\ (\mathbf{1.00})$

SCPF = 1.033

SCPF = 1.03

401 Mix – Single Sublot 401.19(b)

QA Adjustment ($) = L x U x (SCPF – 1.00) / MAF

L = Sublot Quantity

U = Unit Price

SCPF = Sublot Composite Pay Factor

MAF = Mixture Adjustment Factor ← ?

401 Mix – Single Sublot

MAF_i = DMF Gmm ÷
2.465 for 9.5 mm
2.500 for all else

DMF Gmm = 2.544

MAF_i = (**2.544/2.465**) = **1.032**

$MAF_i > 1.020$ → $MAF = MAF_i – 0.020$

$0.980 \le MAF_i \le 1.020$ → $MAF = 1.000$

$MAF_i < 0.980$ → $MAF = MAF_i + 0.020$

MAF = (**1.032**) - 0.020 = **1.012**

401 Mix – Single Sublot

QA Adjustment ($) = L x U x (SCPF – 1.00) / MAF

L = Sublot Quantity
U = Unit Price
SCPF = Sublot Composite Pay Factor
MAF = Mixture Adjustment Factor

QA ($) = 600.00ton x $74.00/ton x (1.03 – 1.00) / 1.012

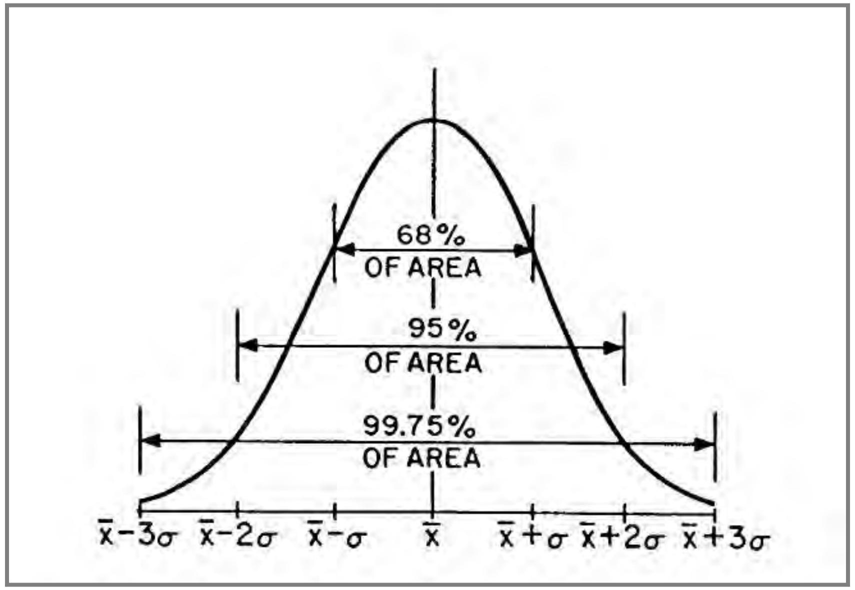
QA ($) = **+ $1,316.21**

QA ($) = **+ $1,332.00**
(No MAF)

401 Mix – **Percent-Within-Limits** (By Lots) 401.19(a)

Quality Measure

- Estimates the percentage of material within specification limits
- Assumes normal distribution



Benefits

- A more discerning quality measure:
- Captures the mean *and* standard deviation
- Encourages Uniformity and Consistency within tolerances

401 Mix – <u>P</u>ercent-<u>W</u>ithin-<u>L</u>imits (By Lots) 401.19(a)

- Mean – average
- Standard Deviation – measures the variability (spread) of data

Pick 10 Density values from a lot with average of 93.0%

89.9, 95.9, 96.0, 87.9, 93.2, 94.3, 92.8, 97.5, 87.7, 94.8

- Average = 93.00%
- Std. Dev. = 3.44

93.0, 93.0, 93.0, 93.0, 93.0, 93.0, 93.0, 93.0, 93.0, 93.0

- Average = 93.00%
- Std. Dev. = 0.00

401 Mix – PWL (By Lots) 401.19(a)

$$\text{Air Voids, \%} = 100 \times \frac{(Gmm - Gmb_{pill})}{Gmm}$$

$$\text{Vbe, \%} = VMA - Air\ Voids$$

$$\text{VMA, \%} = 100 - \frac{(Gmb_{pill} \times Ps)}{Gsb}$$

$$\text{Density, \%} = 100 \times \frac{(Gmb_{core})}{Gmm}$$

Average, $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$

Standard Deviation, $s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

401 Mix – PWL (By Lots) 401.19(a)

401.19 Specification Limits

	Lower Spec Limit LSL	Upper Spec Limit USL
Air Voids @ Ndes, %	**3.60**	**6.40**
Vbe @ Ndes, %	Spec	Spec + 2.50
	11.00	**11.00** + 2.50
		13.5
Core Density, % Gmm	**93.00**	**Not Applicable**

401 Mix – PWL (By Lots)

9.5 mm Surface	DMF Target	Sublot 1 600 tons	Sublot 2 600 tons	Sublot 3 600 tons	Sublot 4 600 tons	Sublot 5 600 tons	$\bar{x}$	S
Air Voids	5.00	4.46	4.07	4.99	5.25	7.36	**5.23**	**1.28**
Vbe Gsb = 2.710	11.20	12.69	12.98	12.97	12.56	11.59	**12.56**	**0.57**
Density (% Gmm)		92.48	93.02	92.66	93.36	89.32	**93.38**	**1.80**
		95.78	94.53	93.18	94.35	95.13		

401 Mix – PWL (By Lots)

9.5 mm Surface	$\bar{x}$	s	Q_U			Q_L			Total PWL
			USL	$Q_U = \frac{USL - \bar{x}}{s}$	PWL_U	LSL	$Q_L = \frac{\bar{x} - LSL}{s}$	PWL_L	
Air Voids n = 5	5.23	1.28	**6.40**			**3.60**			
Vbe n = 5	12.56	0.57	**13.5**			**11.0**			
Density (% Gmm) n = 10	93.38	1.80				**93.00**			

401 Mix – PWL (By Lots)

9.5 mm Surface	$\bar{x}$	s	Q_U			Q_L			Total PWL
			USL	$Q_U = \frac{USL - \bar{x}}{s}$	PWL_U	LSL	$Q_L = \frac{\bar{x} - LSL}{s}$	PWL_L	
Air Voids n = 5	5.23	1.28	**6.40**	0.91	81	**3.60**	1.27	91	72
Vbe n = 5	12.56	0.57	**13.5**	1.65	99	**11.0**	2.74	100	99
Density (% Gmm) n = 10	93.38	1.80				**93.0**	0.21	58	58

401 Mix – PWL (By Lots)

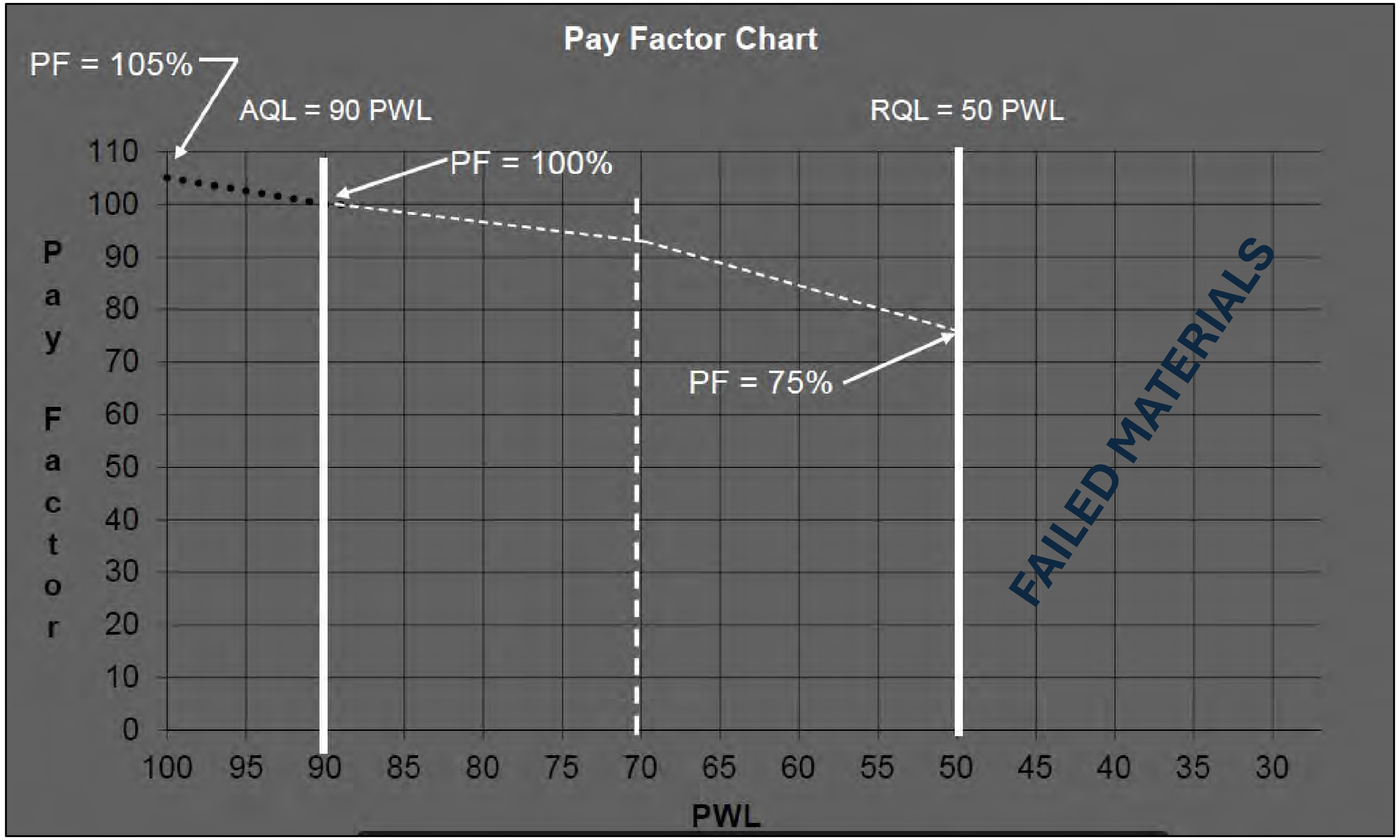
Air Voids		Vbe		Density		LCPF	QA Adjustment
PWL = 72		**PWL = 99**		**PWL = 58**			
PF	0.30 x PF	PF	0.35 x PF	PF	0.35 x PF		

401 Mix – PWL (By Lots)

Estimated PWL > 90:
PF = ((0.50 x PWL) + 55.00)/100

Estimated PWL > 70 and ≤ 90:
PF = ((0.40 x PWL) + 64.00)/100

Estimated PWL ≥ 50 and ≤ 70 :
PF = ((0.85 x PWL) + 32.5)/100



401 Mix – PWL (By Lots)

Pay Factors										
PWL	9	8	7	6	5	4	3	2	1	0
100	1.05									
90	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.01	1.01	1
80	1.00	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.96	0.96
70	0.96	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92
60	0.91	0.90	0.89	0.89	0.88	0.87	0.86	0.85	0.84	0.84
50	0.83	0.82	0.81	0.80	0.79	0.78	0.78	0.77	0.76	0.75

401 Mix – PWL (By Lots)

Lot Composite Pay Factor

$$LCPF = 0.30\,(PF_{VOIDS}) + 0.35\,(PF_{VBE}) + 0.35\,(PF_{DENSITY})$$

Air Voids		Vbe		Density		LCPF	QA Adjustment
PWL = 72		**PWL = 99**		**PWL = 58**			
PF	0.30 x PF	PF	0.35 x PF	PF	0.35 x PF	0.93	
0.93	0.279	1.05	0.368	0.82	0.287		

401 Mix – PWL (By Lots)

QA Adjustment ($) = L x U x (LCPF – 1.00) / MAF

L = Lot Quantity

U = Unit Price

LCPF = Lot Composite Pay Factor

QA ($) = 3000.00ton x $74.00/ton x (0.93 – 1.00) / 1.012

QA ($) = **- $15,355.73**

401 Mix – PWL (By Lots)

QA Adjustment ($) = L x U x (LCPF – 1.00) / MAF

L = Lot Quantity

U = Unit Price

LCPF = Lot Composite Pay Factor

Make sure you maintain the "+" or "–" sign within these parenthesis!

This will result in either a positive or negative QA Adjustment.

QA ($) = 3000.00ton x $74.00/ton x (0.93 – 1.00) / 1.012

QA ($) = **- $15,355.73**

401 Mix – PWL (By Lots)

HMA Pay Wizard

QA/Appeal Unified	Sample Date	Related Sample Id	Rep. Qty (Tons)	Mix % Binder	Mix Gmm	Pill 1 Gmb	Pill 2 Gmb	Pill Avg. Gmb	Core A Gmb	Core B Gmb
Sublot 1	08/22/2019	A194515524100	600.00	6.49	2.399	2.341	2.333	2.337	2.264	2.280
Sublot 2	04/08/2019	R194515524101	600.00	6.60	2.426	2.355	2.350	2.353	2.299	2.311
Sublot 3	04/09/2019	R194515524102	600.00	6.49	2.428	2.337	2.330	2.334	2.260	2.305
Sublot 4	04/09/2019	R194515524103	600.00	6.54	2.428	2.336	2.332	2.334	2.235	2.230
Sublot 5	04/09/2019	R194515524104	600.00	6.58	2.427	2.348	2.349	2.349	2.267	2.212

QA Adjustment **+$4,590.00**

Appeal Adjustment **$500.00**

Total Lot Quantity **3000 Tons**

INDOT T30 Detail

Mix Properties for Acceptance

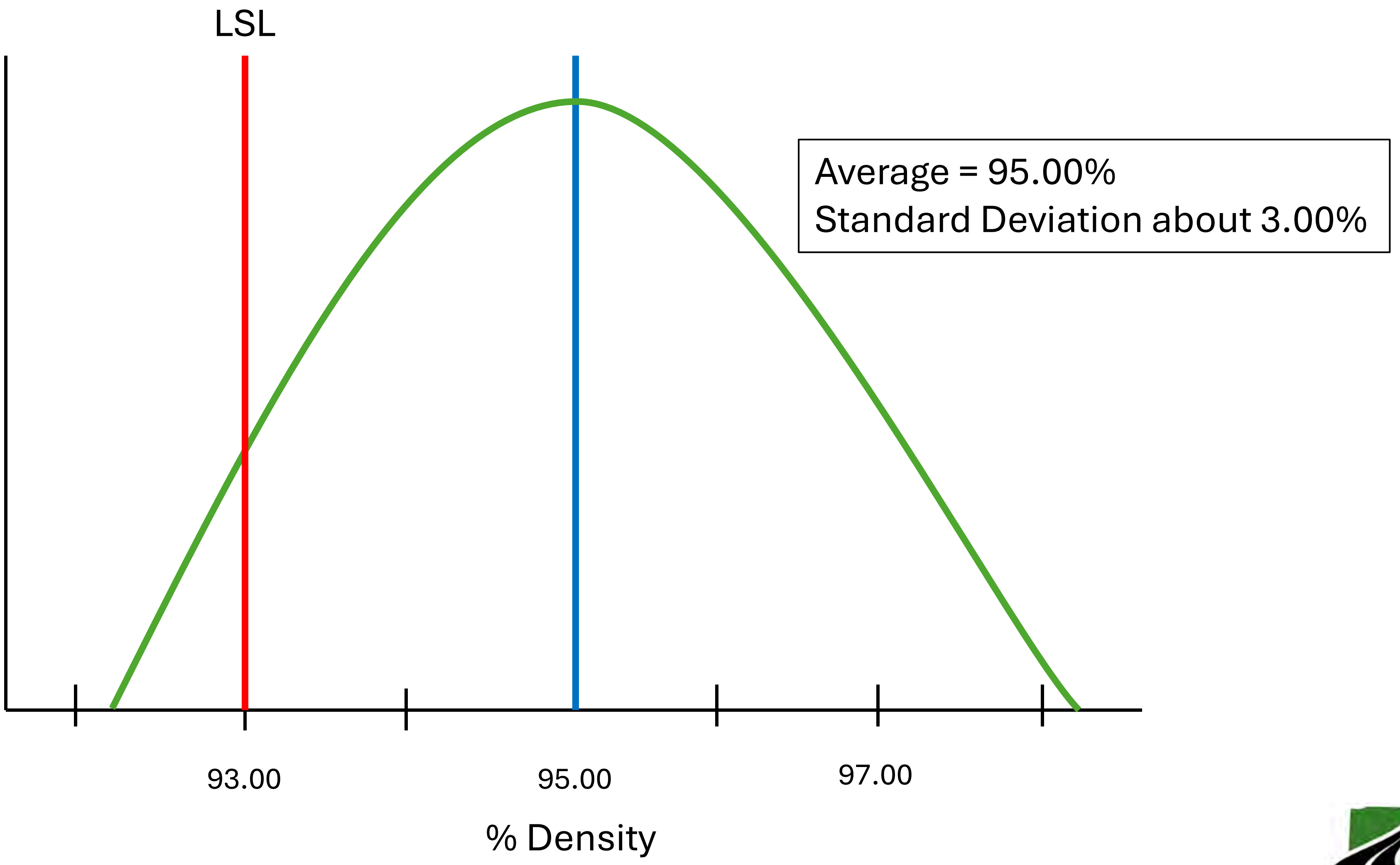
Acceptance Results and Pay Factors, Final

	Average	Sigma	N	Qu USL	Qu	PWLu	Ql LSL	Ql	PWLl	Total PWL	Pay Factor	LCPF
% Air Voids	3.31	0.65	5	5.40	3.22	100	2.6	1.09	86	86	0.98	1.02
% Vbe	12.21	0.55	5	13.50	2.35	100	11	2.2	100	100	1.05	
% Density	93.52	1.53	10	-	-	-	91	1.65	96	96	1.03	

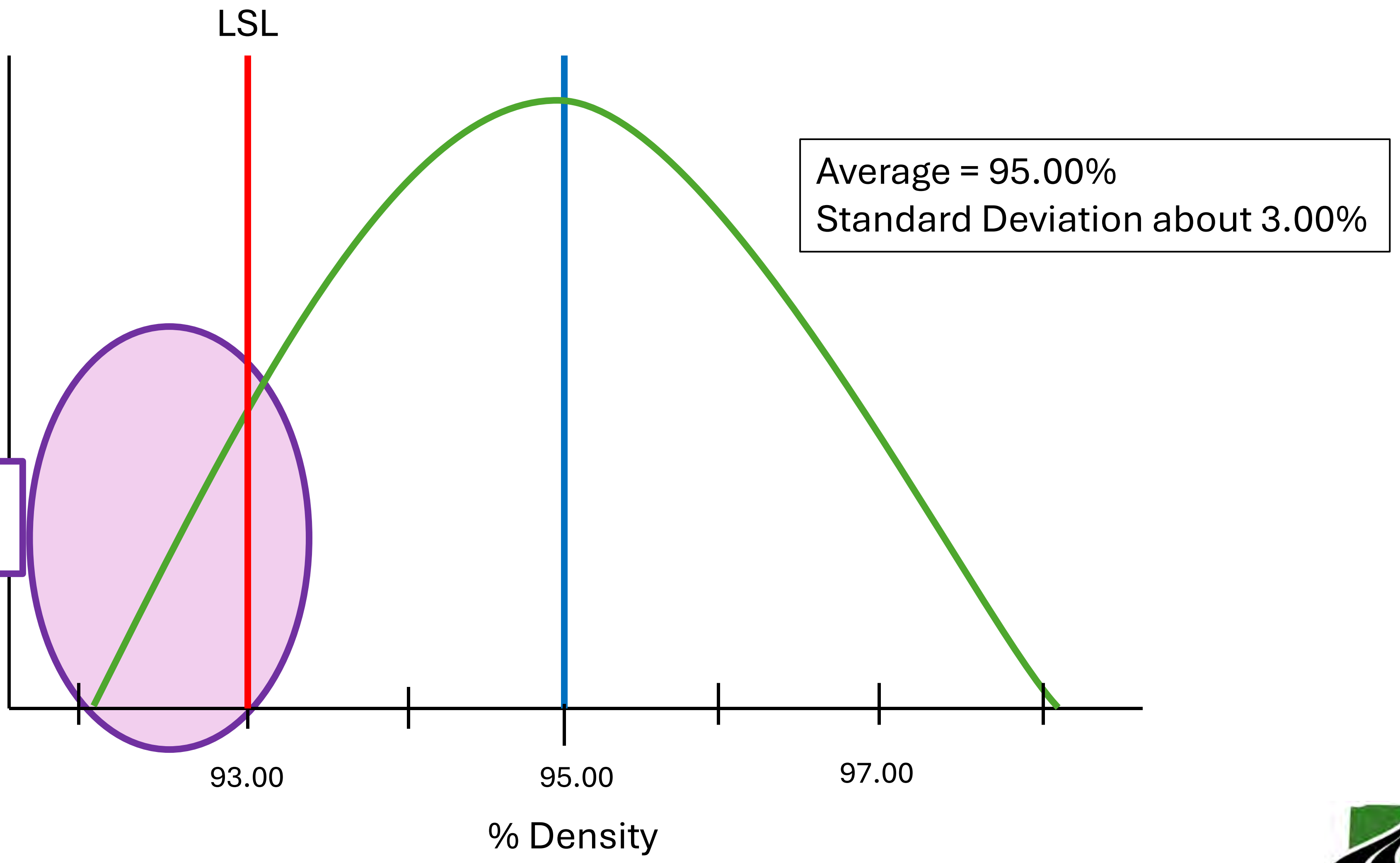
401 Mix – PWL

Now that you understand the math behind PWL, let's look at it conceptually...

PWL

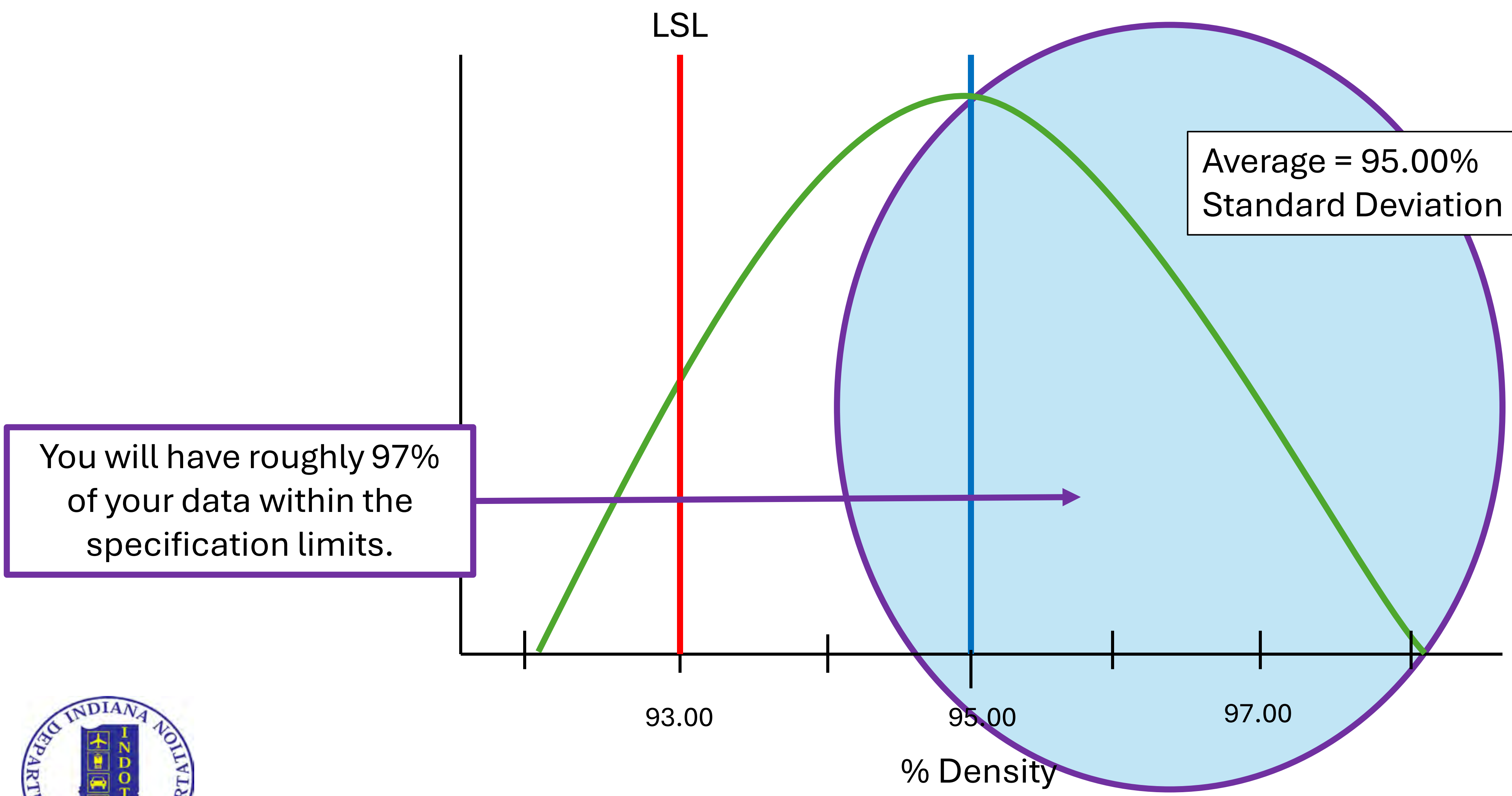

LSL
Average = 95.00%
Standard Deviation about 3.00%
93.00
95.00
97.00
% Density

PWL



Some of the data falls below the LSL

PWL

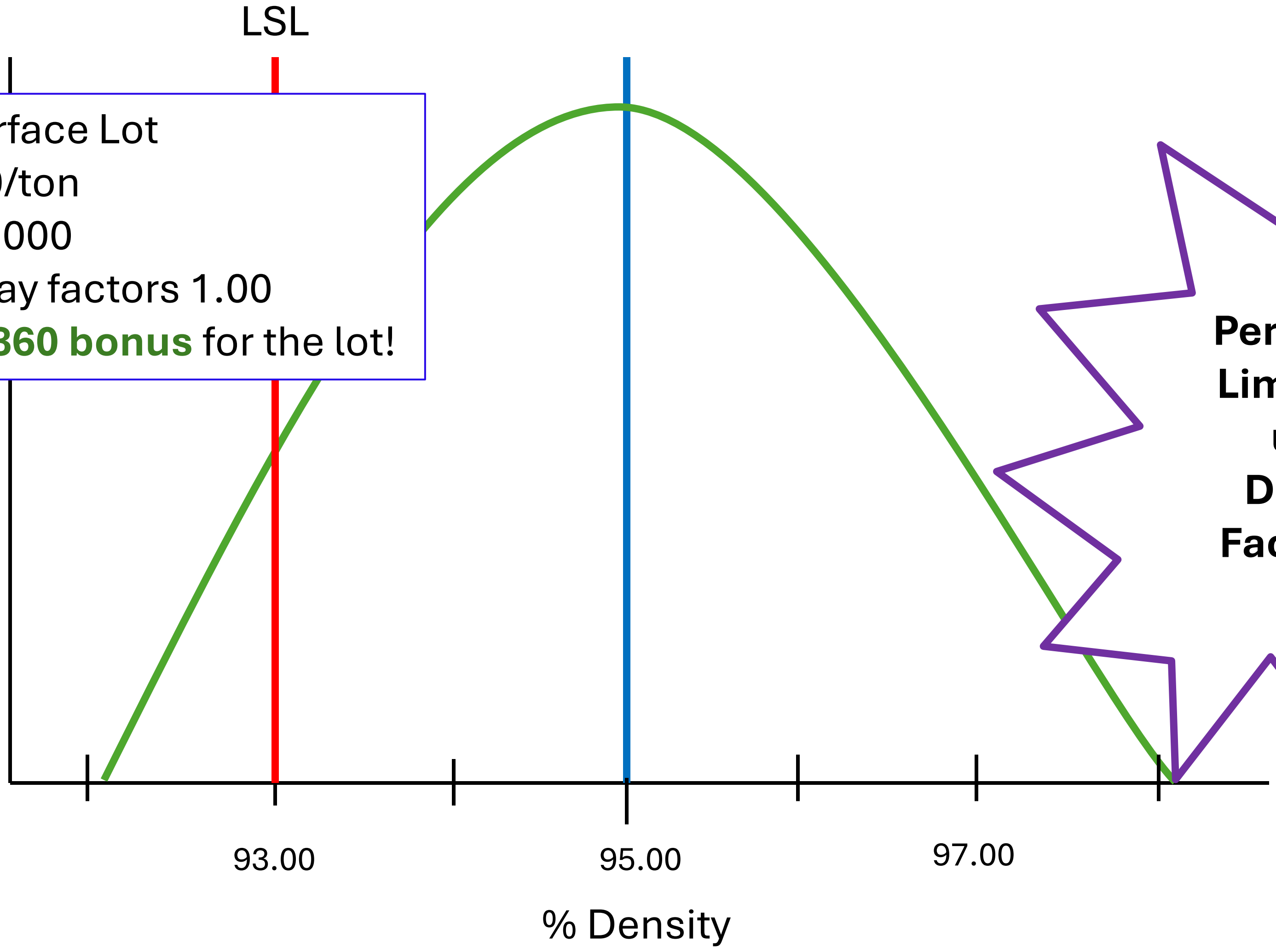

LSL
Average = 95.00%
Standard Deviation about 3.00%
You will have roughly 97% of your data within the specification limits.
93.00
95.00
97.00
% Density

401 Mix – PWL (By Lots)

Pay Factors										
PWL	9	8	7	6	5	4	3	2	1	0
100	1.05									
90	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.01	1.01	1
80	1.00	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.96	0.96
70	0.96	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92
60	0.91	0.90	0.89	0.89	0.88	0.87	0.86	0.85	0.84	0.84
50	0.83	0.82	0.81	0.80	0.79	0.78	0.78	0.77	0.76	0.75

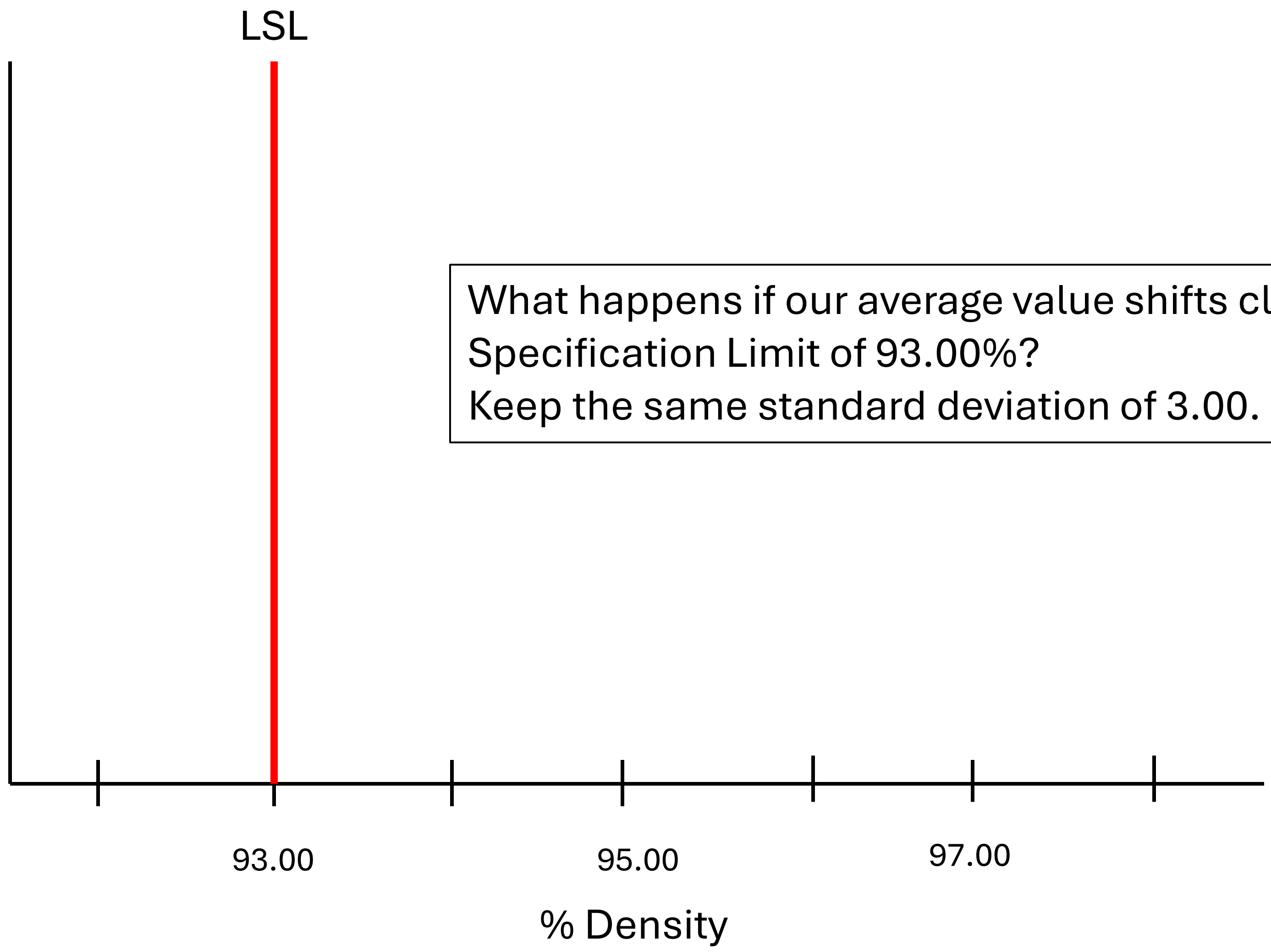
PWL

3,000 ton Surface Lot
At $80.00/ton
MAF = 1.000
Assume all other pay factors 1.00
For this mix, that's a **+$3,360 bonus** for the lot!



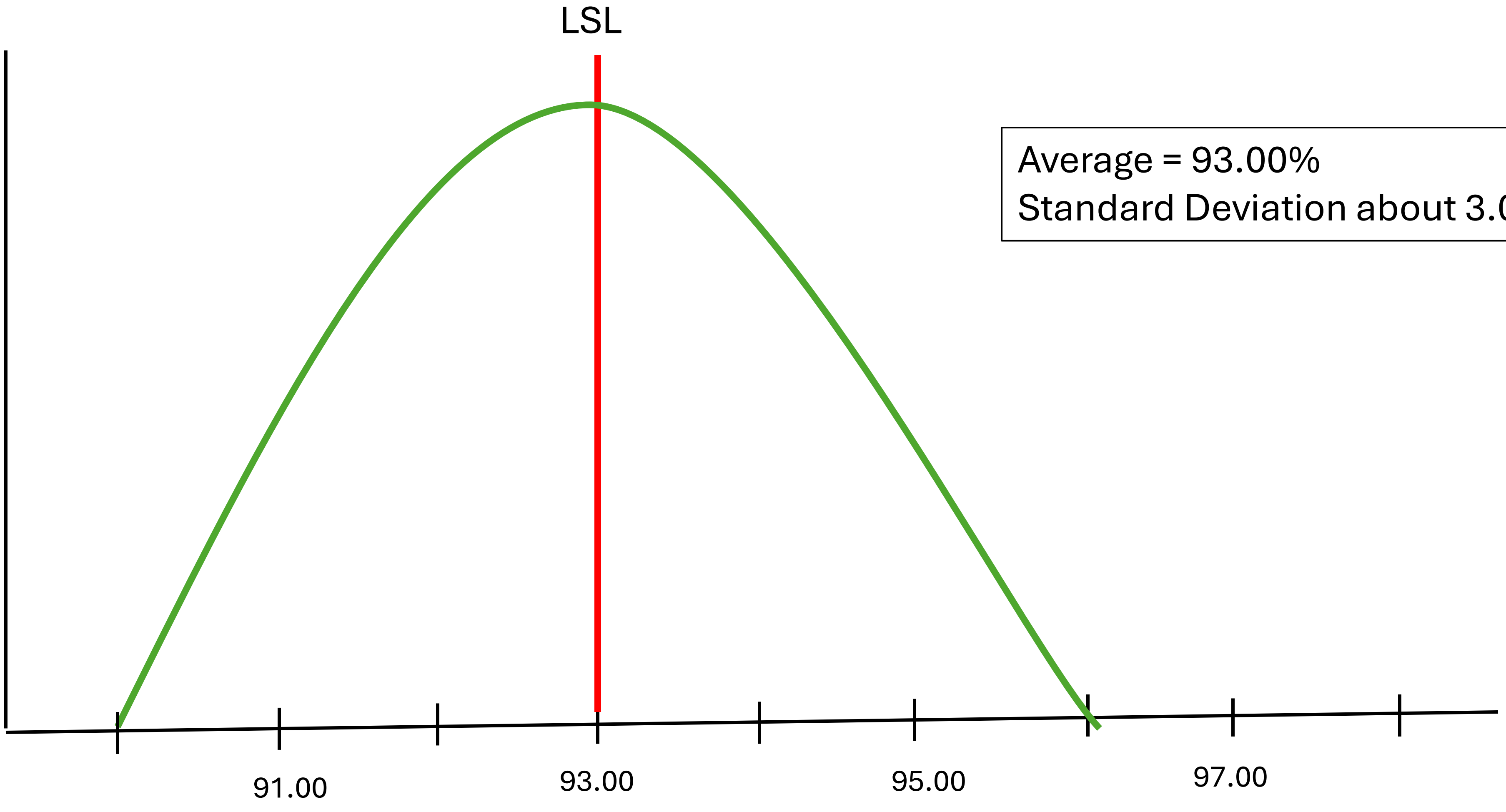
With 97 Percent Within Limits, we end up with a Density Pay Factor of 1.04!

PWL



What happens if our average value shifts closer to the Lower Specification Limit of 93.00%?
Keep the same standard deviation of 3.00.

PWL



INDOT
INDIANA DEPARTMENT OF TRANSPORTATION

APAI
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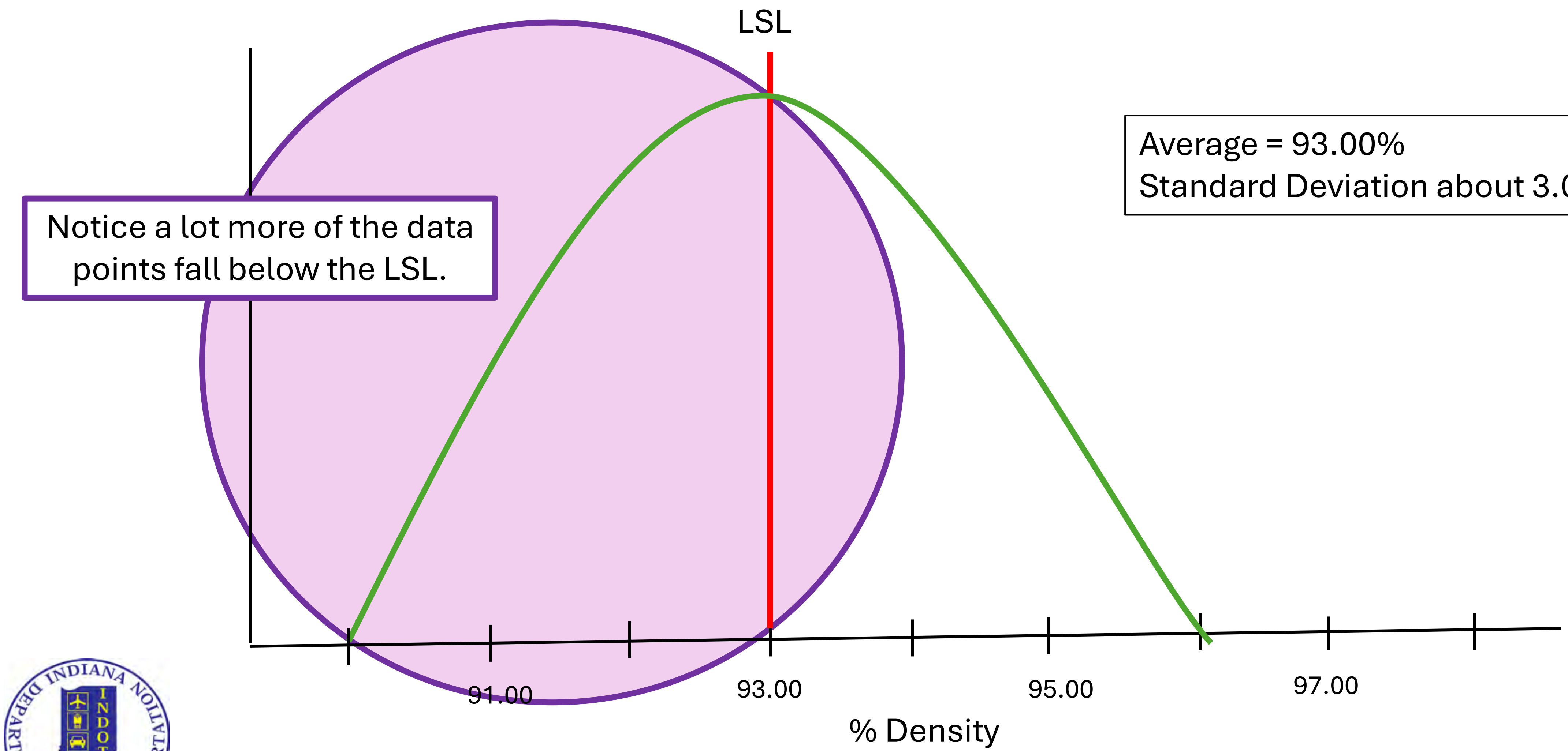
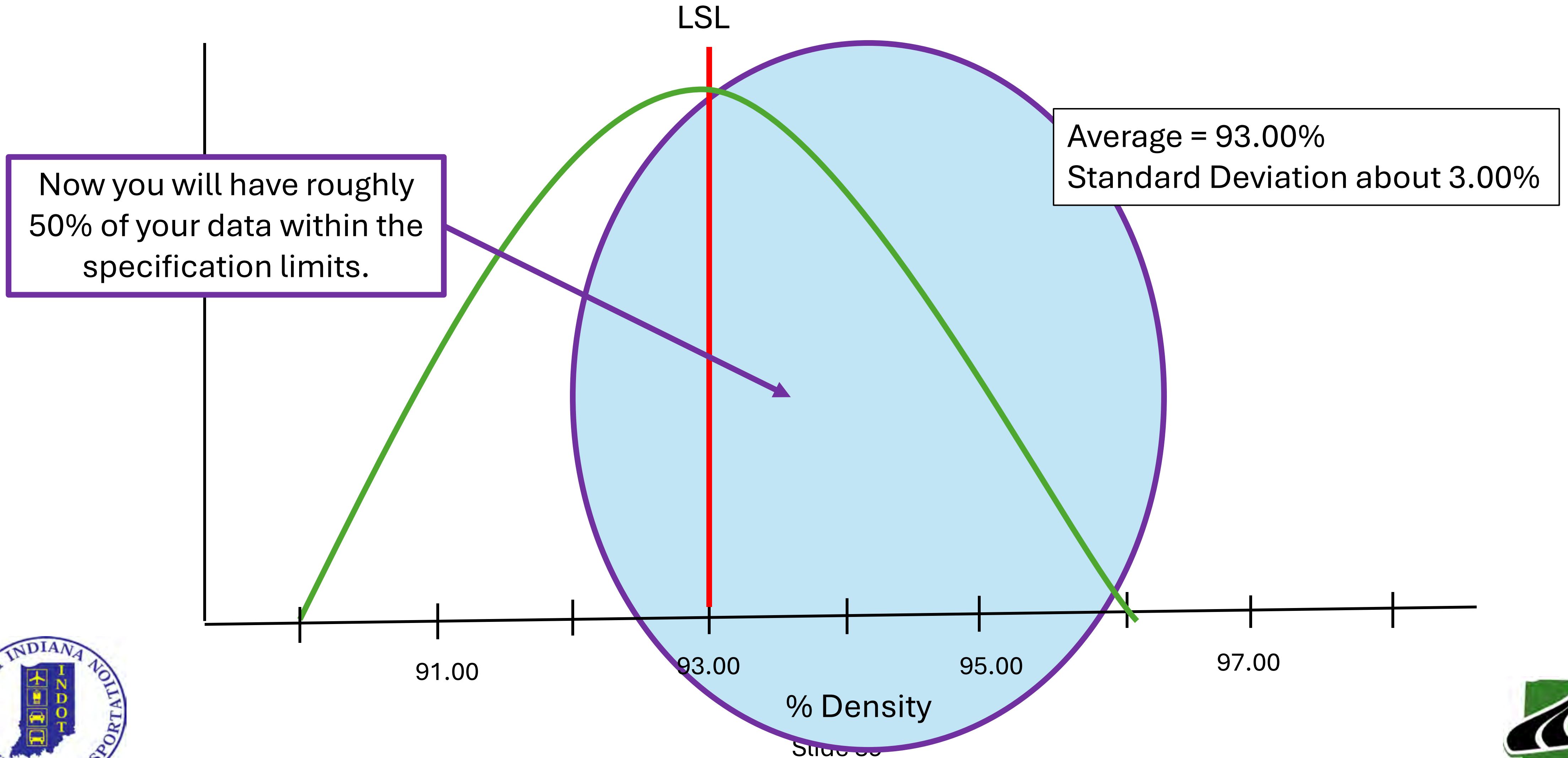
PWL


LSL
Notice a lot more of the data points fall below the LSL.
Average = 93.00%
Standard Deviation about 3.00%
91.00
93.00
95.00
97.00
% Density

PWL

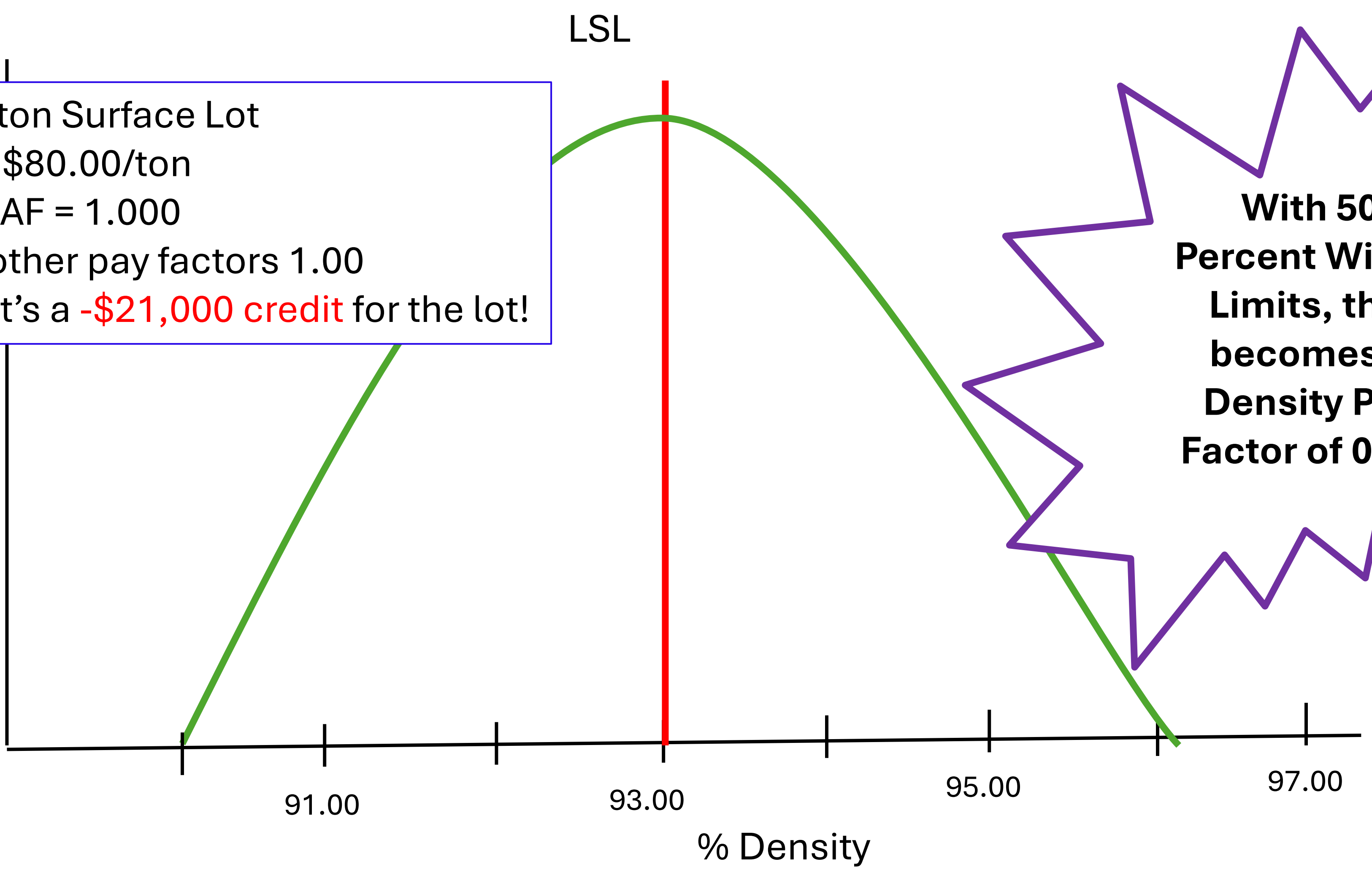

LSL
Now you will have roughly 50% of your data within the specification limits.
Average = 93.00%
Standard Deviation about 3.00%
91.00
93.00
95.00
97.00
% Density

401 Mix – PWL (By Lots)

Pay Factors										
PWL	9	8	7	6	5	4	3	2	1	0
100	1.05									
90	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.01	1.01	1
80	1.00	0.99	0.99	0.98	0.98	0.98	0.97	0.97	0.96	0.96
70	0.96	0.95	0.95	0.94	0.94	0.94	0.93	0.93	0.92	0.92
60	0.91	0.90	0.89	0.89	0.88	0.87	0.86	0.85	0.84	0.84
50	0.83	0.82	0.81	0.80	0.79	0.78	0.78	0.77	0.76	0.75

PWL

3,000 ton Surface Lot
At $80.00/ton
MAF = 1.000
Assume all other pay factors 1.00
For this same mix, that's a -$21,000 credit for the lot!



With 50 Percent Within Limits, this becomes a Density Pay Factor of 0.75!

410 Mix – Stone Matrix Asphalt (Adjustment Points) 410.19

SMA is accepted by 3 main properties

- Aggregate Gradation
- Binder Content
- Density

410 Mix – SMA (Adjustment Points)

410.19 of the specifications

ADJUSTMENT POINTS FOR GRADATION								
Adjustment Points	Sieve Size							
	25.0 mm	19.0 mm	12.5 mm	9.5 mm	4.75 mm	2.36 mm	600 µm	75 µm
For each 0.1% up to 1.0% out of tolerance	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3
For each 0.1% > 1.0% out of tolerance	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.6

ADJUSTMENT POINTS FOR RANGE	
Sieve Size and Binder Content	Adjustment Points (For each 0.1% out of range)
2.36 mm	0.1
600 µm	0.1
75 µm	0.1
% Binder	1.0

DENSITY	
Percentages are based on % MSG	Pay Adjustments – Percent
> 97.0	Submitted to the Office of Materials Management*
93.0 – 97.0	0.00
92.0 – 92.9	0.20 points for each 0.10% below 93.0
91.0 – 91.9	2.00 + 0.40 points for each 0.10% below 92.0
89.0 – 90.9	6.00 + 1.00 points for each 0.10% below 91.0
≤ 89.0	Submitted to the Office of Materials Management*

* Test results will be considered and adjudicated as a failed material in accordance with normal Department practice as listed in 105.03.

410 Mix – SMA (Adjustment Points) 410.19

QA Adjustment ($) = (L x U x P/100) / MAF

L = Lot Quantity

U = Unit Price

P = total adjustment points

Example:

Lot Quantity = four 600 ton sublots = **2,400 tons**

Unit Price = **$69.00** / ton

MAF = **1.124**

total adjustment points = **4.0**

410 Mix – SMA (Adjustment Points) 410.19

Lot Quantity = four 600 ton sublots = 2,400 tons
Unit Price = $69.00 / ton
MAF = 1.124
total adjustment points = 4.0

QA ($) = 2,400.00 tons x $69.00 per ton x (4.0/100) / 1.124

*QA ($) = **$5,893.24**

*There are no bonuses with SMA, so any adjustment points means a credit to the contract ($ to INDOT)

410 Mix – SMA (Adjustment Points) 410.19

Lab Test #									
Sublot No.	1	2	3	4					
Ton Sampled	600	600	600	600					
Sieve Size % CAA & % Binder	Test 1 % Passing	Test 2 % Passing	Test 3 % Passing	Test 4 % Passing	Average Value	Required By DMF/JMF Mass	Accept Tolerance Low	Accept Tolerance High	Adjust Points
25.0 mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
19.0 mm	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	
12.5 mm	100.0	100.0	100.0	100.0	100.0	100.0	98.0	100.0	
9.5 mm	88.8	89.3	90.2	90.0	89.6	89.1	70.0	95.0	
4.75 mm	40.3	41.1	41.4	39.3	40.5	40.0	30.0	50.0	
2.36 mm	24.2	25.1	24.5	23.9	24.4	25.5	21.5	29.5	
600 µm	16.2	16.6	15.8	16.2	16.2	16.5	14.5	18.5	
75 µm	10.1	10.3	9.9	10.1	10.1	10.0	8.5	11.5	
% CAA							95	100	
% Binder	5.1	5.7	5.8	5.3	5.5	5.9	5.6	6.2	4.0
							Adjustment Points		4.0

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
MSG	2.823	2.801	2.795	2.813
$BSG_{Core\ 1}$	2.636	2.595	2.664	2.639
$BSG_{Core\ 2}$	2.567	2.642	2.545	2.704
BSG_{avg}	2.602	2.619	2.605	2.672
$Density_{\%Gmm}$	92.2	93.5	93.2	95.0

Sieve Size & % Binder	Actual Range Max	Actual Range Min.	Actual Range Difference	Allowable Range	Adjust. Points
2.36 mm	25.1	23.9	1.2	12.0	
600 µm	16.6	15.8	0.8	6.0	
75 µm	10.3	9.9	0.4	2.0	
% Binder	5.8	5.1	0.7	1.0	
			Adjustment Points		0.0

Notes

Density					
Sublot 1	Sublot 2	Sublot 3	Sublot 4	Average Density	Adjust. Points
92.2	93.5	93.2	95.0	93.5	
					0.0

Excel Workbook

Total Adjustment Points	4.0
Total Pay Factor	0.960
Credit	-5893.24

ASPHALT PAVEMENT ASSOCIATION of INDIANA

Open Graded Mix – single sublot 401.19(b)

Sublot Composite Pay Factor

$$SCPF = 0.20\ (PF_{BINDER}) + 0.35\ (PF_{VOIDS}) + 0.45$$

$$SCPF = 0.20\ (\mathbf{1.04}) + 0.35\ (\mathbf{1.00}) + 0.45$$

$$SCPF = 1.008$$

SCPF = 1.01

Open Graded Mix – single sublot 401.19(b)

LOT OG3 SUMMARY

STATE - ACCEPTANCE TEST RESULTS

Property		Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
Test Date		8/2/18	8/2/18	8/8/18	8/8/18	9/6/18
LabTest # Prefix		R1823805	R1823805	R1823805	R1823805	R1823805
Lab Test Mix #		18631	18632	18633	18634	18635
Quantity		1000.00	1000.00	1000.00	1000.00	1000.00
Mix	% Binder	3.85	3.81	3.86	3.83	3.91
Mix	MSG	2.507	2.545	2.592	2.596	2.570
Pill 1	BSG	2.101	2.098	2.185	2.158	2.194
Pill 2	BSG	2.109	2.116	2.183	2.157	2.214
Pill Avg	BSG	2.105	2.107	2.184	2.158	2.204

STATE - GRADATIONS (% PASSING)

Sieve Size	DMF	Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
37.5 mm	100.0	100.0	100.0	100.0	100.0	100.0
25.0 mm	100.0	100.0	100.0	100.0	100.0	100.0
19.0 mm	95.6	94.4	97.0	96.8	94.4	93.9
12.5 mm	65.4	56.8	66.5	65.0	61.2	64.4
9.5 mm	48.3	42.0	51.3	52.1	47.9	51.2
4.75 mm	24.9	23.0	27.8	28.7	25.7	29.1
2.36 mm	16.3	16.7	17.8	16.7	15.9	18.0
1.18 mm	11.0	12.4	12.3	11.4	11.1	12.2
600 µm	7.7	9.8	9.5	8.6	8.4	9.1
300 µm	6.0	8.3	8.0	7.2	7.0	7.5
150 µm	4.7	7.0	6.8	6.1	5.9	6.2
75 µm	3.6	5.4	5.2	4.7	4.5	4.7

STATE - MIX PROPERTIES ACCEPTANCE

Property	Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
% Binder	3.85	3.81	3.86	3.83	3.91
% Air Voids	16.04	17.21	15.74	16.87	14.24
% VMA	23.57	23.46	20.71	21.63	20.02
% Vbe	7.53	6.25	4.97	4.75	5.78
% Pbe	3.69	3.06	2.34	2.27	2.70

MIX DEVIATIO N

Property	Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
% Air Voids	1.3	0.1	1.6	0.4	3.1
% Binder	0.4	0.4	0.3	0.4	0.3

Pay Factors	Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
Air Voids	1.00	1.05	1.00	1.05	0.98
Binder	1.02	1.02	1.04	1.02	1.04
SCPF	1.00	1.02	1.01	1.02	1.00
Adjustment $	$0.00	$720.00	$360.00	$720.00	$0.00
		Bonus	Bonus	Bonus	

Report	ORIGINAL

CONTRACT INFORMATION

Contract	
Contractor	
Plant Loc.	
Plant No.	
Plant Tech.	
District	
Route	
P.E./P.S.	

DMF/JMF INFORMATION

Factor	Value
DMF Number	
Mix Designat	
Course	Intermediate
Application	Mainline
% Binder Act	4.20
% Air Voids @	17.30
% VMA @ Nd	n/a
Agg Blend G	2.648
Gmb @ Ndes	2.115
Gmm	2.557
Material Code	401m34561

Signature Technician:

Adjustment Factors	
Unit Cost	$36.00
MAF	1.000

Excel Workbook

QA Adjustment ($) = L x U x (SCPF – 1.00) / MAF

QA ($) = 1000.00 tons x $36.00 x (1.01 – 1.00) / 1.000

QA ($) = $360.00

Pay Factors	Sublot 3
Air Voids	1.00
Binder	1.04
SCPF	1.01
Adjustment $	$360.00

402 Mix – (Certification)

401.09 of the Standard Specifications:

"Acceptance of mixtures for binder content and air voids at N_{des} will be based on a type D certification in accordance with **402.09** for dense graded mixtures with **original contract pay item quantities less than 300 t."**

402.09 of the Standard Specifications:

"Acceptance of mixtures will be in accordance with the Frequency Manual on the basis of a type D certification in accordance with 916. The test results shown on the certification shall be the quality control tests representing the material supplied and include air voids and binder content. **Air voids tolerance shall be ± 2.0%** and **binder content tolerance shall be ± 0.7% from DMF**."

402 Mix – Type D Certification

INDIANA DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT (HMA) TYPE D CERTIFICATION

CONTRACT NUMBER R-54321 DATE 05/05/18

CERTIFIED HMA PRODUCER Awesome Construction Company

CERTIFIED HMA PLANT NUMBER 1234 DMF NUMBER 181234

PG BINDER SOURCE Asphalt Supplier PG BINDER GRADE 64-22

MIXTURE TYPE AND SIZE Surface 9.5mm

DESIGN ESAL Cat 2

Air Voids 5.0 (from DMF) Binder Content 5.7 (from DMF)

This is to certify that the test results for Air Voids and Binder Content represent the HMA mixture supplied to this contract.

Air Voids 5.1 (±2.0 % from DMF) Binder Content 5.2 (± 0.7% from DMF)

* [ ] Test results are not available for submittal. A production sample shall be taken within the first 250 t (250 Mg) and each subsequent 1000 t (1000 Mg) for base and intermediate mixtures and each subsequent 600 t (600 Mg) for surface mixtures.

* ✓ If Applicable

Signature of Level 1 or Certified Asphalt Technician

Nathan Awwad

Printed Name

INDIANA DEPARTMENT OF TRANSPORTATION INDOT

APAI ASPHALT PAVEMENT ASSOCIATION of INDIANA

Dispute Resolution (Appeals)

- What if the QC results are different than INDOT's QA test results?
- A request for dispute resolution shall be submitted within seven calendar days of receiving the results from INDOT by the Contractor.

Dispute Resolution (Appeals)

- QC/QA HMA and OG
  - The contractor may dispute the binder content, Gmm, Gmb of pills, or Gmb of core(s) by sublot .
  - QC and QA results must differ by at least one of the following:
    - Binder greater than 0.25
    - Gmm is greater than 0.10
    - Gmb of pills is greater than 0.10
    - Gmb of the density core is greater than 0.20
  - Contractor can request cores to be exempted from a dispute of the mix properties if both QC and QA density values are greater than 93.00%
  - There is a $500 credit to the contract for each sublot disputed where the results did not improve overall pay of the sublot or entire lot for PWL acceptance.

Dispute Resolution (Appeals)

- SMA
  - The contractor may dispute one or more of the following test for each sublot:
    - Binder content
    - Gradation
    - Gmm
    - Gmb of density cores
  - No tolerances or $500 credit for SMA appeals

Failed Materials – Directive 112

- Failed Materials
  - This is an acceptance test noted in the specification as "Submitted to Division of Materials and Tests"
  - A "pink sheet" will be sent by the District office to the Contractor and PEMS. The PEMS will fill out the appropriate information and return to the District office.
  - Once this additional contract information is provided, the matter is handled by one of two means, depending on the degree of failure:
    1. District resolution in accordance with Directive 112
       - When PWL is 49 to 27
       - Single sublot
         - Air Void deviation from 2.1 to 3.0%
         - Vbe from +3.1 to +3.5%, or more than -2.0%
         - Density from 89.0 to 89.9%, 98.0 to 98.9%
    2. Resolution by Failed Material Committee (FMC)
       - Beyond District resolution limits
       - Based on Engineering Judgment from the committee members

Failed Materials – Directive 112

- The Division of Materials and Tests, Contractor, District, and PEMS receive copies of the Failed Material resolution letter.
- If the Contractor disagrees with the initial resolution, they may dispute the decision within 15 days of the notification date for the Failed Material.
- The Failed Committee consists of:
  - Director, Division of Materials and Tests, Chair
  - State Materials Engineer – voting member
  - State Construction Engineer – voting member
  - A representative from Pavement or Bridge Asset Management – voting member
  - A representative from Design – voting member
  - Chief Engineer of Construction – only in the event of an appeal
  - FMC Coordinator

Chapter 13

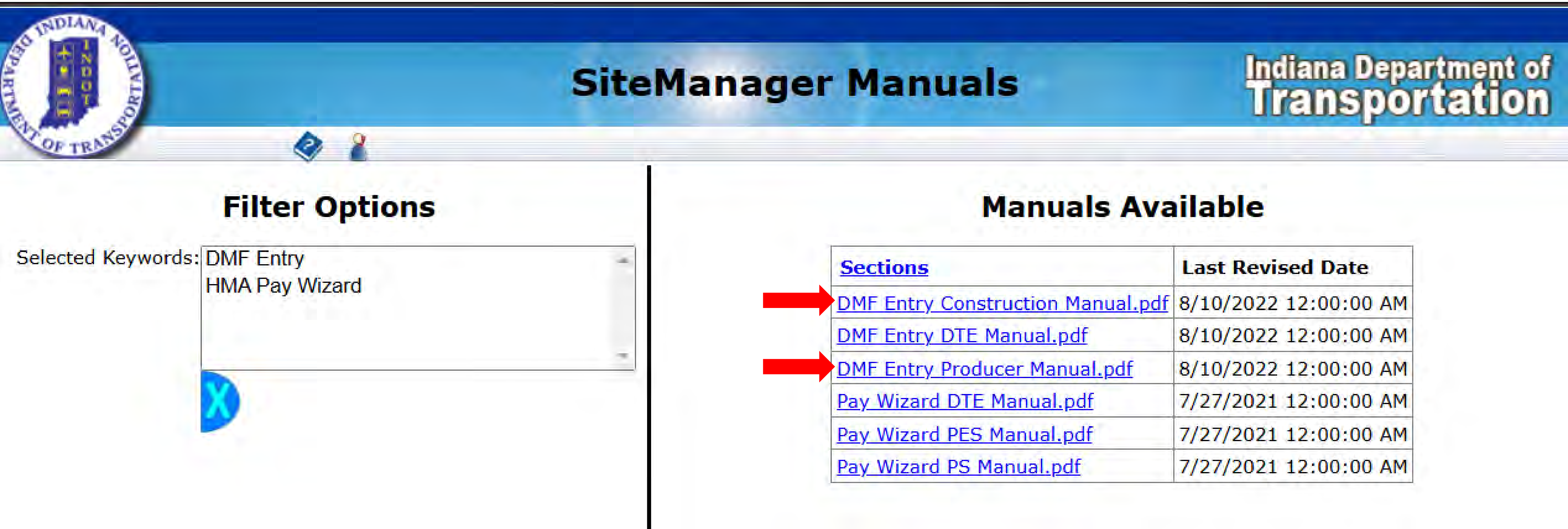
ITAP

INDOT Certified Asphalt Technician Course

Presented by: Nathan Awwad, INDOT and Brad Cruea, Milestone

User Manuals

- User manuals
- https://erms12c.indot.in.gov/sitemanagermanuals/



Sections	Last Revised Date
DMF Entry Construction Manual.pdf	8/10/2022 12:00:00 AM
DMF Entry DTE Manual.pdf	8/10/2022 12:00:00 AM
DMF Entry Producer Manual.pdf	8/10/2022 12:00:00 AM
Pay Wizard DTE Manual.pdf	7/27/2021 12:00:00 AM
Pay Wizard PES Manual.pdf	7/27/2021 12:00:00 AM
Pay Wizard PS Manual.pdf	7/27/2021 12:00:00 AM

Accessing the Application via ITAP

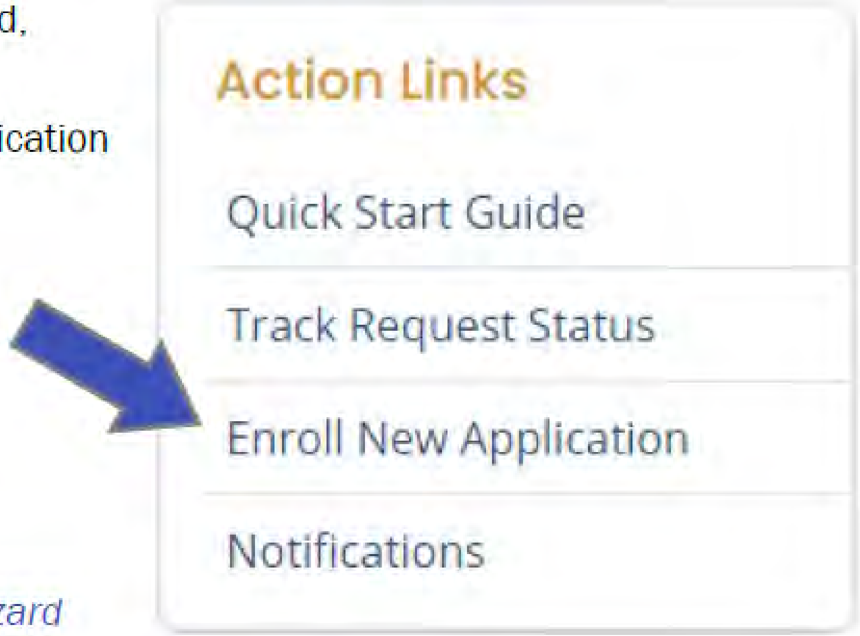
1. Registering for ITAP

ITAP (INDOT Technical Application Pathway) is accessed by going to https://itap.indot.in.gov with an approved browser, namely Edge, Chrome, or Firefox. INDOT personnel are automatically registered for Access Indiana and assigned an ITAP account. External users must register for Access Indiana and ITAP manually. If you have already registered, you may proceed to enrollment.

2. Enrolling in the HMA Pay Wizard app

To enroll in an ITAP application:

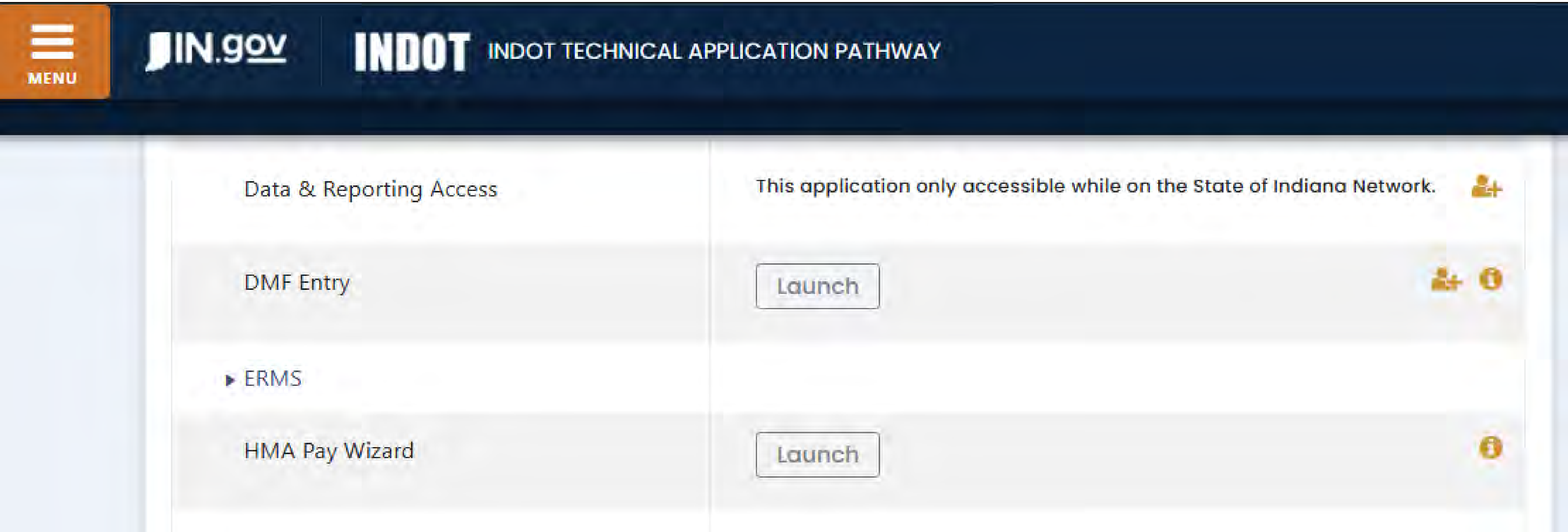
1. From the ITAP home screen, on the Action Links card, select *Enroll New Application*.
2. Navigate to and select *HMA Pay Wizard* on the Application Enrollment page, then hit Next >.
3. Select your role from the list, then hit Submit.
4. Your ITAP Administrator will have to approve your access to *HMA Pay Wizard*. You can track the progress of your application request by selecting *Track Request Status* on the Action Links card.



Upon approval, access the app by scrolling to *HMA Pay Wizard* and selecting Launch.

ITAP

- **I**NDOT **T**echnical **A**pplication **P**athway
- https://itap.indot.in.gov/Dashboard



Design Mix Formulas (DMFs)

- Shall be in accordance with 401.05, 402.05 or 410.05
- DMFs must come from an INDOT Approved Mix Design Laboratory
- All mix must be produced at an INDOT Certified HMA Plant
- Online system “DMF ENTRY”

Design Mix Formulas (DMFs)

- QC responsibilities
  - Creating and entering new DMF
  - Submitting new DMF for review by INDOT
  - Assigning DMF to contracts and items as applicable
    - Note: DMFs cannot be added unless the item is applicable
    - Verify any change order items have been added to the contract with the PEMS
- QA responsibilities
  - Reviewing and assigning INDOT mix design numbers by the District
- Demonstration

Field Assistant/SiteManager

- Field Assistant HMA Tracker used for HMA Paving on contracts
  - Programmatically determines test locations
  - Payments are made on tons delivered (MAF adjusted)
  - 530s are auto-submitted and payment is made when the Daily is synced

- SiteManager 530s
  - Contract Item & Represented quantity are required and District Testing ***must*** be contacted with the Sample ID (R-number) and DMF

Field to Hub

- Plate samples and cores are taken by the INDOT representative on site, marked with the Sample ID
- When all samples have been taken for a sublot, Construction is to contact District Testing to coordinate for pickup.
  - Waiting for too long to contact District Testing extends the total testing time for the sublot
- QC sample data may be entered into the HMA Pay Wizard at this point ***only*** if Field Assistant was used to enter the sample data. Otherwise, QC data can be entered after the District Support ticket is requested.
  - **Note: This can take up to several days. QC testing is typically done the same day or within 2 days so you will need to go back and enter the QC data**

At the Hub

- Samples arrive at the District HMA hub
- District Testing personnel are to check:
  - Is the sample complete?
  - Is the sample ID (R-number) in SiteManager?
  - Is the DMF (mix ID) in SiteManager?
- Sample information is entered into shipment log
- Box/cylinder labels are printed
- Testing labs are notified
- Labs pickup samples
- Backup samples (if appealed) are retained at the hub

At the Testing Lab

- Samples arrive at the lab and are checked immediately with data received.
- Verify DMF in the system matches what is on the label.
- Conduct testing. The DMF selection at check-in shows mix specific criteria, like dry-back etc.
- Once all tests are complete, samples are approved for Pay Wizard.
  - Note: Only the QC person that entered the QC data will receive notification when testing is complete for that sublot.
  - If testing is complete and no QC data has been entered, the person that submitted the DMF for that sublot will receive notification of complete testing.
- When the appeal window is opened, the Contractor can request a test to be re-run using backup plates or cores.
  - Properties that can be appealed per the specification will be highlighted in green.

At the Testing Lab

- Appeal requests and appeal results are final.
- PWL lots should be appealed once all sublots original testing has completed.
- Any questions should be directed to the District Testing for that contract.

HMA Pay Wizard

- QC responsibilities
  - Enter QC results   Sample Id (R-number) is very important
  - Assign correct Lot and sublot
  - Designate a Lot as complete
  - Decide whether to accept results or appeal the Lot/sublot
- QA responsibilities
  - Enter test results into Paywizard
  - Fix anything "stuck"
  - Copy QA to QC
  - ommtesting@indot.in.gov
- Demonstration

HMA Pay Wizard

Summary

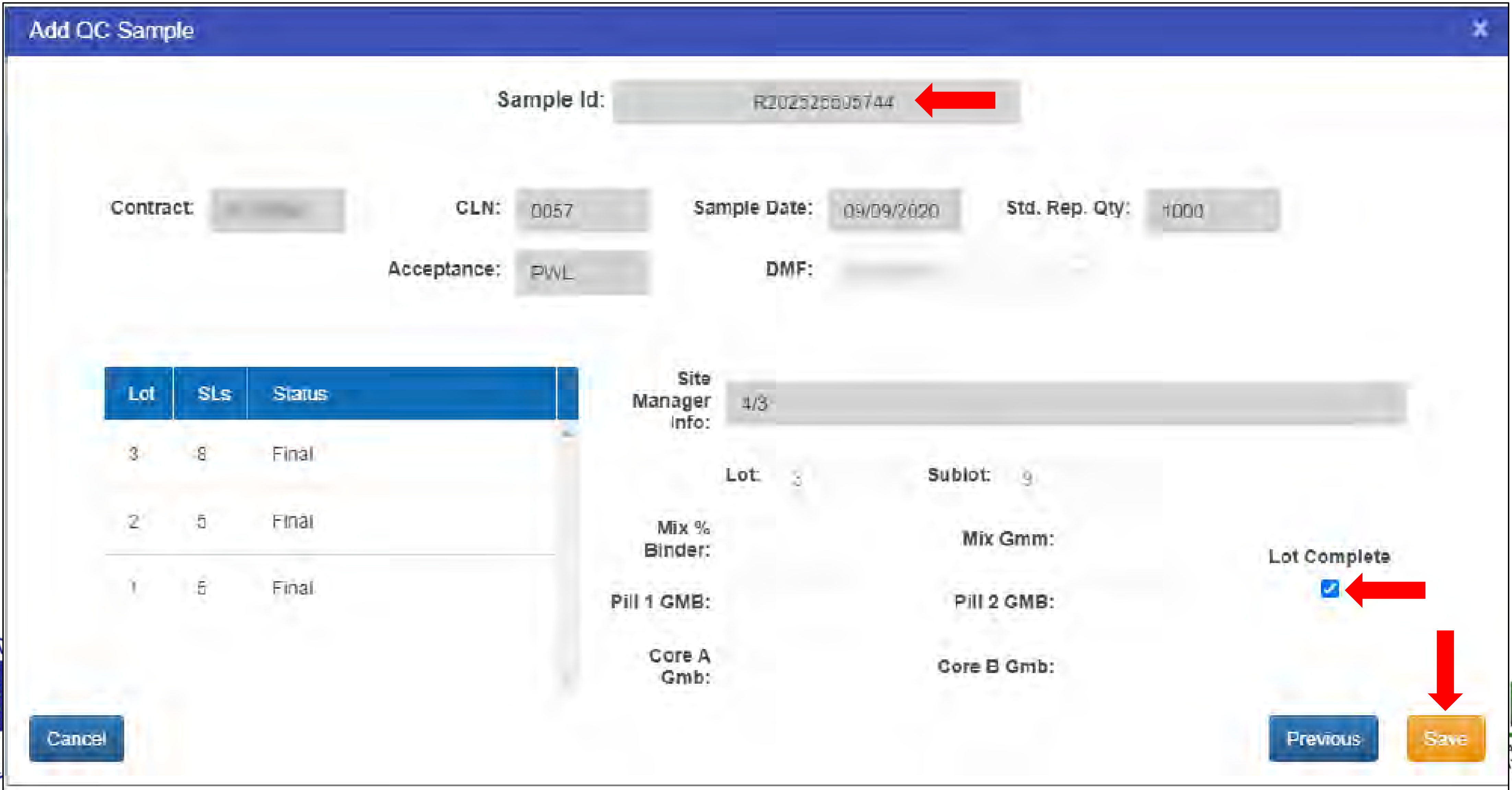
Add Sample

Search for Contract...

Contract Number

CLN	Lot	SLs	Acceptance By	DMF	Status	Last Updated
0033	1	5	PWL	[illegible]	Complete	08/14/2020
0033	2	3	PWL	[illegible]	Appeal Window Open	08/14/2020
0031	2	5	PWL	[illegible]	Final Results Pending	07/16/2020
0031	1	5	PWL	[illegible]	Final Results Pending	07/16/2020
0031	3	1	PWL	[illegible]	Not Complete	07/13/2020
0032	1	6	PWL	[illegible]	Final Results Pending	07/02/2020

HMA Pay Wizard



HMA Pay Wizard

QA/QC Δ	Mix % Binder	Mix Gmm	Pill Avg. Gmb	Core A Gmb	Core B Gmb	Appeal	Accept Results	Status
Sublot 1	0.56	0.009	0.005	0.000	0.005	Appeal	Accepted	
Sublot 2	0.34	0.031	0.006	0.036	0.014	Appealed	Accept	
Sublot 3	0.31	0.021	0.013	0.005	0.015	Appeal	Accepted	
Sublot 4	0.19	0.002	0.013	0.038	0.138	Appeal	Accept	
Sublot 5	0.42	0.005	0.006	0.004	0.004	Appeal	Accept	
Sublot 6	0.24	0.016	0.018	0.034	0.005	Appeal	Accepted	
Sublot 7	0.08	0.003	0.003	0.003	0.001	Appeal	Accepted	

ASPHALT PAVEMENT ASSOCIATION of INDIANA

HMA Pay Wizard

PWL acceptance; Lot 2 and Sublot 5 Results Available. Contract R -42253, DMF 243363017 0037

OMMTesting@indot.in.gov

To Brad.Cruea; INDOT District 01 Testing; INDOT Ommtesting

Reply | Reply All | Forward

Tue 11/26/2024 9:15 AM

Lot 2 and Sublot 5 for R -42253 has results available in HMA Pay Wizard. The appeal window has begun and ends 12/03/2024 at 11:59pm. R -42253 243363017 Lot 2 and Sublot 5 Crawfordsville 0037 R241507640144 R241507640143 R241507640142 R241507640145

Quality Adjustment; Lot 1 Available. Contract R -42619, DMF 243353008, 0043

OMMTesting@indot.in.gov

To Brent, Jeff; INDOT District 04 Testing

Cc INDOT Ommtesting

Reply | Reply All | Forward

Tue 11/26/2024 3:15 PM

Lot 1 for R -42619, 0043 testing has completed. More information can be found in HMA Pay Wizard. R -42619 243353008 Lot 1 LaPorte 0043

HMA Pay Wizard

- Demonstration

HMA Pay Wizard – FAQs

- The Sample ID is not working for QC data entry
  - Ensure the correct ID is entered and it matches the sample box from the field
  - Data may be incomplete. DMF or contract association may be missing.
- QC data was entered incorrectly and needs to be changed.
  - Contact District Testing with the Sample ID and what needs to be corrected.
- Need to extend a lot or mark a lot complete.
  - Contractor needs to mark whether a lot is completed.
  - If a lot is not marked complete but should have been or if sublots need to be rolled into a previous lot, contact District Testing.