Aggregate Characteristics and Handling

For Asphalt Mixes

Aggregates 102 Seminar
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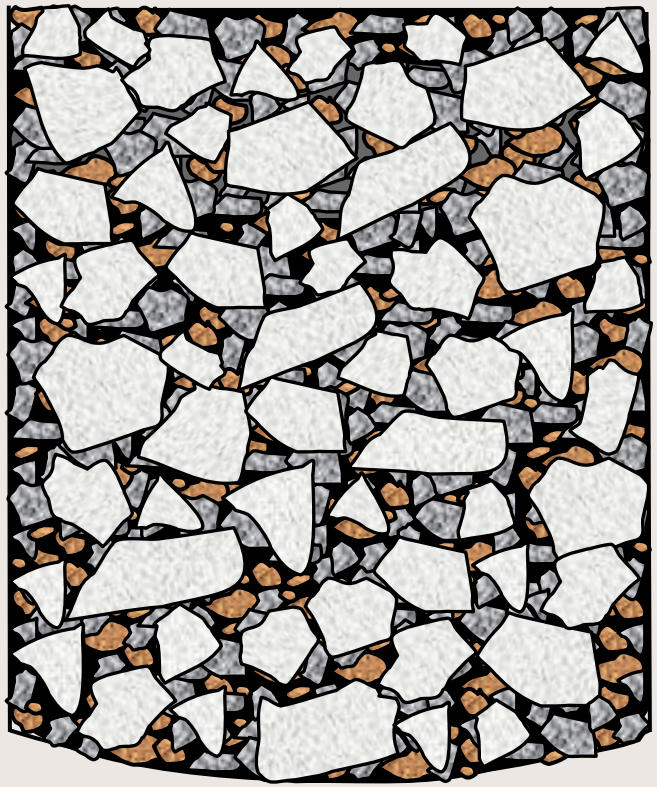
IDOT Asphalt Mix PFP and QCP Pay Factors

- **Statistical** Based Specs
  - **VMA = 30%**
  - Air Voids = 30%
  - Density = 40%

- **Aggregate** (as **% mix**)
  - ~95% by **WEIGHT**
  - ~80% by **VOLUME**

- **Consistency**

What is **VMA**?
Voids in the **M**ineral **A**ggregate



- Voids in the **total** aggregate structure
- Function of **aggregate**
- Air Voids are function of:
  - Aggregate
  - ***Effective*** AC Volume

$$VMA = 100 - \left\{ \frac{\left(G_{mb} * P_s \right)}{G_{sb}} \right\}$$

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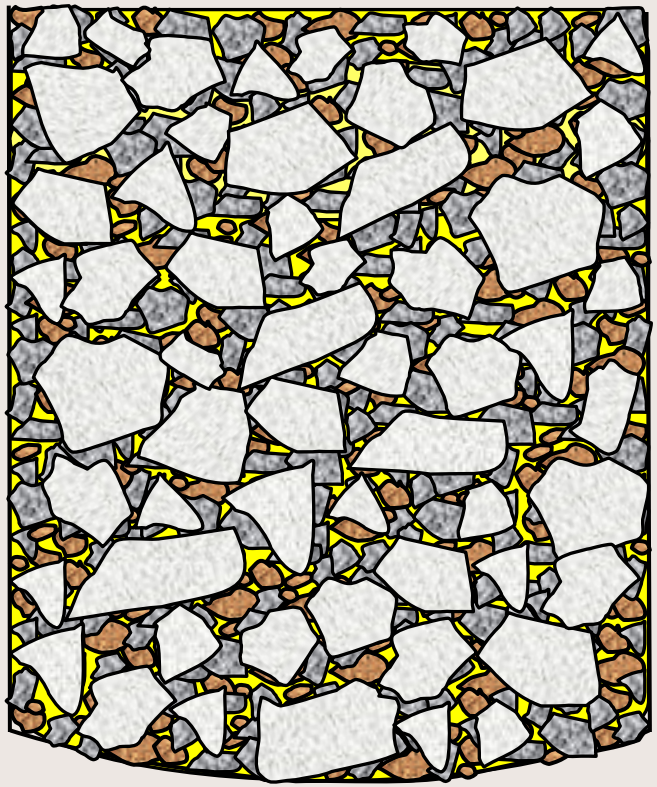

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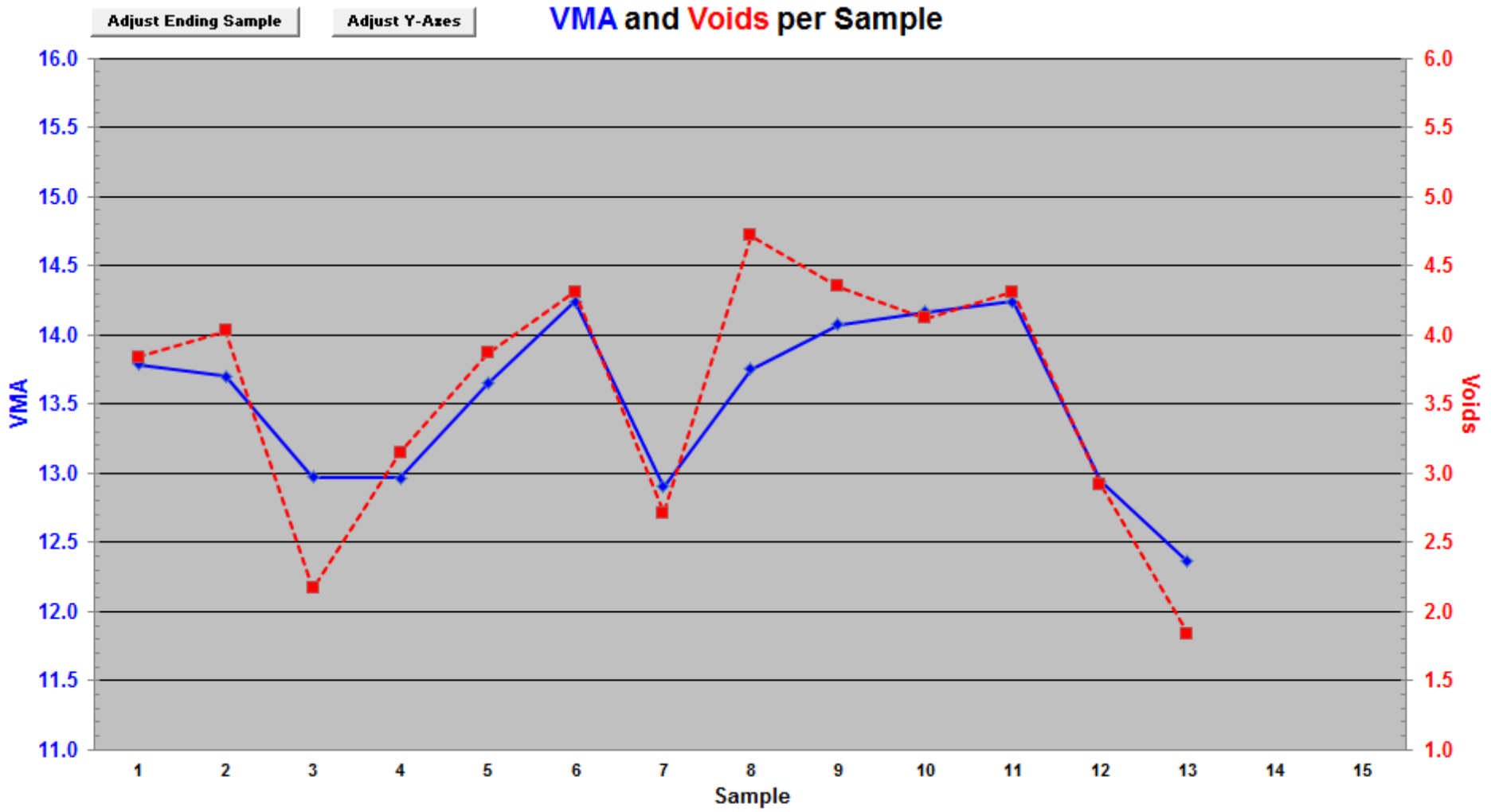
Why Is **VMA** Important?

- Essential Asphalt Mix Properties:
  - Stability
  - Durability
- **VMA** promotes **durability** – it is the room between the aggregate particles for AC and Voids

VMA Drives Air Voids

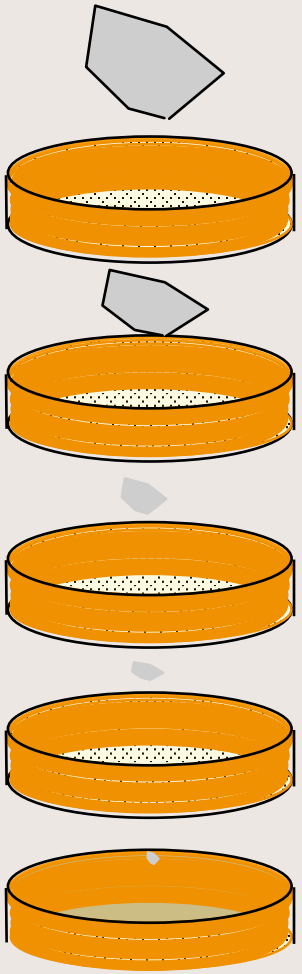


Variability of VMA and Voids

- Std Dev of VMA = 0.4
- Std Dev of Voids = 0.5
- (0.4/0.5) x 100 = 80%
- Virtually ALL variability in VMA and MOST variability in Voids is variability in the aggregate structure

Aggregate Packing Characteristics
Drive **VMA**

- **Gradation**
  - Continuously-Graded, Gap-Graded, etc.
- **Shape**
  - Flat & Elongated, Cubical, Round
- **Strength**
  - Weak vs. Strong, Influence of Particle **Shape**
- **Texture (micro-texture)**
  - Smooth, Rough



Gradation

- ***Primary*** factor that controls aggregate packing (**VMA**)
- Combined blend gradation influences mix **sensitivity** to gradation fluctuations

Gradation

- Mix size impacts product role
  - FA-22 in 9.5mm mix (**CA**)?
  - FA-22 in 19.0mm mix (**FA**)
- Product amount in a mix impacts its influence

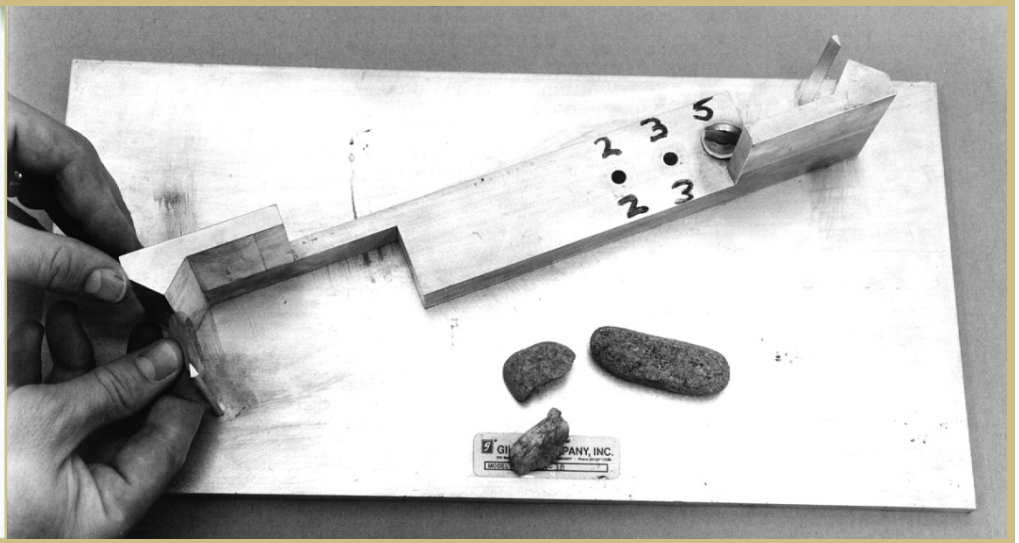
Gradation – **P**rimary **C**ontrol **S**ieve

The **break** between **Coarse** and **Fine** in a combined blend.

Mixture NMAS	**Primary Control Sieve**
37.5 mm (1-1/2”)	9.5 mm (3/8”)
25.0 mm (1”)	4.75 mm (#4)
19.0 mm (3/4”)	**4.75 mm (#4)**
12.5 mm (1/2”)	2.36 mm (#8)
9.5 mm (3/8”)	**2.36 mm (#8)**
4.75 mm (#4)	1.18 mm (#16)

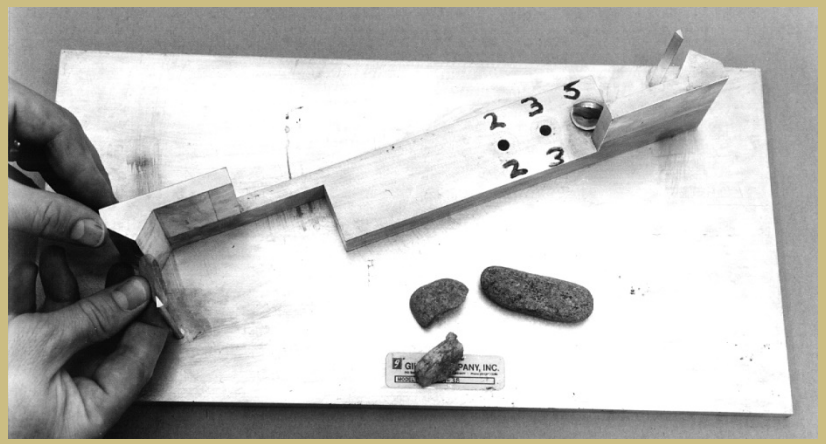
Shape

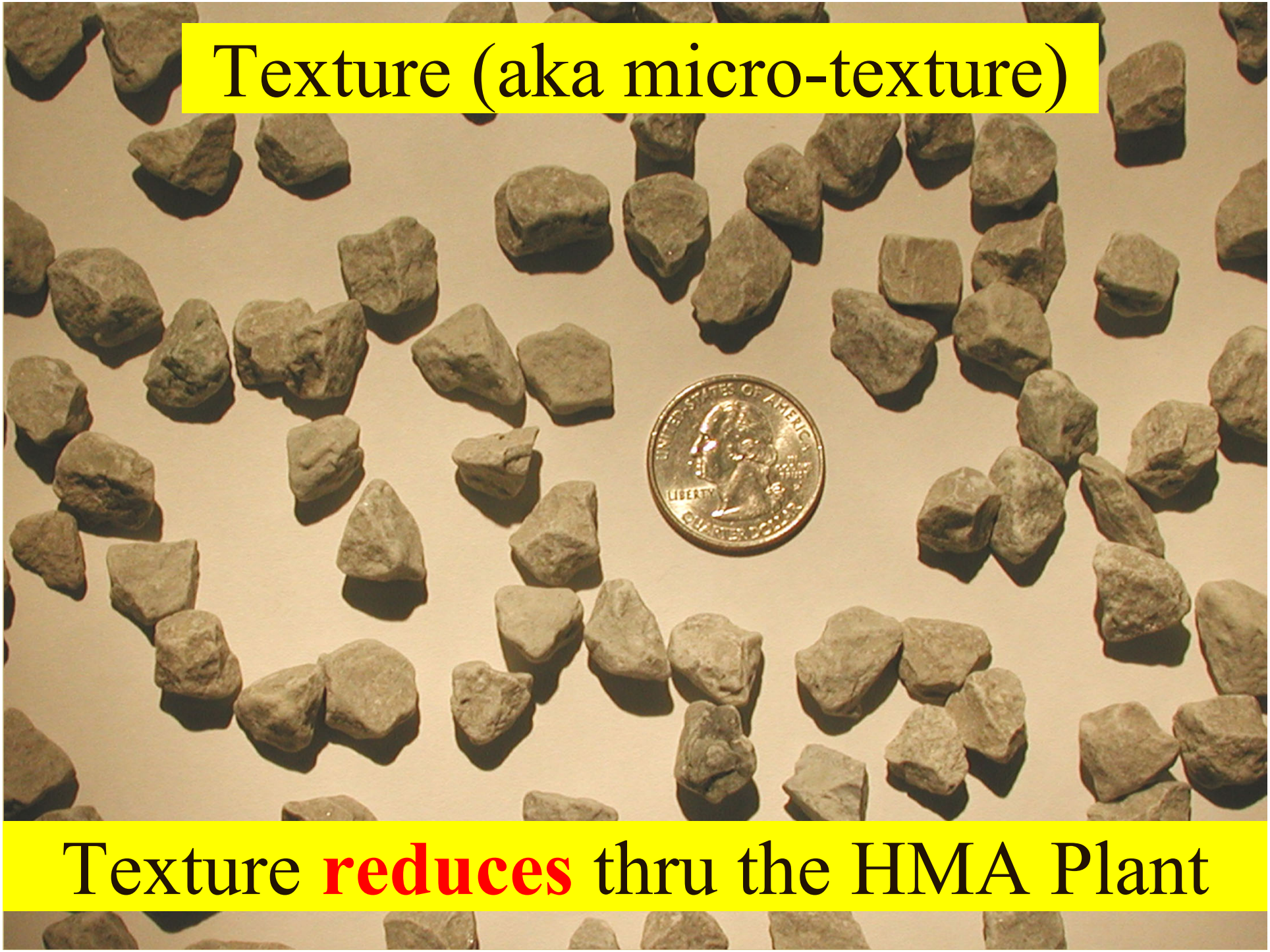
- Round, Cubical, or Flat and Elongated
- **SIGNIFICANTLY** influences agg packing (**VMA**)!
- Directly impacts particle **STRENGTH**



Strength

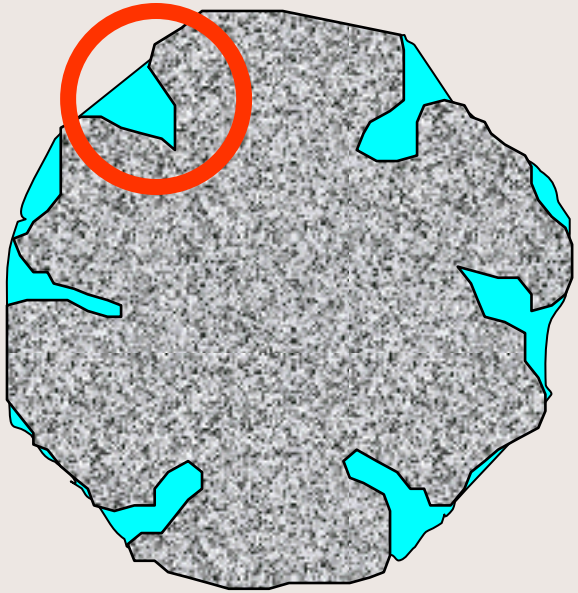
- Related to G_{sb} from a <u>given</u> aggregate source
- **SIGNIFICANTLY** influenced by particle **SHAPE**




Texture (aka micro-texture)
Texture **reduces** thru the HMA Plant

Importance of Aggregate G_{sb}

- **Accurate VMA**
- Virgin Agg's:
  - IDOT provides moving average
  - Process to eliminate flyers
- RAP:
  - Fixed values (north vs. south) **unless** slag is involved



$$VMA = 100 - \left\{\frac{(Gmb * Ps)}{Gsb}\right\}$$

Water Abs → AC Abs

- AC absorption (P_{ba}) is typically 65% of water absorption
- Range of 50-80%
- Porosity plays a role too!
- Directly affects <u>total</u> AC content
- Compare **water absorption** of your products to those of your competitors

Water and AC Absorption Calcs

- CA #1 – 35% (H_2O abs = 1.2%)
- CA #2 – 30% (H_2O abs = 1.6%)
- FA #1 – 25% (H_2O abs = 2.1%)
- FA #2 – 10% (H_2O abs = 0.9%)

- ***Combined*** H_2O abs = (0.35 x 1.2) + (0.30 x 1.6) + (0.25 x 2.1) + (0.10 x 0.9) = **1.52%**

- **Asphalt abs (P_{ba})** = 0.65 x 1.52% = **0.98%**

Can Two Designs at the SAME **VMA** & Voids Require Different AC Contents?

- **Design 1**
  - **VMA** = 13.4%
  - Voids = 4.0%
  - **Total AC = 4.6%**

- **Design 2**
  - **VMA** = 13.4%
  - Voids = 4.0%
  - **Total AC = 4.8%**

- The Difference Is **Asphalt Absorption**
- Design AC chosen @ 4.0% voids, so a difference in AC content between two designs is a function of:
  - **VMA** and/or
  - **Asphalt Absorption**

Consistency

- **VMA** is a function of:
  - Gradation, Shape, Texture and Strength
- What personnel and equipment **influence** these characteristics in your aggregate products?
- **Everyone** plays a role in Quality Control!

Quality Control

- ***Representative*** samples are crucial!
- But…**QC** isn't just sample testing!
- Inspection, Analysis and Action:
  - Action occurs before sampling or before testing
  - We react too often – we must be proactive
  - Don't assume the owner's minimal requirements will suffice
- **QC** personnel seldom have time to test and oversee the process
- **QC** Managers play a vital role

Issues that Impact the Product

- Management
- Plant superintendents
- Ledge shots / Pit areas
- Primary, secondary and tertiary crushing operations
  - Equipment used
  - Operation rate
  - Equipment maintenance
- Log washer / Classifier operations

Issues that Impact the Product

- Stockpiling operations
  - Radial stacker, loader or trucks?
  - Multiple layers?
  - Location/direction?
  - Identification?
  - Intermingling issues?
- Load out operations
  - Trucks
  - Rail
  - Barge

Build them right

Prevent intermingling

Load out of them right

Issues at the HMA Plant

- Stockpiling and load out just as important!
- ***Multiple*** Cold Feeds for a ***single*** aggregate
  - Split if agg > 30%
  - Feed each CF from a different location in stockpile
- Mini Stockpile when multiple CF's aren't an option

Communication

- **Ensure communication** between your QC personnel and ours!
- **Communicate** any changes that impact gradation, shape, texture and strength, such as:
  - Personnel
  - Ledges or areas within a pit
  - Shot, mining or dredging methods
  - Crushing and/or classifying equipment
  - Production methods, especially screen decks
  - Stockpiling methods
  - Load out methods

Communication

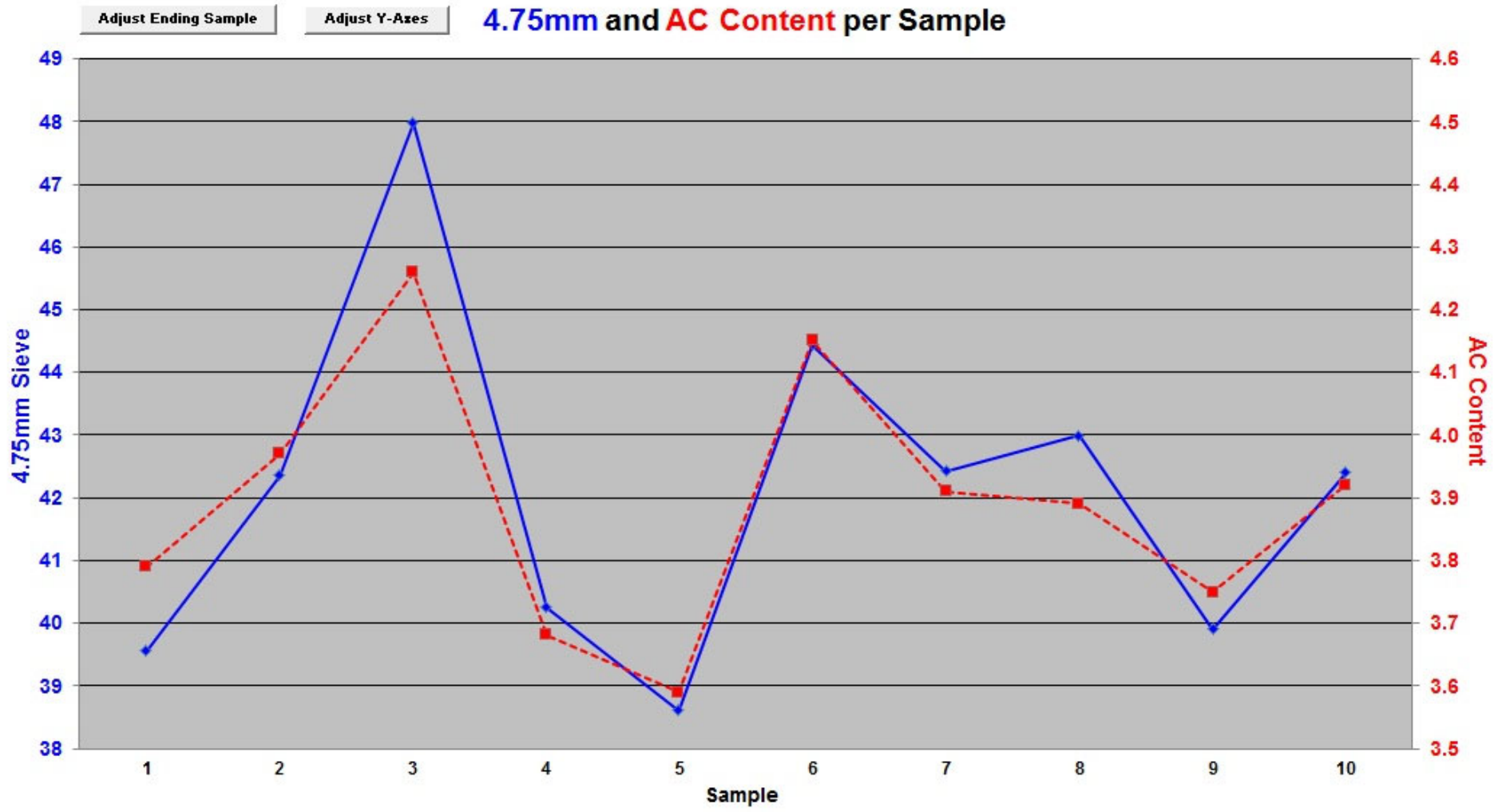
- Changes will take place – planned or not!
- Impact on our mix results depends on our ability to work together
- Is there time to determine how much the “change” is going to affect our mix?
- What we can do to minimize or negate the effect?

Help Us With **Our** Flaws…

- **Encourage** your QC personnel to visit our asphalt plant:
  - Are we stockpiling correctly?
  - Are our stockpiles clearly identified?
  - Are our stockpiles separated to prevent intermingling?
  - Are we loading out of them in a manner that helps reduce variability?
  - How do our test results compare to yours?
  - Are we having success on our projects where your product is being used?

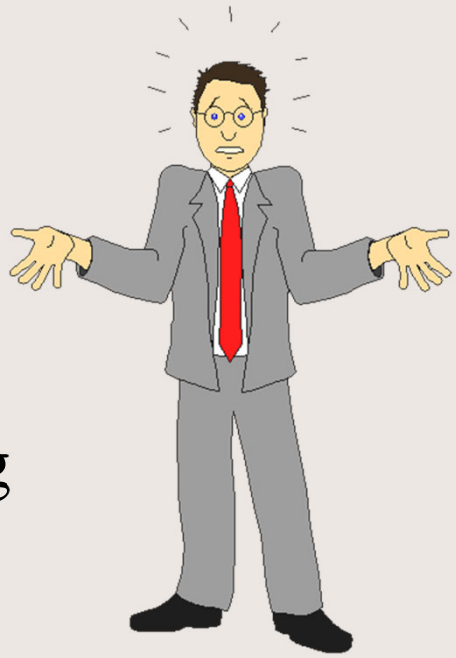

POWERSCREEN

Segregated Mix



Balanced Mix Design (BMD)

- One of the hottest HMA topics around the U.S.
- Two basic characteristics for HMA:
  - Strength (**Rutting** resistance)
  - Durability (**Cracking**/Stripping resistance)
- Lot's of tests being evaluated…



Performance Test Challenges…

- Does the test ***clearly*** relate to field performance?
- How ***easy*** is it to perform?
- How much ***time*** does it take?
- What does the equipment ***cost***?
- Recommended specs, mix/specimen aging and parameters ***relative to*** our mixes/area?
  - Are the acceptance parameters the same for all mix types, sizes and uses?

Balanced Mix Design (BMD)

- Illinois has chosen:
  - Hamburg Wheel (**Rutting**)
  - I-FIT (**S**emi-**C**ircular **B**end) (**Cracking**)

What Impacts Performance Tests?

- There are things we:
  - know that we know…
  - know that we don't know…
  - don't know that we don't know…
- We (IDOT and Industry) are learning…
- It'll come down to:
  - Aggregate properties (**recycle included**)
  - Asphalt Cement properties (**recycle included**)
  - How we produce and place the product…

What Are Our Needs?

- Product **consistency**:
  - **Gradation**
  - **Shape**
  - **Strength**
  - **Texture (micro-texture)**
- Communication and partnership with you:
  - We understand things change and stuff happens…
  - We want to share results, thoughts and concerns

What Are Our Needs?

- ALL HMA aggregates are important to:
  - Achieve **VMA**
  - Produce **consistent** HMA
  - **Meet** Performance Test Requirements
- Angular products:
  - Are here to stay:
    - Stability
    - Durability (**VMA**)


Thank You!