2024 Nebraska Asphalt Paving Workshop

Asphalt Mix Adjustment

Asphalt Mix Design

- Provides test results for the proposed aggregate structure at selected asphalt binder contents.
- Test results are summarized in a Job Mix Formula which provides target values for field production.
- Provides a useful guide for mix production, but may differ from the plant-produced asphalt mix.

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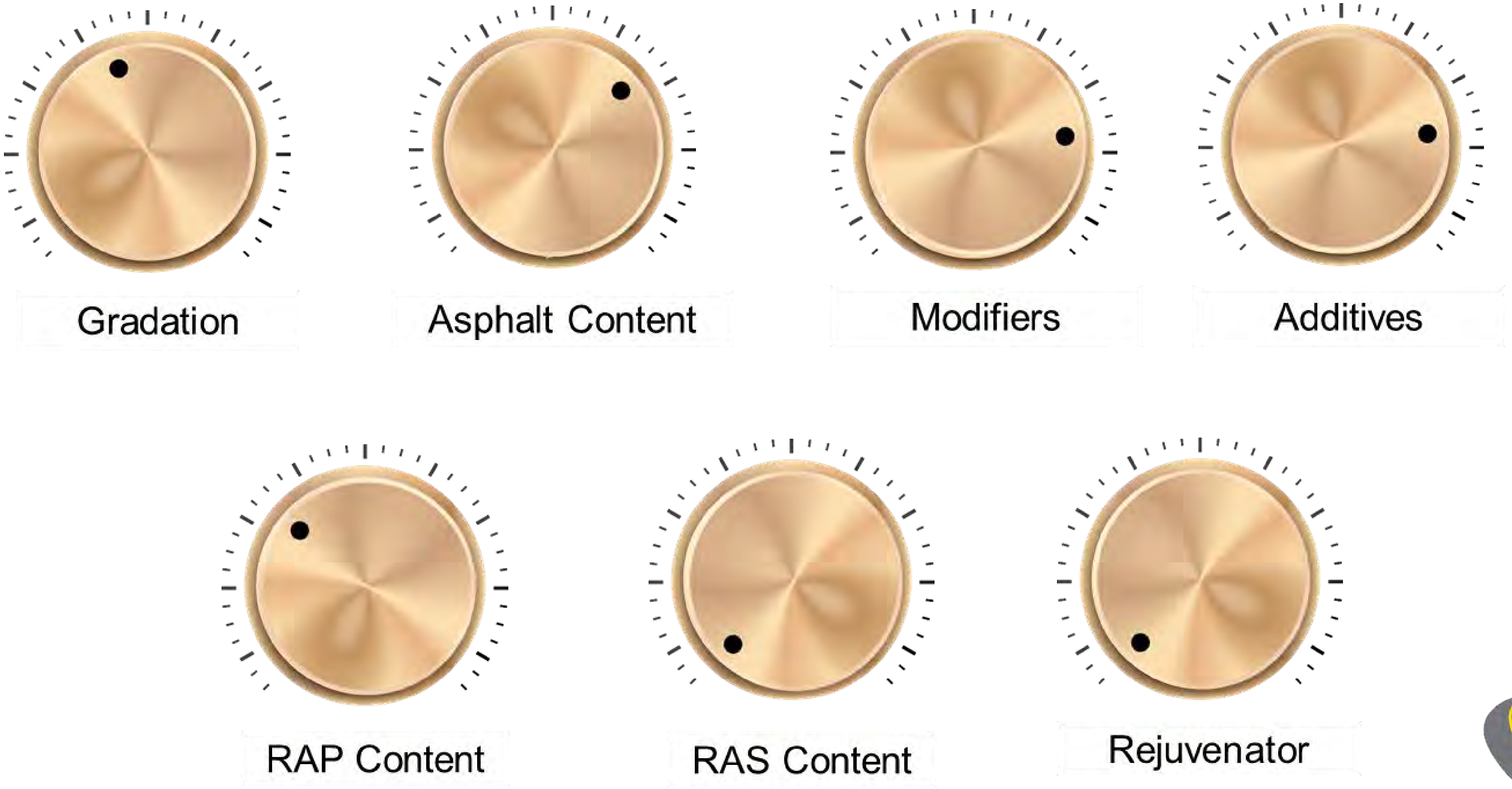
Mix Adjustments



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Comparison of Mix Conditions

Mix Design Conditions	Field Conditions
Asphalt Binder	
Aged using RTFO and PAV	Aging is more complex
Loose mix aged to allow for absorption	Mix may be used right away, or may be stored in silos for some time
Aggregate	
Gradation is carefully controlled	Gradation varies through stockpiles, cold feed, drying, and mixing
Aggregate is completely dry	Aggregate may contain 0.1 - 0.5 % moisture
Uniform heating of coarse and fine aggregate	May be distinct temperature differences based on heat transfer
Fines are retained during mixing	Some fines may collect in the baghouse

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Comparison of Mix Conditions

Mix Design Conditions	Field Conditions
Mixing Process	
Asphalt binder is essentially unaged	Mixing time can substantially increase the binder viscosity up to 4 times
Compaction	
Uses standard compactor and procedure to simulate field orientation of particles	Particle orientation and compaction energy varies by roller type and effort
Samples are confined	Mix is generally unconfined
Compaction is quick; temperature is constant	Compaction occurs over wide variation in time available and placement temperature
Compaction occurs against a solid foundation	Compaction occurs with a range in foundation stiffness

During production of the mixture, problems may occur!

Work the problem!

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Prior to making an adjustment to the mix, make sure of the following:

- Mix design is correct.
- Mix design is correctly input into the plant.
- Plant components are properly calibrated.
- Lab equipment is properly calibrated.
- Personnel are properly educated / certified.
- Personnel roles and responsibilities are assigned.
- Sample is random and representative.
- Sample is processed correctly (e.g., split).
- Proper test procedures are being utilized.
- Results are double checked.

Adjustment Tips

- Avoid having multiple people making adjustments.
- Try to make only one adjustment at a time.
  - Multiple adjustments can make cause and effect impossible.
  - Can prolong or exacerbate the problem.
- Produce sufficient mix after adjustment to make accurate determination on the adjustment impact.
  - Let the plant adjust to the adjustment (50 to 100 tons minimum)
- Maintain adjustment diary or log.
  - Track the history to better understand future adjustments.

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Adjustment Thoughts to Remember

- Know your mixes and their sensitivity to various changes.
- Commonly used rules of thumb for mix adjustment may not be exact for your mix.
- Base adjustments on all QC testing and inspection data.
- Don't adjust based on one test

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Typical Problems with a Mix Design

- Volumetrics
  - Air Voids
  - VMA
  - Possible causes?

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Mix Adjustments: General Rules of Thumb

- VMA is most affected by the P_{-200} and the relative proportions of coarse and fine aggregate.
- VMA can be increased by reducing the amount of P_{-200} or natural sand.
- VMA can also be increased by moving the gradation away from the Maximum Density Line, especially for mixes with no natural sand, or by using more angular aggregate.
- Air voids is most affected by asphalt content, P_{-200}, and the relative proportions of coarse and fine aggregate.
- Air voids can be increased by reducing asphalt content and P_{-200}.

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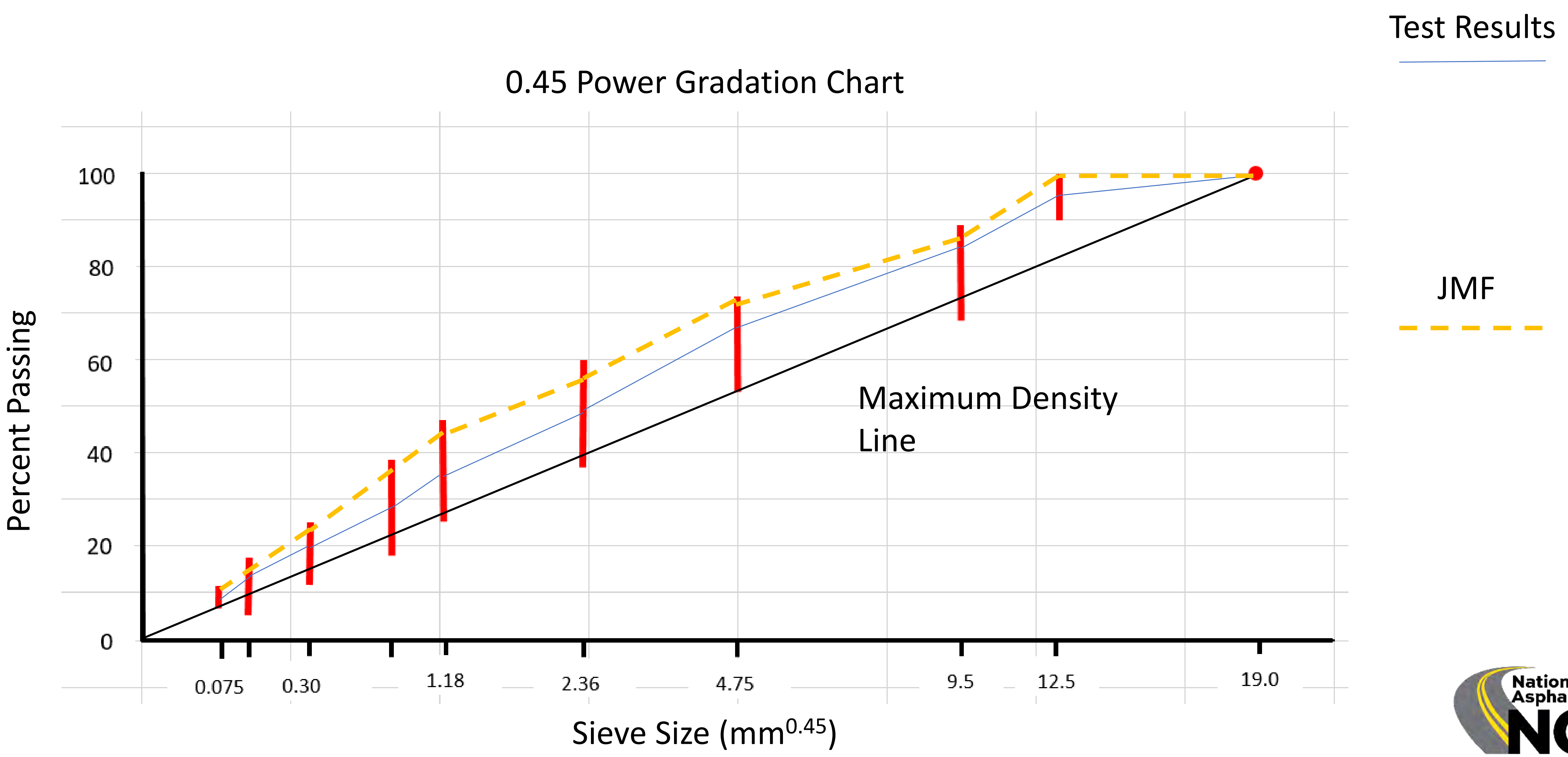
Maximum Density Line



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VMA

- VMA is the void space between aggregate particles
- Includes air voids and AC, but not the AC absorbed by the aggregate
- $VMA = V_a + V_{be}$
  - V_a = air voids
  - V_{be} = Volume of effective (non-absorbed) binder
- To change VMA:
  - Adjust gradation (not just the dust proportion)
  - Particle shape is critical (rounded particles fit more closely together and have a lower VMA)

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Increase of P_{-200} During Mix Design

- Typically P_{-200} is 1.0 to 1.5% higher in plant-produced mix than in combined stockpile gradations
- Aggregate also gets rounded-off during production
  - Results in VMA and air void collapse at start-up
- Increase in P_{-200} generally reduces VMA and air voids
- Account for the difference during mix design or you may have to make field adjustments later

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Relationships

Asphalt / Air Voids Relationship:

$0.4\% \, \Delta \, AC = 1.0\% \, \Delta$ Air Voids

or $0.1\% \, \Delta \, AC = 0.25\% \, \Delta$ Air Voids

Asphalt / VMA Relationship:

Small Δ AC = No VMA Effect

P_{-200} / VMA and Air Voids Relationship:

$1.0\% \, \Delta \, P_{-200} = 0.3\% \, \Delta$ VMA and Air Voids

P_{-8} / VMA Relationship:

Coarse: $+ P_{-8} = -$ VMA

Fine: $+ P_{-8} = +$ VMA

Notes:

1. *General rules of thumb.*
2. *Basis for initial adjustment.*
3. *Local relationships needed.*

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General Proportionality Rules

Proportion	Gmm	Gmb	Va	VMA	Density
% AC increases	↓	↑	↓	--	↑
% AC decreases	↑	↓	↑	--	↓
Gradation becomes finer	--	↓	↑	↑	↓
Gradation becomes coarser	--	↑	↓	↓	↑
P_{-200} increases	--	↑	↓	↓	↑
P_{-200} decreases	--	↓	↑	↑	↓

These proportion rules are theoretical concepts, but may vary between mix designs.

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General Proportionality Rules

Proportion	Gmm	Gmb	Va	P_b	P_{200}
% AC stays the same; fine gradation get coarser	--	--	↓	--	--
% AC stays the same; fine gradation gets finer	--	--	↑	--	--
% AC stays the same; Gmb goes down	--	--	--	--	↓
% AC stays the same; Gmb goes up	--	--	--	--	↑
Gmm goes down	--	↑	--	↑	--
Gmb goes down	↑	--	--	↓	--

These proportion rules are theoretical concepts, but may vary between mix designs.

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Typical Problems with a Mix Design

- Binder content
  - Too high or too low
  - Causes?
- Gradation
  - Too coarse or fine
  - Causes?

What causes a mix to strip?

- Loss of adhesive bonding between the binder/mastic and the aggregates
- Loss of cohesion in the mastic due to the presence of moisture

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Design Modifications to Address Stripping

- Changing binder source
- Changing aggregate type
- Adding an anti-strip agent

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Stripping: Case Study 1

- Factor: binder source
- HWTT

Binder Source	HWTT Rut Depth at 20k Passes
Source A	3.0 mm
Source B	> 12.5 mm

15% RAP Mix
PG 58H-28
5.6% AC

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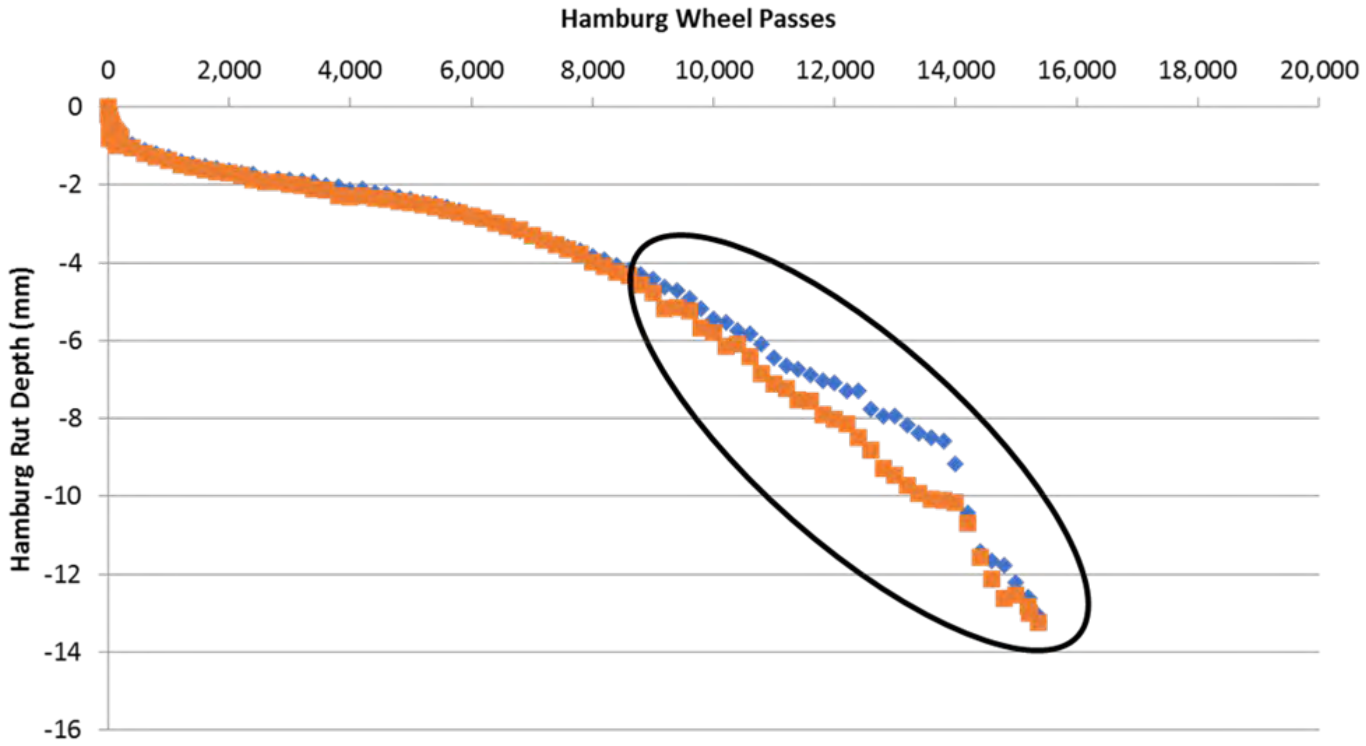
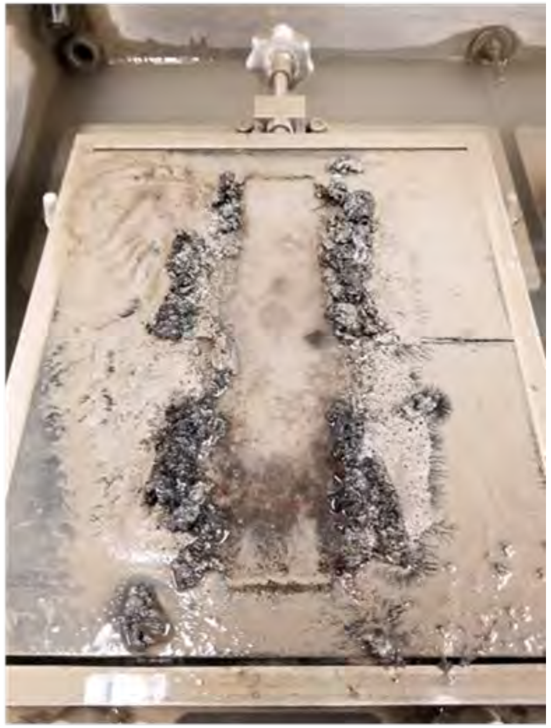
Stripping: Case Study 1

- PG 58H-28 Binder, Source B





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Stripping: Case Study 2

- Factor: liquid anti-strip additive
- Tensile Strength Ratio (TSR)
- Virgin mix, granite aggregate (with known stripping issues), 5.4% AC

Liquid Anti-strip	TSR
No Anti-strip	0.26
+ Product A	0.67
+ Product B	0.85

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Factors to Consider for Design Optimization

Performance

Cost

Material Availability

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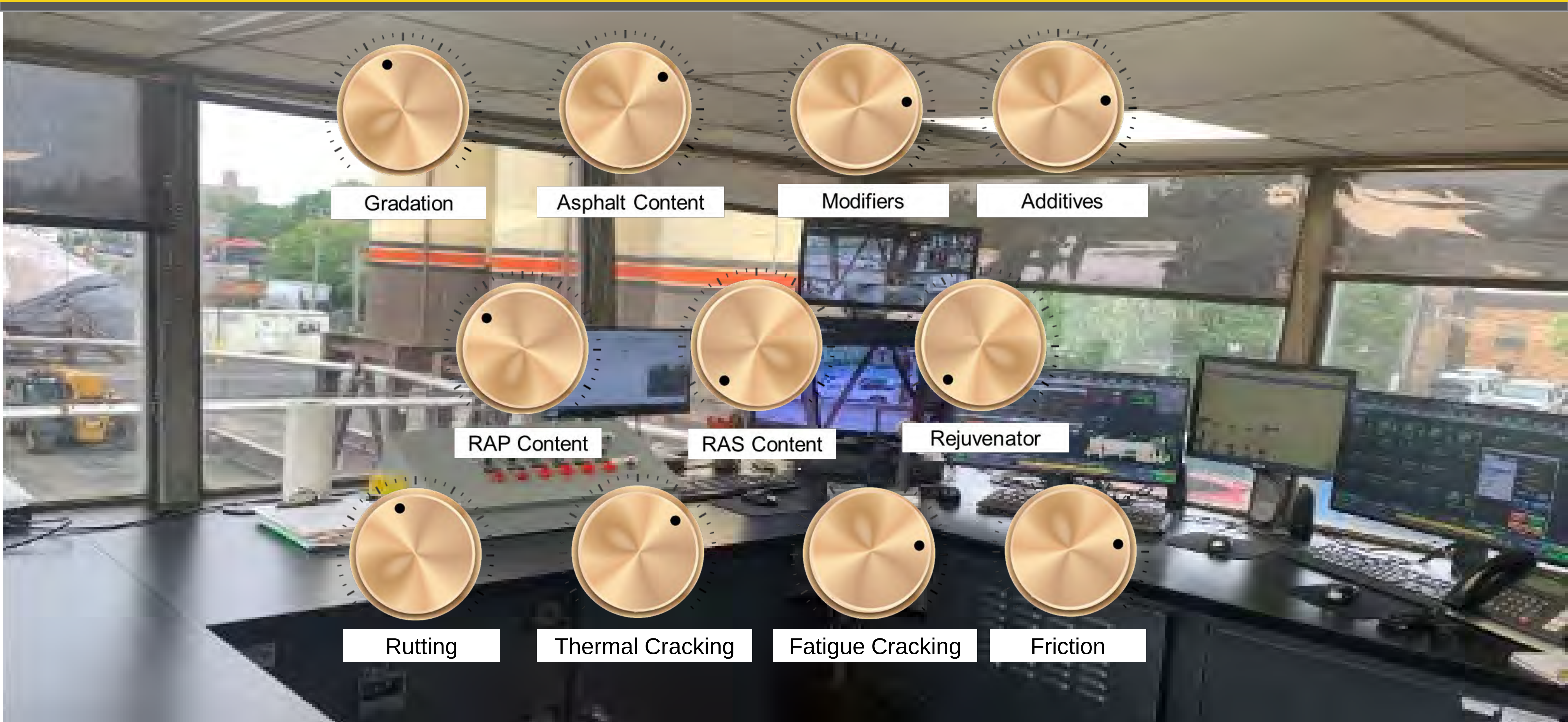
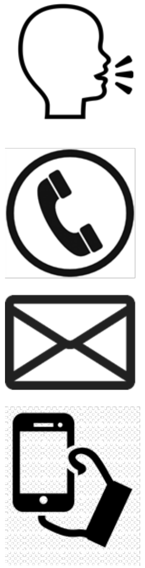


QUESTIONS ?

How do I communicate with NCAT?

- Contact Tom or Travis
  - travis.walbeck@auburn.edu
  - (334) 740-9176 cell / text
  - Tom.Harman@Auburn.edu
  - (410) 215-2762



NCAT Webpage

http://NCAT.us