HMA Production and Best Practices

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Flexible Pavement *Smoothness*: Construction, Performance, Measurements and Rolling Resistance

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HMA Production and Best Practices

Where do we start?...

- The "To-Do" list for achieving mix ***Consistency and Quality*** is long and ranges from managing individual ingredients to field compaction of the mix:
  - A high-quality asphalt mix that is produced, transported, placed and compacted ***correctly and consistently*** gives us the best opportunity to achieve ***smoothness*** in the finished product.
  - Well maintained and calibrated equipment, operated by trained and experienced personnel play a vital role!
  - Let's start with what can cause ***smoothness*** issues, so we can focus on preventing them.
  - Then we'll ***touch on*** some best practices…

Mix Tenderness

- **Mix that moves/slides during field compaction** makes in-place density and ***smoothness*** difficult to achieve
- Often disguised when paving on a milled surface
- **Avoiding** a tender mix starts with the mix design:
  - Aggregate structure – gradation, shape, texture and strength
  - Virgin AC properties (neat vs. modified) – impacts mix stiffness as a function of mix temperature at time of compaction
  - Recycled contribution – both agg and AC properties contribute to the overall mix with the impact also being a function of the amount used
  - Volumetric results (VMA and Voids at Optimum AC)?
  - Tensile strength?

Mix Tenderness (cont.)

- **Avoiding** a tender mix starts with the mix design (cont.):
  - Additives/Modifiers – Antistrip, Fibers, Softeners, WMA, etc., contribute to mix stiffness at a given temperature
  - Mix **type** and **size** vs. Compacted thickness in field:
    - **Compaction difficulties = Smoothness difficulties**
    - Placing a mix too thin can cause compaction difficulties
    - Placing a mix too thick can cause vertical variability in compaction
    - Knowing the target compacted thickness in the field can influence mix design choices, providing specs allow

Lift Thickness	Minimum*	Maximum
C-G and SMA	4 x NMAS	8 x NMAS
Fine-Graded	3 x NMAS	6 x NMAS

* NCHRP Report 531 – Conclusions and Recommendations

Mix Tenderness (cont.)

- **Residual moisture** content of the mix is **often** the root cause of tenderness, but not easy to quantify ***accurately***!
  - **Total fluids content** is the combination of effective AC and **residual moisture** of the mix:
    - Excess (effective) AC is rarely a continuous problem, simply due to economics
    - **Residual moisture** in the aggregate, escaping through the asphalt film, ***temporarily*** reduces the AC viscosity (stiffness) by emulsifying the AC
      - 0.1% **residual moisture** can ***temporarily*** drop the high temperature stiffness by one PG grade (e.g., a PG 64 "acts like" a PG 58)
      - **Residual moisture** content can vary for a host of reasons…

Mix Tenderness (cont.)

- Manage aggregate and recycle stockpiles:
  - Bucket up! – leave the wettest material on the ground (bottom 2-3’)
  - Pave and Slope the stockpile yard
  - Build to load out of correctly (not last in, first out)
  - Monitor stockpile moisture frequently:
    - It matters when and where samples are taken
    - Real time moisture monitoring on Cold Feed’s being used at some HMA plants
  - High moisture contents impact production rate and mix temperature:
    - Highly absorptive aggregates vary more in moisture content
    - Dense-graded and/or smaller aggregates have higher surface areas, allowing them to hold more **free** moisture and they drain slower than typical CA’s
    - Larger CA particles harder to dry than smaller particles

Mix Tenderness (cont.)

- ***Signs*** of excess **residual moisture** in the mix:
  - Excessive heat loss from plant discharge to back of paver
  - Larger CA particles bubbling in the asphalt mix at the point of discharge from the mixing drum
  - Silos “raining” (water dripping out)
  - Mix slumping in a haul truck after movement
  - Moisture collected under truck tarp after transporting mix to the project
  - Moisture running out of bed when dumping load on the project
    - Excess release agent can be a cause too but its external – not inside the aggregate
  - **When a mix is tender during compaction – look for moisture first!**

Mix Tenderness (cont.)

- Time from AC addition to mix placement impacts:
  - Moisture released, asphalt absorbed into the aggregate (therefore effective AC), and mix temperature
- Mix temperature:
  - What's the right production and placement temp for the mix?
  - Where should we measure mix temp in the overall process?
    - Plant discharge, Truck loading, Truck discharge and/or Behind the paver
  - **Excessive heat loss from plant discharge to back of paver is an indicator of excess residual moisture**

What we're placing the mix on matters!

- Agg base, soil, concrete, asphalt (aged vs. new), milled?
  - What are we placing the mix on and what's its condition?
- Prime or tack application:
  - Surface characteristics, type of material, residual rate, application uniformity, adequate break/cure time to avoid tracking issues, etc.
- **Smoothness** of the existing surface:
  - Cracks, joints, patches, overall grade, texture consistency, etc.
  - Impacts thickness uniformity of newly placed mix
  - Impacts in-place density as well

Mix Transfer to Paver

- Directly dumping trucks into the paver has more risk:
  - Trucks bumping paver
  - Fold the hopper wings or not?
  - Don’t expose the slats
- MTD use:
  - Stirs the mix, releasing moisture
  - Remixes/reduces physical and thermal segregation
  - Helps maintain adequate mix quantity in paver hopper or insert which
  - Helps maintain a more consistent paver speed which
  - Helps maintain a more consistent head of material on the screed
  - But…the underlying pavement structure must support the MTD!

Mix Placement

- Avoid stops – use fast stops and fast starts?
- Achieve a **consistent** paver speed:
  - Coordinate production rate, haul rate, placement rate and compactive effort
  - Easier to maintain consistent head on screed
- Keep the augers turning 90% + of the time
- Auger extensions/tunnel extensions help keep the forces on the screed more uniform and reduce segregation
- End gates help confine the outside edges
- Kickback paddles reduce the opportunity for segregation down the center of the mat

Mix Placement (cont.)

- Grade and slope control impacts **smoothness** of the mix:
  - Smooth mat on a rough surface
  - Rough mat on a smooth surface
- Screed type and condition impacts mat uniformity and density prior to roller compaction
- Check density transversely behind paver:
  - Consistency across mat (transversely)
  - Areas of truck exchange (longitudinally)
- **The mat (prior to rolling) is as smooth as it gets!**

Mix Compaction

- Density vs. Smoothness – can we achieve both?
  - Rollers do **not** make a mat smoother as we compact it
  - But we have to compact the mix to achieve in-place density
    - Mixes that are difficult to compact will have **smoothness** challenges
- Roller types impact how the mix reacts during compaction:
  - Static, vibratory, oscillatory, pneumatic (tire pressure matters!)
- Number of rollers needed to keep up with the paver and provide acceptable in-place density results
- Roller speed – matched to placement rate and roller type/settings
- Keep them rollers movin!

Mix Compaction (cont.)

- Roller settings (e.g., vibratory) – frequency and amplitude matter:
  - Frequency – minimum of 10-12 impacts/foot
  - Amplitude – relative to mix thickness and underlying support
- Rolling pattern:
  - Breakdown – one pattern at a time vs. multiple?
  - Starting and stopping/overlaps (check density longitudinally here too!)
  - Pattern length and mix temperature at each end
  - Intelligent compaction can improve density ***uniformity***
- Density monitoring (breakdown, intermediate and finish zones)
- **Smoothness** – did the process control work?...


Thank You!