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Cold Weather Paving

WAPA 63rd Annual Conference & Business Meeting
November 29, 2022

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Topics of Discussion

- Hot Mix Asphalt (HMA) Basics
- Adverse Weather
- WisDOT Requirements
- Cold Weather Paving Examples
- Paving in Cold Weather
- Cold Weather Paving Observations
- Extreme Cold Weather STSP
- Conclusions

Topics of Discussion

- There will be changes coming
- Discussions are being had on items to improve
- Not discussing Standard Specification Chapter 1
- Not discussing contract administration items

Goal is to re-iterate the specifications/guidance, intent and interpretation

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HMA Basics

Asphalt 101

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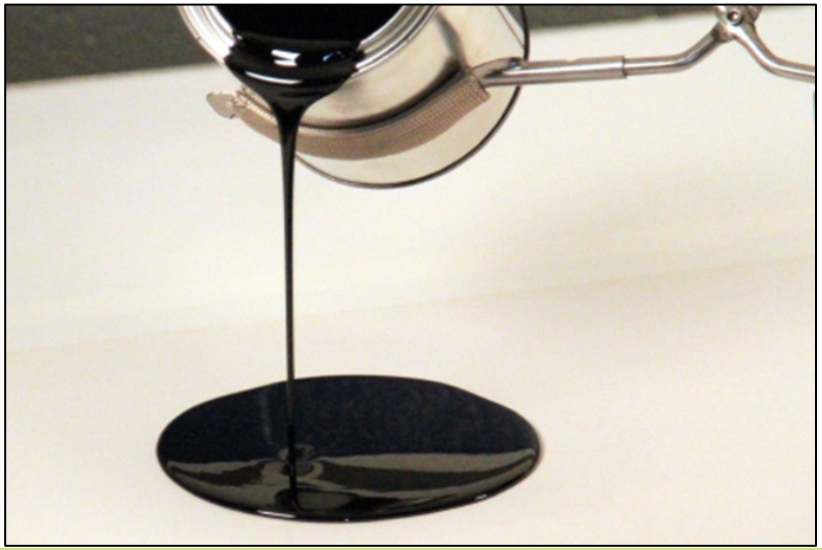
What is HMA made of?

- Aggregates
  - Load bearing components
    - Skid resistance, stability, workability
- Asphalt Binder
  - Glue/muscle that holds everything together
    - Flexibility, durability
- Air
  - Accommodates particle alignment
    - Allows proper compaction for the pavement to remain flexible



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Aggregates

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Aggregates

- Important physical properties:
  - Gradation & Size
  - Particle Shape
  - Toughness
  - Durability / Soundness
  - Cleanliness (deleterious materials)
  - Absorption
  - Specific Gravity
  - Adhesion
  - Surface Texture

WisDOT Standard Specification 460

- RAM (Recycled Asphaltic Materials)

  Stockpile sampling/testing same as other aggregate sources

  - Extractions required to adjust asphalt contents
  - Controlled by binder replacement percentage and not by weight

  – RAP-Reclaimed Asphaltic Pavements
    - May be fractionated into different sizes, then identified as FRAP

  – RAS-Recycled Asphalt Shingles
    - Tear offs or manufactured waste
    - Limited to 5% total weight

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Asphalt Binders

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Asphalt Binder

- Northern Asphalt Zone
  - New construction, reconstruction or pavement replacement
    - Upper Layer: PG 58-34
    - Lower Layers: PG 58-28
  - Other projects (overlay, rehab, etc.)
    - All Layers: PG 58-28
- Southern Asphalt Zone
  - All Layers, all types of construction (new construction, replacement, overlays, reconstructs, etc.)
    - PG 58-28

Asphalt Binder Designation

- Binder grades to be based on expected traffic level:
  - S – Standard (normal projects)
  - H – Heavy (slow moving traffic, higher truck movements, roundabouts, turn lanes, etc.)
  - V – Very Heavy (extreme traffic, very slow traffic, stopping & starting)
  - E – Extremely Heavy (toll booths, port facilities-currently not part of the WisDOT matrix)

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Air Void Regression

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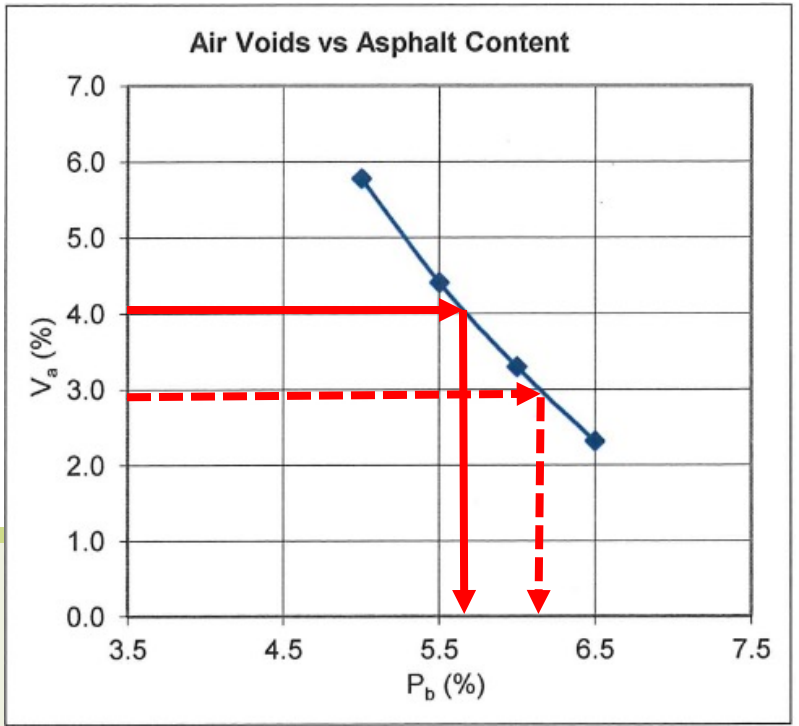
Air void regression 101

- All asphaltic mix designs will remain at 4.0%
- Looking at the mix design, the AC needed to achieve 3.0% air voids is determined
  - Values are established @ 3.0% for:
    - Gmm
    - Gmb
    - Va
    - VMA



Original Optimum %AC = ~ 5.7

Regressed Optimum %AC = ~ 6.1

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Air void regression impacts for cold weather

- Addition of virgin asphalt binder (approx. 0.3-0.4%)
- Increased durability, increased asphalt film thickness
- Increased in place density/decreased permeability
- Improved workability

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Mixture Classifications

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4.75 mm (No. 6)

9.5 mm (No. 5)

12.5 mm (No. 4)

Mixture Nmas Gradations

19.0 mm (No. 3)

25.0 mm (No. 2)

37.5 mm (No. 1)

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Dense Graded Mixtures

- A dense-graded mix is a well-graded (even distribution of aggregate particles from coarse to fine), HMA mixture consisting of aggregates and asphalt binder
- Properly designed and constructed mixtures are relatively impermeable

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Dense Graded Mixes

- Further be classified as either
  - Fine graded
  - Coarse graded

Simply put, fine graded mixes have more fine sand size particles than coarse graded mixes but both are well blended/graded

*Wisconsin uses fine graded mixtures

Gap Graded Mixes

- Stone Matrix Asphalt (SMA) maximizes rutting resistance and durability with a stone-on-stone skeleton held together by a rich mixture of asphalt binder, filler, and stabilizing agents such as fibers and/or asphalt modifiers
- Considered a premium upper layer mix with improved performance for medium/high traffic loading situations

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Adverse Weather Conditions

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Potential Weather Conditions

- High winds
- Rain/Sleet
- Snow
- Temperature

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Factors for Wind

- PPE requirements to protect vision
- Awareness of visibility issues
- Traffic control concerns
- Raised truck boxes
- May affect HMA mixture
  - Surface temperature of mix (rapidly cooling)
  - Prone to segregation
  - Workability issues

Factors for Rain/Sleet

- How hard is it raining
  - Drizzle
  - Continuous
  - Downpour
- Weather forecast
- May affect HMA mixture
  - Bonding of tack coat
  - Temperature of mixture (rapid cooling)
  - Density gauge operations are affected

Factors for Snow

- How much and for how long
- Weather forecast
- May affect HMA mixture
  - Bonding of tack coat
  - Temperature drops
    - Underlying pavement structure
    - HMA mixture rapidly cools
    - Possible joint issues
    - Aesthetics affected

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WisDOT Design Requirements

Facilities Development Manual
FDM 19-5

WISCONSIN DEPARTMENT OF TRANSPORTATION

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Hot Mix Asphalt (HMA) Cold Weather Paving, Item 450.4000

KEY TAKEAWAYS:

- Don’t pave in cold weather if possible
- However, there are times when you have to pave in cold weather

Hot Mix Asphalt (HMA) Cold Weather Paving, Item 450.4000

KEY TAKEAWAYS:

- For design estimates, determine tonnage placed during timeframes:
  - Northern Zone (September 15 – June 1)
  - Southern Zone (October 1 – May 15)

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Hot Mix Asphalt (HMA) Cold Weather Paving, Item 450.4000

KEY TAKEAWAYS:

- Consider paving portions next season with SPV for final upper layer

Considerations for paving the following year

- Existing pavement structure: Would the lower layers of asphalt placed this season be sufficient to support traffic over the winter season?
- Business and local resident impacts: Are there reasons that carrying over would cause undue burden to the businesses or local residents?
- Maintenance and cost responsibility: Consider work zone traffic control, detours, temporary and permanent signage, drainage, erosion control, business and pedestrian accommodations, etc. Who will maintain and repair these items over the winter season and who will pay to repair and replace?

Considerations for paving the following year

- Project schedule impacts: Are there reasons that carry over of this project would cause problems with the staging of other projects?
- There may be additional considerations, but these are some items to think about when considering using an SPV to carry over the construction project to the following construction season

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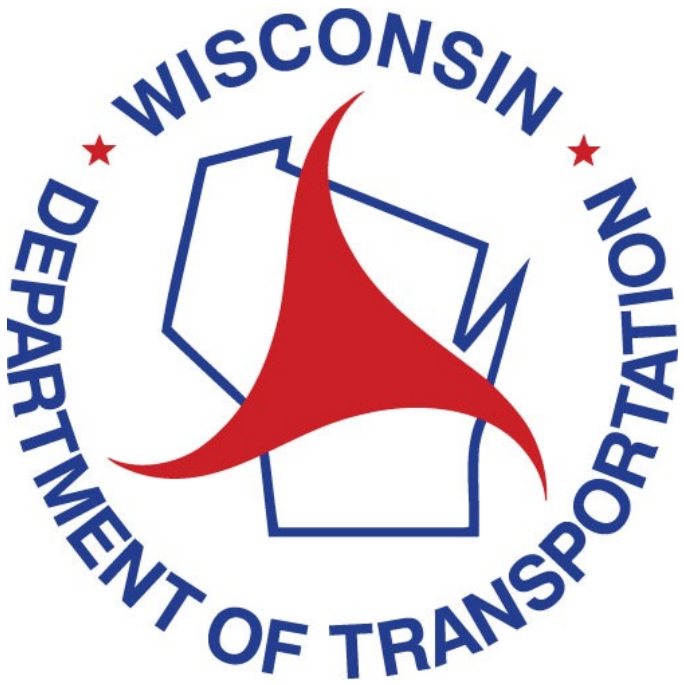
WisDOT Specifications for Construction

WisDOT Standard Specifications Construction Maintenance Manual (CMM)



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WisDOT Standard Specification 450

KEY TAKEAWAYS:

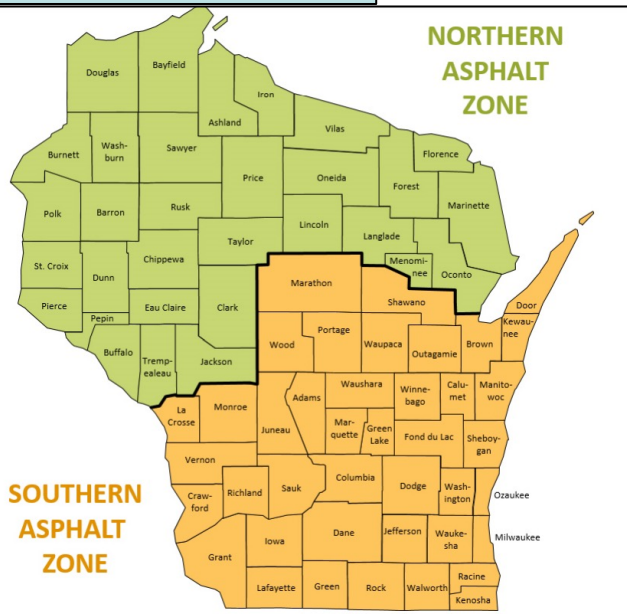
- Don’t pave upper layer <36 F
- Don’t pave lower layer <32 F

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Pave northern zone May 1 - October 15
- Pave southern zone April 15 - November 1

The project team and contractor should make a concentrated effort to make sure paving takes place during the acceptable paving times (CMM 458.10)



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WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Don’t pave on frozen or unstable ground

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450.3.2.1.2 Cold Weather Paving

KEY TAKEAWAYS:

- Quality is the contractor's responsibility while continuing to adhere to all specification requirements

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Submit a cold weather paving plan when <40 F

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Use warm mix additive as a compactive aid from the Approved Product List
- Identify additive and dosage used
- Identify modifications to compaction when needed

Load tickets will identify when the cold weather paving item is in effect (CMM 458.10.1(2))

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Warm Mix Additives-Compactive Aid

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How does the WMA additive work

- WMA technologies reduce the viscosity of the asphalt binder so that aggregates can be coated at lower temperatures
- Reducing the viscosity also makes the mixture easier to compact at lower temperatures

Keeps the mix workable longer

WMA Additives

- Most can be added at the asphalt terminal or added at the plant
- Chemical additive dosage rates depend on the selected additive and purpose of the mixture
  - Compactive aid
  - Mix temperature reduction

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Paving plan must be accepted in writing by the Engineer

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Do not pave <40 F without approved cold weather paving plan

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- 24 hours prior to paving, if forecast is <40 F
  Engineer validates plan for paving

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Once plan is validated, it remains in effect for that day regardless of temperature

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Cold weather paving is a bid item paid by the ton

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- Bid item covers all costs incurred to adhere to paving plan

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- If lot density is not achieved, the cold weather item is not paid
- The item is not paid if liquidated damages are being assessed

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- No disincentives assessed for density or ride, relief given for cold weather damage/defects if there is an excusable compensable delay and paving occurs below 36 F for upper layers and 32 for lower layers

WisDOT Standard Specification 450

KEY TAKEAWAYS:

- If paving is done in cold weather conditions <40 F and item is not in the contract, it is to be paid for as extra work
- The mixture is paid for under the appropriate 460/465 bid items

CMM 458

KEY TAKEAWAYS:

- The main concern regarding cold weather paving is being able to achieve density

CMM 458 General Rules

- If temperatures 24 hours in advance look like they will drop below acceptable paving temperatures, no paving is to occur (or not until required temperatures are met-and still allow for anticipated production tonnage). For temperatures below 40F (but > 36F for upper layer, and > 32F for lower layer), a cold weather paving plan is to be in place and full specifications apply.
- In all cases, conversations need to occur between the project engineer the day before paving, and before production starts for the shift on the day of paving. This conversation is to ensure both parties are in agreement on the operations and if the cold weather paving bid item is in effect or not.

CMM 458 General Rules

- Standard Spec 108 discusses how to handle adverse weather in the contracts and applies to cold weather for paving as well.
- Use of warm mix additive as a compaction aid will help with compaction of the mix above 40F, and should be considered as appropriate, and agreed to by the project engineer and the contractor in advance.
- Contract schedule and future forecast should not be used to limit when the contactor can pave using the cold weather paving item. There are many times near the end of the construction season when several contracts need to be completed, and not all of them can wait for ideal conditions to pave.

CMM 458 General Rules

- Ideally, all paving will be completed above 40F, and the cold weather paving provisions will be rarely used. Interim completion dates for paving items, mandatory start dates for contracts, and project completion dates should all be used to minimize asphalt paving in early spring or late fall conditions.

CMM 458.10 Cold Weather HMA Paving

40F or Above

Upper Layer Normal Paving

Lower Layer(s) Normal Paving

< 40F to > 36F

Upper Layer Pave with Cold Weather Plan

Lower Layer(s) Pave with Cold Weather Plan

< 36F to > 32F

Upper Layer NO PAVING

Lower Layer(s) Pave with Cold Weather Plan

Below 32F

Upper Layer NO PAVING

Lower Layer(s) NO PAVING

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Cold Weather Paving Examples

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CMM 458 Example #1

Temperature 24 hours in advance: Over 40F

Actual temperature day of paving: Below 40F

Discussion: If the forecasted temperatures are close to 40F, discussions should take place between the department and contractor regarding how long the temperatures look to be below 40F, and whether or not the start time needs to be adjusted. A cold weather paving plan should be confirmed or revised as needed. If paving below 40F, the cold weather paving plan is in effect. The cold weather paving plan would be in effect with full specifications, and the cold weather paving item would be measured and paid for accordingly.

CMM 458 Example #2

Temperature 24 hours in advance: Over 36F

Actual temperature day of paving: Below 36F

Discussion: If the forecasted temperatures are close to the 36F allowable temperature, discussions should take place between the department and contractor regarding how long the temperatures look to be below 36F, and whether or not the start time needs to be adjusted. Regardless, upper layer paving is not to occur until 36F is reached. Additional conversation between the department and the contractor should occur before loadout. Once temperatures are reached, the paving plan is in effect and remains for the entire day with full specifications.

CMM 458 Example #3

Temperature 24 hours in advance: Over 32F

Actual temperature day of paving: Below 40F, but over 32F

Discussion: Cold weather paving plan is in effect and remains for the entire day with full specifications. The tonnage placed is calculated and the cold weather paving item is measured and paid.

CMM 458 Example #4

Temperature 24 hours in advance: Below 40F

Actual temperature day of paving: Above 40F

Discussion: Paving is to occur as planned. Additional conversations should occur between the department and the contractor before production starts to ensure both parties are on the same page. If the project engineer and contractor agree to pave under the cold weather paving plan in advance, and the contractor has already added the warm mix additive to the tanks of PG Binder, the project engineer and contractor will discuss how to proceed and whether or not payment for the cold weather paving item is reasonable.

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Paving in Cold Weather

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Cold Weather Compaction (heat loss)

- The following list summarizes the primary factors influencing the rate of heat loss in HMA
  - Lift thickness-thicker lifts hold temperature longer than thinner lifts. The heat retained in asphalt lifts is not a linear relationship, but an exponential one.
  - Base temperature-the heat, or thermal energy stored in the HMA, quickly transfers to the cold base as the system tends toward thermal equilibrium.

Cold Weather Compaction (heat loss)

- Mix delivery temperature-provides a starting point for the cooling process after the HMA comes in contact with the base layer.
- Ambient air temperature- has a relatively minor influence on the cooling rate of HMA. However, if the ambient air temperature is combined with wind, a condition of both conductive and convective heat transfer occurs. Heat is now being lost to the base through conduction and to the air through convection.

Cold Weather Compaction (heat loss)

- Solar-radiant flux-refers to the net heat loss from the pavement that is the difference between the heat absorbed by the pavement from the sun’s rays and the heat that radiates off the mat into the air.

CMM 458 Compaction Time

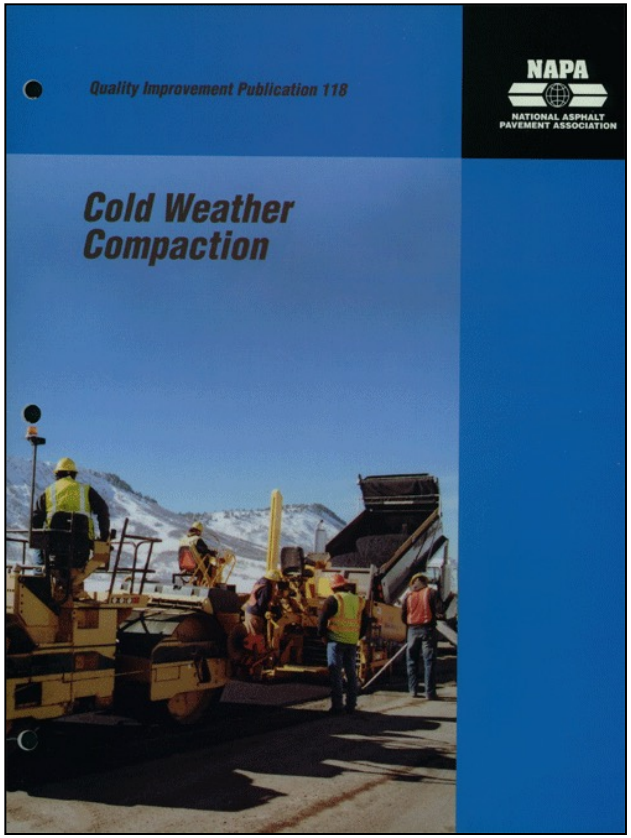
- It is generally accepted that thicker pavements cool slower than thinner pavements resulting in a longer compaction time window. Increased wind speed can also lead to a quicker cooling of the layer. These variables (and others) can be input into the Multicool software http://www.asphaltpavement.org/multicool to see the effect on the necessary compaction time. This software can be used by the contractor and, as necessary, engineer to monitor the effectiveness of the cold weather paving operations.

Cold Weather Paving Suggestions

- Roll longitudinal joints as quickly as possible to avoid shrinkage cracks
- Keep the screed hot – should be within 75 degrees of the mix temperature
- Establishing and maintaining consistent cycling of trucks at the plant and the paver
- Work to maintain continuous paver speed
- Paver should run continuously, at a constant paving speed, for the entire shift.
- Adjust the compaction operation to achieve optimum density in a shorter period of time

Cold Weather Paving Suggestions

- May see the largest rollers used for breakdown and intermediate rolling
- Running two rollers doubles the compactive effort that is offered in a given amount of time



CMM 458 Possible items in Paving Plan

- Avoid handwork or feathering of the HMA mix
- Adjustments could be made to the mix temperature per the PG binder and WMA additive manufacturer production temperature recommendations
- Use heated or insulated boxes on trucks hauling asphalt

- Tightly tarp the loads for longer hauls and to prevent exposure to the elements, as loose, flapping tarps may actually increase heat loss
- Use of transfer device may be helpful

CMM 458 Possible items in Paving Plan

- Using more or higher capacity rollers such as rubber-tired rollers. However, measures are needed to prevent tracking of the asphalt when using rubber-tired rollers, and heating the tires is recommended. The rollers can be fitted with skirting around the tires.

- Keep the rollers as close to the paver as possible

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Cold Weather Paving Observations

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CMM 458 Paving Observations

KEY TAKEAWAYS:

- If base is unstable, inadequately compacted, or frozen, don't pave
- If being overlaid, ensure underlying pavement is dry
- Confirm the cold weather paving plan meets requirements with written acceptance
- At close of business and prior to next shift, determine if contractor is allowed to pave

CMM 458 Paving Observations

KEY TAKEAWAYS:

- Tickets will identify cold weather mix design used
- Same mix design will be used all day
- Ensure adequate mix temperature
- Document any additional steps contractor made to comply with the cold weather paving plan

CMM 458 Paving Observations

KEY TAKEAWAYS:

- Rollers should be close to the paver, but not over compacting the mix

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Asphaltic Mixture for Extreme Conditions

STSP 450-010

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CMM 458 General Rules

- Also note, that paving below 32F should not occur, unless under an emergency or temporary traffic control situation. STSP 450-010 for extreme cold weather paving is used only for temporary traffic and staging conditions, and should not be used as an extension of the paving season.

Asphaltic Mixture for Extreme Conditions STSP 450-010

- In extreme cases, the STSP should be used on a project-by-project basis and approved by FHWA. It must be included for those projects that have paving occur within the following:
  - Northern Asphalt Zone from November 1 - April 15, or
  - Southern Asphalt Zone from November 15 - April 1

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Asphaltic Mixture for Extreme Conditions STSP 450-010

- This can happen by design, during construction as an excusable compensable delay, or by request of the contractor. Paving station limits must be identified. The STSP is only to be used for traffic control, temporary pavements or in emergency situations. Permanent pavement is not to be constructed under this STSP.

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Conclusions

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Conclusions

- The intent of the Department is not to pave asphaltic material during cold weather
  - However, there will be situations where paving needs to occur during cold weather
  - The project team and contractor should make a concentrated effort to make sure paving takes place during the acceptable paving times
- A cold weather paving plan must be in effect prior to placement when temperatures go below 40°F

Conclusions

- The cold weather plan requires a WMA additive to be used to aid in compaction
- Good communication between project staff and the contractor is critical to the success of cold weather paving

Conclusions

- Paving crews that get the mix to the job site in a timely fashion; keep the trucks cycling at the plant and paver consistently; keep the paver moving all day at the same speed and get the maximum compactive effort in the shortest amount of time will find success even under adverse conditions

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Questions

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Thank you

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