Balanced Mix Design Question and Answer

BACK TO THE BASICS

February 13th and 14th, 2025

Q# 1 – What sampling and testing procedures are required for the new BMD Specification?

- LOT Size Designation – 6,000 Tons
- Max Sublot Size – 1,500 Tons
- 4 Quality Control Tests need different random numbers generated @ different tonnage.
- 2 Quality Control continuous data coverage.
- 6 Quality Assurance Test need different random numbers generated @ different tonnage.
- Random #s **WILL** overlap!

Pay Factor Overview

Density

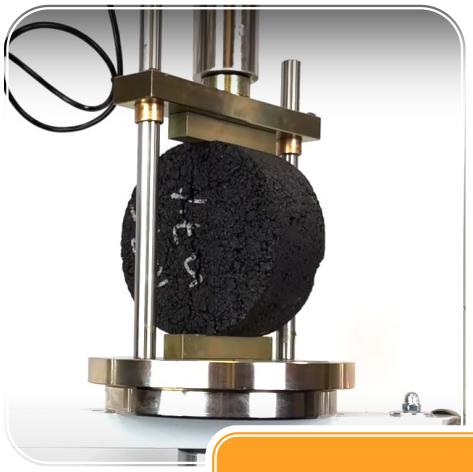
% AV

% AC

$$PF_T = + (0.5)\, PF_{Density} + (0.25)\, PF_{Va} + (0.25)\, PF_{AC}$$

- Maximum PF_T Incentive = 3 %
  - Max $PF_{Density}$ = 1.5 %
  - Max PF_{Va} = 0.75 %
  - Max PF_{AC} = 0.75 %

Pay Factor Overview



CT_{Index}

PMTP

Smoothness (IRI)

- Max CT_{Index} Incent. = 3 %
  - Passing TSR Result
  - Passing RT_{Index} Result

- Max PMTP Incent.= 2 %
  - Low Segregation
  - $40 per 150 lin. Ft ~
  - 2 % for a 2-inch overlay

- Max IRI Incent =
  - 3% for percent improvements
  - 5 % for new construction

QC & QA Testing Overview

- QC/QA BMD Random Samples @ Plant
- QC/QA Volumetrics & % AC Random Samples @ Plant
- QC/QA TSR Random Samples @ Plant
- QC/QA Mat Density & Unconfined Long. Joint Random Cores in the Field
- QC PMTP – Continues Data in the Field
  - QA FLIR Random Images
- QC IRI Profiler – Continues Data in the Field
  - QA Random IRI Profiler check

QC BMD Random Sampling

TEST	FREQUENCY	MIN. NO OF SPECIMENS
QC – CT_{Index}	1 Set per 3000 tons (2 Sets per Lot)	5 Compacted Specimens
QC – RT_{Index}	1 Set per 3000 tons (2 Sets per Lot)	3 Compacted Specimens
QC – BMD Loose Mix Retained	125 lbs per 3000 tons	Retained by Contractor
QA – BMD Loose Mix Retained	125 lbs per 6000 tons	Retained by MoDOT

QC Volumetric Random Sampling

TEST	FREQUENCY	MIN. NO OF SPECIMENS
QC - % AC Content	1 Sample per Sublot	1 Sample
QC - Gmm	1 Sample per Sublot	1 Sample
QC – % Air Voids	1 Set per Sublot	2 Compacted Specimens
QC –Loose Mix Retained	30 lbs per Sublot	Retained by Contractor
QA – Loose Mix Retained	30 lbs per Lot	Retained by MoDOT

Other QC Random Sampling

TEST	FREQUENCY	MIN. NO OF SPECIMENS
QC – Tensile Strength Ratio (TSR)	250 lbs loose mix per 12,000 tons	8 Compacted Specimens

TEST	FREQUENCY	MIN. NO OF CORES
QC – Mat Density	1 Sample per Sublot	1 Core per Test
Unconfined Joints	1 Sample per Sublot	1 Core per Test

TEST	FREQUENCY
QC – PMTP	Continuous
QC - IRI	Continuous

QA Random Sampling

TEST	FREQUENCY	MIN. NO OF SPECIMENS
QA – CT_{Index}	1 Set per 12,000 ton	5 Compacted Specimens
QA – RT_{Index}	1 Set per 12,000 ton	3 Compacted Specimens
QA – %AC, Gmm, % Av	1 Sample/1 Set per Lot	1 Sample Each/ 2 Compacted Specimens
QA – TSR	250 lbs loose mix/Project	8 Compacted Specimens

TEST	FREQUENCY
QA – FLIR	Twice per Day
QA - IRI	Random %

QA Retained Sample Rules

- All Retained QA Loose Mix Material
  - 13” x 13” x 4.5” Cardboard Box to meet Safety Requirements
  - Supplied by MoDOT
  - Roughly provides ~ 40 lbs of Mix

QC Retained ?

Retained Samples

- Contractor and MoDOT Retain BMD Loose Mix material until passing QC and QA RT results are obtained.

QC – RT_{Index}	1 Set per 3000 tons	3 Compacted Specimens
QC – BMD Loose Mix Retained	125 lbs per 3000 ton	Retained by Contractor
QA – BMD Loose Mix Retained	125 lbs per 6000 ton	Retained by MoDOT
QA – RT_{Index}	1 Set per 12,000 ton	3 Compacted Specimens

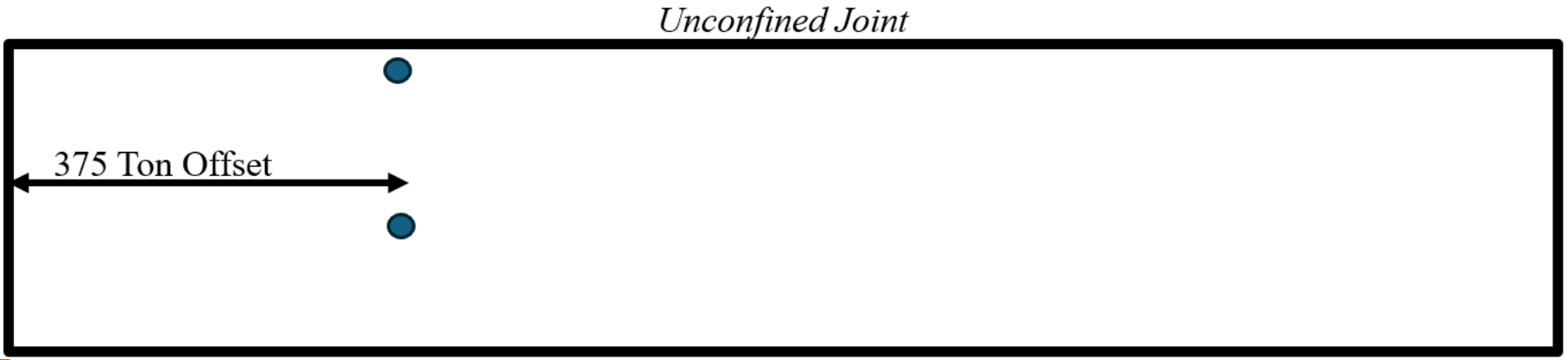
Entity	Quantity per 12,000 tons	~ # Boxes
QC	500 lbs Retained	13 Boxes
QA	250 lbs Retained	7 Boxes

Q# 2 – How are Random #s Used with BMD?

One Random Number Generated for Each of Below Tests		
Random Number	**Test**	**Tonnage**
1	QC – CT and RT Testing	3,000 Tons
2	QC – Volumetrics and % AC	Sublot Size – Set by QC Plan
3	QC – TSR	12,000 Tons
4	QC – Mat Density & Unconfined Longitudinal Joint	Sublot Size – Set by QC Plan
5	QA – CT and RT Testing	12,000 Tons
6	QA – Volumetrics and % AC	6,000 Tons
7	QA – TSR	Once per Project
8	QA – Mat Density & Unconfined Longitudinal Joint	6,000 Tons

Q# 3 – Can Mat Density and Unconfined Long. Joints be Sampled at the Same Time?

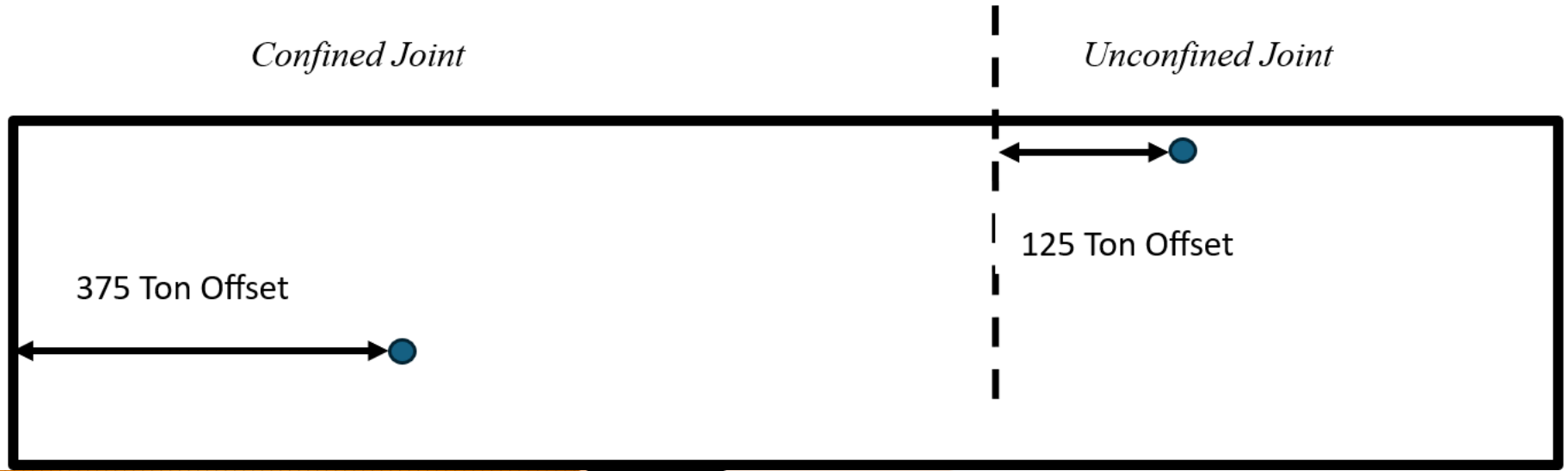
- YES!
  - Limits Work zone Exposure
  - Does not break rules from the “Randomness” of statistics.



But what if Unconfined Joint is Intermittent Throughout Project?

- The same random number for mat density is used to determine the location of the unconfined joint. Unconfined joints are offset based on tonnage.
- Pay adjustments/corrections only apply to the full width adjacent to the unconfined joint.
- If less than 200 tons of unconfined joint area – No coring is required.

Example - 1,500-ton sublot with a random number of 0.25. 1000 tons of sublot have a confined joint and 500 tons of sublot have an unconfined joint. For density core 0.25 x 1,500 = 375 tons offset. For unconfined joint density core 0.25 x 500 = 125 ton offset.



Q# 4 – What happens if a Random Number falls at the same time?

- Sampling and sample fabrication will be conducted in the order received!
  - Contractor will be allowed to complete one of the test first, then immediately sample/fabricate samples for the 2nd test thereafter.
  - The contractor can choose to hold on to loose mix sampled for volumetric testing until after the BMD testing is complete.
  - Once sampled, BMD testing needs to be completed without interruption.

Q# 5 – If a random number falls at the end of the paving shift, can the BMD random be moved up?

- Yes, not ideal for statistical randomness, but necessary due to the time and effort required.
  - Recommending a 2-hour tonnage offset when BMD random comes up at the very end of a paving shift.
  - Good QC/QA communication needed on the daily production rate.

Q# 6 – What BMD sampling methods are allowed?

- Follow AASHTO R 97
  - Sampling from Conveyor Belt
  - Sampling from Transport Unit (i.e. Truck)
  - Sampling from a flat surface of a Stock-Pile
- Beware of grabbing samples from the silo chute
  - Segregation can easily occur.
  - Recommend a continuous flow from beginning to end for this method.
- Sampling from multiple trucks or from different times is not needed.

Q# 7 – How much notice needs to be given for BMD testing at the plant?

- Random Number Notification is Immediate.
- MoDOT's intent is to start sampling immediately when the random tonnage is reached.
- Exceptions are permitted!
  - Contractor allowed to finish informational or a previous random sampling test prior to starting the new test.
  - Start sampling the new random test as soon as practical.
- No plant adjustments shall be made after being notified of the new random test until sampling has been completed.

Q# 8 – Can the contractor make plant adjustments after being given a random testing notification?

- ABSOLUTELY NOT!

THERE ARE EXCEPTIONS!

- If a random number falls at the very beginning of the day at plant start-up, the contractor should be allowed to make plant adjustments to improve quality and better represent the asphalt material of the entire sublot. As a rule of thumb, MoDOT should allow 150 tons prior to issuing the random number at plant start-up.

Q# 9 – How does MoDOT use informational test results taken outside of random numbers?

- Used to test quality of isolated areas that QC/QA random tests do not capture.
- Can be used to identify, quantify, and determine limits of any needed corrections.
- Informational test has no impact on pay factors.
  - Total tonnage may be adjusted within PWL calculations based upon the informational test results.
  - Informational Testing During Plant Start-Up - MoDOT informational testing limited. More emphasis should be placed on getting adequate field density with minimized segregation.

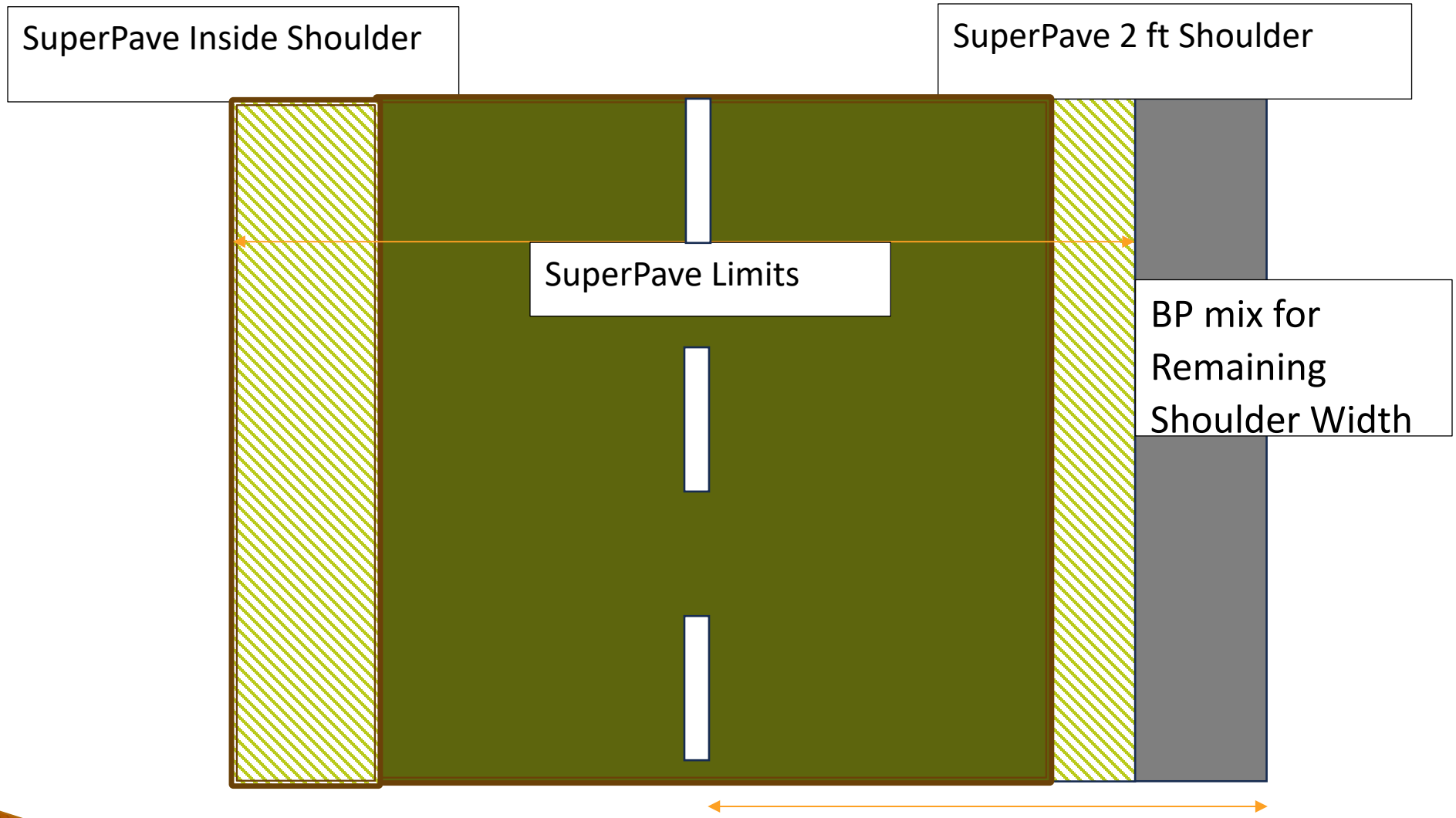
Q# 10 – When is split sample testing Utilized?

- Split samples - Ensure that the proper sampling, handling, and testing procedures are being followed by both QC and QA.
  - Accurate Results Obtained / Favorable Comparisons
  - Ideally started early in the project to head off issues
- Also requested when QA missed witnessing a QC sample. QA may request to test the retained portion as a check since no inspection was done.

Q# 11 – Procedures for when QC and QA BMD tests do not compare.

- QC/QA Favorable Comparisons:
  - QC/QA CT_{Index} within +/- 30 points for SuperPave; +/- 60 points for SMA.
  - All SuperPave CT_{Index} results > 80; All SMA CT_{Index} results > 190.
  - QC/QA RT_{Index} results within +/- 15 percent.
  - All RT_{Index} results greater than minimum threshold.
- When QC/QA CT_{Index} or RT_{Index} or DO NOT compare?
  - Check sampling and testing errors by either party.
  - CT_{Index} - QA results are added to the QC results.
  - RT_{Index} – QC and QA runs Hamburg test to resolve discrepancy.

Q# 12– Inspection Scenarios for Section 403



Section 403 Incentives/Disincentives Clarified

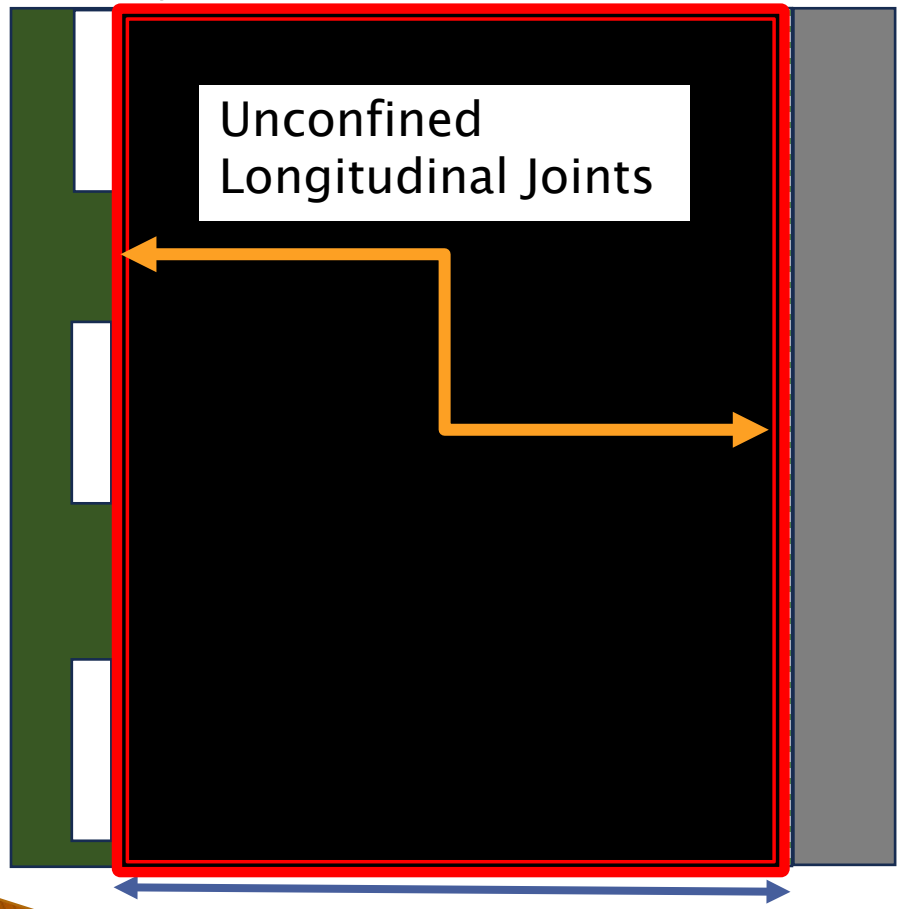
- Density, % AC, VMA, % Av, TSR, and BMD incentives/disincentives apply to all SuperPave mixes shown on the typical sections.
- Section 401 (BP mixes) apply to the areas that show BP on typical sections.
- Section 610 Smoothness incentives/disincentives apply to the travel way only.

Density Requirements Clarified

- The mat density of the travel way shall be between 92.5% and 98.0% of Gmm.
- Mat density shall be taken from travel way and not from shoulder areas (Sec 403.5.2.2).
- Shoulders are considered Non-Traffic Areas and density is in accordance with Sec 403.15.3.
  - MoDOT wants to reach density for the mixture (92.0% of Gmm); especially new construction.
  - Underlying layer issues – Density requirements relaxed and a rolling pattern established to achieve optimum density.
  - Once rolling pattern confirmed to achieve optimum density, the density testing may be waived at the discretion of the engineer.

Q # 13 -Unconfined Joint Density Clarified

SuperPave on 12-ft travel way and 2 ft Shoulder



Ex. 2 – 1st Pass of Paving Operation at 14 ft wide.

- **Covered in Section 403.1.1.1 – Unconfined Longitudinal Joint Density Adjustment**
- Only the unconfined joint near the centerline is held to joint density requirements ~ 90.5% for SP and 92.0% for SMA.
- There is no density requirement for the unconfined shoulder joint because it is not in the travel way.
- The unconfined shoulder joint gets the same compacted effort as the shoulder.

Q# 14 – The plans show a ¾” coldmill with a 2” overlay. Is the longitudinal joint considered confined or unconfined?

- HEY NAPA?
- For any partial coldmilling (coldmilling depth less than asphalt lift being placed); the longitudinal joint is considered unconfined; and unconfined longitudinal joint cores would need to be cored and tested to meet specified density.

Q# 15 – Does corrective action on longitudinal joints such as using an RPE make you eligible for full bonus?

- Low density on longitudinal joint cores now requires the application of a rapid penetrating emulsion (RPE)
- Answer: No, as written in the spec corrective action gives 100% pay factor for PF_T
- Milling and Replacing does allow for full bonus but entire sublot is required to be milled.

Rapid Penetrating Emulsion

Longitudinal Joint Density	
Field Density (Percent of Laboratory Max. Theoretical Specific Gravity)	Percent of Contract Unit Price
SuperPave Mixtures	
≥ 90.5	PF_{Total} not changed by longitudinal joint density
89.5 – 90.4	Maximum **PF_{Total} = 100%;** Correction Required[(a)]
< 89.5	Remove and Replace
SMA Mixtures	
≥ 92.0	PF_{Total} not changed by longitudinal joint density
90.0 – 91.9	Maximum **PF_{Total} = 100%;** Correction Required[(a)]
< 90.0	Remove and Replace

(a) Correction requires spraying rapid penetrating emulsion on deficient density areas in accordance with JSP2303. All costs associated with correction shall be at the contractor's expense with no additional payment.

Q# 16 – When new asphalt is required to be removed and replaced, is new performance testing required?

- All replacements over 6,000 tons must be fully tested
- Replacements under 6,000 tons depends on the reason why it must be replaced
- If the material is being rejected due to failed performance testing, then new performance testing is required.

Q# 17 – Does the department have a preference between load frames that are hydraulic or screw driven?

- There is no specification requirements for types of load frames or manufacturers of the load frame.
- MoDOT Districts will have all Instrotec load frames for the near future

Q# 18 – How will Mix ID's be handled with binder source changes moving forward?

1. If the virgin binder source changes but the virgin binder grade stays the same,
   - The current Mix ID will be given a letter at the end
2. Virgin binder grade changes or the mix is used for a different contract grade
   - New Mix ID given and new BMD testing required.
   - Volumetric testing will not be required for the new Mix ID

Q# 19 – Combining tonnage at the end of the project for BMD testing

- **This only applies to the last partial tonnage at the end of a project**
- CT & RT max represented tonnage is 4,500 tons
- TSR max represented tonnage is 18,000 tons
- Volumetric max sublot size is 2,500 tons

Q# 20 – Small Quantity Clarification

- The Spec defines Small Quantity as any Line Item under 6,000 tons.
- Still allow short sections of pavements (ex. Tie-ins) when the total tonnage for the day is planned to be under 1,000 tons to be accepted as small quantity.

Q#21 – How to handle segregation identified by the PMTP?

- The PMTP Veta file may be used as a tool by the project office to locate areas of thermal segregation.
- If segregation is not visible, then remedial action is not warranted.
- In the event of a dispute, segregated areas must be quantified by nuclear density method.

Q# 22 – How to handle PMTP loss of data due to equipment malfunction.

- The contractor is required to make a reasonable effort to resolve the issue immediately.
- If the issue can not be resolved immediately the contractor will be allowed to continue paving without receiving incentives for the PMTP data.
- If the issue continues for multiple days, it is recommended that the RE receive a time frame from the manufacture of when the PMTP can be replaced.
- The contractor has that time frame to get the PMTP replaced before all paving operations shall be halted until the PMTP is replaced

Q# 23 – Clarification to implement Nuclear Density testing in leu of Coring

- Contractors have the option to use nuclear density testing in leu of coring for density bonus
- However, the contractor is still required to cut a core for QA density testing.