2023 APAM Conference Hot Mix Asphalt (HMA) Update

NATHAN MAACK

HMA OPERATIONS

MICHIGAN DEPARTMENT OF TRANSPORTATION

CHUCK MILLS

ASPHALT PAVEMENT ASSOCIATION OF MICHIGAN

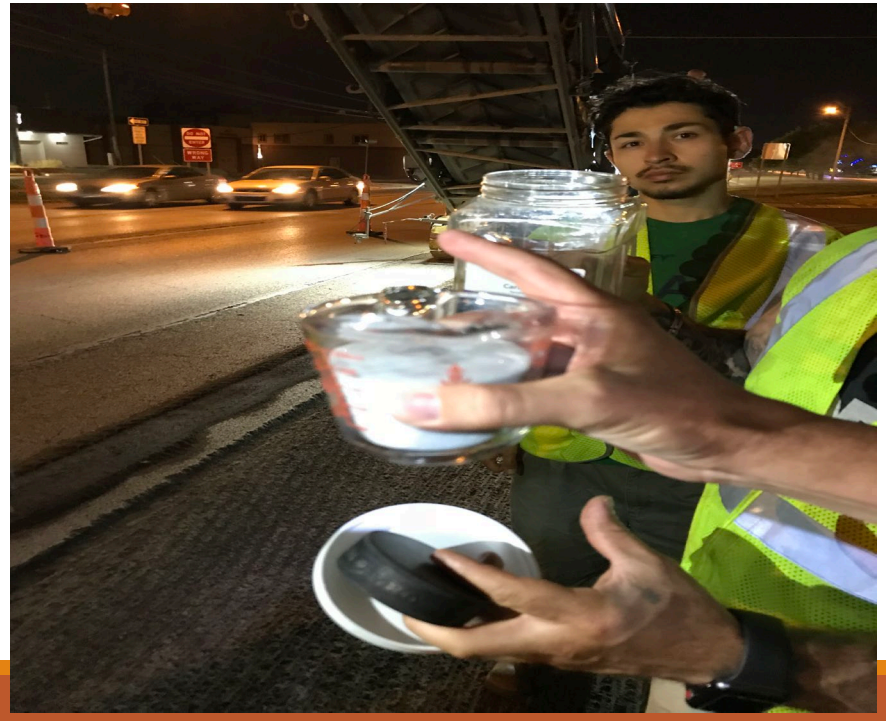
FEBRUARY 22, 2023

Fine Texture Pavement Milling

- FUSP 501J Combined with Micro Texture Milling
- For use on trunkline, one course, non-freeway mill and resurface projects
- Where the existing pavement condition allows for traffic to be maintained on the milled surface for up to 72 hours
- Allows for an increase in production paving and expedited project schedules
- Has a shorter paving train and requires fewer trucks in the work zone

Fine Texture Pavement Milling

Ensure the milling operation is providing an acceptable surface texture by achieving a maximum Macro texture of 0.08 inches thickness according to ASTM E 965.



Measuring Pavement Density

❑ Density Profiling System (DPS)

- Nondestructive, GPR-based technology
- Measures in-situ **dielectric** values
- Allows for on-site continuous evaluation of relative compaction effectiveness
  - ➢ For full surface layers and/or longitudinal joints

DPS Technology

- A GPR antenna transmits and receives electromagnetic pulses
- Reflected pulses from asphalt surface is recorded (at ~ 1.5” depth)
- HMA **Dielectric Constant (DC)** is calculated

  - ✓ HMA **dielectric constant** ranges from **3 to 6**, depending on its components (air, asphalt binder, and aggregate)
  - ✓ Binder DC ~2.6 to 2.8
  - ✓ Aggregate DC ~ 4.5 to 6.5

constant per mix type

  - ✓ Air DC

variable per compaction effort (air voids%)

DPS Technology

- Real-time **dielectric constant (DC)** correlate to real-time **asphalt density**

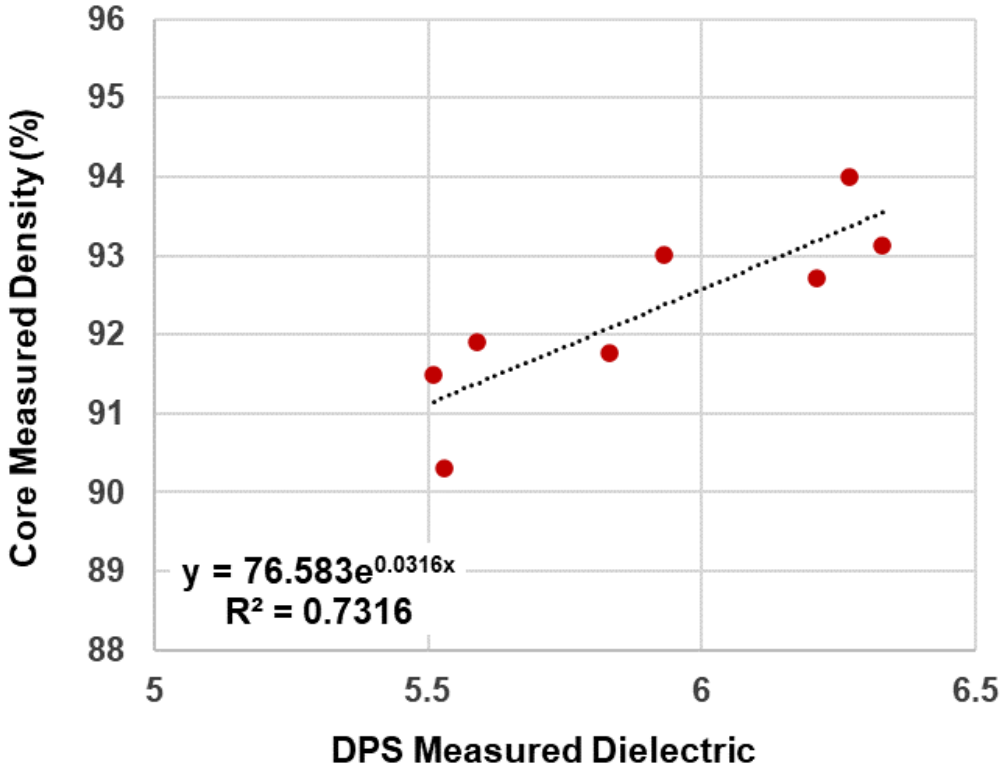
Low Dielectric Value

↓

Higher Air Void Content

↓

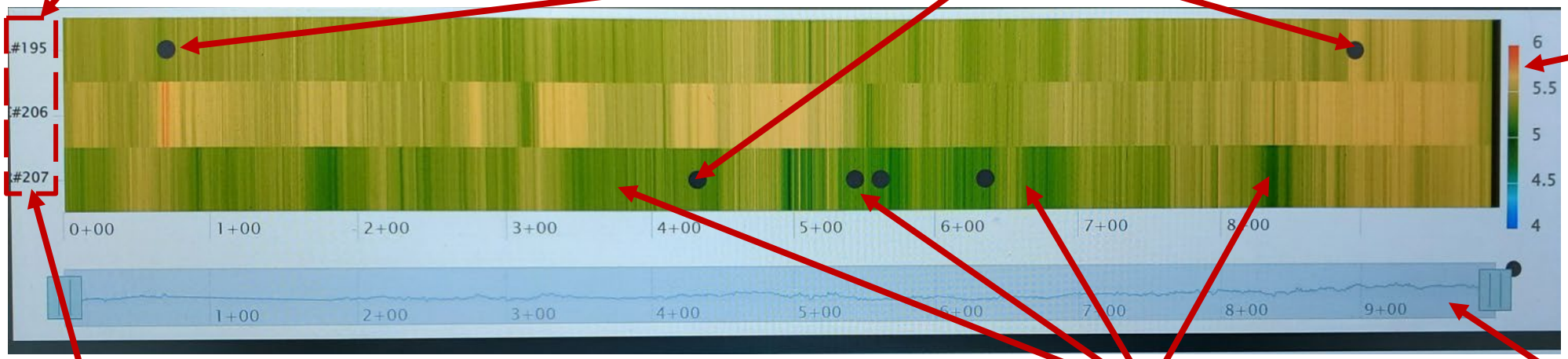
Lower Density



MDOT: US-31 (Holland)

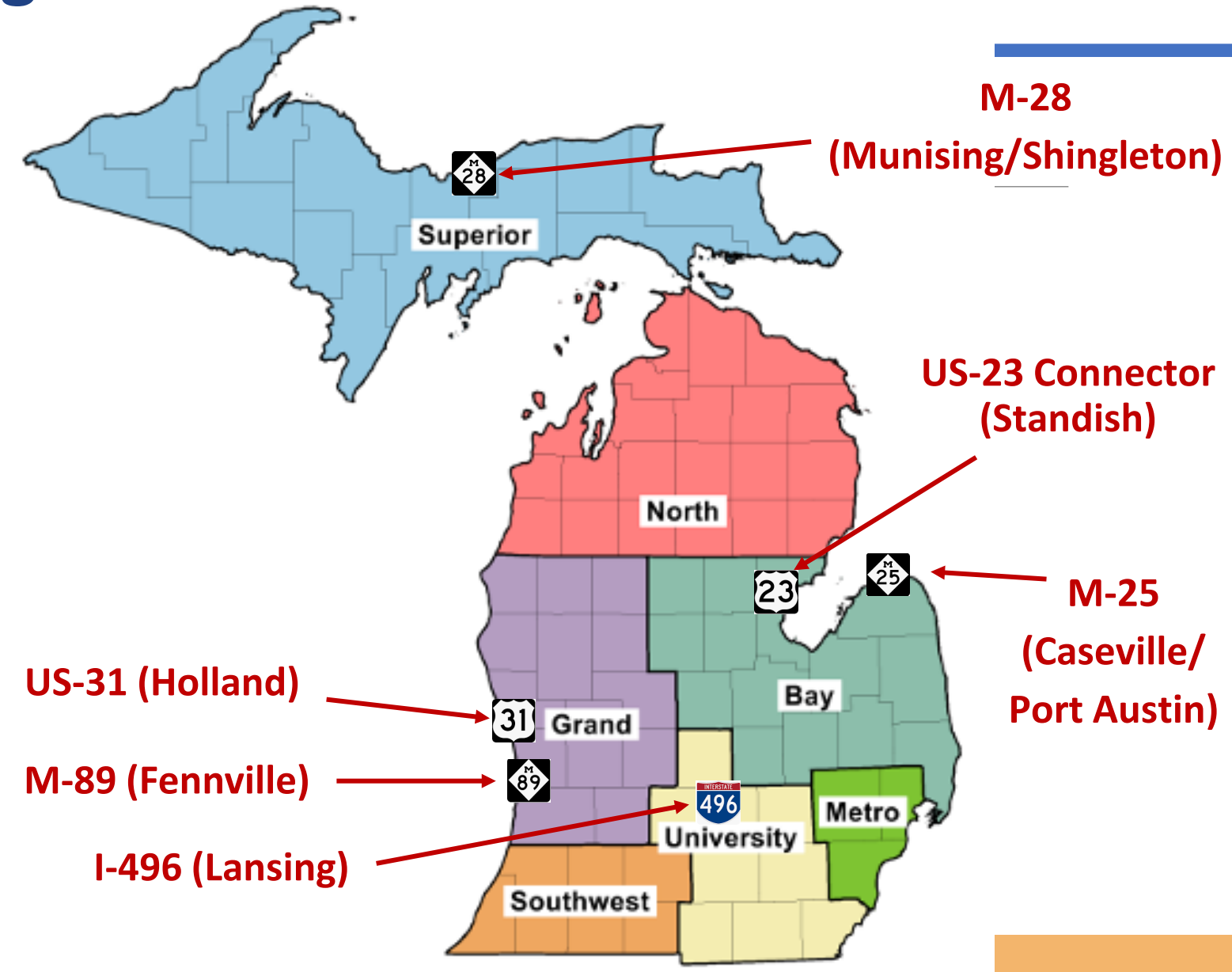
Example DPS Data Outputs

Low Dielectric Value → Higher Air Void Content → Lower Density



MDOT's 2022 DPS Testing

- **Six projects**
  - 1,000 ft of HMA surface layer
- **Five different mix types**
  - SMA, 5EMH, 5EML, 5EL, 4EMH
- **Three different long. joints**
  - Cold joint
  - Hot joint (Echelon paving)
  - Tapered joint
- **Dielectric – Air Voids**
  - Correlation from field cores

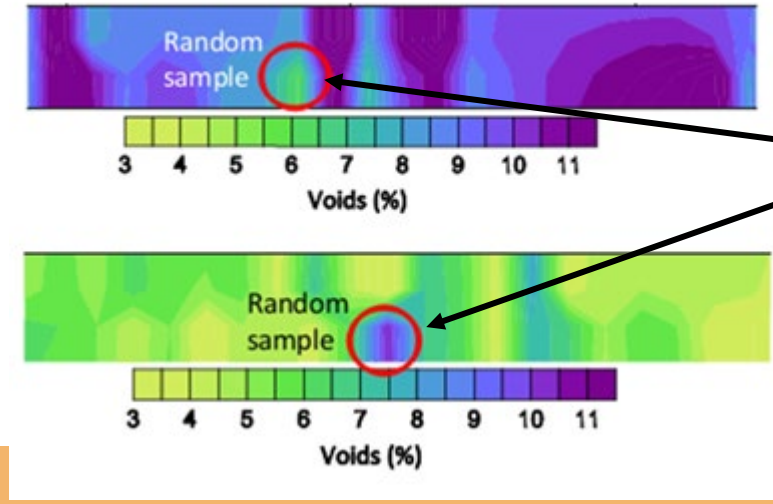


DPS Benefits

- A **non-destructive**, **continuous**, and **efficient** method to complete the QA/QC process
  - ***Non-destructive***: QA/QC of new pavements without coring (or reduced coring)
  - ***Continuous:*** Real-time continuous assessment of relative compaction effectiveness (identify high and low compaction areas)
  - ***Efficient:*** Can be operated without extensive training
    ~100% coverage of the constructed layers

✓ Minimize Agency Risk

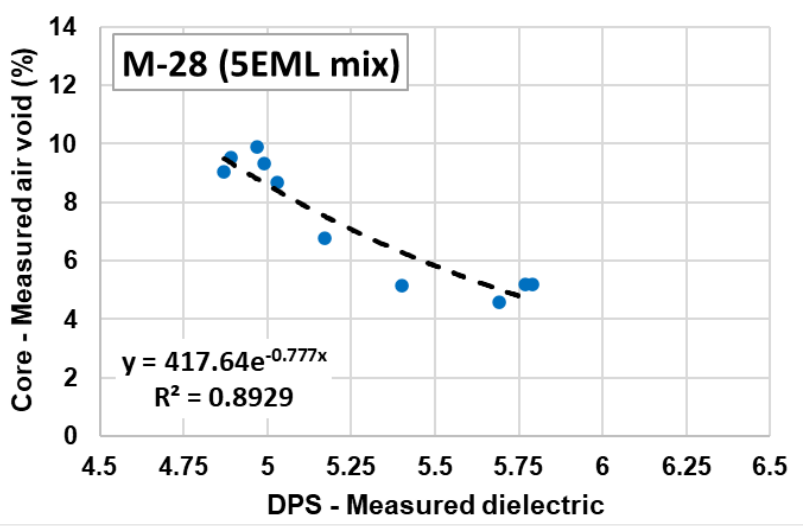
✓ Minimize Contractor Risk

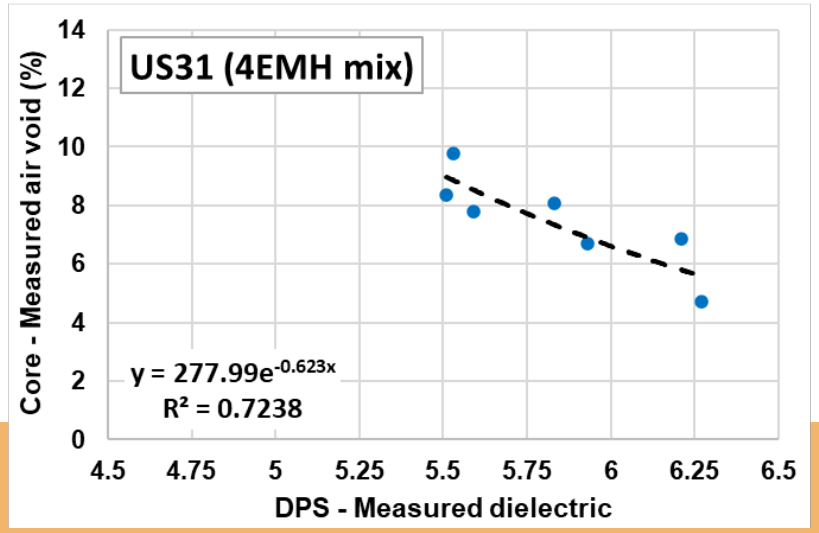


Prevent random sampling from non-representative areas

Core Calibration

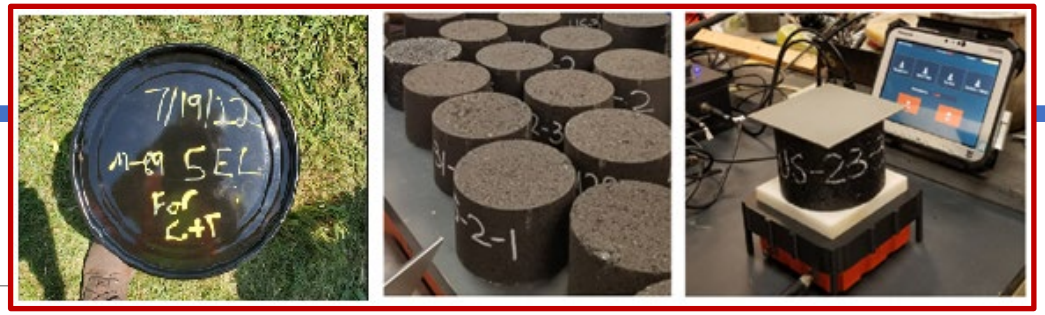
- **Dielectric – % void** relationship is highly dependent on asphalt mix (aggregates and binder properties)
  - Any change in asphalt mix requires a unique calibration curve
  - SMA, 5EMH, 5EML, 5EL, and 4EMH were tested
- DPS suggests core locations (high, medium, and low)



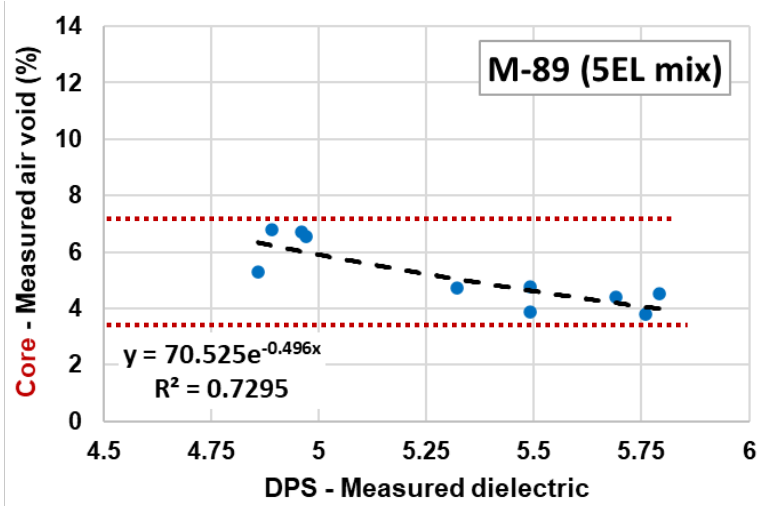


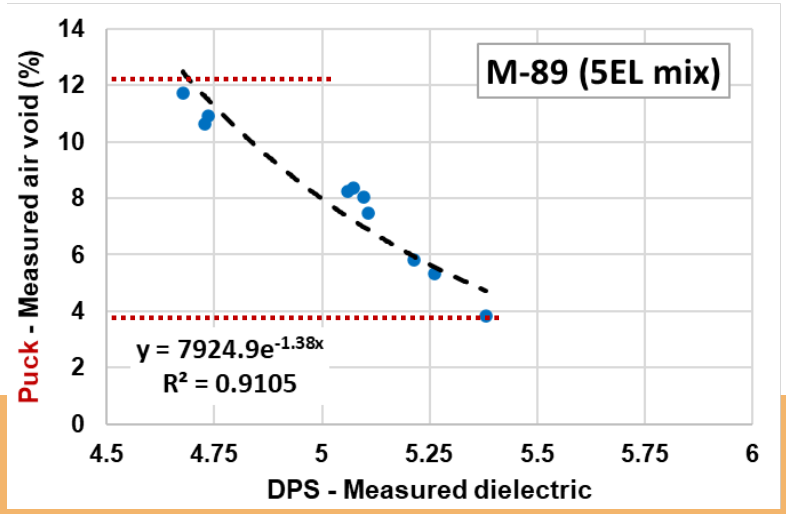
MDOT

Mix Calibration



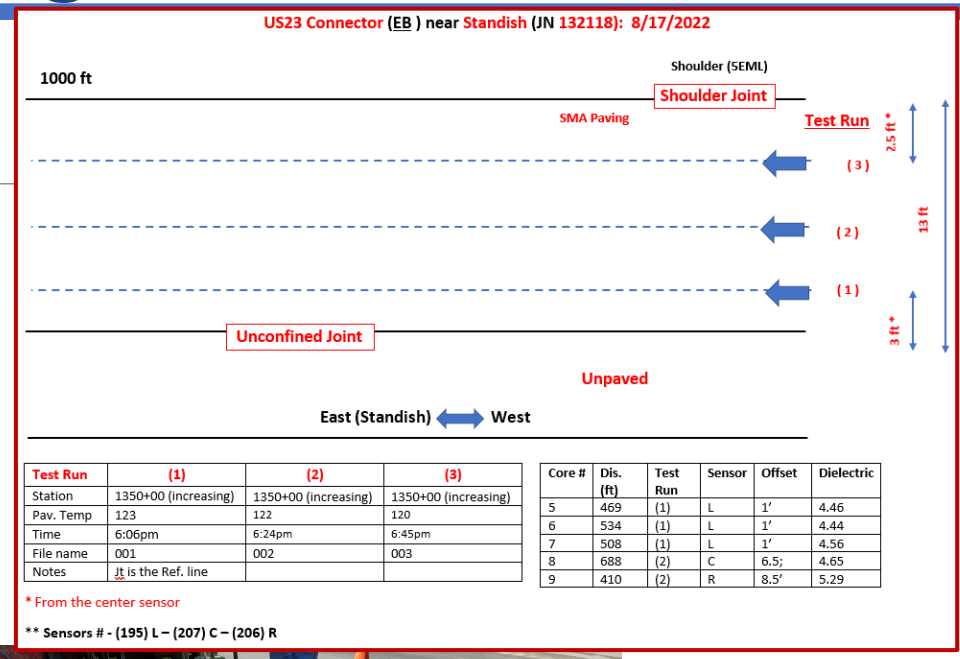
- **Lab (Puck)** calibration is also possible
  - Puck samples from field loose mix
  - Turnaround time (~ 2-3 days)
- Benefits & challenges
  - Robust modeling – a wide range of air void contents
  - No field cores!
  - Minimize field operations disruption
  - Is it a representative of field density?
  - Process is under development by other agencies





Lessons Learned from MDOT Field Testing

- DPS testing is a two-person operation
- Plan testing details ahead of time based on work zone set-up & time available on site (traffic closure, testing pattern, etc.)
- Quick learning curve for field testing
- Testing restrictions/limitations:
  - QC core collection needs to be delayed until DPS testing is complete – possible delays in opening the road for traffic
  - Some areas were excluded from the DPS testing due to the presence of water from coring operations
  - DPS testing speed limitations!



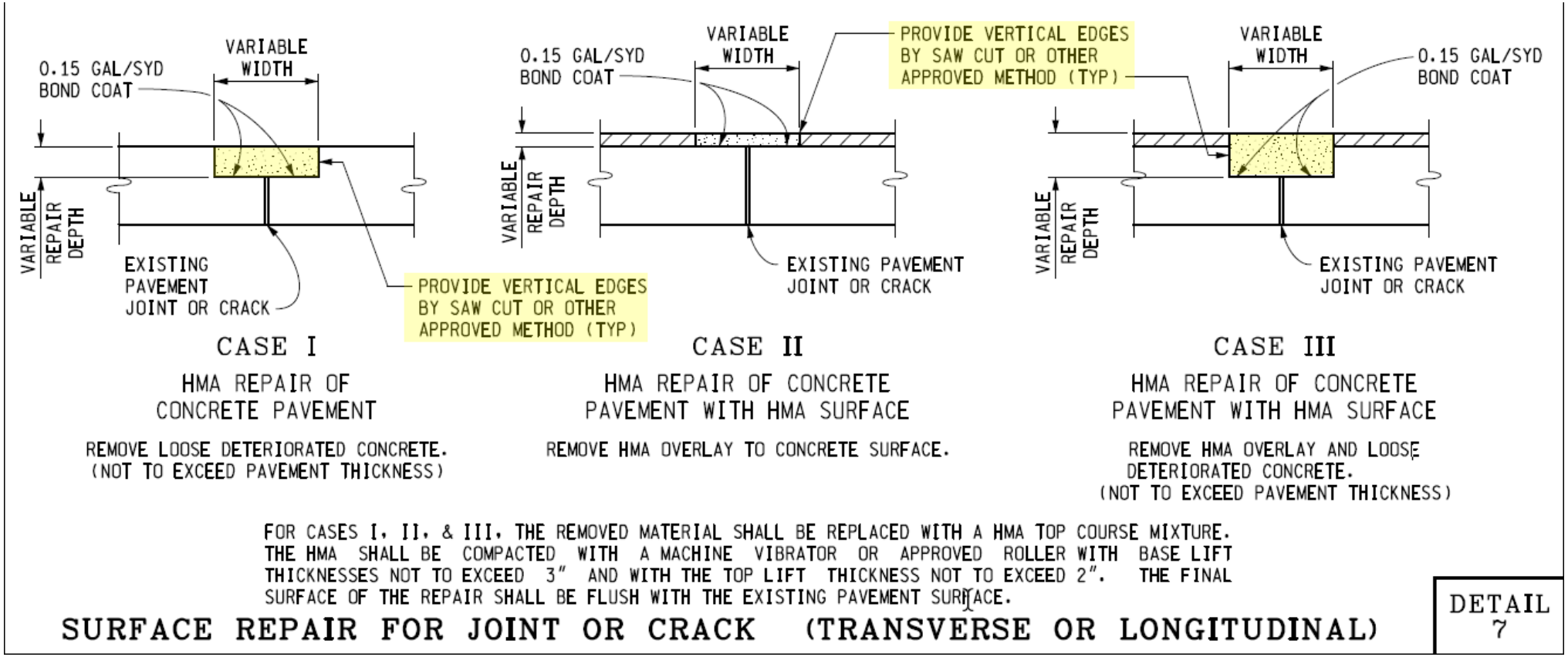
Test Run	(1)	(2)	(3)
Station	1350+00 (increasing)	1350+00 (increasing)	1350+00 (increasing)
Pav. Temp	123	122	120
Time	6:06pm	6:24pm	6:45pm
File name	001	002	003
Notes	Jt is the Ref. line		

Core #	Dis. (ft)	Test Run	Sensor	Offset	Dielectric
5	469	(1)	L	1'	4.46
6	534	(1)	L	1'	4.44
7	508	(1)	L	1'	4.56
8	688	(2)	C	6.5;	4.65
9	410	(2)	R	8.5'	5.29

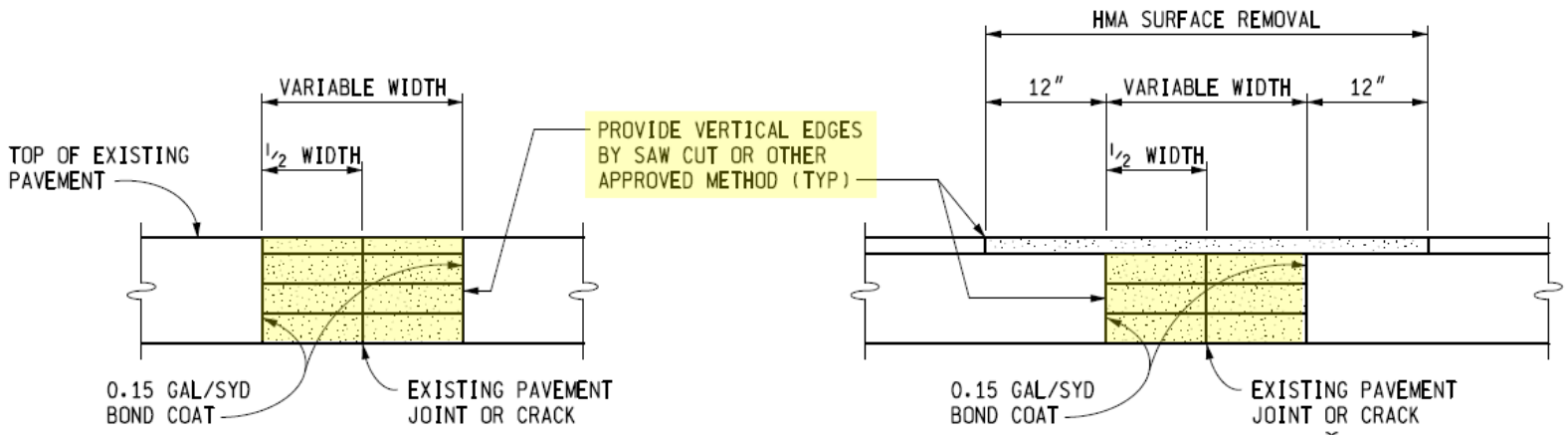
* From the center sensor

** Sensors # - (195) L – (207) C – (206) R

Detail 7s and 8s



Detail 7s and 8s



CASE IV

FULL DEPTH HMA REPAIR OF CONCRETE PAVEMENT

REMOVE THE DETERIORATED CONCRETE FULL DEPTH. COMPACT LOOSE EXISTING BASE. REPLACE AND COMPACT WITH HMA ANY LOST BASE.

CASE V

FULL DEPTH HMA REPAIR OF CONCRETE PAVEMENT WITH HMA SURFACE

REMOVE EXISTING HMA DETERIORATED CONCRETE PAVEMENT FULL DEPTH. COMPACT LOOSE EXISTING BASE. REPLACE AND COMPACT WITH HMA ANY LOST BASE.

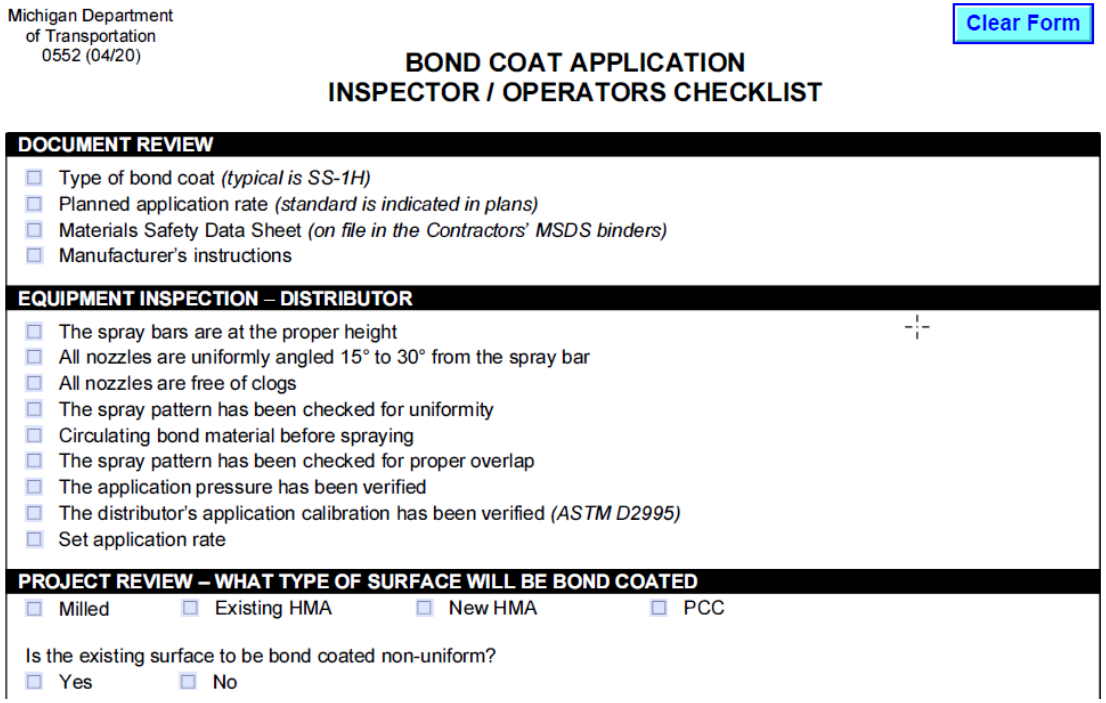
FOR CASES IV, & V, THE REMOVED MATERIAL SHALL BE REPLACED WITH A HMA TOP COURSE MIXTURE. THE HMA SHALL BE COMPACTED WITH A MACHINE VIBRATOR OR APPROVED ROLLER WITH BASE LIFT THICKNESSES NOT TO EXCEED 3" AND WITH THE TOP LIFT THICKNESS NOT TO EXCEED 2". THE FINAL SURFACE OF THE REPAIR SHALL BE FLUSH WITH THE EXISTING PAVEMENT SURFACE.

FULL DEPTH REPAIR FOR JOINT OR CRACK (TRANSVERSE OR LONGITUDINAL) DETAIL 8


12
DO NOT
ENTER
WRONG
WAY
SLOW
AMTRAK
Dearborn, MI
John D. Dingell
Transit Center

Bond Coat Checklist

- Form 0552
- Available on the MDOT website



Michigan Department
of Transportation
0552 (04/20)

Clear Form

BOND COAT APPLICATION
INSPECTOR / OPERATORS CHECKLIST

DOCUMENT REVIEW

- ☐ Type of bond coat *(typical is SS-1H)*
- ☐ Planned application rate *(standard is indicated in plans)*
- ☐ Materials Safety Data Sheet *(on file in the Contractors' MSDS binders)*
- ☐ Manufacturer's instructions

EQUIPMENT INSPECTION – DISTRIBUTOR

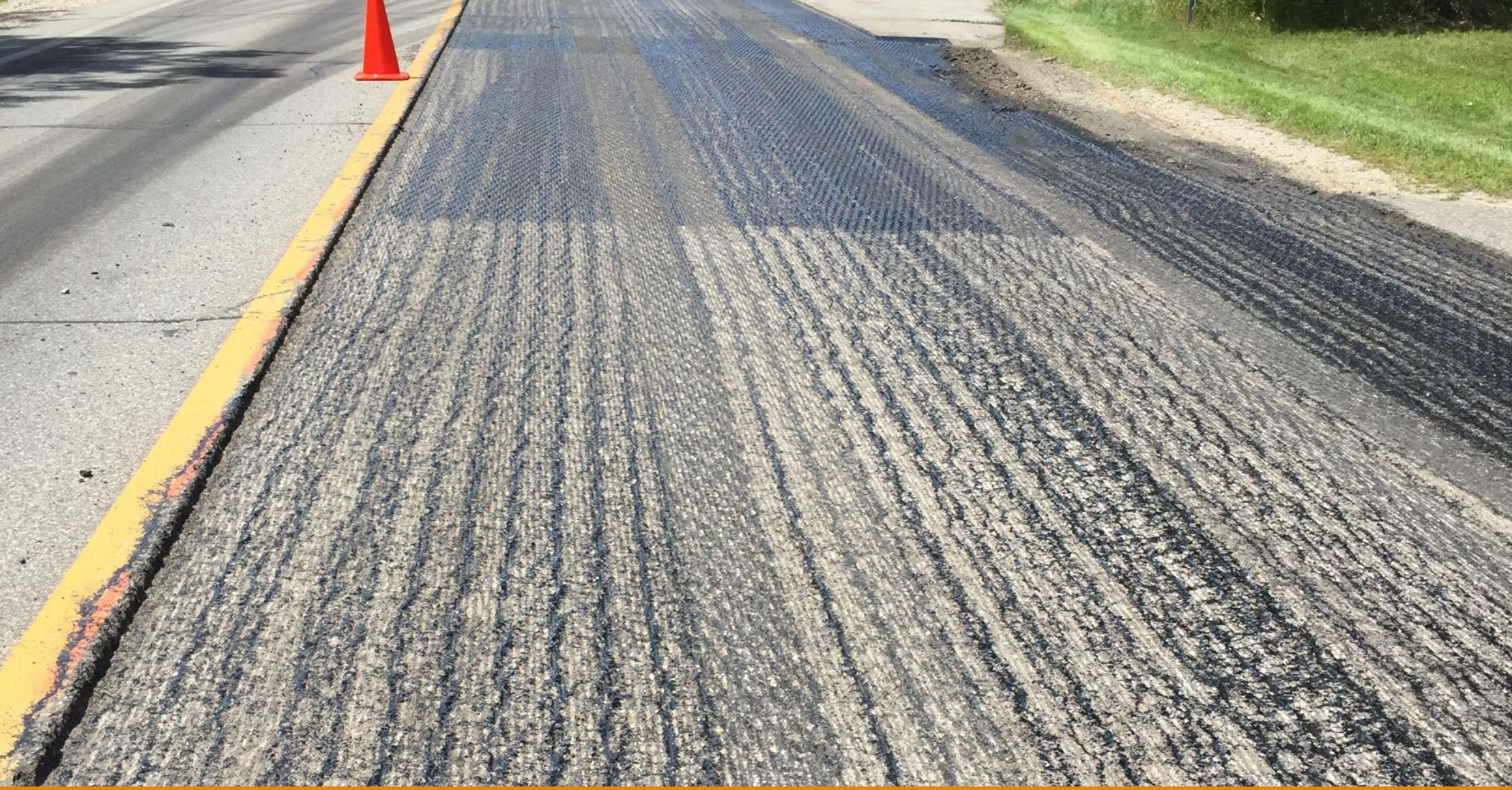
- ☐ The spray bars are at the proper height
- ☐ All nozzles are uniformly angled 15° to 30° from the spray bar
- ☐ All nozzles are free of clogs
- ☐ The spray pattern has been checked for uniformity
- ☐ Circulating bond material before spraying
- ☐ The spray pattern has been checked for proper overlap
- ☐ The application pressure has been verified
- ☐ The distributor's application calibration has been verified *(ASTM D2995)*
- ☐ Set application rate

PROJECT REVIEW – WHAT TYPE OF SURFACE WILL BE BOND COATED

☐ Milled ☐ Existing HMA ☐ New HMA ☐ PCC

Is the existing surface to be bond coated non-uniform?

☐ Yes ☐ No



Coring for Thickness

Thickness cores are taken on Design-Build and Alternate Bid projects

Special Provision updated to:

- Allow density cores to be used in lieu of thickness cores
- Use Total Station Survey to determine thickness
- Revert to the original process if there is a disagreement

PWL Specification Update

Changed IPL Waiver Requirements

- Added: If an IPL was not completed for this mix design the contractor will be allowed to submit 4 consecutive QA tests, STA or PWL, from the current or prior season that meet the requirements in subsections e.3.C and e.3.D.
- Now allowed a waiver in consecutive seasons
- Deleted Section 2 - requiring 2 lots to be completed

Updated section references and links

Stone Matrix Asphalt Update

- 2021 SMA Round Robin
- Reviewed multiple state DOT specifications
- Collected PWL and STA QA results from 2014 - 2021
- Used the QA results to develop a new specification
- New SP will be contractor option

Stone Matrix Asphalt Update

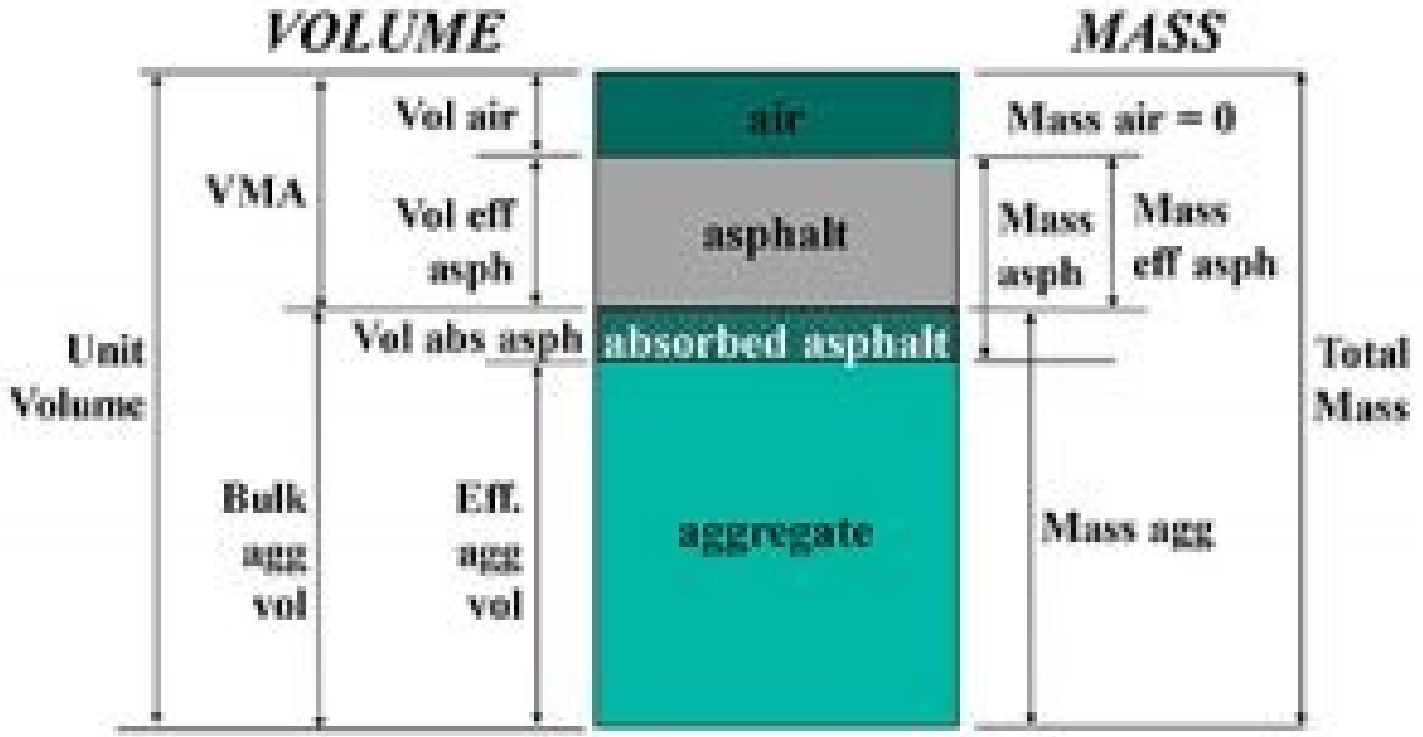
3 Pay Factors

- Air Voids
- Volume of Effective Binder, Vbe
- Density

Overall Lot Pay Factor

- Air Voids 30%
- Vbe 30%
- Density 40%

Binder Content is a Quality Control parameter



Stone Matrix Asphalt Update

Stone Matrix Asphalt Update

Air Voids

- Spec Limit +/-1.50
- RQL +/-2.00

Vbe

- Target 15.00
- Spec Limits -1.00, +1.50
- RQL -1.50, +2.00

Density

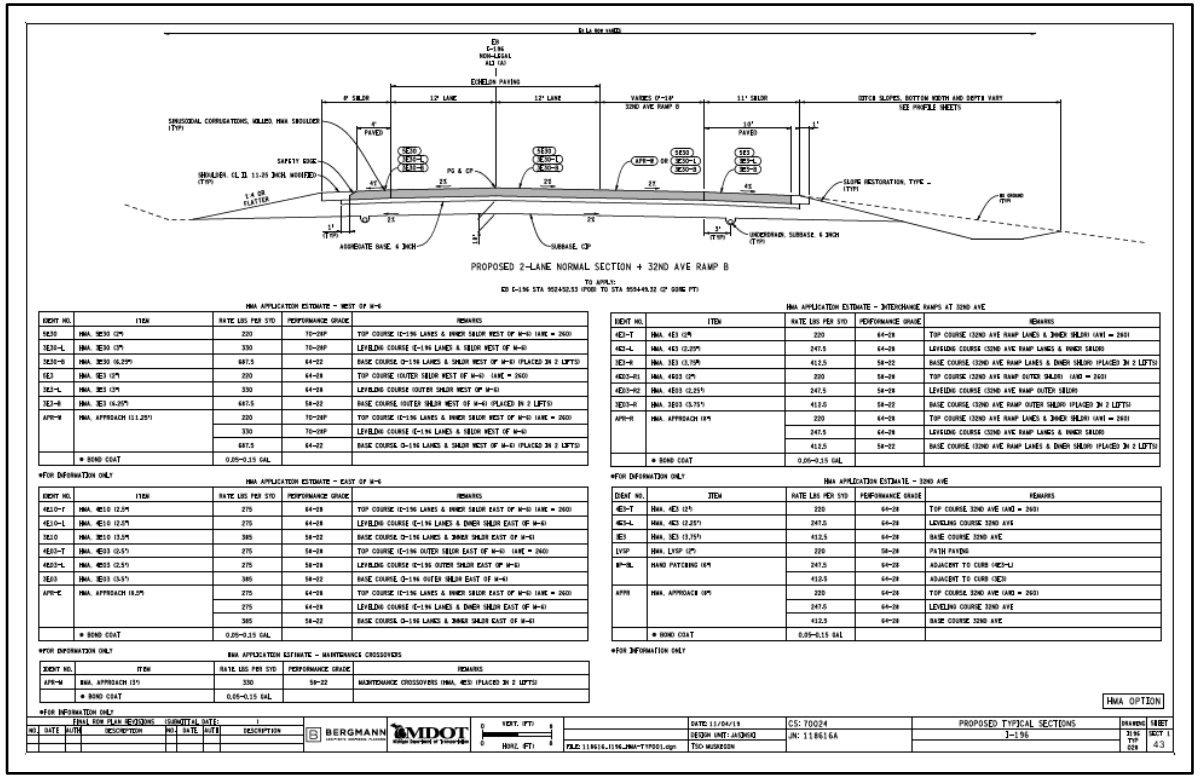
- 92.50% Minimum

Acknowledgments

- Fawaz Kaseer, P.E.
- Ethan Akerly
- Marc Beyer

New MDOT Mix Designations

- LVSP and E03 combined into EL
- E1 and E3 combined into EML
- E10 and E30 combined into EMH
- E50 eliminated and replaced with EH
- Gap Graded Superpave (GGSP) renamed to Stone Matrix Asphalt (SMA) to be consistent with national standards



New MDOT Mix Designations

- Major changes made to Tables 501-3 and 902-6
  - New Mix Design Designations
  - Changes mostly relevant to Mix Designers
- Minor changes to Tables 501-1, 501-2, 501-4 and 902-5

Table 501-3

Existing Criteria					
Superpave Gyratory Compactor (SGC) Compaction Criteria					
		Number of Gyrations			
Estimated Traffic (million ESAL)	Mix Type	%Gmm at (Ni)	Ni	Nd	Nm
< 0.3	LVSP	91.50%	6	45	70
< 0.3	E03	91.50%	7	50	75
< 1.0	E1	90.50%	7	76	117
< 3.0	E3	90.50%	7	86	134
< 10	E10	89.00%	8	96	152
< 30	E30	89.00%	8	109	174
<100	E50	89.00%	9	126	204

Proposed Criteria					
Superpave Gyratory Compactor (SGC) Compaction Criteria					
		Number of Gyrations			
Estimated Traffic (million ESAL)	Mix Type	%Gmm at (Ni)	Ni	Nd	Nm
≤ 0.3	EL	≤91.5%	7	50	75
>0.3 - ≤3.0	EML	≤90.5%	7	75	115
>3.0 - ≤30.0	EMH	≤89.0%	8	100	160
>30.0 - ≤100	EH	≤89.0%	9	125	205

Table 902-6

Existing Criteria

Superpave Aggregate Requirements

		Percent Crushed Minimum Criteria		Fine Aggregate Angularity Minimum Criteria		% Sand Equivalent Minimum Criteria		Los Angeles Abraision % Loss Maximum Criteria		% Soft Particles Maximum Criteria (a)		% Flat and Elongated Particles Maximum Criteria (b)	
Estimated Traffic (million ESAL)	Mix Type	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base
< 0.3	LVSP	55/-	-	-	-	40	40	45	45	10	10	-	-
< 0.3	E03	55/-	-	-	-	40	40	45	45	10	10	-	-
< 1.0	E1	65/-	-	40	-	40	40	40	45	10	10	-	-
< 3.0	E3	75/-	50/-	43	40	40	40	35	40	5	5	10	10
< 10	E10	85/80	60/-	45	40	45	45	35	40	5	5	10	10
< 30	E30	95/90	85/75	45	40	45	45	35	35	3	4.5	10	10
<100	E50	100/100	95/90	45	45	50	50	35	35	3	4.5	10	10

Proposed Criteria

Superpave Aggregate Requirements

		Minimum Criteria		Angularity Minimum		Minimum Criteria		Abraision % Loss		Maximum Criteria (a)		Particles Maximum	
Estimated Traffic (million ESAL)	Mix Type	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base
≤ 0.3	EL	55/-	-	-	-	40	40	45	45	10	10	-	-
		55/-	-	-	-	40	40	45	45	10	10	-	-
>0.3 - ≤3.0	EML	75/-	50/-	43	40	40	40	35	40	5	5	10	10
		75/-	50/-	43	40	40	40	35	40	5	5	10	10
>3.0 - ≤30.0	EMH	90/85	80/75	45	40	45	45	35	35	3	4.5	10	10
		90/85	80/75	45	40	45	45	35	35	3	4.5	10	10
>30.0 - ≤100	EH	100/100	95/90	45	45	50	50	35	35	3	4.5	10	10

(a) Soft particles maximum is the sum of the shale, siltstone, ochre, coal, clay-ironstone and particles that are structurally week or are non-durable in service.

(b) Maximum by weight with a 1 to 5 aspect ratio.

Note: "85/80" denotes that 85 percent of the coarse aggregate has one fractured face and 80 percent has at least two fractured faces.

Local Roads

Existing Criteria													
Superpave Aggregate Requirements													
		Percent Crushed Minimum Criteria		Fine Aggregate Angularity Minimum Criteria		% Sand Equivalent Minimum Criteria		Los Angeles Abraision % Loss Maximum Criteria		% Soft Particles Maximum Criteria (a)		% Flat and Elongated Particles Maximum Criteria (b)	
Estimated Traffic (million ESAL)	Mix Type	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base
< 0.3	LVSP	55/-	-	-	-	40	40	45	45	10	10	-	-
< 0.3	E03	55/-	-	-	-	40	40	45	45	10	10	-	-
< 1.0	E1	65/-	-	40	-	40	40	40	45	10	10	-	-
< 3.0	E3	75/-	50/-	43	40	40	40	35	40	5	5	10	10

Proposed Criteria													
Superpave Aggregate Requirements													
		Minimum Criteria		Angularity Minimum		Minimum Criteria		Abraision % Loss		Maximum Criteria (a)		Particles Maximum	
Estimated Traffic (million ESAL)	Mix Type	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base	Top & Leveling	Base
≤ 0.3	EL	55/-	-	-	-	40	40	45	45	10	10	-	-
		55/-	-	-	-	40	40	45	45	10	10	-	-
>0.3 - ≤3.0	EML	75/-	50/-	43	40	40	40	35	40	5	5	10	10
		75/-	50/-	43	40	40	40	35	40	5	5	10	10

Concern over E1 moving to EML

New MDOT Mix Designations

MICHIGAN DESIGN MANUAL
ROAD DESIGN

6.03.09A1d (continued)

Hot Mix Asphalt (HMA) Mixture Selection Guidelines

North, Grand, Bay, Southwest and University Region

Mixture Type	HMA Mainline and Ramps		High Stress HMA	
EH, SMA	PG 70-28P PG 64-22	Top & Leveling Course Base Course	PG 76-28P PG 64-22	Top & Leveling Course Base Course
EML, EMH	PG 64-28 PG 58-22	Top & Leveling Course Base Course	PG 70-28P PG 58-22	Top & Leveling Course Base Course
EL	PG 58-28 PG 58-22	Top & Leveling Course Base Course	PG 64-28 PG 58-22	Top & Leveling Course Base Course

Superior Region

Mixture Type	HMA Mainline and Ramps		High Stress HMA	
EL, EML, EMH	PG 58-34 PG 58-28	Top & Leveling Course Base Course	PG 64-34P PG 58-28	Top & Leveling Course Base Course

Metro Region

Mixture Type	HMA Mainline and Ramps		High Stress HMA	
EH, SMA	PG 70-22P PG 64-22	Top & Leveling Course Base Course	PG 76-22P PG 64-22	Top & Leveling Course Base Course
EML, EMH	PG 64-22 PG 58-22	Top & Leveling Course Base Course	PG 70-22P PG 58-22	Top & Leveling Course Base Course
EL	PG 58-22	Top, Leveling & Base Course	PG 64-22 PG 58-22	Top & Leveling Course Base Course

NOTES:

1. For shoulders paved greater than or equal to 8 feet or in a separate operation, use PG 58-28 for top and leveling course and PG 58-22 for base course for all Regions
2. For Temporary Roads, commercial and private Approaches, Wedging, and Hand Patching, use PG 64-22 for all Regions except Superior and North, use PG 58-28.

Asphalt Mix Selection

APAM Mix Recommendations

APAM suggests avoiding the use of 13A/LVSP Mixes

a. Coarse graded 13A (LVSP) mixes don't look good

   i. Appearance is not a "specified" item, but it can become a problem when the mix "looks" bad.

   ii. They are more susceptible to segregation, which can lead to performance issues.

Asphalt Mix Selection

APAM Mix Recommendations

APAM Suggested Top Course Mixes

Use 5E (SuperPave) Mix

The traveling public will appreciate the nice appearance and good performance.

Asphalt Mix Selection

5E Superpave Mixture

- Regress mix to 3% air voids.
- Appropriate for traffic level
- Layer thickness between 1 ½” to 2”

Asphalt Mix Selection

Consistency is Important

In order to have better quality, more cost-effective mixes:

a. Fewer mix designs in a plant's operating area is desirable.
   - It is not efficient for one plant to make 10 different 5E1 mixes.

b. Avoid small quantities of a single mix.

a. Avoid small quantities of special binders.

Asphalt Mix Selection

Less is More

- Less mix designs.
- Less yard space.
- Less variability.

- Less cost.

LESS

- More streamlined.
- More efficient.
- More consistent.

- More lane miles paved.

MORE

Questions?

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