United States
Department of Transportation

SUMMARY REPORT

I-70 Reconstruction

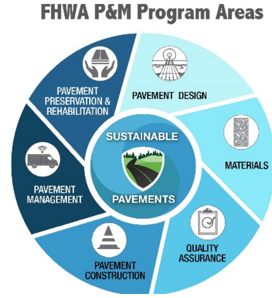
Grainfield, KS

August, 2019



FHWA MCTC Project # KS1905

FHWA P&M Program Areas



Federal Highway Administration
Office of Preconstruction,
Construction, and Pavements
1200 New Jersey Avenue, SE
Washington, DC 20590

MCTC Field Report – Kansas

Summary of the Visit

The Federal Highway Administration (FHWA) Mobile Concrete Technology Center (MCTC) visited the I-70 pavement replacement project in Grainfield, Kansas from July 29 to August 8, 2019. The objective of the MCTC visit was to demonstrate innovative technologies currently in the implementation phase; This site visit is in conjunction with monitoring and testing work being done on this project using FHWA Performance Engineered Mixtures Implementation Incentive funding.

During this visit, the MCTC conducted a PEM Open House on August 8, 2019 in coordination with the National Concrete Pavement Technology Center (CP Tech Center), and Todd LaTorella of the Missouri-Kansas Concrete Paving Association. A planned companion workshop titled “Ensuring Quality in the Concrete Paving Process” has been deferred until in-person training events can be held

This report summarizes the test results, observations, and other activities conducted during this visit. Numerical values of the test results are presented in the Appendices.

Highlights or Impacts During the Field Visit

- Kansas Department of Transportation (KDOT) Central Office personnel, including Mr.Dan Wadley, have done significant work with the SAM meter. The MCTC staff and Mr. Dan Wadley’s group were able to learn from each other’s experiences with the SAM meter. On a few occasions, the SAM tests were conducted side by side by the MCTC and KDOT staff. The KDOT SAM test procedure, field documentation form and companion technician training program that Mr. Wadley and KDOT have developed are a model for any other agency looking to implement the SAM.

- The initial PEM efforts have been led by personnel at KDOT's Central Office. The MCTC visit and Open House provided an opportunity for KDOT's District personnel and contractor staff to learn more about the PEM initiative and testing technologies, as well as KDOT's steps to move towards a more performance-type specification for concrete.

- Training and Open House presentations during the MCTC visit reinforced KDOT's decisions to promote certain PEM technologies for use in their first shadow specifications. Industry learned why KDOT is interested in the PEM implementation efforts and how they may benefit from the new technologies.

- The demonstration / testing on site was a success. Koss Construction (paving contractor) staff were very interested in the tests that were showcased, especially the SR meter. The contractor reached out to the MCTC more than 6 months after leaving the project for information/data on the Surface Resistivity test. On this project, KDOT required only the Boil test as an indicator of permeability. There is pay incentive/disincentive associated with the results from this test.

- There was great interest in the MIT Scan T3 for measuring pavement thickness. Rob Percival, KDOT District Construction / Materials Engineer, staff from the FHWA Division Office and the contractor were present during its demonstration in the field. After the MCTC left the project site, Waseem Fazal, FHWA Kansas Division Office, inquired about this Technology. Based on the MCTC visit**, KDOT has worked with the FHWA Division office and developed a specification on the use of the MIT Scan T3 for PCCP NDT Thickness Determination. In 2020, KDOT successfully implemented this specification on two projects, one in Hays, KS and another in Osborne, KS. KDOT is currently evaluating making the MIT-Scan T3 device an available option for HMA contractors on projects that require thickness determination.**

- One of the big impacts of the MCTC visit is the relationships built with the KDOT District Construction / Materials Engineer and Contractor from this project, where they welcomed the role of the MCTC in showcasing new technologies and demonstrating best practices. Rob Percival and the contractor r**eached out to the MCTC staff six months to a year after the MCTC left the project site for technical assistance** (questions on MIT Scan T3 and Surface Resistivity).

Summary: MCTC Test Results

- **Box Test**: The Box Test results indicated the mixture was workable and would generate a good finish without any edge slump issues. As expected, the workability and finish of the mixture in field compared well to the Box Test results.

- **Gradations:** The mixture met two of the three criteria of the Tarantula Curve criteria. The mixture did not meet the individual sieve criteria for sieve sizes #4 and #8. Per the Tarantula criteria, the maximum recommended percent retained for these sieve sizes are 20 and 12 respectively. However, the percent retained for these sieve size for the project mixture (based on mixture design) were 25 and 15 percent respectively. While the tested mixture did not meet the optimized gradation, the paste content was lower than the maximum (25%) as recommended for paving concrete in the PEM Guide (AASHTO PP 84)

- **Air System**: The air void system, as tested in the plastic concrete, was excellent for the freeze-thaw conditions in Kansas. This is based on the SAM and AVA testing performed by the MCTC.

- **Permeability / Surface Resistivity:** The MCTC test results for Surface Resistivity indicated that the concrete mixture used in this project fell in the medium permeability category at 56 days.

- **Strengths**: The 28-day compressive and flexural strengths indicate adequate strength even at very high air contents. Since the MCTC specimens were cast at the plant, the average air content of the strength specimens was 10.8%.

- **Consistency**: The unit weight and total air content tracked well together, as would be expected from uniform concrete production. The data from the semi-adiabatic calorimetry data indicated consistent cementitious contents and sources.

- **Construction Aspects**: Maturity was used to measure opening strength. Based on the MCTC data, opening strength of 450 psi was reached in three days. The MIT Dowel Scan found dowels to be properly located without any major alignment issues. Based on the MCTC MIT Scan T3 testing, the average pavement thickness measurements met the design thickness of 12”. The correlation of the MIT scan T3 pavement thickness readings and the cores taken at the same locations by KDOT was excellent.

Summary – MCTC Observations

There were many positive observations made during the visit to this project both from agency specification and contractor quality control perspective. Some of them include the following:

- Kansas DOT
    - Low paste content of the mixture.
    - Workable mixture.
    - Emphasis on air characteristics (SAM / Hardened Air).
    - Emphasis on permeability (Boil Test).
- Contractor
    - Quality conscious, examples include good stockpile management practices, consistency in production, and good construction practices.
    - Vibration monitoring.

MCTC Recommendations

Based on the testing / observations at this project, the MCTC recommends incorporating the following into specifications/policies/procedures:

- Kansas DOT
    - Continue to emphasize lowering cement / paste content.
    - Optimize aggregate gradation. Since the contractors are already using an intermediate aggregate in Kansas, they should only need some minor adjustments to optimize their gradation to reduce paste, reduce permeability and ASR potential.
    - Surface Resistivity for permeability (this test can be used in lieu of or in addition to the Boil test).
    - Continue to evaluate / incorporate the Super Air Meter.
    - Use the MIT Scan T3 for pavement thickness measurement in lieu of taking cores.
- Contractor
    - Incorporate the Box Test during the mixture design phase.
    - Use Semi-adiabatic calorimeter for measuring consistency of cementitious systems during production and identify any possible field problems during mixture design phase.
    - Incorporate SR Meter.

For questions pertaining to the report, please contact either Mike Praul (Michael.Praul@dot.gov), FHWA Senior Concrete Engineer or Jagan Gudimettla (Jagan.m.gudimettla.ctr@dot.gov), consultant, MCTC Project Manager. Details on the MCTC program and the technologies listed in this report can be found on the MCTC website at https://www.fhwa.dot.gov/pavement/concrete/trailer/.

Project Background

This was a multi-year pavement replacement project on I-70 in Gove County. The project area covers a 9-mile portion starting one mile west of the K-23 spur near Grainfield and ending approximately four miles east of K-211. The plan calls for replacing the pavement on the eastbound lanes in 2019, followed by the westbound lanes in 2020. Weather permitting, work was expected to be completed by November 2020. Koss Construction of Topeka was the primary contractor for the $38.1 million project. Additional information on this project can be found at: http://www.ksdot.org/bureaus/divOperat/I70ImprovementsInGoveCounty.asp

Project Details

- The mainline concrete pavement design thickness is 12 inches.
- Shoulders thickness 12" variable, plain PCCP
- Base Course (same for mainline and shoulders)
  - 12" FDR (75% of project)
    - 12" FDR with 6% Cement by weight varying proportions of RAP/Soil. Majority of project was 6"-8" of in-place RAP with 6"-4" of in-place Soil
    - 6% Cement by weight
  - 12" Subgrade Modification (25% of project)
    - 12" RAP imported RAP (from project) with 1" in-place Soil
    - 6% Cement by weight
- PAMS Curing Compound

Project Specifications for Paving Concrete on I-70

- Target air content: 6.5% (range 5% to 8%), Target w/cm: 0.42.
- Minimum cement content: 517 pounds per cubic yard
- 28 Day minimum compressive strength: 4000 psi. For PWL analysis used 3500 psi as the LSL. Opening to Construction Traffic Strength: 450 psi flexure.
- Pavement thickness cores used for measuring compressive strength.
- The pay adjustments at this project were based on results from four tests; thickness, compressive strength (from cores), volume of permeable voids (Boil test) and air content. Table below shows the pay adjustment equations.

Pay Adjustment Equations

	Property	PWL	Individual Pay Factor	Maximum Incentive / Disincentive
Equation 1	Thickness	90	P_T	+0.010/-0.040
Equation 2	Compressive Strength	90	P_S	0.000/-0.120
Equation 3	Volume of Permeable Voids	90	P_{VPV}	+0.025/-0.100
Equation 4	Measured Air Content	90	P_A	+0.025/-0.100

Combined Pay Factor, $P = P_T + P_S + P_{VPV} + P_A$

- In addition to the tests listed in the table in the previous page, SAM Number, Hardened Air Content, and Spacing Factor were also measured during production.

Concrete Plant, Aggregates, and Stockpiles

- The concrete was produced by a Rex Con Single Drum Plant.
- Three aggregates were used.
- Aggregates were stockpiled on site and no contamination was observed between stockpiles.
- MCTC staff observed very good stockpile management practices. Stockpiles were built that were short and wide to reduce segregation. Aggregates were also mixed well prior to use.

Concrete Plant

Coarse (1" Crushed Rock)

Coarse (3/8" RockUncrushed)

Fine (Washed 3/4" Minus Sand)

Aggregate Stockpiles

Good Stockpile Management by mixing aggregates prior to use.

Mixture Design and Paste Content

- Cement (75%).
- Fly Ash (25%).
- Total Cementitious Content: 540 lbs.
- Paste content for this mixture was lower (24.5%) than the maximum recommended value of 25% for paving mixtures in PEM (AASHTO PP 84).

Material	Source	Weight
Cement, Type IL, lbs	LaFarge Holcim, Florence, CO	405
Fly Ash, Class C, lbs	Boral Resources, St Marys, KS	135
1" Crushed Rock, lbs	Huber Sand	605
3/8" Rock (Uncrushed), lbs	Prowers Aggregate Operators	665
Washed 3/4" Minus Sand, lbs	Huber Sand	1754
Water, lbs	Koss Construction	227
Water / Cementitious Ratio		0.42
Air-Entraining Agent, oz/cy		9.0
Type A - Water Reducer, oz/cy		22.5
Target Air		6.5%
Contractor's Average 28 day Compressive Strength, psi		7350
Volume of Permeable Voids (Boils Test), %		11.9

Paste Content Calculations

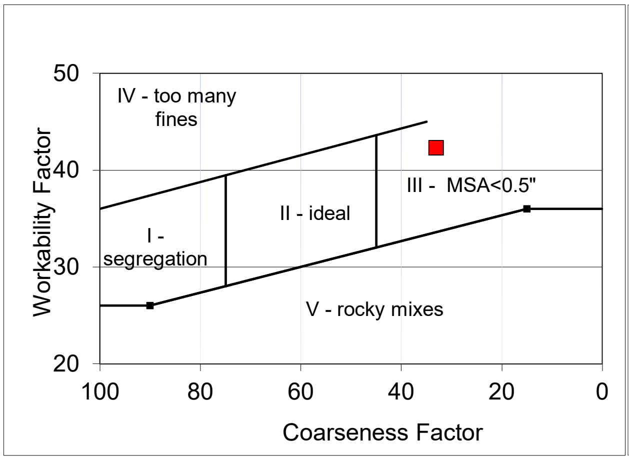
	Batch Weights wt.cu/yd	Specific Gravity	Absolute Volume cu,yd	Percent of Total Volume
Cement	405.0	3.02	2.15	7.98
Fly Ash, C	135.0	2.65	0.82	3.03
3/4" Sand	1754.0	2.62	10.73	39.82
3/8" Rock	665.0	2.6	4.10	15.21
1" Rock	605.0	2.58	3.76	13.95
Water	227.0	1.00	3.64	13.50
w/c ratio				
% Air	6.5	0.00	1.755	6.51
Total volume of known ingredients			26.94	100.00
			It needs to be 27 t	
	3024.0			
% Paste =		**24.5**		

% Paste should be less than 25% for reducing shrinkage crack potential, reduce permeability, and reduce ASR potential (PEM requirement).

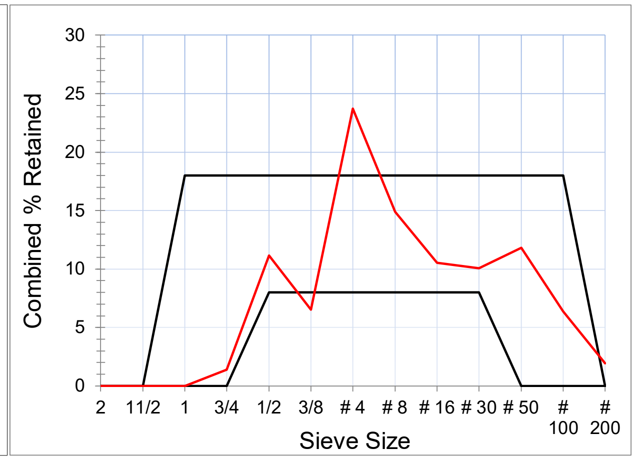
Combined Aggregate Gradations

- The combined gradation did meet the Shilstone gradation criterion but did not meet the criterion of the 8-18 percent retained graph (maximum retained on #4 sieve size was 23% while the maximum recommended was 18 percent).

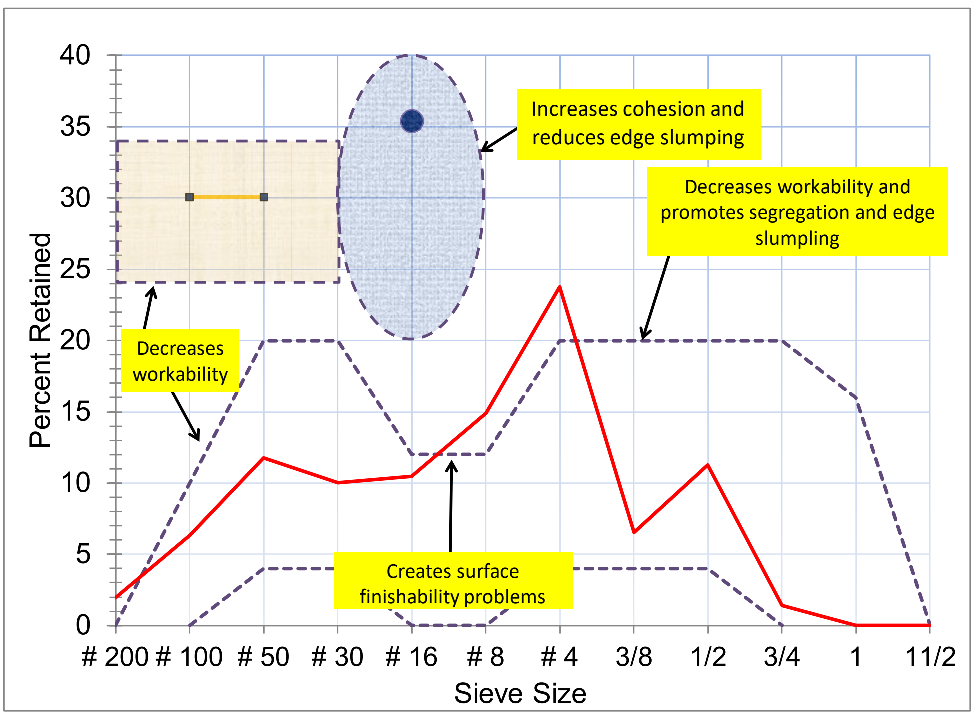
- The combined gradation met two of the three criteria of the Tarantula Curve criteria. The mixture did not meet the individual sieve criteria for sieve sizes #4 and #8. Per the Tarantula criteria, the maximum recommended percent retained for these sieve sizes are 20 and 12 respectively. However, the percent retained for these sieve size for the project mixture (based on mixture design) were 25 and 15 percent respectively.



Coarseness Factor Chart



Percent of Aggregate Retained



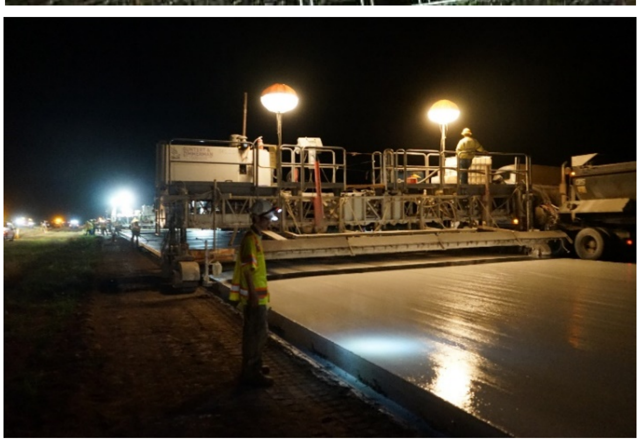
Tarantula Curve

Paving Operations

- Stringless paving.
- Two spreaders were used.
- Dowel Baskets used with shipping wires cut.
- Burlap drag and longitudinal tining.








MCTC Visit

- Timeline: Site visit from July 29 through August 8.
- Sampling at the plant.
- Mainline paving.
- Night paving.

Sampling and Testing Locations

QC/QA on the grade

MCTC Sampling on grade

MCTC Fresh Concrete Testing Matrix

Date	Sample Day	Sample ID
7/31/2019	1	1-1, 1-2, 1-3, 1-4
8/1/2019	2	2-1, 2-2, 2-3
8/4/2019	3	3-1, 3-2, 3-3, 3-4, 3-5
8/5/2019+	4	4-1, 4-2F*, 4-3F*

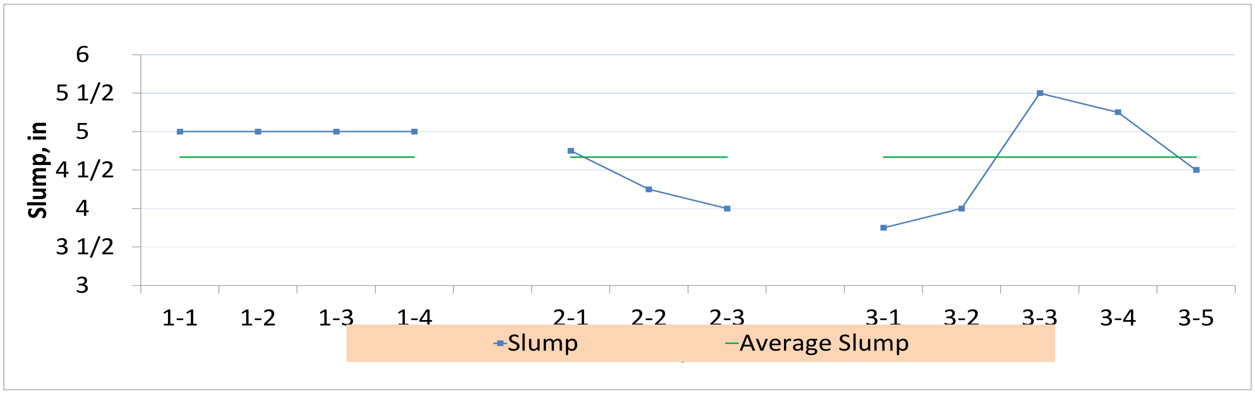
+only Super Air Meter (SAM) and Air Void Analyzer Tests were conducted on samples from the fourth sampling day.
*indicates samples that were taken from the field. All other samples were taken at the plant.

TEST RESULTS

- Numerical values of the MCTC tests results are shown in the Appendix C.

Slump

- Twelve tests were performed at the plant.
- Average Slump: 4.7”, Standard deviation: 0.6”.
- High slump measurements were observed since tests were performed at the plant.



Box Test Results and Analysis

- Three box tests were performed.
- No edge slump or consolidation issues noticed.
- All three box tests exhibited similar characteristics even though slump on these samples varied from 4” to 5.5”.

Sample 1-3 (Slump 5”)

Sample 2-3 (Slump 4”)

Sample 3-3 (Slump 5.5”)

Assessment of Change in Workability with Time

- Box test was carried out on sample 2-3 multiple times at intervals of 15 minutes.
- Based on this testing, it appeared that the mixture would be workable until 45 minutes after sampling. At 60 minutes after sampling, the Box test indicated workability and finishablity problems as shown in the picture below.

15 minutes

30 minutes

45 minutes

60 minutes

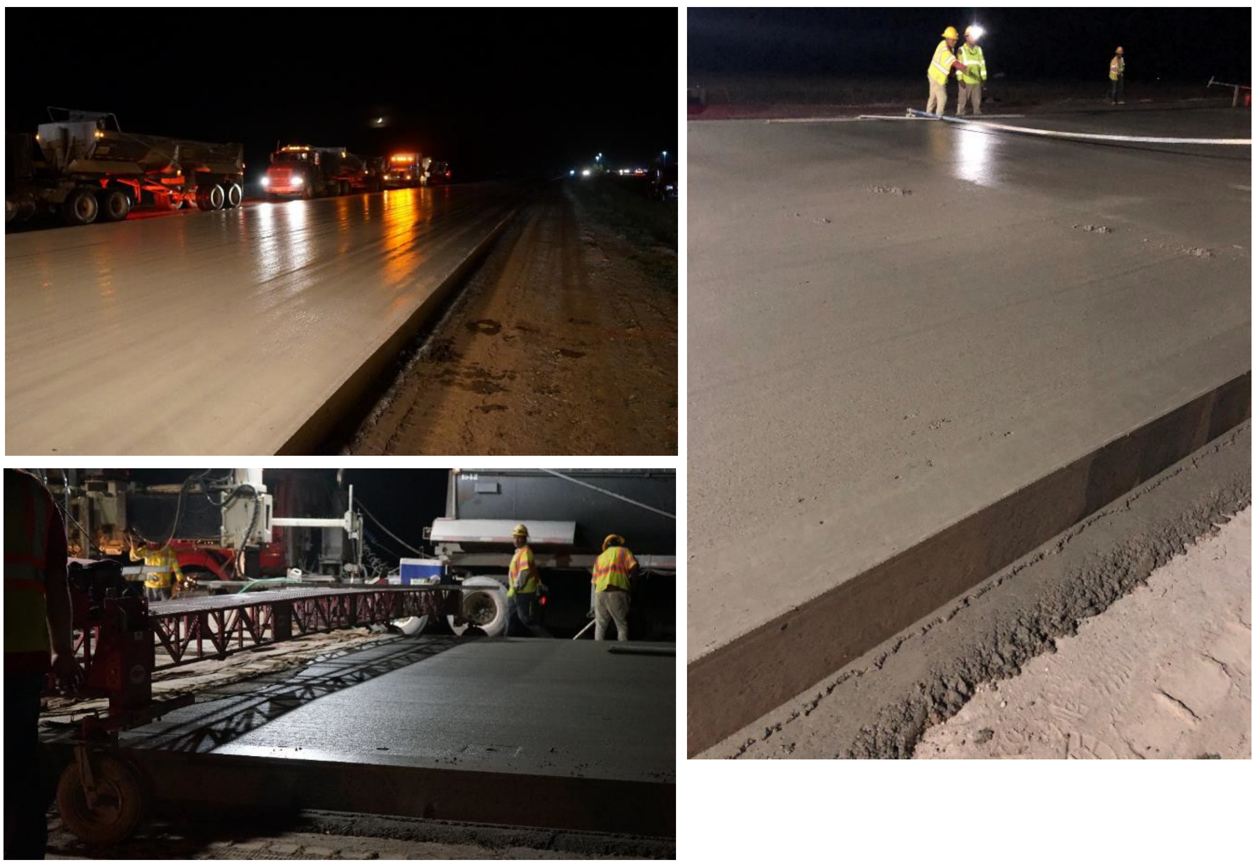
Box Test versus Field Observations

- The field observations on the workability / finishability and edge of the pavement reflected the results from the Box Test.

- Similar to the Box test results, there were no edge slump issues observed in the field.

- There were no consolidation issues observed in the field and the finish of the pavement is exactly as the Box test indicated.

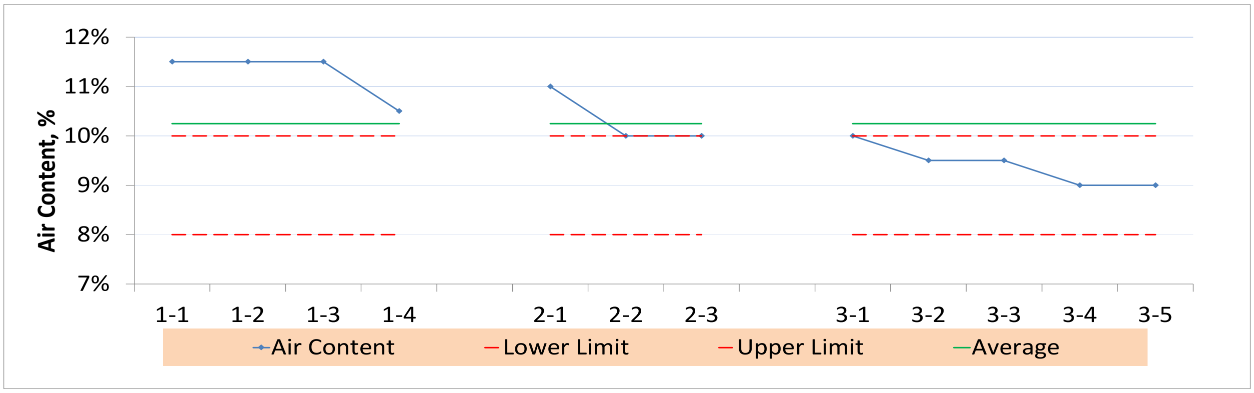
- The interesting aspect is that the Box tests measurements were made at the plant. This illustrates the point that in addition to the water content, the Box test considers the aggregate gradation and the paste content in its measurement of workability unlike the slump test.



Finish and Edge of the pavement immediately after being constructed.

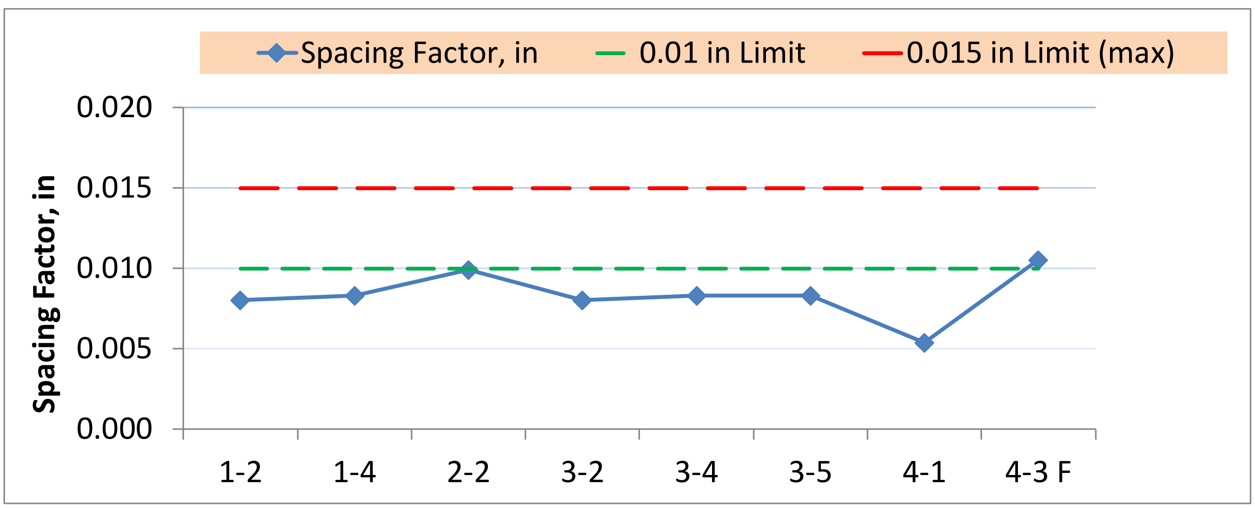
Total Air Content

- Sixteen air tests (total air) were performed, all of them at the plant.
- Average air content:10.3%, Standard Deviation: 0.9%.
- The total air content had a decreasing trend with each sampling day. Since the haul distance was decreasing each passing day, the target air content at the plant was also lowered.



Air Void System Measured by the Air Void Analyzer (AVA)

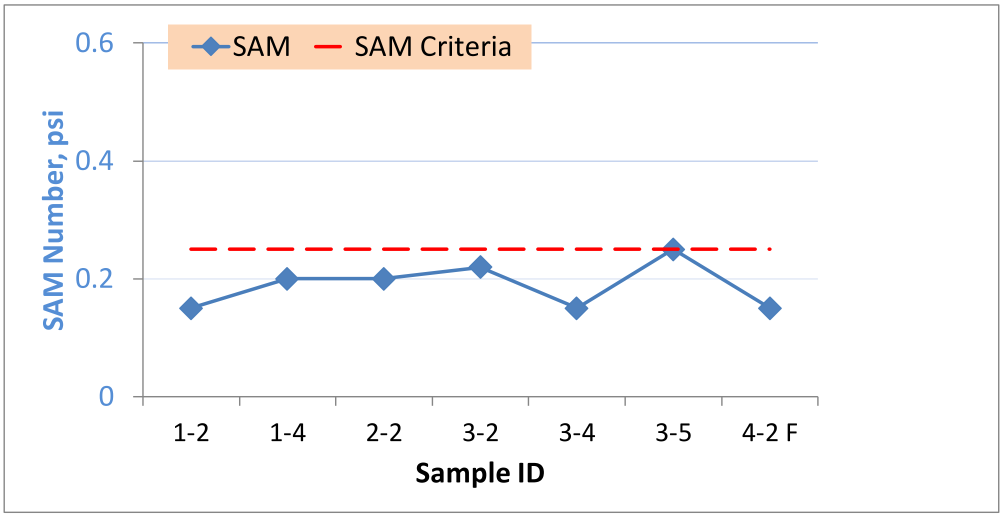
- Seven tests were performed from samples taken at the plant and one test was performed from a sample taken in the field (4-3F).
- Average Spacing Factor from AVA: 0.008 and Standard Deviation of 0.0015.
- Majority of the results are below or close to the maximum recommend value of 0.01 in.
- Spacing factor from the field was the highest (0.0105 in).



Air Void System Measured by the Super Air Meter (SAM)

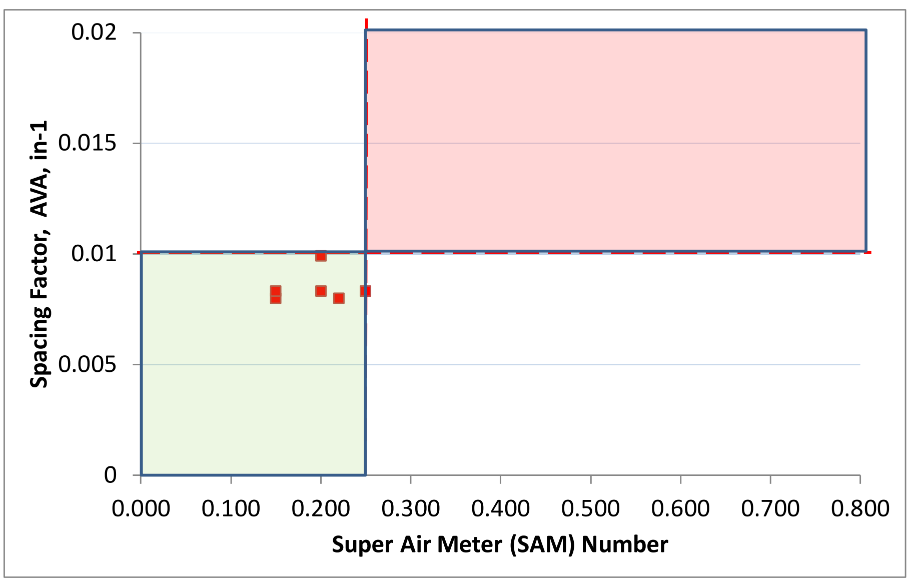
- Six tests were performed at the plant and one was performed in the field.
- SAM results: Average 0.19, Standard Deviation of 0.04.

- SAM results indicate durable concrete from a freeze-thaw resistance standpoint.
- SAM number from the field sample (4-2F) is in line with all the other SAM tests performed at the plant. The data are consistent with the theory that the loss of air through transport and normal paver consolidation is from the loss of larger bubbles and does not impact the freeze/thaw resistance of the air system.



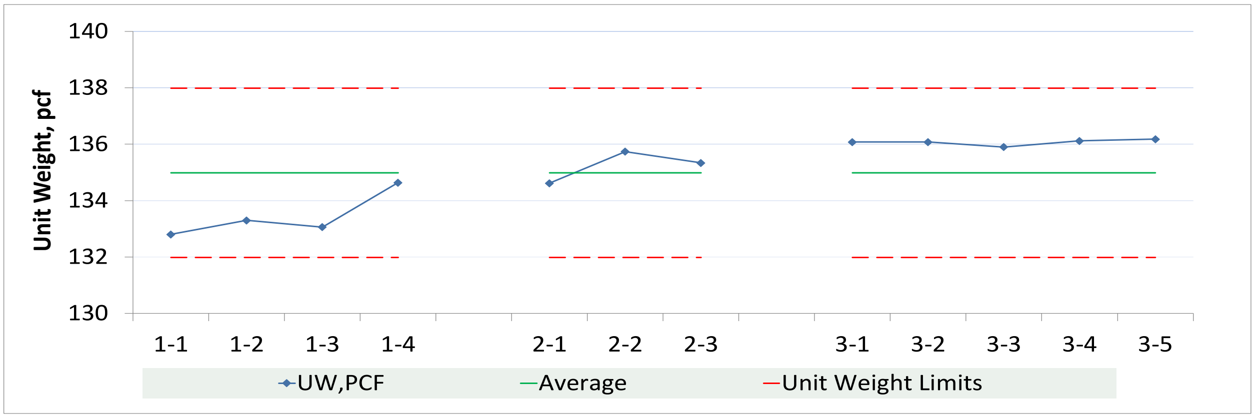
Comparison between Spacing Factor from Air Void Analyzer and the SAM Number from the Super Air Meter (SAM)

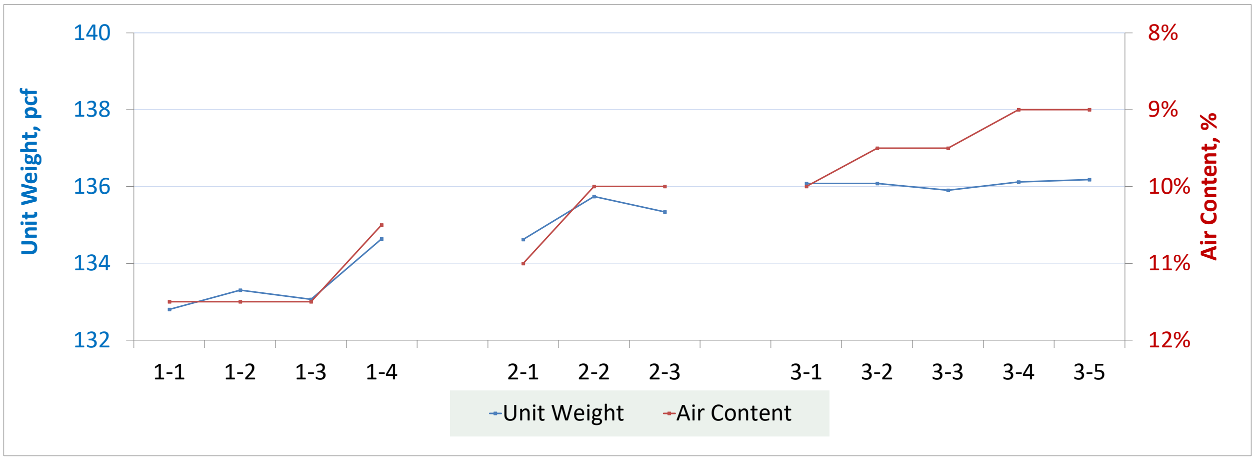
- Both the tests categorize the concrete having good freeze-thaw resistance.



Unit Weight

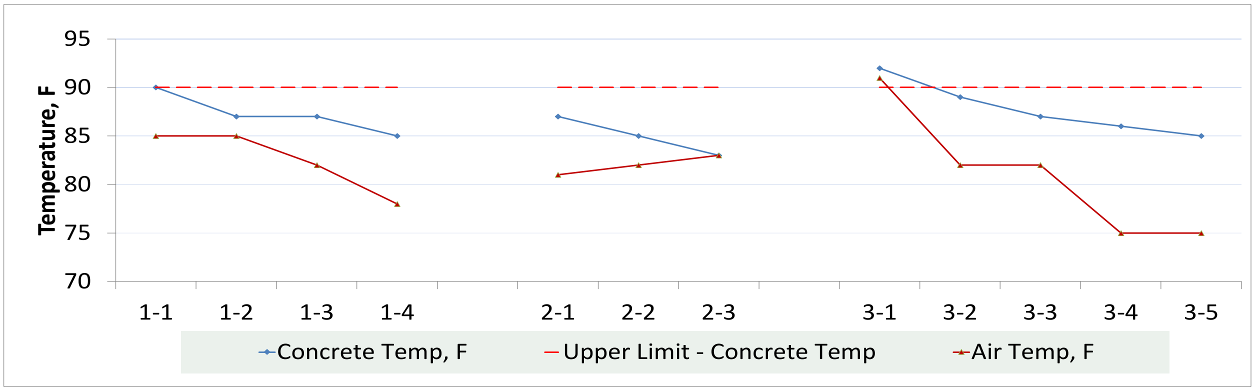
- Simple tests to check uniformity: weight and volumetric proportions.
- Twelve tests were performed at the plant.
- Average unit weight: 135 pcf, Standard Deviation: 1.3 pcf.
- Consistent with the air content, the unit weight changed with each passing day. This change can be attributed to the lower target air content with decreased haul distance with each passing day.





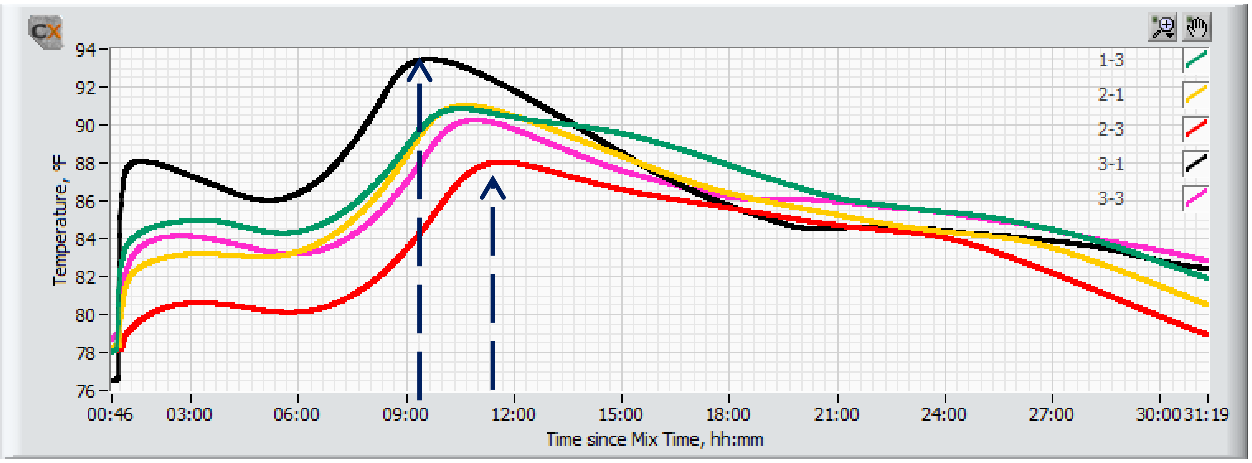
Concrete Temperature

- Twelve tests were performed at the plant.
- Concrete temperature effects the hydration rate, which can impact workability and compatibility.
- Air temperature stayed between 75 and 91°F.
- Variability of the concrete temperature was low, ranged between 83 and 92°F.



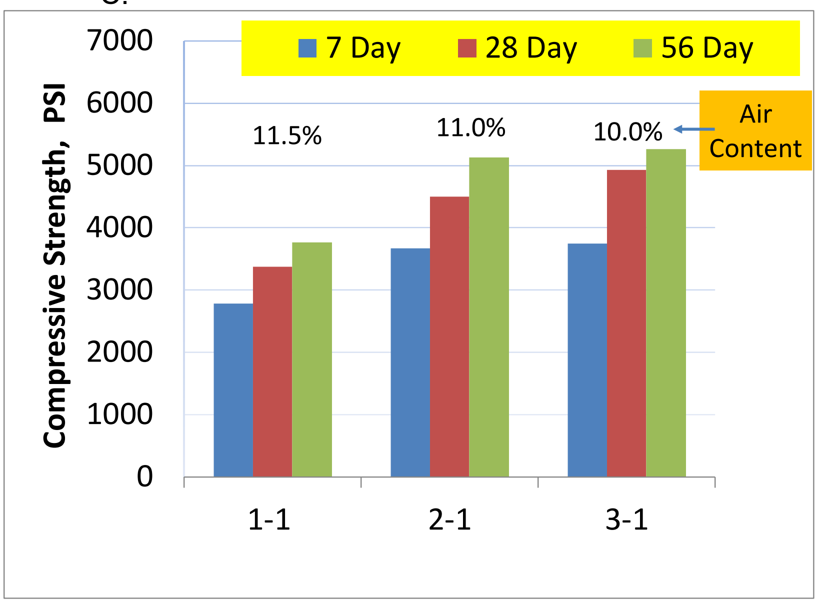
Heat Signature / Semi-Adiabatic Calorimetry

- Identifies changes in cementitious hydration due to cement, SCM's and admixtures.
- Five tests were performed.
- The overall shape of each of the hydration curves remained the same, which indicates consistent cementitious contents and sources.
- The time to reach peak heat of hydration for the five curves ranged from 9 hours 20 minutes to 11 hours and 20 minutes. These changes were due to the change in the initial concrete temperature.



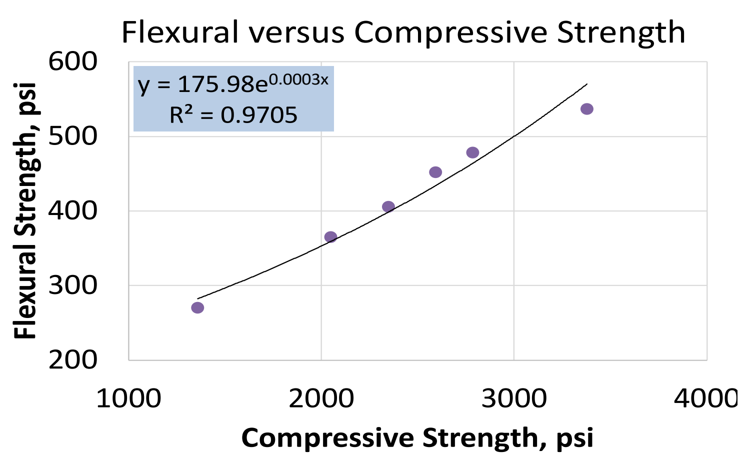
Compressive Strength

- Nine specimens each were cast on three different production days (sample 1-1, 2-2 and 3-1).
- Three specimens from each sample were tested for compressive strength at 7, 28 and 56 days.
- As expected, the measured compressive strengths were inversely proportional to the total air content for these samples.
- The overall compressive strengths were adequate; however, they were lower than the mixture design submittal value. This decrease in compressive strength would be expected since the MCTC samples were taken at the plant where the concrete intentionally had a high air content.. The average air content for the compressive strength specimens was 10.8% versus the mixture design target of 6.8%.
- Numerical values of compressive strength at different ages are shown in the Appendix C.



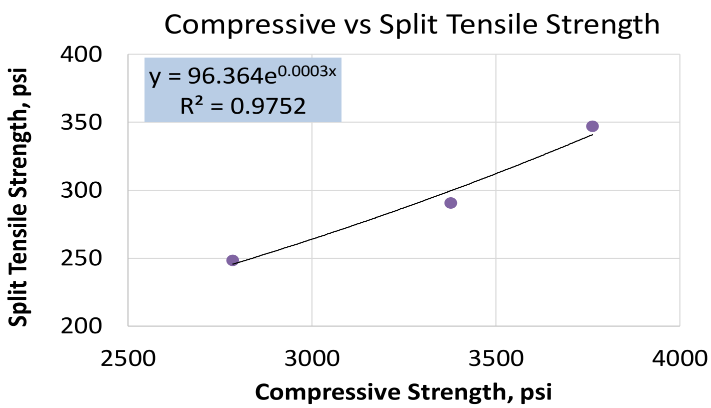
Flexural Strengths

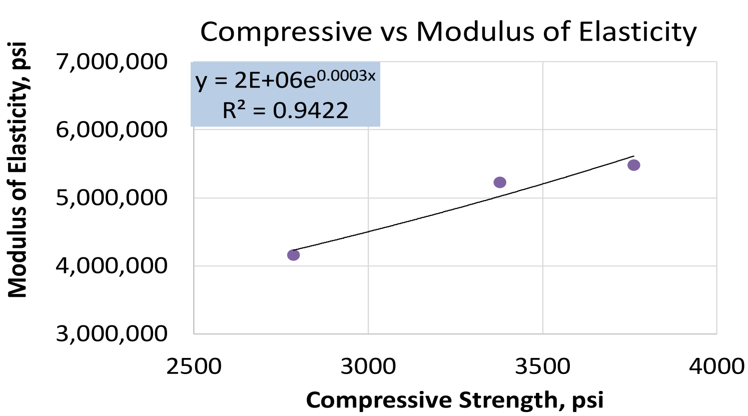
- Flexural strengths were measured at 1, 2, 3, 5, 7, and 28 days on sample 1-1.
- Excellent correlation between compressive and flexural strengths.
- 28 days flexural strength was 537 psi (based on total air content of 10.8%).
- Numerical results shown in Appendix C.



Other Strength Tests

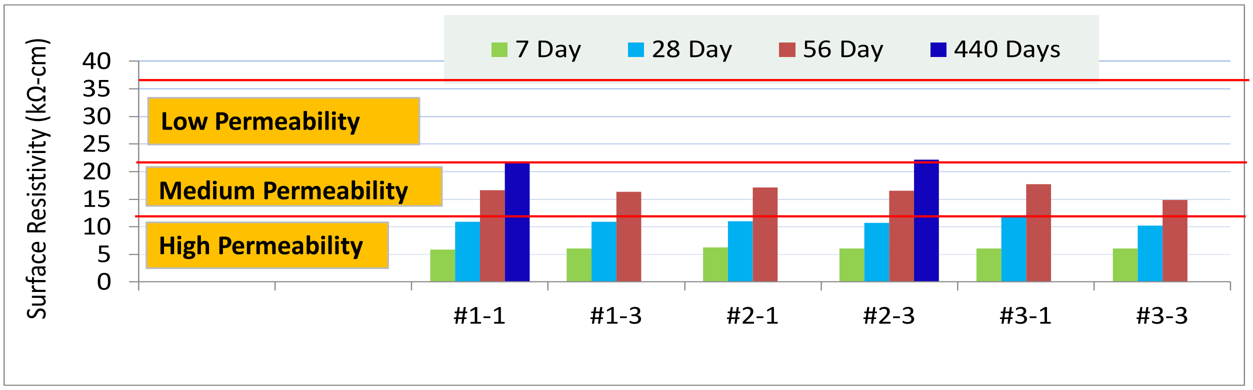
- Split Tensile strength tests, Modulus Of Elasticity (MOE) and Poisson's ratio were measured on sample 1-1 at 7, 28 and 56 days.
- They show a good correlation with Compressive Strength.
- MOE and Poisson's ratio are inputs in the AASHTO Pavement ME software for Jointed Plain Concrete Pavements and Split Tensile strength for Continuously Reinforced Concrete Pavements.





Permeability / Surface Resistivity

- Six tests were performed using the Surface Resistivity Test.
- This test is more efficient in both time and effort compared to the Rapid Chloride Penetrability Test.
- The results showed that the concrete samples all had medium permeability at fifty-six days.
- Specimens from two of the six samples (samples 1-1 and sample 2-3) tested at 440 days did reach the "low" permeability range



Coefficient of Thermal Expansion

- Coefficient of Thermal Expansion (CTE) is an input for pavement design in the AASHTO Pavement ME software.
- As expected, no significant different in CTE of concrete between the two production days (sample 2-1 versus sample 3-2) was observed.
- Based on conversations with the KDOT Pavement Design Group, a CTE value of 5.5 was used when running the design in Pavement ME, which is close to the measured value below (5.25 microstrain//ºF).

Sample ID	Cast Date	Age, Days	CTE, Microstrain/ºF
2-1	8/1/2019	215	5.2
3-2	8/4/2019	212	5.3

Maturity Tests

- Technique used to determine in-place strength of concrete.

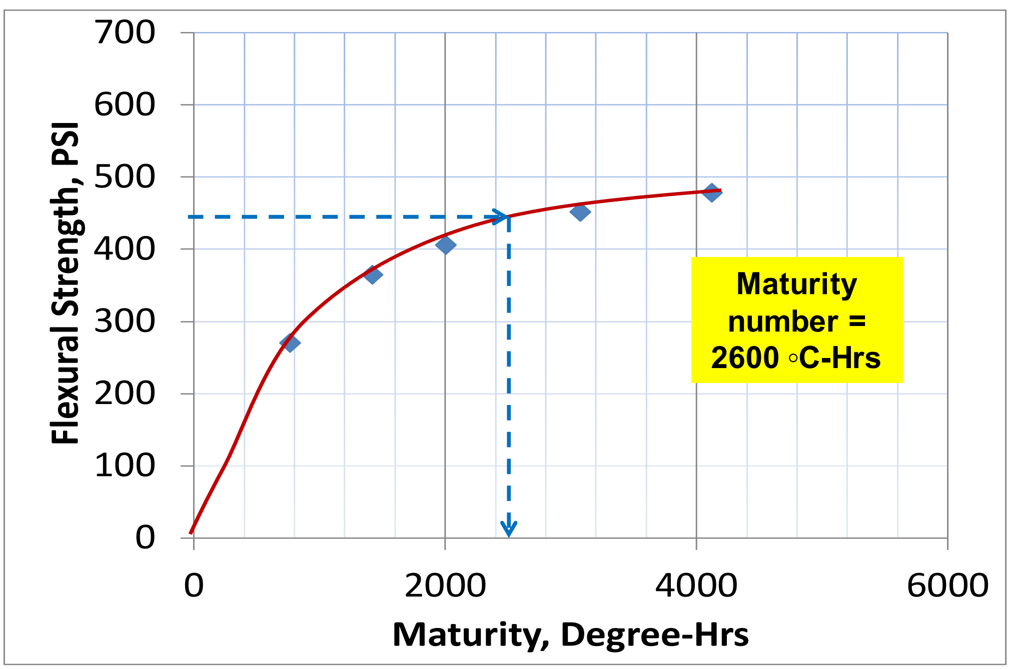
- This test is for measuring opening strength only, not 28-day strength, and should not be used for concrete strength acceptance.

- Two-step process:
  - Build a Maturity Curve in the laboratory or in the field (uses temperature and time factors).
  - Measure maturity in the field to determine in-place strength using the maturity curve.

- A calibration curve was built based on concrete specimens cast from sample 1-1 (date of production - 7/31/19). Maturity sensor is placed in one of the beams cast. The maturity and flexural strength data for the calibration curve is included in the Appendix C.

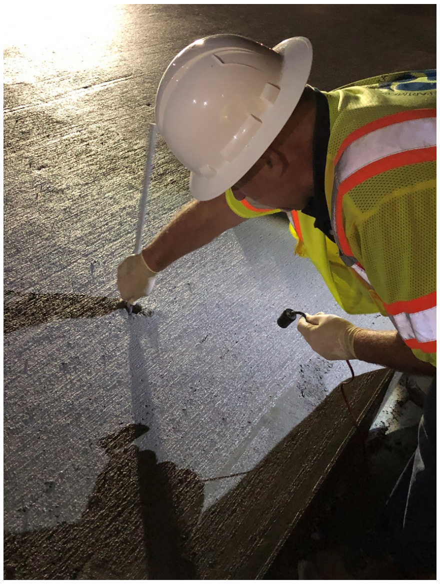
Flexural strength specimens cast for building the maturity calibration curve.

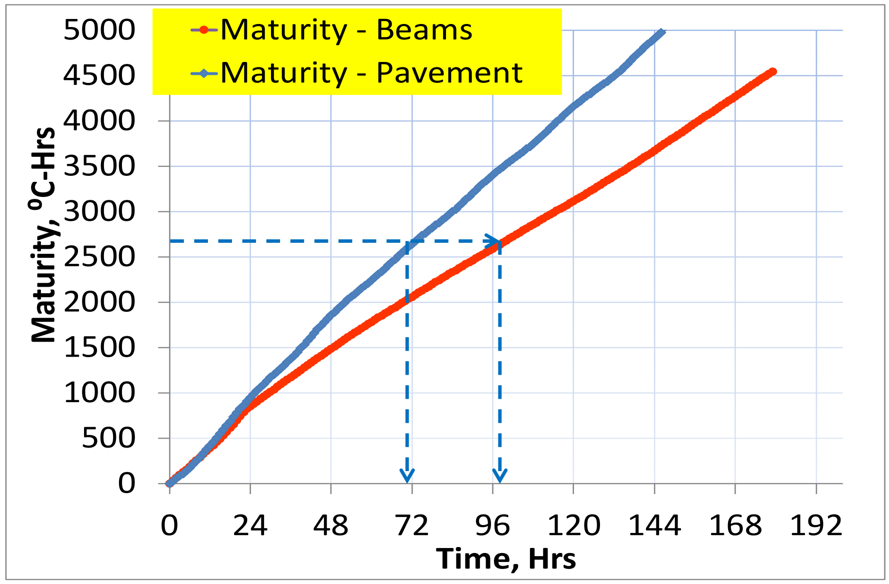
The required strength for opening pavement to construction traffic in Kansas is 450 psi flexural strength. Based on the maturity – calibration curve, the corresponding maturity number for 450 psi flexural strength is 2600 ˚C-hrs. Iowa uses 500 psi center point loading, which would correspond to roughly 425 psi third point loading. 450 psi is a good number and in line with most other states that uses flexural strength of opening pavements to construction traffic.



Flexural Strength – Maturity Calibration Curve

- Maturity sensor was placed in the pavement and maturity monitored.
- Based on the maturity data from the pavement, the time taken to reach the maturity number of 2600 ˚C-hrs (equivalent to 450 psi) is less than 3 days. The reason for the difference is due to difference in curing temperatures experienced by the pavement and the lab cured beams.

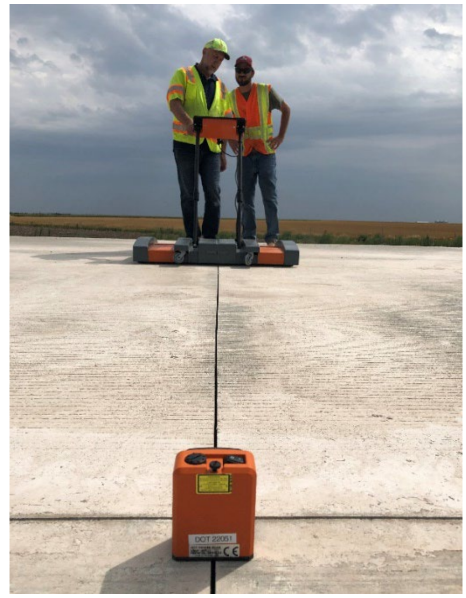




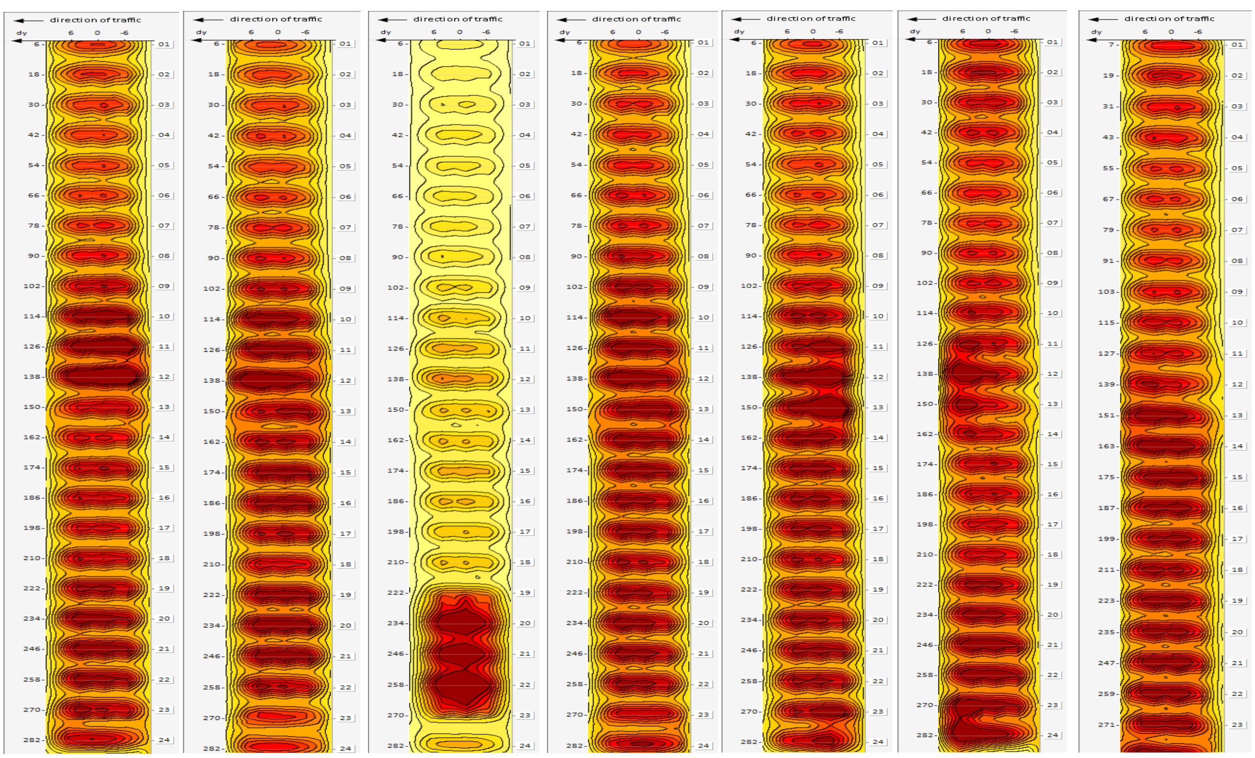
Maturity readings for Field Concrete and Lab Cured Specimens.

Dowel Bar Alignment

- MIT-Dowel-Scanner uses pulse induction technology to measure dowel bar alignment.
- Nondestructive approach.
- Data generated within a couple of minutes of scan.
- Ten joints were scanned by the MCTC staff.
- One of the output is a signal intensity contour map. Each red bar in figures below indicate a dowel.
- Results from the scans indicate no major issues with dowel bar alignment.
- Shipping wires must be cut if dowels are to be seen clearly in the contour maps.
- The third scan in the figure below indicate that the shipping wires were not cut at this joint. When shipping wires are not cut, the device / analysis software of the MIT-Dowel-Scanner assumes that all the dowels are one piece of metal, so distinct contour magnetic maps of the dowels are not possible.

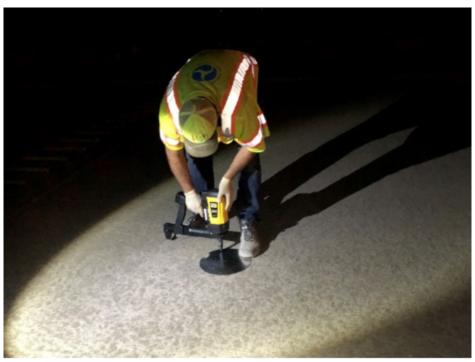
MCTC Personnel showcasing the MIT Dowel Scanner to the FHWA Division Administrator in Kansas, FHWA Pavements and Materials Engineer from the California Division Office, and the Contractor QC manager from Koss Construction.



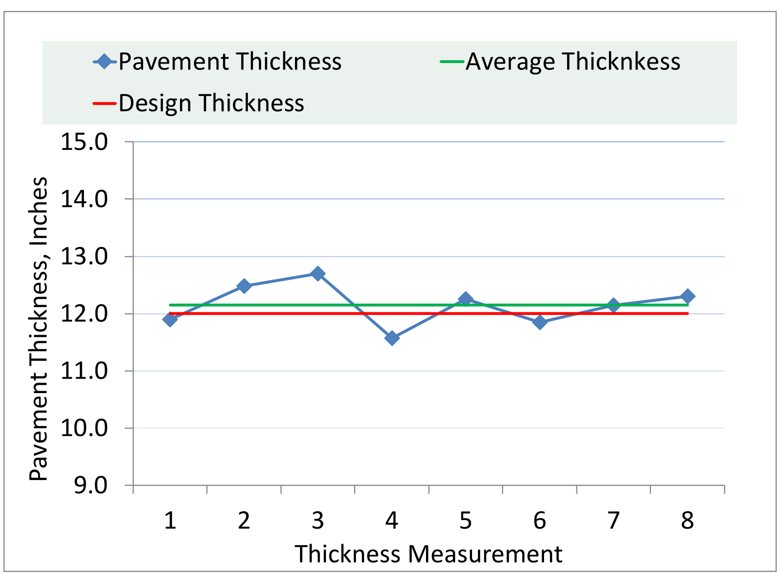
Contour maps representing dowel bar alignment from the MCTC Scans at the Project Site.

Pavement Thickness

- MIT Scan T3 uses pulse induction technology to measure pavement thickness.
- This is a nondestructive approach and takes a couple of minutes to take measurements.
- The technology requires placement of a metal disc on the base prior to placement of concrete.
- Concrete pavement thickness was measured in ten different locations utilizing the MIT Scan T3.
- The project staff and the FHWA Division Office personnel witnessed the MIT Scan T3 testing.

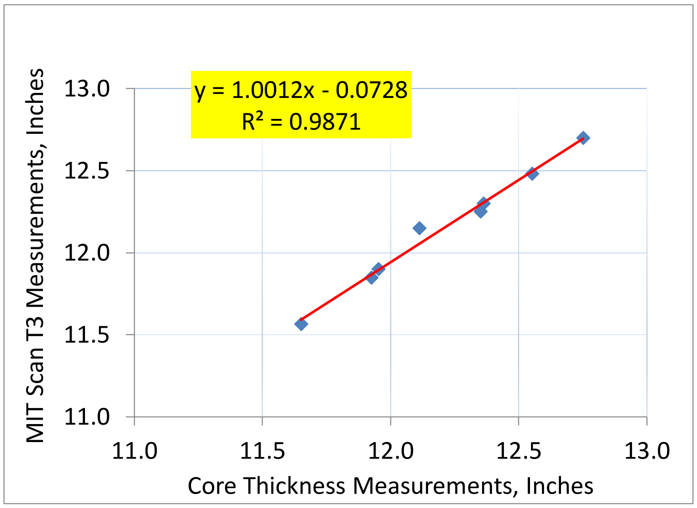


- The design thickness of the pavement was 12.0”. Average thickness measurement from the MIT Scan T3 was 12.2”.



- Kansas DOT verified the accuracy of the MIT Scan T3 by taking cores at the same locations.

- The correlation between the MIT Scan T3 and core results was excellent.



MCTC Activities

- July 29 - Kick Off Meeting at Quinter, KS (Additional info Appendix D).
- July 29 – August 7 Testing.
- August 8 - Open House (Additional info Appendix D).
- August 8 – Close Out.

MCTC Kick Off in Quinter, KS

MCTC / PEM Open House

- A PEM open house event was held during the MCTC visit on August 8. This visit was locally coordinated by Mr. Todd LaTorella of the Missouri-Kansas Concrete Paving Association. Many industry and KDOT attendees were present, and presentations were made by personnel from Iowa State's Concrete Pavement Technology Center (CP Tech Center), FHWA MCTC, KDOT, and Koss Construction, and others. During the open house, several PEM and non-PEM technologies were showcased by the MCTC staff.

MCTC / PEM Open House

Acknowledgements

- Rob Percival (Kansas DOT)
- Dave Meggers (Kansas DOT)
- Dan Wadley (Kansas DOT)
- David Behzadpour (Kansas DOT)
- Ryan Barrett (Kansas DOT)
- Rick Barezinsky
- Waseem Fazal (FHWA Divison Office)
- Doug Daugherty (FHWA)
- Rick Barezinsky (Kansas DOT)
- Kevin Palic (Kansas DOT)
- Todd LaTorella (Missouri-Kansas ACPA)
- Chris Berroth (Koss Construction)

Appendices

Appendix – A: Project Overview

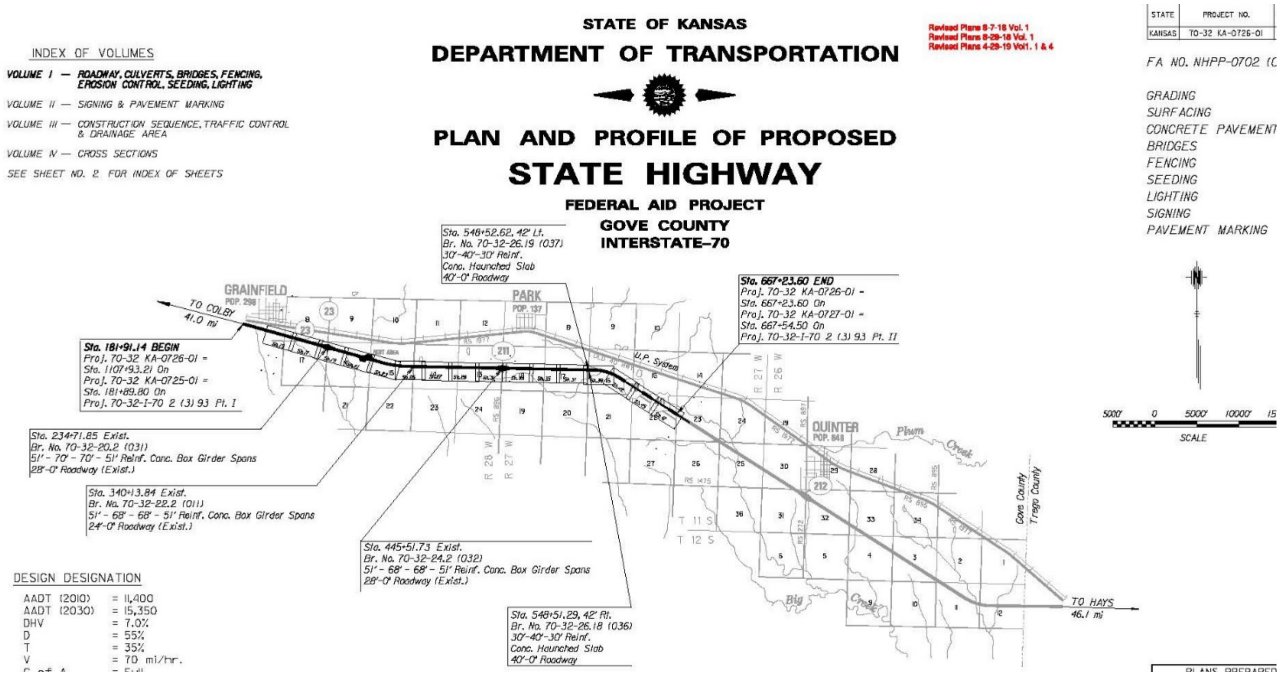


Figure A1: Overview of the project site from project drawings

Appendix – B: Mixture Design

DTMT252 Kansas Department Of Transportation PAGE - 1
Run Date: 07 24 19 PCC Design Mix
Run Time: 11:51 AM

PC Mix #: 3P19012D E Matrl Code: PCC000001 Name: CONC (MA) PAVEMT AE W/C Max: 0.45
Spec Min CF: 517 Design CF: 540 % Air: 6.5 Design W/C: 0.42
Water Source: KOSS/PARK Eff Date: 07 15 19 Term Date: 01 01 20

Material	Name	Prod #	Prod Name	spg	% Blend	W1 wt
001240112	CPA-4 CRUSHED GRAVEL	00812701	HUBER SAND CO (028)	2.58	20.0	1235
001220112	IMA-CRUSHED GRAVEL	00847901	PROWERS AGGR (CO)	2.60	22.0	1228
001090312	BASIC CG FOR MA-7	00812701	HUBER SAND CO (028)	2.62	58.0	618

Cement	Name	Prod #	Prod Name	spg	% Blend
161090400	BLEND CEMNT TY-IL(*)	00007504	HOLCIM (FLORENCE,CO)	3.02	75.0
164010000	FLY ASH/CONC/CLASS C	00018903	WESTAR ENERGY (075)	2.65	25.0

Lbs Per Cubic Yard			Material	Name	Prod #	oz/cy
Agg1= 605	Water= 227	AEA	041000000	AIR-ENTRAINING AGENT	00001201	9.0
Agg2= 665	Cmnt1: 405	ADMIX1	04201000A	TYPE-A (WATER REDUCE	00001201	22.5
Agg3= 1,754	Cmnt2: 135	ADMIX2				
Agg4=	Cmnt3:	ADMIX3				

Total: 3,792 Conc Unit Wt: 140.43 Air Free Unit Wt: 150.19
Contactor's AVG Comp Strength: 7350 Rapid Chloride: Boil: 11.9 Resitivity:
Remarks:

Appendix – B: Combined Gradation

Sieve Size, in	FA 1	#78M	#57	Combined % Passing
2"	100	100	100	**100**
1.5"	100	100	100	**100**
1"	100	100	100	**100**
3/4"	100	93	100	**99**
1/2"	98	43	100	**87**
3/8"	94	22	100	**81**
No. 4	84	5	34	**57**
No.8	70	3	5	**42**
No.16	53	3	2	**32**
No.30	36	2	2	**22**
No.50	16	2	1	**10**
No.100	5	2	1	**4**
No.200	2	1	1	**2**
Proportions	**58%**	**20%**	**22%**	**100%**

Appendix – C: MCTC Test Results

Fresh Concrete Properties

S. No	Sample ID	Date	Time, Local	Slump, Inches	Conc Temp, °F	Air Temp, °F	Unit Weight, pcf	Air Content, %	Box Test	
									Ranking	Edge Slump
1	1-1	7/31	8:40pm	5.00	90	85.0	132.8	11.5%		
2	1-2	7/31	9:45pm	5.00	87	85.0	133.3	11.5%		
3	1-3	7/31	11:15pm	5.00	87	82.0	133.1	11.5%	1	None
4	1-4	7/31	11:48pm	5.00	85	78.0	134.6	10.5%		
5	2-1	8/1	8:10pm	4.75	87	81.0	134.6	11.0%		
6	2-2	8/1	8:49pm	4.25	85	82.0	135.7	10.0%		
7	2-3	8/1	10:32pm	4.00	83	83.0	135.3	10.0%	1	None
8	3-1	8/4	7:28pm	3.75	92	91.0	136.1	10.0%		
9	3-2	8/4	8:27pm	4.00	89	82.0	136.1	9.5%		
10	3-3	8/4	9:32pm	5.50	87	82.0	135.9	9.5%	1	None
11	3-4	8/4	10:30pm	5.25	86	75.0	136.1	9.0%		
12	3-5	8/4	11:30pm	4.50	85	75.0	136.2	9.0%		
Specification Requirement					≤ 90			**5-8%**		

Air Void Characteristics (Air Void Analyzer and Super Air Meter (SAM))

		AVA				SAM		
Sample ID	Date	Spacing Factor, in	Max Rec	Specific Surface. 1/in	Min Rec	SAM Number	Max Rec	SAM Air
1-2	7/31/2019	0.008	0.0100	534	**600**	0.15	0.25	**11.0%**
1-4	7/31/2019	0.0083	0.0100	488	**600**	0.20	0.25	**9.7%**
2-2	8/1/2019	0.0099	0.0100	483	**600**	0.20	0.25	**8.8%**
3-2	8/4/2019	0.008	0.0100	589	**600**	0.22	0.25	**9.2%**
3-4	8/4/2019	0.0083	0.0100	525	**600**	0.15	0.25	**8.6%**
3-5	8/4/2019	0.0083	0.0100	545	**600**	0.25	0.25	**8.7%**
4-1	8/5/2019	0.0054	0.0100	639	**600**		0.25	
4-2 F	8/5/2019		0.0100		**600**	0.15	0.25	7.90%
4-3 F	8/5/2019	0.0105	0.0100	591	**600**		0.25	

Average Compressive Strength

Average Compressive Strength, psi			
	1-1	2-1	3-1
1 Day	1358		
2 Day	2049		
3 Day	2350		
5 Day	2593		
7 Day	2785	3673	3749
28 Day	3377	4498	4930
56 Day	3761	5127	5263

Average Flexural and Split Tensile Strength

Sample 1-1	Compressive Strength, psi	Flexural Strength, psi	Split Tensile Strength, psi	MOE, psi	Poisons Ratio
Day 1	1358	270			
Day 2	2049	365			
Day 3	2350	406			
Day 5	2593	452			
Day 7	2785	478	248	4,162,120	0.17
Day 28	3377	537	291	5,228,504	0.19
Day 56	3761	--	347	5,477,054	0.19

Surface Resistivity

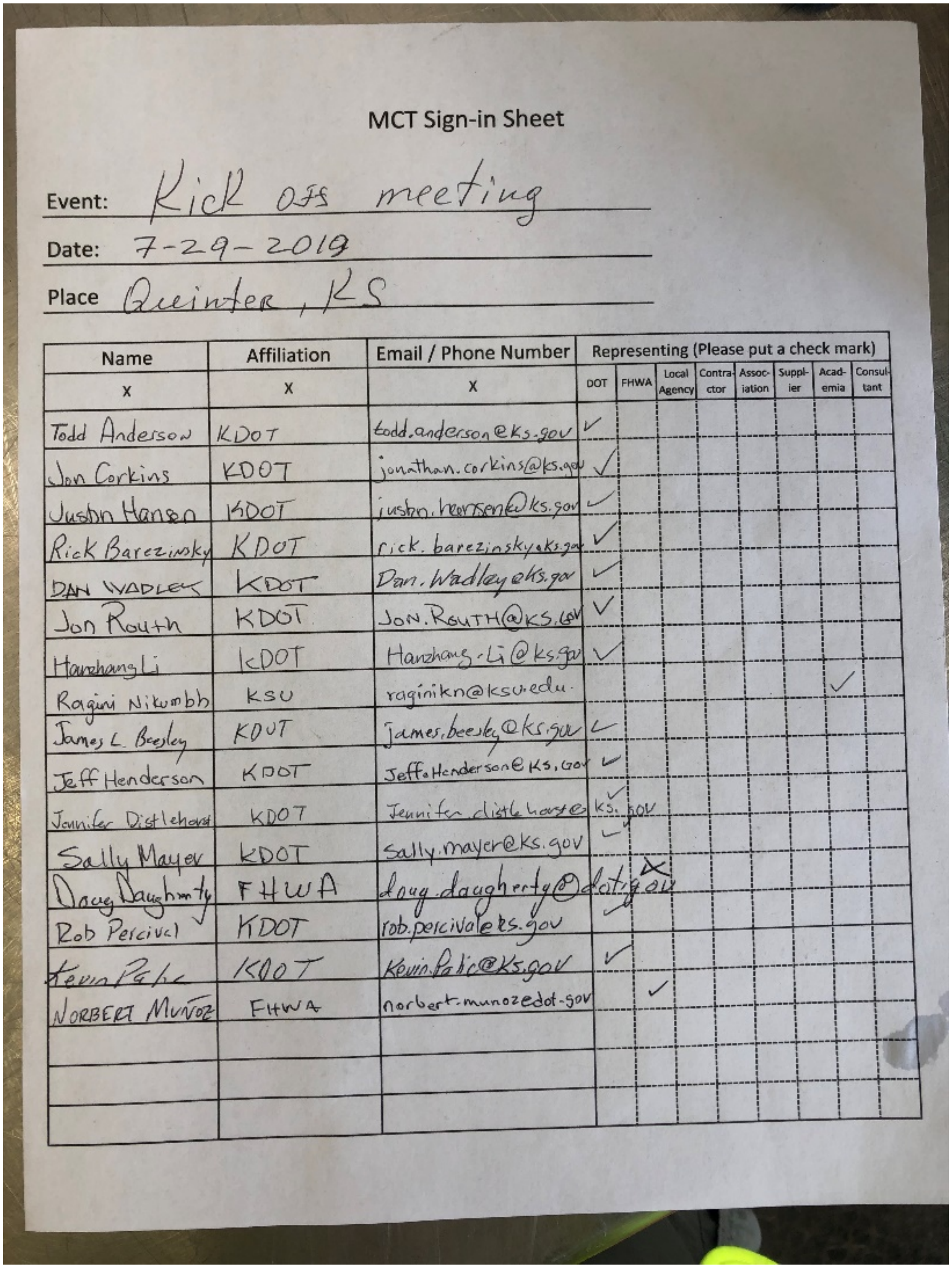
ID	Cast Date	Days	0	90	180	270	0	90	180	270	AVG	AVG * 1.1
#1-1	7/31/2019	7	5.5	5.2	5.4	5.1	5.5	5.2	5.4	5.2	5.3	5.8
#1-3		7	5.5	5.3	5.6	5.5	5.6	5.3	5.6	5.5	5.5	6.0
#2-1	8/1/2019	7	5.7	5.7	5.7	5.8	5.5	5.7	5.7	5.5	5.7	6.2
#2-3		7	5.6	5.4	5.4	5.7	5.5	5.5	5.4	5.7	5.5	6.1
#3-1	8/4/2019	7	5.5	5.4	5.7	5.6	5.5	5.5	5.6	5.6	5.6	6.1
#3-3		7	5.6	5.5	5.4	5.5	5.6	5.5	5.5	5.5	5.5	6.1
#1-1	7/31/2019	29	10.1	9.9	10.0	9.7	10.1	10.0	10.0	9.8	10.0	10.9
#1-3		29	10.1	9.8	9.9	9.9	10.1	9.9	10.0	9.9	10.0	10.9
#2-1	8/1/2019	28	10.2	9.9	10.2	9.7	10.2	10.0	10.2	9.8	10.0	11.0
#2-3		28	9.9	9.6	9.5	10.1	10	9.6	9.5	10	9.8	10.8
#3-1	8/4/2019	28	10.7	10.7	11.2	10.9	10.7	10.8	11.2	10.7	10.9	11.9
#3-3		28	9.4	9.3	9	9.3	9.3	9.5	9	9.3	9.3	10.2
#1-1	7/31/2019	56	15.7	15.2	15.3	14.7	15.6	15	15.1	14.7	15.2	16.7
#1-3		56	15.2	14.6	15	14.4	15.2	14.8	14.9	14.6	14.8	16.3
#2-1	8/1/2019	56	15.7	15.7	15.5	15.1	15.8	15.8	15.6	15.2	15.6	17.1
#2-3		56	15.2	14.8	14.7	15.6	15.2	14.7	14.5	15.6	15.0	16.5
#3-1	8/4/2019	56	15.9	16.1	16.7	15.9	15.6	15.8	16.8	15.8	16.1	17.7
#3-3		56	13.9	13.5	13.2	13.6	13.9	13.4	13.1	13.7	13.5	14.9

Pavement Thickness Measurements

S. No	MIT Scan T3 Measurements, inches	Cores Thickness, inches	Design Thickness, inches
1	11.90	12.0	12.0
2	12.48	12.6	
3	12.70	12.8	
4	11.57	11.7	
5	12.25	12.4	
6	11.85	11.9	
7	12.15	12.1	
8	12.30	12.4	
Average	12.15	12.21	

Appendix – D: MCTC Other Activities

Kick-Off Meeting – Sign-in Sheet



MCT Sign-in Sheet

Event: Kick off meeting

Date: 7-29-2019

Place Queinter, KS

Name	Affiliation	Email / Phone Number	Representing (Please put a check mark)							
X	X	X	DOT	FHWA	Local Agency	Contractor	Association	Supplier	Academia	Consultant
Todd Anderson	KDOT	todd.anderson@ks.gov	✓							
Jon Corkins	KDOT	jonathan.corkins@ks.gov	✓							
Justin Hanson	KDOT	justin.heersen@ks.gov	✓							
Rick Barezinsky	KDOT	rick.barezinsky@ks.gov	✓							
DAN WADLEY	KDOT	Dan.Wadley@ks.gov	✓							
Jon Routh	KDOT	JON.ROUTH@KS.GOV	✓							
Hanzhang Li	KDOT	Hanzhang.Li@ks.gov	✓							
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James L. Beesley	KDOT	james.beesley@ks.gov	✓							
Jeff Henderson	KDOT	Jeff.Henderson@KS.GOV	✓							
Jennifer Distlehorst	KDOT	Jennifer.distlehorst@ks.gov	✓							
Sally Mayer	KDOT	sally.mayer@ks.gov	✓							
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Rob Percival	KDOT	rob.percival@ks.gov	✓							
Kevin Palic	KDOT	Kevin.Palic@ks.gov	✓							
NORBERT MUÑOZ	FHWA	norbert.munoz@dot.gov		✓						

MCTC / PEM Open House Agenda

OPEN HOUSE

The Federal Highway Administration & Kansas Department of Transportation are bringing the Mobile Concrete Technology Center (MCTC) to Kansas

The MCTC

The MCTC lab

You are invited to an Open House on **August 8, 2019** featuring Performance Engineered Mixture (PEM) Test Methods.

Location: Kansas Department of Transportation – District 1
121 SW 21st Street - Topeka, Kansas 66612

AGENDA

10:00 - 10:05	Welcome
10:05 - 11:30	Presentations • PEM Approach, National CP Tech Center • Agency Perspective on PEM, KDOT • Industry Perspective on PEM, Missouri/Kansas ACPA • PEM Test Methods, FHWA MCTC • I-70 Project Overview, Koss Construction Company
11:45 - 12:30	Lunch
12:45 – 4:00	Visit FHWA MCTC *(Located in the adjacent parking lot)*
12:45 - 2:00	Demonstrations of the PEM Tests at the MCTC
2:00 - 3:00	Showcasing non-PEM related innovative tests at the MCTC
3:00 - 4:00	Ongoing demonstrations and tour of the MCTC

If you cannot attend the morning session, you can still visit the MCTC in the afternoon.

What is it about? The FHWA's Mobile Concrete Technology Center (MCTC) introduces agency and industry personnel to the state-of-the-art concrete technology in materials selection, mixture design, field and laboratory testing, and pavement evaluation. The MCTC is visiting Kansas to introduce new test methods related to the Performance Engineered Mixtures (PEM) initiative and other innovative tests related to concrete materials and construction relevant to field performance.

What does it involve? Demonstration and interactive opportunities for PEM test methods, including:

- Super Air Meter (SAM)
  - Cutting edge technology to measure air void characteristics of concrete
- Surface Resistivity
  - Rapid measurement to indicate permeability of concrete
- Box Test
  - Measurement of workability
- V-Kelly
  - Measurement of workability

Why attend? This is a very unique opportunity to learn about the new PEM tests that guide and confirm design and construction of concrete mixtures for performance. Additionally, the FHWA MCTC also showcases other new technologies related to concrete. Many of these technologies are state of the art, that are performance indicators and provide information in real-time.
More information on the MCTC: https://www.fhwa.dot.gov/pavement/concrete/trailer/
More information on PEM: https://cptechcenter.org/performance-engineered-mixtures-pem/

Who should I contact for more information?

Jagan Gudimettla, P.E., FHWA MCTC - Jagan.m.gudimettla.ctr@dot.gov, 703-963-4939
(or)
Todd LaTorella, P.E., MO/KS CHAPTER ACPA - todd@moksacpa.com , 816-392-9196 (c)

Lunch Sponsors:

- **Koss Construction Company**
- **LafargeHolcim**
- **MO/KS Chapter, American Concrete Pavement Association**

Please register by August 2, 2019 so we can plan for the number of lunches.

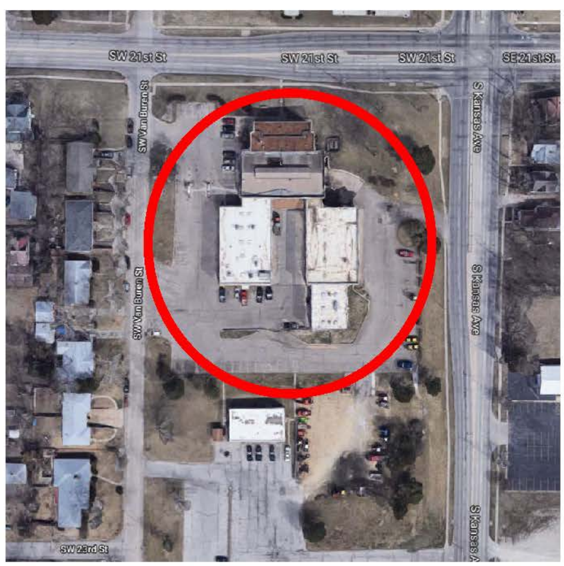
Email Registration to Melisse Leopold:
mleopold@snyder-associates.com
Phone: 515-964-2020
Please register by: **August 2, 2019**

Name(s): ______________________________

Company: ______________________________

Phone: ______________ Email: ______________

Open House Location – KDOT District One Office



MCTC / PEM Open House Sign-in Sheet

Performance Engineered Mixtures TPF-5(368)
Kansas Open House
August 8, 2019
Sign In Sheet

Name	Organization	Phone	Email
Jerod Gross	CP Tech Center	515-964-2020	jgross@snyder-associates.com
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Kansas Department of Transportation

National Concrete Pavement Technology Center

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