PA Route 376 Fiberless SMA

Lindy Paving & Ingevity

January 2023 PA Asphalt Paving Conference

Agenda

1. Mix Design overview
2. Performance Tests
   - HWTT AASTHO T 324
   - Cantabro (AASTHO TP108)
   - IDEAL CT (ASTM D8225)
   - IDEAL RT (ASTM D8360)
   - Smart Rock Workability Evaluation
3. Reduced Fuel at Lower Production Temperatures

Lindy Paving Neville Island Plant

Penn. DOT PUB 408 / 419 SMA Specifications:

TABLE B
Mix Design Requirements for SMA Mixtures

AGGREGATE GRADATION REQUIREMENTS, PERCENT PASSING		
Sieve Size	**9.5-mm Mixture**	**12.5-mm Mixture**
19.0 mm (3/4 inch)	-	100
12.5 mm (1/2 inch)	100	90 – 99
9.5 mm (3/8 inch)	75 – 95	70 – 85
4.75 mm (No. 4)	30 – 50	28 – 40
2.36 mm (No. 8)	20 – 30	18 – 30
1.18 mm (No. 16)	-	-
600 µm (No. 30)	-	-
300 µm (No. 50)	-	-
150 µm (No. 100)	-	-
75 µm (No. 200)	8 – 13	8 – 11
VOLUMETRIC DESIGN REQUIREMENTS		
Design Gyrations (N_{design})	100	
Voids in Mineral Aggregate	18.0 % Minimum	
Voids in Course Aggregate (VCA)	$VCA_{mix} < VCA_{dry\ rodded}$	
Design air voids	3.5 - 4.0 %	
Minimum asphalt binder content	Table C	
Binder grade	PG 64E-22	
Stabilizer content	Cellulose: 0.2 to 0.4 % by total mix weight Mineral: 0.3 to 0.4 % by total mix weight CR: 0.3 to 1 % by total mix weight	
Draindown	0.3 % maximum	

(1) When a warm mix technology is used as the stabilizing agent the VMA may be lowered to a minimum of 17.5%.

(2) When a warm mix technology is used as the stabilizing agent, perform this test at 5 degrees above the desired high production temperature limit in the QC plan, but no higher than 305 degrees

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Penn. DOT PUB 408 / 419 SMA Specifications:

TABLE C
Minimum Asphalt Binder Requirements for SMA Mixtures

Combined Aggregate Bulk Specific Gravity	Minimum Asphalt Content, % by Total Mix Weight
2.400 - 2.449	7.4
2.450 - 2.499	7.2
2.500 - 2.549	7.1
2.550 - 2.599	7.0
2.600 - 2.649	6.8
2.650 - 2.699	6.7
2.700 - 2.749	6.6
2.750 - 2.799	6.5
2.800 - 2.849	6.4
2.850 - 2.899	6.3
2.900 - 2.949	6.2
2.950 - 2.999	6.1
3.000 - 3.049	6.0

Penn. DOT PUB 408 / 419 SMA Specifications:

TABLE D
Composition Tolerance Requirements of the Completed Mix

		Single Sample (n = 1)	Multiple Samples (n ≥ 3)
Gradation			
Passing 9.5 mm (3/8 inch) and Larger Sieves		±5%	±4%
Passing 4.75 mm (No. 4) to 150 µm (No. 100) Sieves (Inclusive)		±4%	±3%
Passing 75 µm (No. 200) Sieve		±3.0%	±2.0%
Asphalt Content			
% Asphalt by Weight		±0.7%	±0.4%
Draindown			
% by Weight		0.3 % maximum	
Temperature of Mixture (F)			
Class of Material	**Type of Material**	**Minimum**	**Maximum**
PG 64E-22	Asphalt Binder	260	330

TABLE E
Volumetric Tolerance Requirements of the Laboratory Compacted Mix

	Single Specimen (n = 1)	Multiple Specimens (n ≥ 2)
Air Voids at N_{design} (V_a)	±2.0% from JMF	±1.5% from JMF
Minimum VMA	17.0	_

When a warm mix technology is used for the stabilizing agent the maximum temperature will be 300 degrees

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Rational to try Fiber less SMA

Looking to produce SMA at any plant without the use of special equipment to provide flexibility and without sacrificing quality of the mix or laydown process

Process for making Fiber less SMA

In order to take fibers out of your existing mix:

- When reducing fibers by 0.1% you reduce your liquid binder by 0.1%
  - I.E - 0.3% fibers lowers the liquid by 0.3%
  - Lower the mix temperature
    - Used Evotherm J1 to produce at a lower temperature of 280 degrees
  - To meet mix design volumetrics, minor aggregate adjustments may have to be made.
- Establish drain down temperature limits
  - We used 280, 285, 290, 295, 300 and 305 as our points
  - 280 and 295 were our target production limits.

Process for making Fiber less SMA

Process for making Fiber less SMA

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Process for making Fiber less SMA

- Made TSR's
  - Used 3 different labs to compare all results
- Performed Hamburg and Ideal RT for Rut testing
  - Compared to traditional SMA
- Performed Ideal CT Testing
  - Ideal CT numbers went up
    - Due to greater film thickness on the aggregate by producing the mix at a lower temperature by using Evotherm J1
    - No premature aging of liquid due to lower temperatures
      - We see more premature aging of binder with higher temperatures

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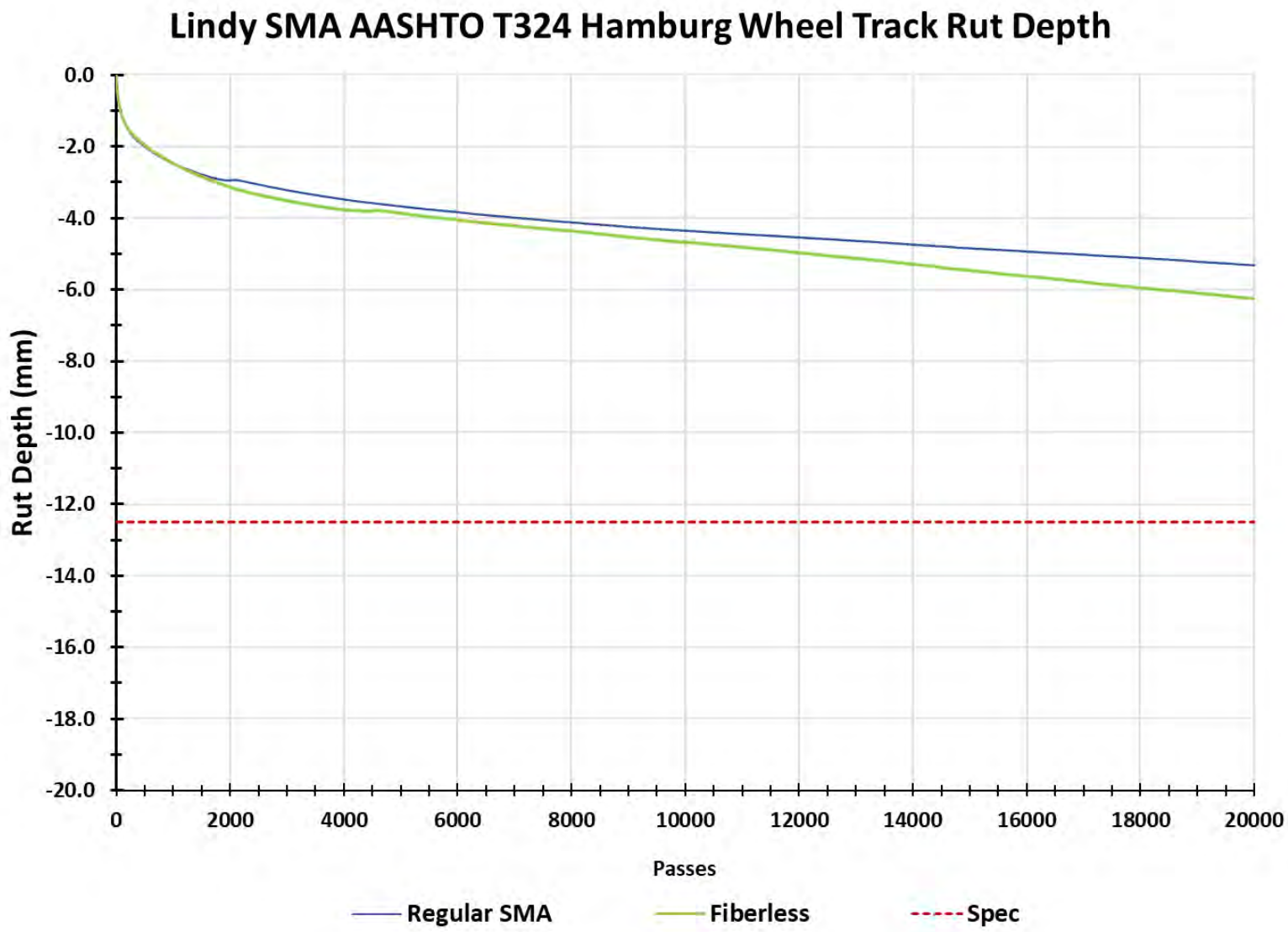
Production Summary

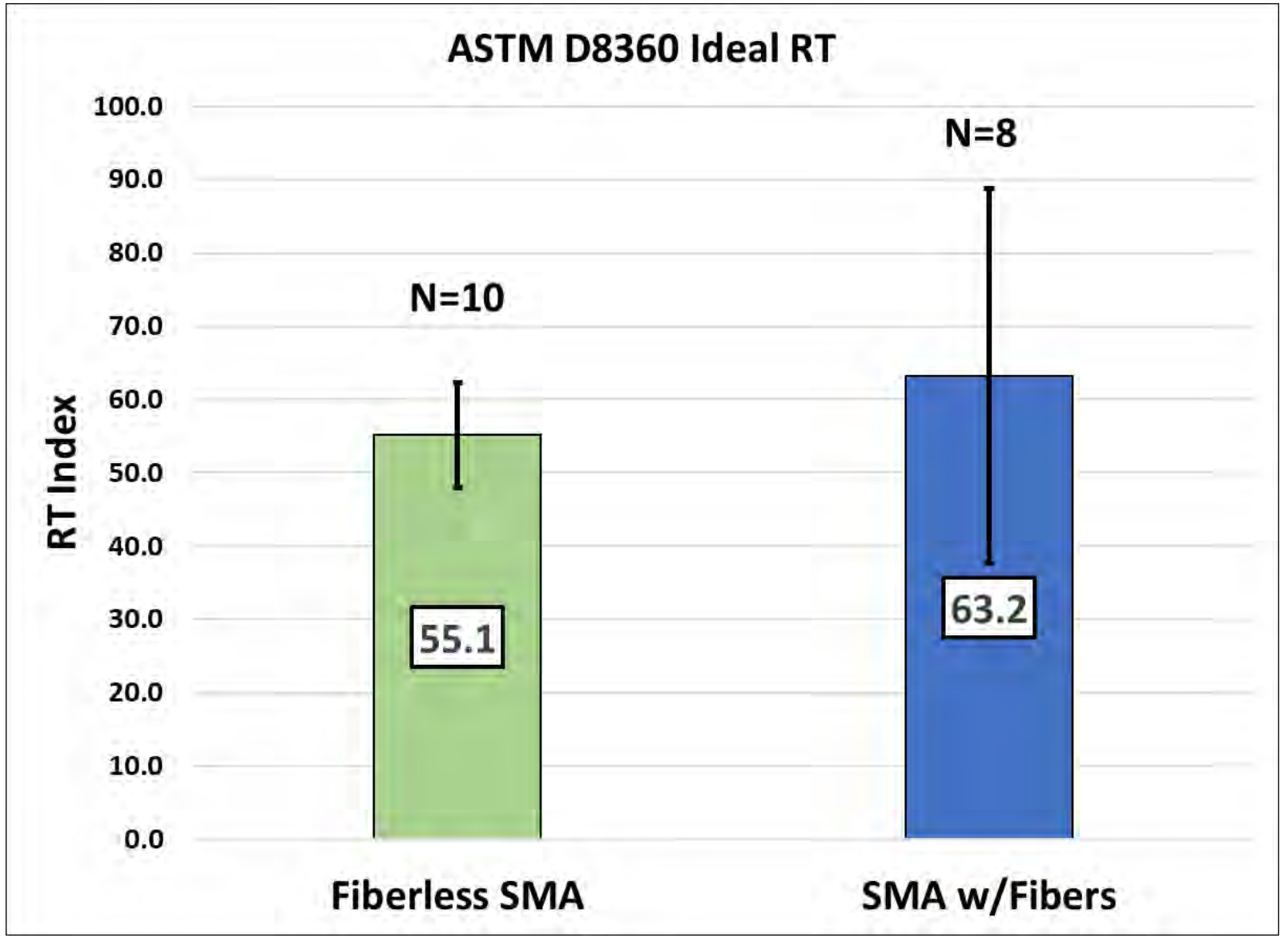
- Production Temp for Standard SMA = 315F to 325F
- Production Temp for Fiberless SMA 275F to 285F
- 35F to 40 F production temperature drop complies with NAPA's Plan for Net-Zero Emissions
- Healthier for your employees
  - No fumes or blue smoke at the plant or paver
- Rain factor.
  - Popup shower at the plant is no longer an issue
- Eliminates fat spots in the final product
- No issue with mix buildup in truck beds
- No issue with hand work

Mix Performance Tests

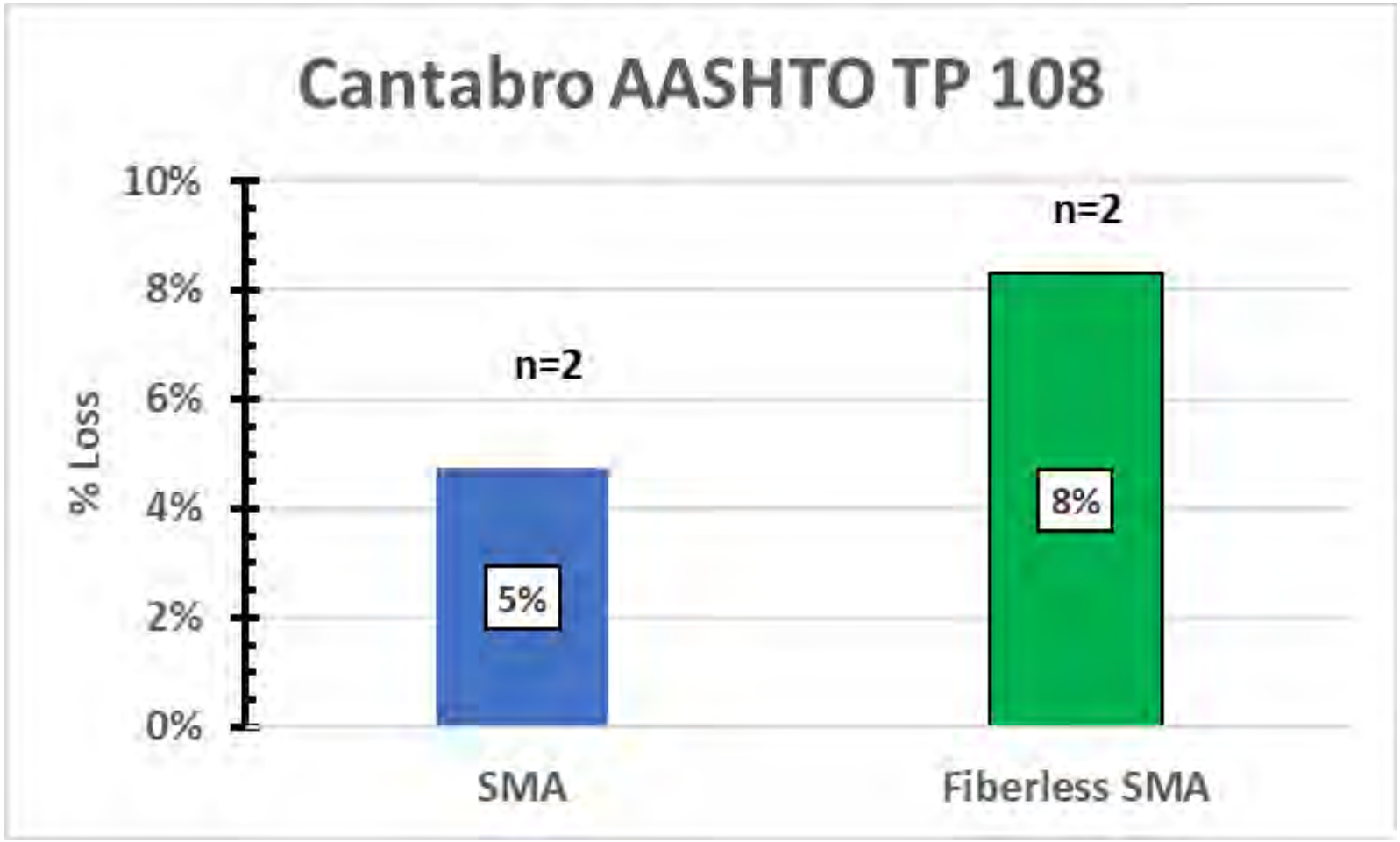
HWT AASTHO T 324



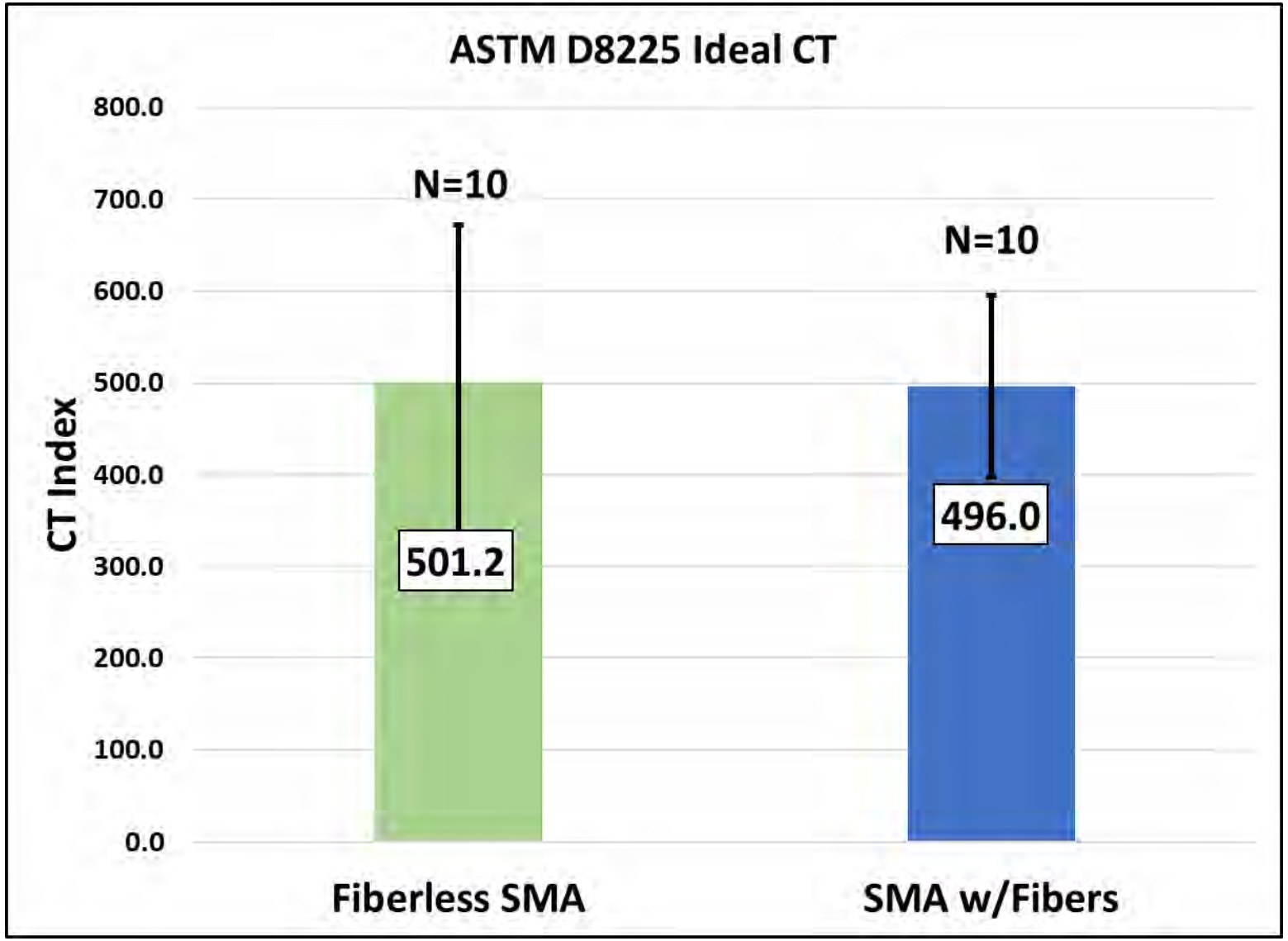
IDEAL RT (ASTM D8360)



Cantabro (AASTHO TP108)



IDEAL CT (ASTM D8225)



Permeation: Measurement of Water Permeability of Compacted Paving Mixtures

Standard Fibers	1	2	3
Area of Tube, a (cm^2)	7.89	7.89	7.89
Thickness of Specimen, L (cm)	7.5	7.5	7.5
Area of Specimen, A (cm^2)	176.7	176.7	176.7
Flow Time, t(s)	1800	1800	
Initial Head, h1 (cm)	82.4	82.4	82.4
Terminal Timing Mark, tf (cm)	63.5	63.5	
Final Head, h2	82.4	82.4	18.9
Temp. Coeff., c	0.99	0.99	
Permeability, k (cm/s)	0.00 E+00	0.00 E+00	

Fiberless	1	2	3
Area of Tube, a (cm^2)	7.89	7.89	7.89
Thickness of Specimen, L (cm)	7.4	7.4	7.4
Area of Specimen, A (cm^2)	176.7	176.7	176.7
Flow Time, t(s)	1800	1800	
Initial Head, h1 (cm)	82.3	82.3	82.3
Terminal Timing Mark, tf (cm)	63.5	63.5	
Final Head, h2	82.3	82.3	18.8
Temp. Coeff., c	1.02	1.02	
Permeability, k (cm/s)	0.00 E+00	0.00 E+00	

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Smart Rock Workability

The Penn State Smartrock Workability device will be used to collect workability data for comparison on the SMA and Fiber-less SMA mixtures.

The device needed repair and has recently been sent to Ingevity lab for use.

Additional information will be presented in the future on the workability aspects of lower production temperature Fiber-less SMA using chemical warm mix versus the traditional SMA.

Fuel Used at Lower Production Temperatures

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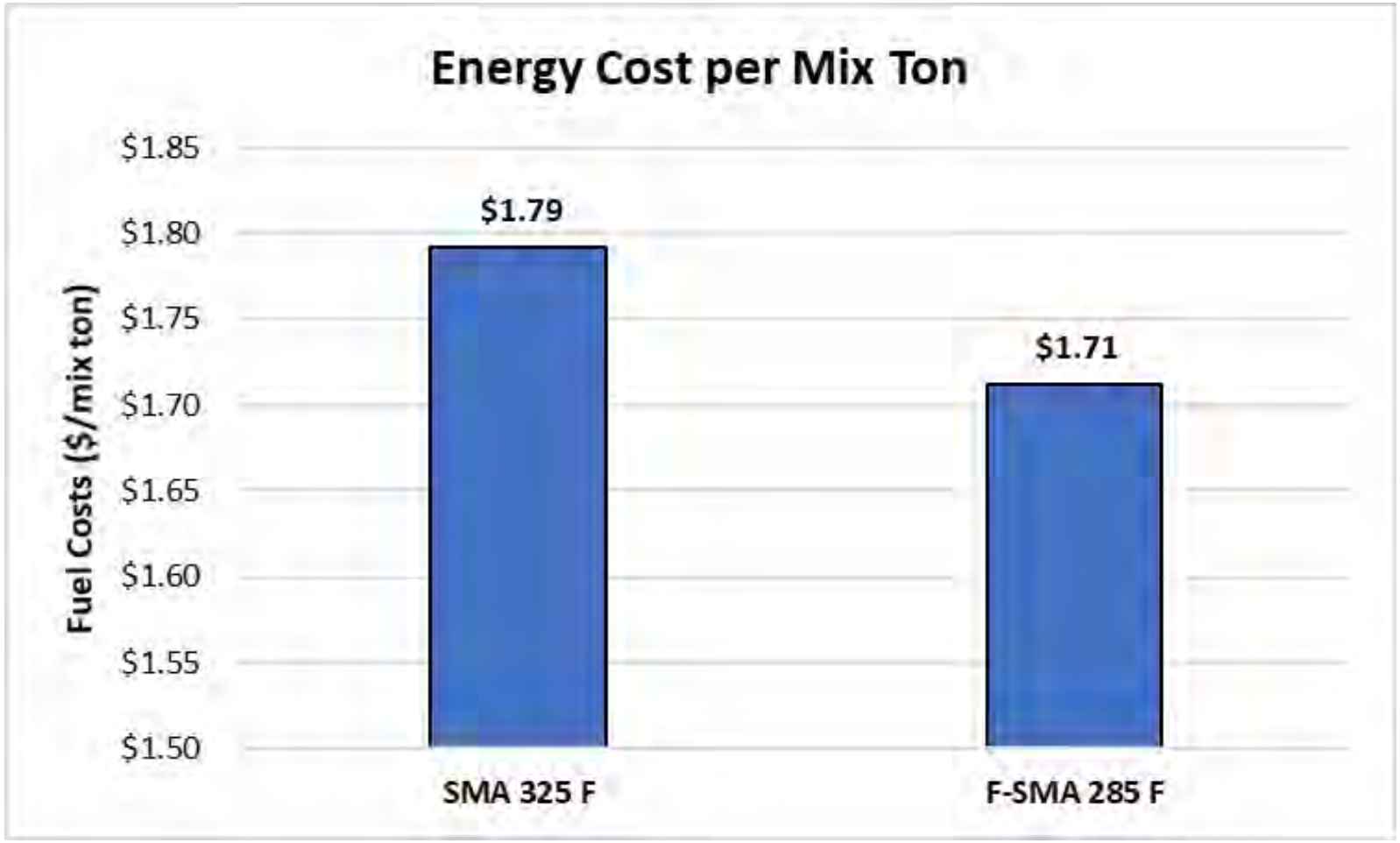
Reduced Fuel at Lower Production Temperatures

Assuming $9/MMBTU



Acknowledgements

PAPA

- Charlie Goodhart
- Gary Hoffman, P.E.

PennDOT

- District 11
- Neal Fannin

Denmarsh photography

Lindy Paving

Tom Bennert - Rutgers University

Ingevity

- Jesse Cook
- Tulsa Lab

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Bryan Pecht
843-259-7605

Pete Trancale
843-714-0246

Dominic Barilla
843-371-7716