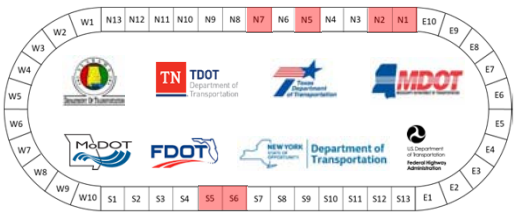
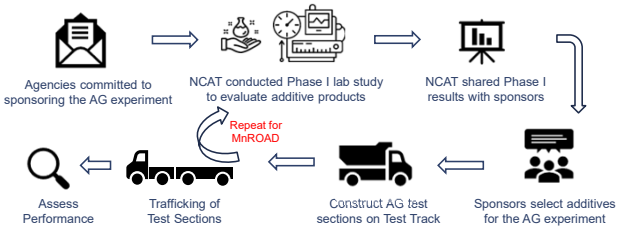
Additive Group Experimental Scope

2021 Additive Group Sponsors



Overall Additive Group Plan



The Additive Group Experiment - Objectives

- Comprehensively evaluate the performance impact of multiple mix additives at the same time
- Establish a process to evaluate future additives without having to build test sections
- Support the goal of providing sustainable pavement technologies that outperform current materials

Selected Phase 2 Additives

Recycled Tire Rubber

entech — wet process

Liberty — dry process

Recycled Plastics

DOW — wet process

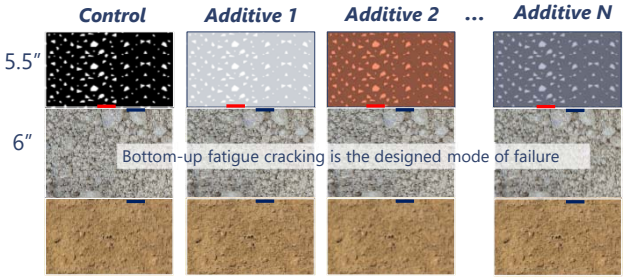
Generic LLDPE rich — dry process

Fibers

SURFACE TECH

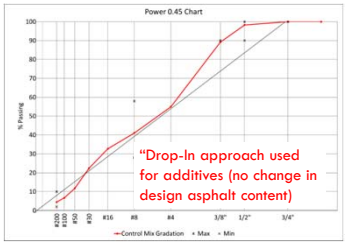
12/3/2024

Southern Additive Group Pavement Design



Mix Design Information

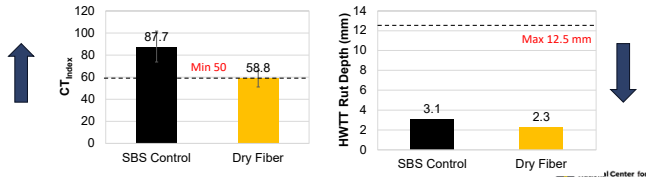
- 12.5 mm NMAS
- 20% RAP
- N_{des} = 60 gyrations
- PG 76-22 binder (5.6%)
- Aggregates:
  - Granite 78 – 26%
  - Granite 89 – 25%
  - Sand – 28%
  - BHF – 1%
  - RAP – 20%



"Drop-In approach used for additives (no change in design asphalt content)

Phase II Plant Mix Characterization (IDEAL-CT, HWTT)

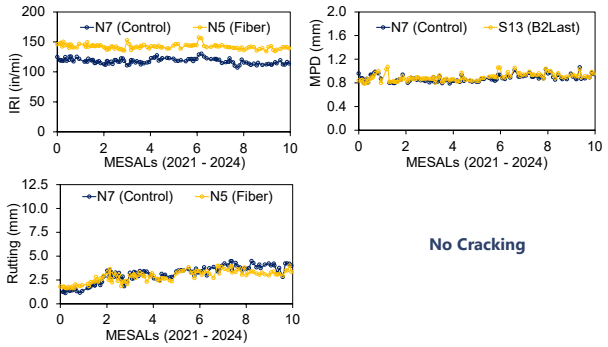
- Cracking resistance: SBS control > dry fiber
- Rutting resistance: SBS control ≤ dry fiber



IDEAL-RT & HT-IDT showing same trend as HWTT

Phase II Test Section Construction

Test Section	SBS Control (N7)	Dry Fiber (N5)	Target
Asphalt layer thickness (in)	5.7	5.6	5.5
Average in-place density (%)	95.9	94.2	> 93.0



No Cracking

Ground Tire Rubber (GTR)

- Wet Process entech
  - Rubber-modified binder that used a PG 64-22 modified with 10% -30 mesh grind rubber (by weight of the virgin binder)
  - Dosage selected to match the PG grade of the SBS binder (PG 76-22)
- Dry Process Liberty
  - PG 67-22 + 12% SmartMIX (by weight of the total binder)
  - 30 mesh grind rubber + extender oil, and held at temp. of 275°F for 30 min
  - After heating, swelling, and saturation, reacted rubber is moved to cooling system and mixed with flow agent to prevent particles sticking

Summary

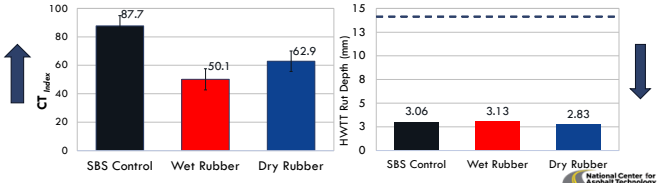
Comparison vs. SBS Control		Dry Fiber
Lab Mix characterization	Stiffness	=
	Cracking resistance	↓
	Rutting resistance	↑
Field Performance	Rutting	=
	Cracking	=

Phase II Plant Mix Production

- Wet rubber: terminal blended binder
- Dry rubber: fed into the plant using a fiber feeder

Phase II Plant Mix BMD Results (IDEAL-CT, HWTT)

- Cracking resistance: SBS control > dry rubber >wet rubber
- Rutting resistance: SBS control = wet rubber = dry rubber



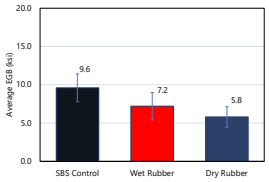
IDEAL-RT & HT-IDT showing same trend as HWTT

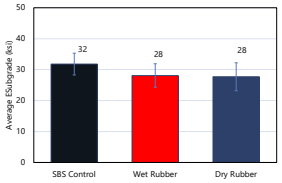
Phase II Test Section Construction

Test Section	SBS Control (N7)	Dry Rubber (N1)	Wet Rubber (N2)	Target
Asphalt layer thickness (in)	5.7	5.7	5.7	5.5
Average in-place density (%)	95.9	94.1	93.7	> 93.0

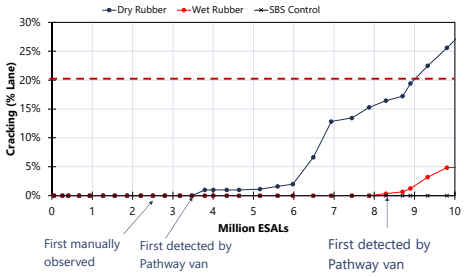
Phase II Pavement Structural Response (10 MESALs)

- FWD back-calculated granular base moduli (E_{GB}), and Subgrade (E_{SG})





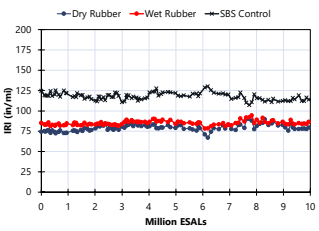
Phase II Pavement Performance (10 MESALs)

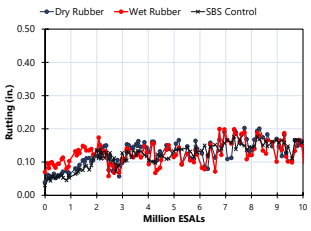


N2-Cracking

N1-Cracking

Phase II Pavement Performance (10 MESALs)





Summary

Comparison vs. SBS Control		Wet Rubber	Dry Rubber
Lab Mix Characterization (Plant Mix)	Stiffness (E*)	≤	≤
	Fatigue Resistance (CF)	↑	↑
	Fatigue Resistance (BBF)	↑	=
	Cracking resistance (IDEAL-CT)	↓	↓
	Rutting resistance (HWTT)	=	=
Field Performance	Rutting	=	=
	Cracking	↓	↓

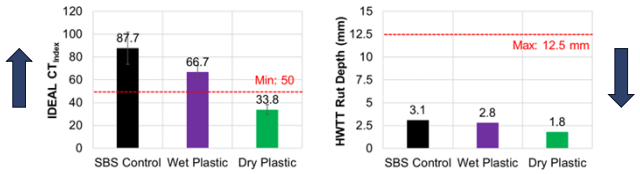
Phase II Plant Mix Production

- Wet plastic: terminal blended binder
- Dry plastic: fed into the plant using a fiber feeder


Recycled Plastic

Phase II Plant Mix Characterization (IDEAL-CT, HWTT)

- Cracking resistance: SBS control > wet plastic > dry plastic
- Rutting resistance: SBS control = wet plastic < dry plastic



IDEAL-RT & HT-IDT showing same trend as HWTT

Plastic-Modified Asphalt

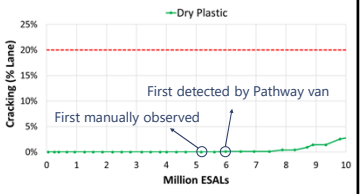
- Wet process (wet plastic mix)
  - PG 76-22 = PG 67-22 + 1.0% LLDPE, 1.5% RET, and 0.32% PPA
  - Dosages selected to match %Recovery of SBS control binder and maintain good storage stability
  - Other mixture components kept the same as SBS control mix
  - 'Plastic' as potential SBS alternative
- Dry process (dry plastic mix)
  - SBS control mix + 0.5% LLDPE (weight of total aggregate)
  - Plastic dosage nearly 10 times higher than wet process
  - Plastic as potential value-added additive

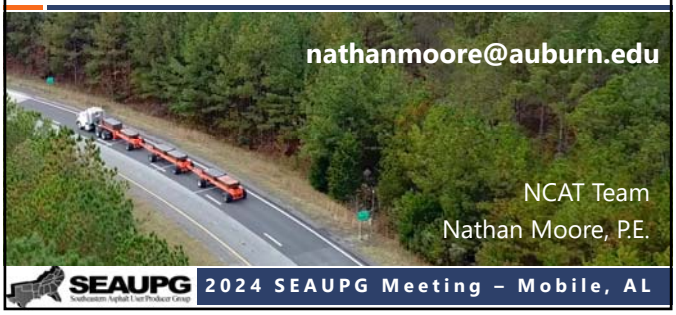
Phase II Test Section Construction

Test Section	SBS Control	Wet Plastic	Dry Plastic	Target
Asphalt layer thickness (in)	5.7	5.7	5.3	5.5
Average in-place density (%)	95.9	93.9	93.5	> 93.0

Phase II Pavement Performance (10 MESALs)

- Minimal rutting (< 0.2 inches)
- Cracking
  - SBS control: no cracking
  - Wet plastic: no cracking
  - Dry plastic: 2.8%
- Steady IRI and MPD





Summary

Comparison vs. SBS Control		Wet Plastic	Dry Plastic
Lab Mix characterization	Stiffness	=	↑
	Rutting resistance	=	↑
	Cracking resistance	↓	↓↓
Field Performance (10 MESALs)	Rutting	=	=
	Cracking	=	↓*

** pending further monitoring*

Final Summary

- Continuing traffic on AG sections
- Monitoring performance and understanding effects of differences in base stiffness and mat density
- Differences in laboratory results will hopefully yield differences in performance
- Development of framework underway