PennDOT's Strategic Recycling Program

Use of Recycled Materials in Transportation Applications

Project Spotlight:
Recycled Plastic Modified Asphalt Project
at the DCNR Ridley Creek State Park

PennDOT Recycled Plastic Pilots:
SR 0051 Section 11A
SR 2017 Crum Creek Road
SR 3017 Section 030

HISTORY OF THE SRP

Initiated in 2000, the SRP seeks recycling opportunities that recognize economic savings and environmental enhancement.

This is accomplished through:

- **Reducing waste materials generated by PennDOT operations;**
- **Review / revise existing procedures and Specs that enable substitution;**
- **Evaluating recycled/recyclable materials for use in transportation and civil engineering applications; and,**
- **Employing procurement and contract bidding options to encourage the use of recycled materials.**

THE SRP KEY FOCUS AREAS

- Research
- Specifications
- Projects
- Outreach
- Contracting

SRP SUPPORTED INITIATIVES

SPECIFICATIONS

- Recycled Asphalt Pavement (RAP)
- Crushed Glass
- Asphalt shingles
- Blast Furnace Slag
- Steel Slag
- Fly Ash
- Bottom Ash
- Aluminum
- Reclaimed Portland Cement Concrete (RPCC)
- Reclaimed Asphalt Manufacturer Shingles
- Scrap Tires
- Compost
- Spent Foundry Sand

LESSONS LEARNED

Regulatory

- Understand consequences

Education

- CM/CI buy-in

Think it through…

- Staging, stockpile & sequence

Typical Pavement Structure. Only the top of surface course would be removed and replaced as it is worn by traffic; the rest of the pavement structure remains in place.

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Project Spotlight

Recycled Plastic Modified Asphalt Project at the DCNR Ridley Creek State Park

Outreach

Material use / Performance
Manufacturers (Dow, GreenMantra, NVIAMG, etc.)
State DOTs (IowaDOT, CalTrans, and DelDOT)
Private Associations (NAPA & PAPA)
Research Institutions (NCAT & PSU)

Environmental Characteristics
State / Local Entities (IowaDOT, CalEPA, PADEP, and Los Angeles Streets Department)
Private Associations (NAPA)
Universities & Research Institutions (NCAT, PSU, and Gannon University)
Laboratories (EMSL, PSU Materials Research Institute, and PADEP)

Project Execution
Project Owner (DCNR)
Contractor (Allan Myers)
Material Manufacturer (NVIAMG)
Laboratory (AAT, Allan Myers, and EMSL)

Research

Evaluated Technologies (i.e. material or process)

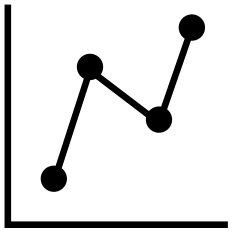
- Performance Advantages / Disadvantages
- Reusability
- Quantity of Recycled Material Use

Then

- Product Types / Manufacturers
- History of the Material
- Specifications
- Environmental Implications (microplastic releases)

Research Analysis

- **Data Gaps**
- **Stakeholder Support**
- **Availability / Location**
- **Environmental Testing**
  - Existing
  - Acceptable Methods
  - Standards / Thresholds



Research Analysis Con't

- **Material Use**
  - Storage
  - Introduction Process
    (wet vs. dry)
  - Permitting
  - Testing requirements

- Sample dia
- Test tempe
- Aging meth
- Displaceme
- Post-peak s
- Failure ene
- Work of fai
- Cracking to

3. Superpave volumetric test
   a. AC content
   b. Voids
   c. VMA
   d. Gmm
   e. Gsb
4. Superpave volumetric test
   a. AC content
   b. Voids
   c. VMA
   d. Gmm
   e. Gradations
   f. In place density (c
   g.
5. Liquid asphalt extraction o
   a. Compute delta Tc
6. Liquid asphalt extraction o
   a. Compute delta Tc

1. Hamburg Wheel track Testing

   Perform HWT testing according to AASHTO T 324 modified as follows:

   - Prepare all HWT test specimens from laboratory-produced asphalt mixture. Do not prepare HWT test specimens from field-produced asphalt mixture.
   - Compact each HWT test specimen to an air void content of 7.0 ± 0.5 percent.
   - Condition loose asphalt mixture for 2 h ± 5 min at 140 ± 3C (285 ± 5F) for PG 58S-28, 145 ± 3C (293 ± 5F) for PG 64S-22, or 153 ± 3C (308 ± 5F) for PG 64E-22 final asphalt binder grade of the JMF.
   - Test compacted test specimens in the HWT device at a test temperature of 122 ± 2F (50 ± 1C).
   - Test compacted test specimens in the HWT device for a maximum of 20,000 passes or a maximum impression depth of 15 mm, whichever occurs first.

   3.b.1 HWT Data Reporting Requirements. Provide the following information on every sample tested:

   - Mixture NMAS
   - JMF number
   - Plant code
   - JMF year
   - Date sample created
   - Sample lot & sublot designation (1-1, 1-2, 1-3 etc.).
   - Air Void Content (%)
   - Number of passes at maximum impression
   - Maximum impression (mm)
   - Test temperature (F)
   - Type and amount of anti-strip additive used
   - Slope of the first steady-state portion of the curve (Creep slope)
   - Slope of the second steady-state portion of the curve (Stripping slope)
   - Stripping inflection point

2. CT-Index testing

   Perform CT_{Index} Testing according to ASTM D8225 modified as follows:

   - Prepare all CT_{Index} test specimens from laboratory-produced asphalt mixture. Do not prepare CT_{Index} test specimens from field-produced asphalt mixture.
   - Compact each CT_{Index} specimen to an air void content of 7.0 ±0.5 percent.
   - Condition loose asphalt mixture for 2 h ± 5 min at 140 ± 3C (285 ± 5F) for PG 58S-28, 145 ± 3C (293 ± 5F) for PG 64S-22, or 153 ± 3C (308 ± 5F) for PG 64E-22 final asphalt binder grade of the JMF.
   - Test compacted test specimens at a test temperature of 77 ± 2F (25 ± 1C).
   - Report CT_{Index} test results according to ASTM D8225, Section 11.

   Provide the following information on every sample tested.

   - Mixture NMAS
   - JMF number
   - Plant code
   - JMF year
   - Date sample created
   - Sample lot & sublot designation (1-1, 1-2, 1-3 etc.).
   - Air Void Content (%)

Collaboration

Sought interest from PennDOT Districts and other state agencies

- **Project garnered support by:**
  - DCNR
  - PADEP
  - DGS / Governor's GreenGov Council

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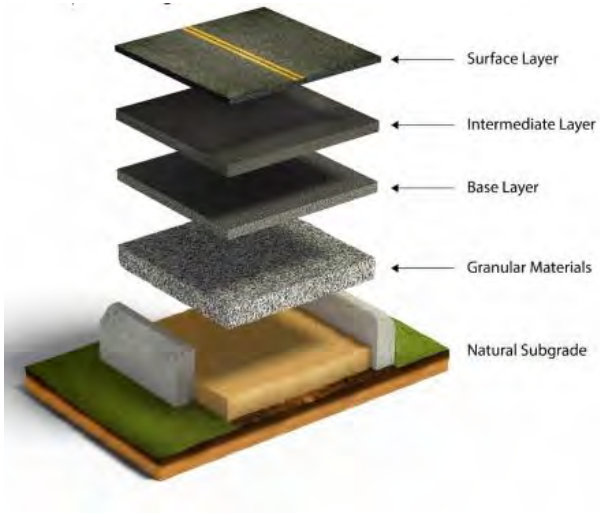
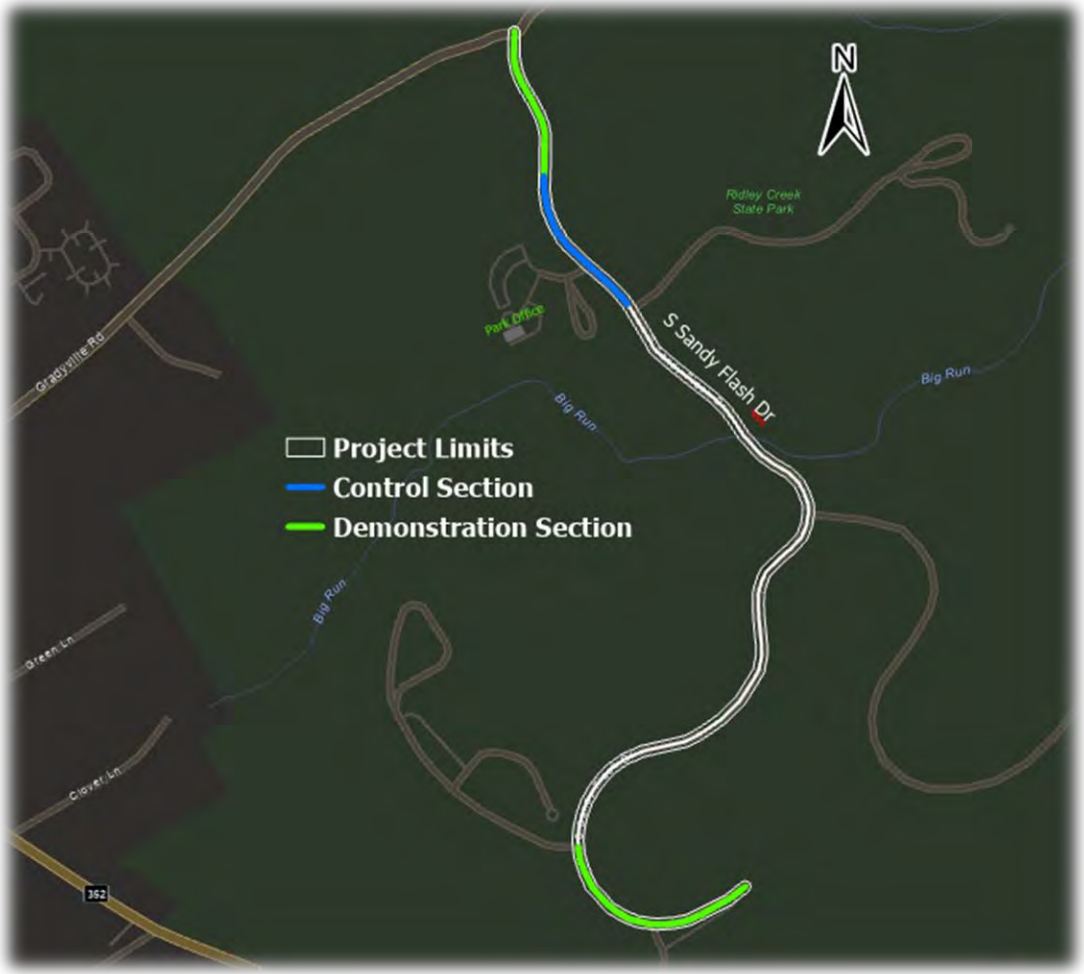
Planning

- **Project Location**
  - Rutting vs Cracking
- **Scope of Work**
  - Overlay vs Full Depth
- **Road Typology**
  - Local Road vs Arterial



Ridley Creek State Park Project

Project Aspects



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Ridley Creek State Park Project

Project Aspects

- **Roadway Reconstruction**
  - Full depth reclamation
  - No. 2A Stone
  - Base Course
  - 1 mile Wearing Course (30% RAP)
  - ½ mile Wearing Course (Recycled Plastic & 30% RAP)
- **New Shoulders**
- **Drainage Repairs**
  - Culverts & Pipe Crossings
  - Ditches
  - Channel Stabilization

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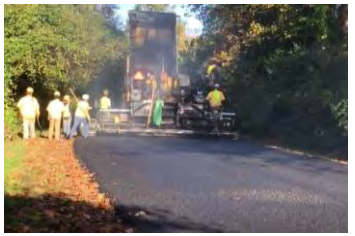
Recycled Plastic Modifier

Received responses from four different manufacturers

- DOW
- GreenMantra
- MacRebur
- NVI AMG



Construction

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Construction

- Compaction
- Hand Work
- Feel of Material
- Visible Difference

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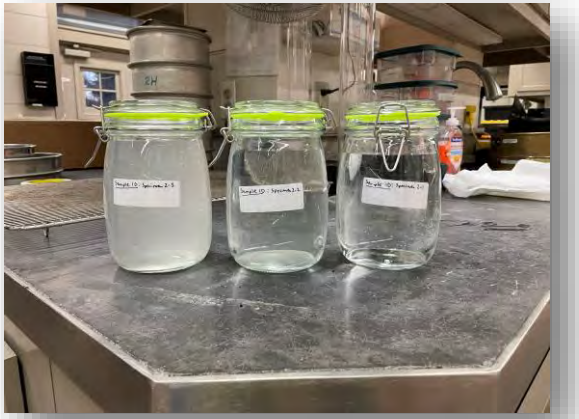
Environmental Testing - Baseline

Environmental Testing (microplastics):

- Baseline
  - Lab Sample Testing
  - Stormwater Sampling
  - Results



Environmental Testing - Project

Environmental Testing (microplastics):

- Project Sample Testing
  - Control and Trial
  - Results

Performance Testing

Performance Testing:

- Volumetrics
- Hamburg Wheel Tracking Test (HWTT)
- Ideal CT
- Liquid Asphalt Extraction
- PennDOT Video Log Van & Visual Inspection

Performance Testing - JMF

TR-448A (6-15)

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JOB MIX FORMULA REPORT

PennDOT Mix Design Designation

Year	Number
2021	W95122H6

Supplier JMF/Design Number (Optional): DA21-W95122H6

Supplier Code	ICM15A41
Material Class	WR9.5
Design ESAL Range	< 0.3 Million
Aggregate Skid Resistance Level (SRL)	H
Mixure Final Asphalt Binder Grade	PG64S-22
Asphalt Mix Type	WMA
Gradation Classification	Coarse-Graded
Original Approval Date	
JMF Status	Approved

Supplier Name Allan Myers Materials — Location Devault, PA
ECMS Number — PO No.-Line Item No. — 408 Spec
SR & Section — Plant Type AD — Plant Size 05
Contractor — Location

Mix Time	
Dry(s)	Wet(s)

Material Supplier	Material Code - Class	Product Name	% Material	Spec. Grav.	% Absorption
VMI66A14	249 (Anti Skid) - AS2	Vulcan 1/4"	24.000	2.744	0.83
PIODEA14	207 (Aggregate Fine) - A	Pioneer Sand	4.100	2.603	0.58
ICM36A14	207 (Aggregate Fine) - B1	Paradise #10	9.000	2.827	0.28
ICM36A14	203 (Aggregate) - A8	Paradise #8	29.100	2.809	0.38
MEAWE 15	187 (WMA Technology) - EVO-M1	Evotherm			
SONNE 15	187 (WMA Technology) - SONNGRas	Organic Additive w/ Anti-Strip Additives	0.300		
MEAWE 15	186 (Asphalt Mixture Additive) - ASTRIP	Antistrip			
ICM15A41	17 (Hot Rap Design) - RAP	RAP	30.000	2.787	0.00
ASSA1 15	1 (Asphalt Binder) - PG58S-28	PG 58S-28		1.030	
AXON1 15	1 (Asphalt Binder) - PG58S-28	PG 58S-28	3.800	1.030	

Performance Testing - JMF

JOB MIX FORMULA AND DESIGN

A.C. / Sieve Size	A.C%	#200	#100	#50	#30	#16	#8	#4	3/8"	1/2"				
Design Target	5.3	6.0	9	12	18	24	33	54	94	100				

% Virgin A.C.	3.8	% Reclaimed A.C. from RAP	1.50	Total % Asphalt (Pb)	5.3
Virgin A.C. PG Binder Grade	PG58S-28	% Reclaimed A.C. from RAS		% Eff. Asphalt Binder (Pbe)	5.2
Calc. Asp. Film Thickness	9.30	Total Reclaimed Binder Ratio	0.28	Fines / Asphalt (F/A) Ratio	1.1

MIX CHARACTERISTICS (GYRATORY)

Design ESAL Range	Mold Diameter (mm)	# Gyrations at Ninitial	# Gyrations at NDesign	# Gyrations at NMaximum	Voids in Mineral Aggregate (VMA) %	Theoretical Max. Sp. Grav. (Gmm)	Bulk Sp. Grav. of Mixture (Gmb)
< 0.3 Million	150	6	50	75	16.3	2.558	2.455
Bulk Sp. Grav. of Combined Aggr.(Gsb)	**Mixture Mass to Compact (g)**	**% Air Voids at Ninitial**	**% Aid Voids at NDesign**	**% Air Voids at NMaximum**	**Voids filled with Asphalt (VFA) %**	**Theoretical Max. Density (lbs/ft3)**	**Bulk Density of Mixture (lbs/ft3)**
2.778	4,950.0	15.0	4.0	2.3	75.0	159.2	152.8

ASPHALT CONTENT TEST METHOD

A.C. Test Method	External Party Oven Make/Model	Furnace Temp (°C)	Sample Size for C.F.	Asphalt C.F.	200 C.F.
PTM No. 757	Thermolyne/NCAT Series 1087	538.0	1,200.0	0.15	0.80

MOISTURE SUSCEPTIBILITY DATA

A.C. Supplier	Name	Dry PSI Strength	Wet PSI Strength	TSR Value	Date of TSR Test	Date of Boil Test
ASSA1 15	PG 58S-28	133.1	110.5	0.83	2/24/21	2/5/20
AXON1 15	PG 58S-28	216.1	190.5	0.88	3/23/18	2/5/20

COMBINED AGGREGATE CONSENSUS PROPERTIES

AASHTO T 176 Sand Equivalency (%)	AASHTO T 304 Fine Aggr. Angularity Uncompacted Voids (%)	ASTM D5821 - Coarse Aggregate Angularity		ASTM D4791 Flat / Elongated Particles		Total % Reclaimed Agg. From RAP and / or RAS
		% 1 Face Crush	% 2 Face Crush	5:1	3:1 SMA only	
85.3	46.2	100.0	100.0	4.0		95.1

Designed By : Troy Wible
Submitted By : Troy Wible
Approved By : Jacob D. Knapp

Designed By Certification ID : 557765
Submitted By Certification ID : 557765
Approved By Certification ID : D. Borkowski

Designed Date : 1/28/21
Submitted Date : 2/24/21
Approved Date : 2/4/21

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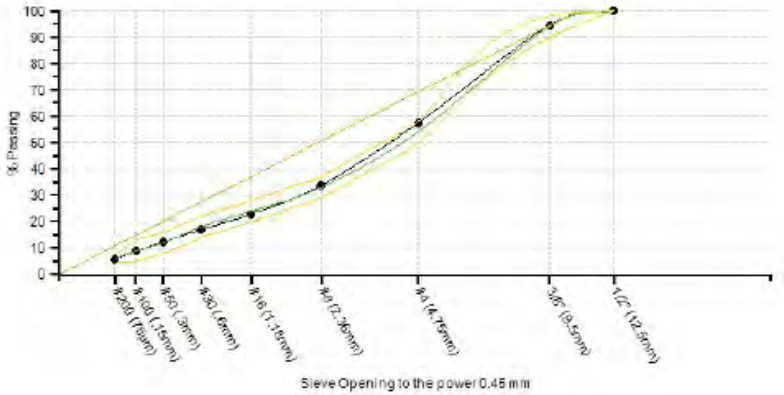
Performance Testing - Volumetrics

Properties					Results	
Test	**Result**	**JMF**	**Tolerances**	**Method**		
AC Content (Absorbed,Pba) %	0.2			AASHTO T312	**Method**	
AC Content (Effective,Pbe) %	5.31	5.2			**Dry Aggregate Mass**	1161
AC Content (Pb) %	5.50	5.3	4.9-5.7	T-308 / D6307	**Gsb**	2.778
DPE	1.11	1.1			**Compaction Temp**	
SPGR (Compacted,Gmb)	2.461				**Mix Temp**	
SPGR (Max,Gmm)	2.554	2.558	2.528-2.588	T-209 / D2041	**AC Cf**	0.14
Gmm@Nini %	86.99				**Binder 1 Grade**	PG 64-22
Gmm@Ndes %	96.36				**Gb**	1.031
Gmb@Ndes	2.461					
Va@Ndes %	3.64	4	2.5-5.5			
VMA@Ndes %	16.29	16.3	≥15			
VFA@Ndes %	77.65	75				

Gradation Results

Sieve	%Passing	JMF	Tolerances
1/2" (12.5mm)	100	100	100-100
3/8" (9.5mm)	95	94	90-98
#4 (4.75mm)	57	54	50-58
#8 (2.36mm)	34	33	29-37
#16 (1.18mm)	23	24	20-28
#30 (.6mm)	17	18	14-22
#50 (.3mm)	12	12	8-16
#100 (.15mm)	9	9	5-13
#200 (75µm)	5.9	6	4.5-7.5



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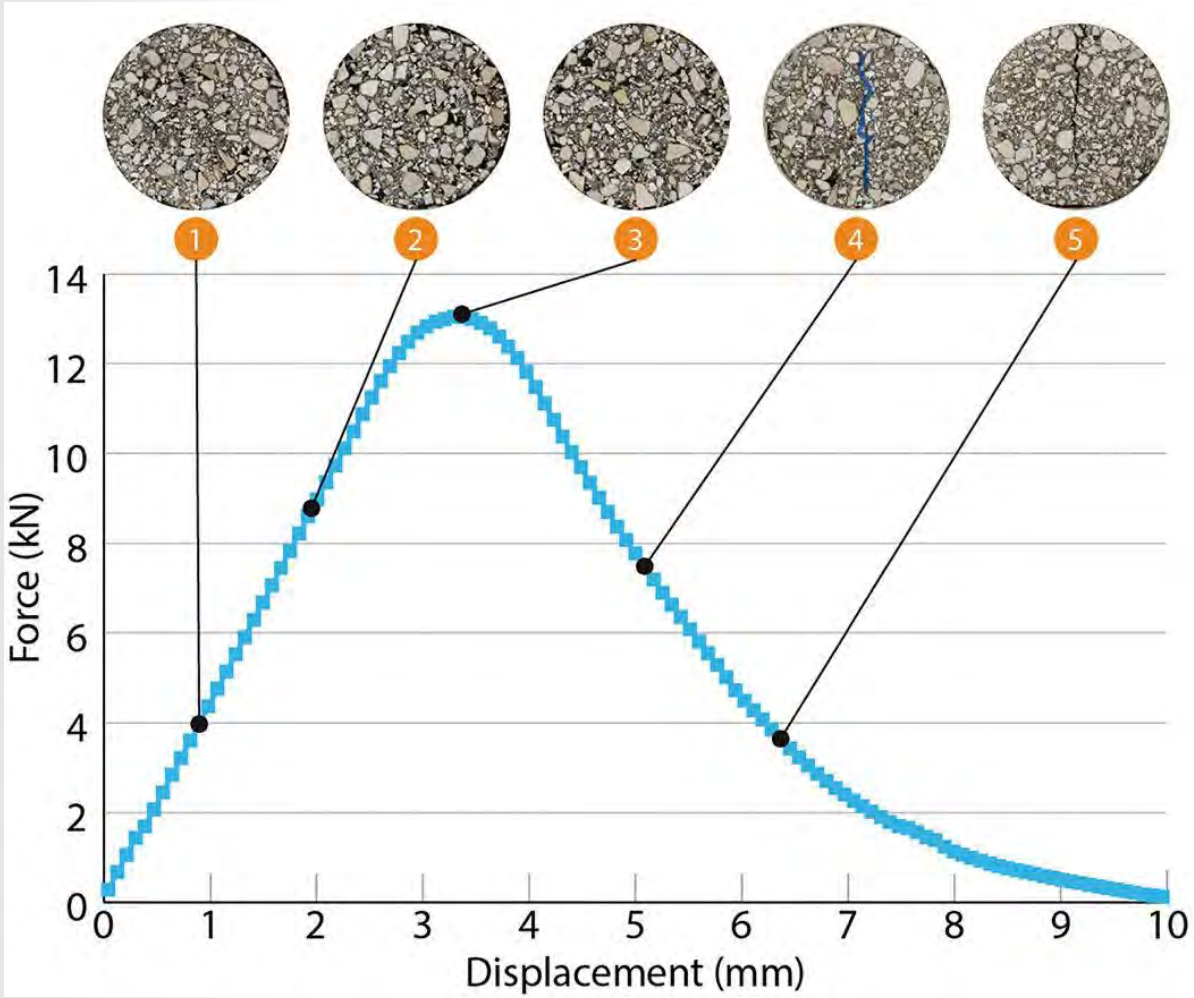
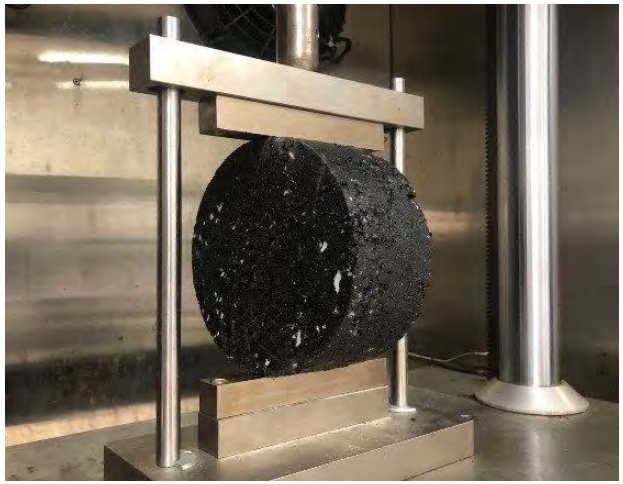
Performance Testing - HWTT

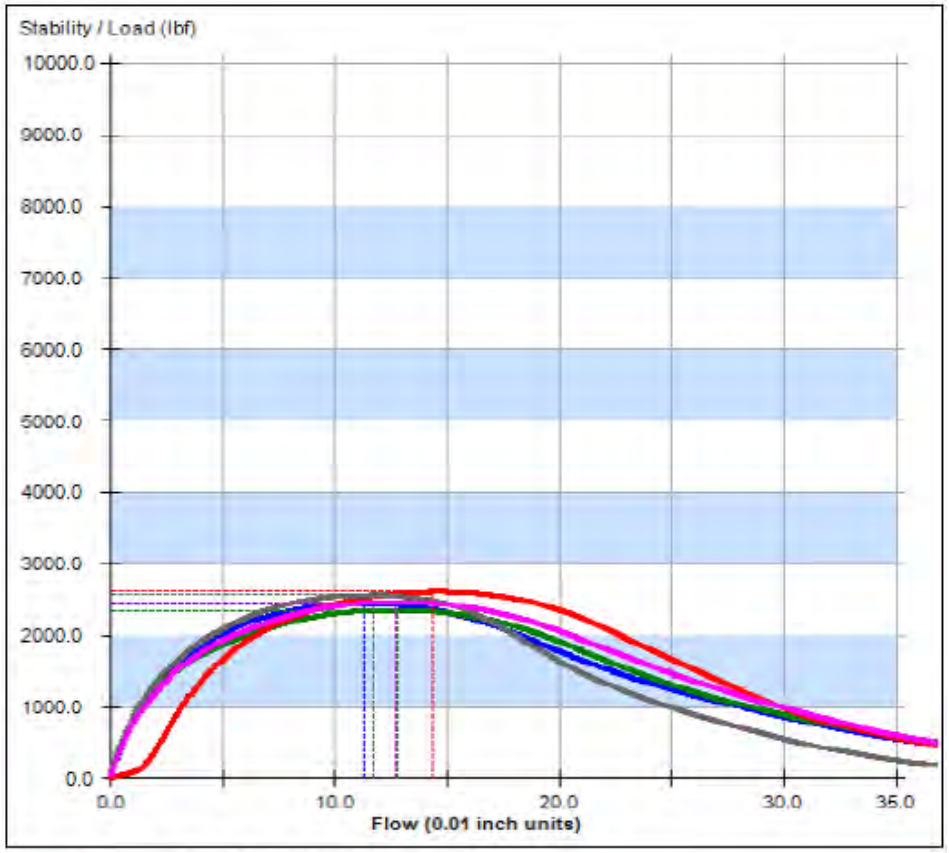
Performance Testing – IDEAL CT





https://www.roadsbridges.com/ideal-candidate

Performance Testing – IDEAL CT



In order of peak load (High to Low):

RIDPAR 7
RIDPAR 8
RIDPAR 9
RIDPAR 5
RIDPAR 6

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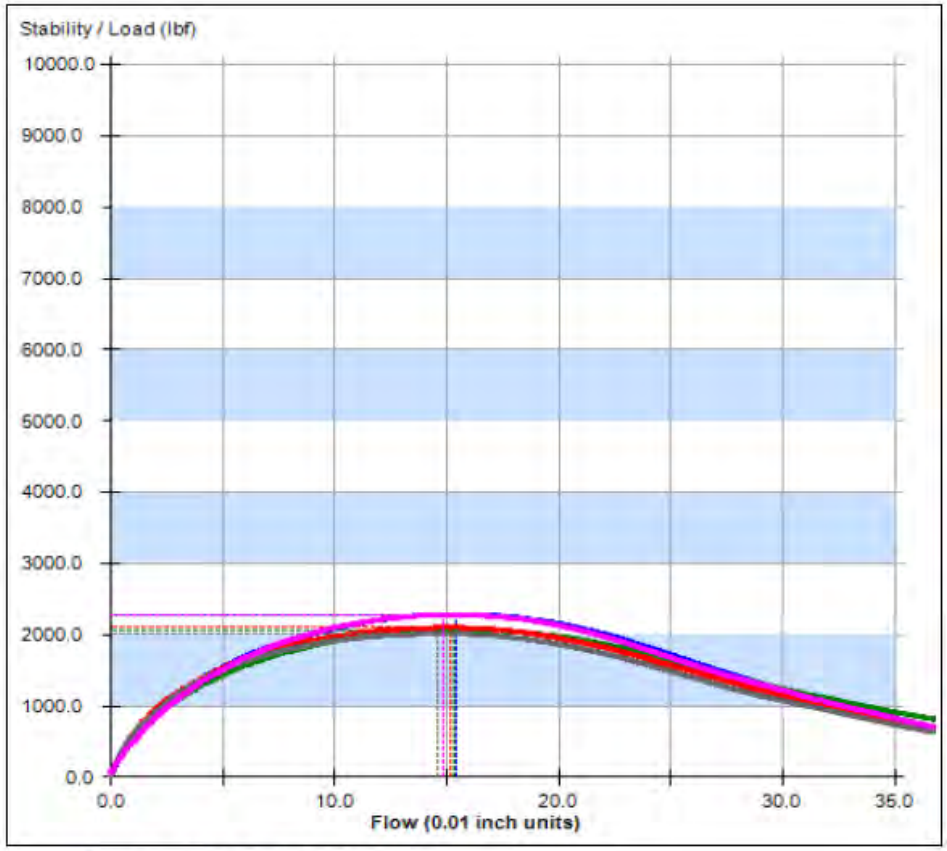
Performance Testing – IDEAL CT



In order of peak load (High to Low):

Ridley Park Plastic All 5 RIDPAR PLASTIC All 5
RIDPAR PLASTIC 5
RIDPAR PLASTIC 3
RIDPAR PLASTIC 2
RIDPAR PLASTIC 4

Performance Testing – Video Log Van

Basic Info | Reports

Pavement Conditions	
Pavement Type	Bituminous
Survey Date	09/03/2019
Rough Average & Rutting (ft)	
Rough Average (IRI)	124
Right Low	63.4
Right Medium	0
Right High	0
Left Low	0
Left Medium	0
Left High	0
Fatigue Cracking (ft)	
Low	54.3
Medium	0
High	0
Transverse Cracking	
Low Count	0
Low (ft)	0
Medium Count	0
Medium (ft)	0
High Count	0
High (ft)	0
Miscellaneous Cracking (ft)	
Low	0

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Data Analysis

The data gathered from this project will aid in:

- Determination of a viable product
- Contribution to a national recycled materials database
- Potential reduction of petroleum content in asphalt
- Advancement of asphalt innovations

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Path Forward

- **Monitor the project for 5 years**
- **Additional projects:**
  - SRP supporting PennDOT lab efforts
    - District 11-0 SR 0051 (completed)
    - District 8-0 SR 3017 (in construction)
    - District 6-0 Crum Creek Road (completed)
    - Two Additional Projects Pending
- **PSU research to develop performance parameters to test these materials**
- **Develop Standard Specifications**

Drone Footage

Questions?

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