Every Day Counts in Puerto Rico and USVI: Warm Mix Asphalt Initiatives

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Acronyms

AASHTO	American Association of State Highways and Transportation Officials
ARRA	American Recovery & Reinvestment Act
CMA	Cold Mix Asphalt
DTPW	Department of Transportation and Public Works
DUI	Driving Under Influence
EDC	Every Day Counts
FARS	Fatal Accidents Reporting System
FHWA	Federal Highway Administration
GTR	Ground Tire Rubber
HMA	Hot Mix Asphalt
ITE	Institute of Transportation Engineers
NAPA	National Asphalt Pavement Association
PRHTA	Puerto Rico Highway and Transportation Authority
PRLTAP	Puerto Rico Local Technical Assistance Program
RDG	Roadside Design Guide
ROR	Run Off the Road Crashes
UPRM	University of Puerto Rico, Mayaguez
USVI	United Sates Virgin Islands
VIDPW	Virgin Islands Department of Public Works
WMA	Warm Mix Asphalt

Introduction

- The Every Day Counts (EDC) Initiative is an FHWA national program designed to identify and deploy innovation in strategic areas aimed at
  - ✓ shortening project delivery,
  - ✓ enhancing the safety of our roadways, and
  - ✓ protecting the environment.

EDC and the 4 i's

1. Innovation
2. Ingenuity
3. Invention
4. Imagination

- The coverage of the EDC national program includes the 50 states, D.C., Puerto Rico and the USVI.

The Role of Puerto Rico Transportation Technology Transfer Center in the EDC Initiatives

1. Assisting in the EDC Implementation Plan of the Department of Transportation and Public Works (DTPW) of the Government of Puerto Rico.
2. Serving as a technical oversight of each EDC
3. Assisting in the development of training modules.
4. New training resources

The Role of Puerto Rico Transportation Technology Transfer Center in the EDC Initiatives (Cont.)

4. Participated in the Safety Edge Shoe training entitled “Hands on training” held in Ocala, FL, June 2011
5. Incorporated FHWA Dwight David Eisenhower Summer Interns from UPRM and Purdue University in research projects at different stages of the EDC initiatives.
6. Provided technical assistance to PRHTA and USVI designated Champions using trained undergraduate, graduate students and consultants to work on EDC research projects.

Nine (9) EDC Initiatives Currently being Implemented in Puerto Rico and the USVI

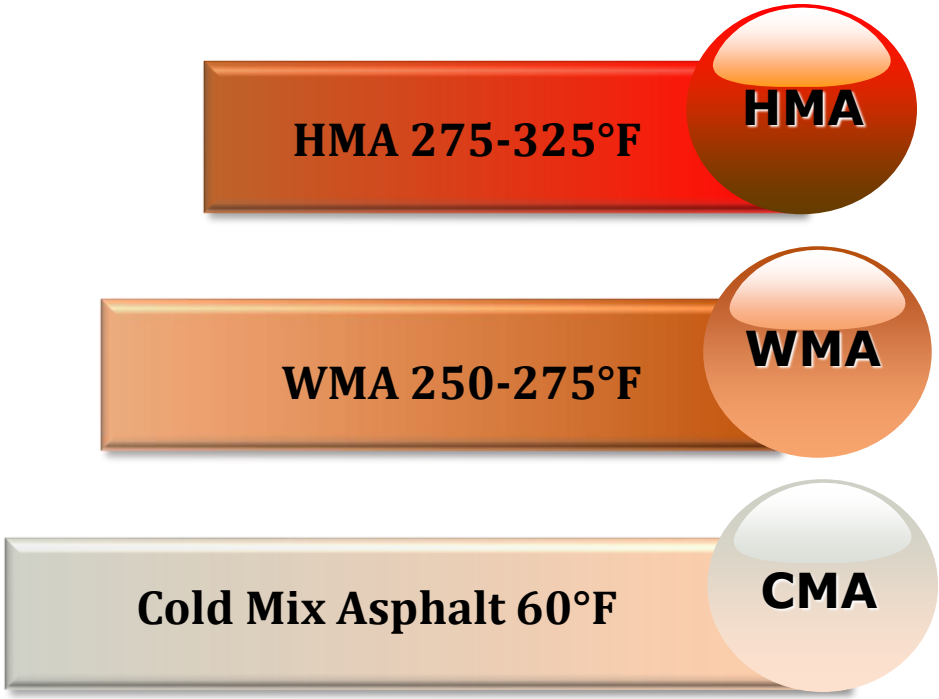
1. **Warm-Mix Asphalt (WMA)*** ✓
2. Safety Edge*
3. Geosynthetic Reinforced Soil (GRS)
4. Prefabricated Bridge Elements Systems (PBES)
5. Adaptive Signal Control Technology (ASCT)
6. Enhanced Technical Assistance on Stalled EISs
7. Flexibilities in ROW *
8. Flexibilities in Utility Relocation
9. Design Build (D-B)

* EDC initiatives also applicable to USVI.

Warm Mix Asphalt (WMA)

Definition

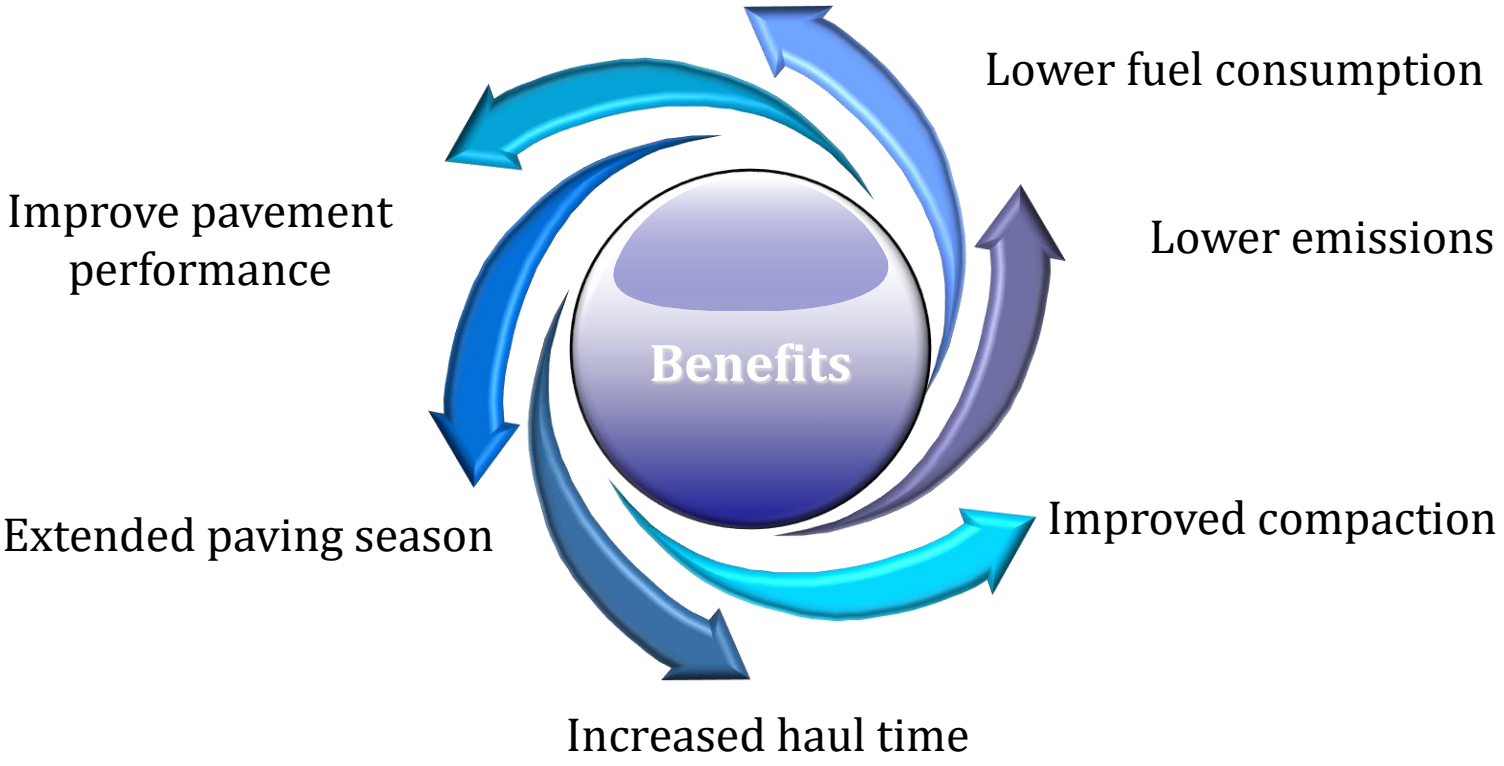
- Asphalt concrete mixtures that are produced at temperatures approximately 50 °F (28 °C) or more cooler than typically used in the production of conventional Hot Mix Asphalt (HMA).



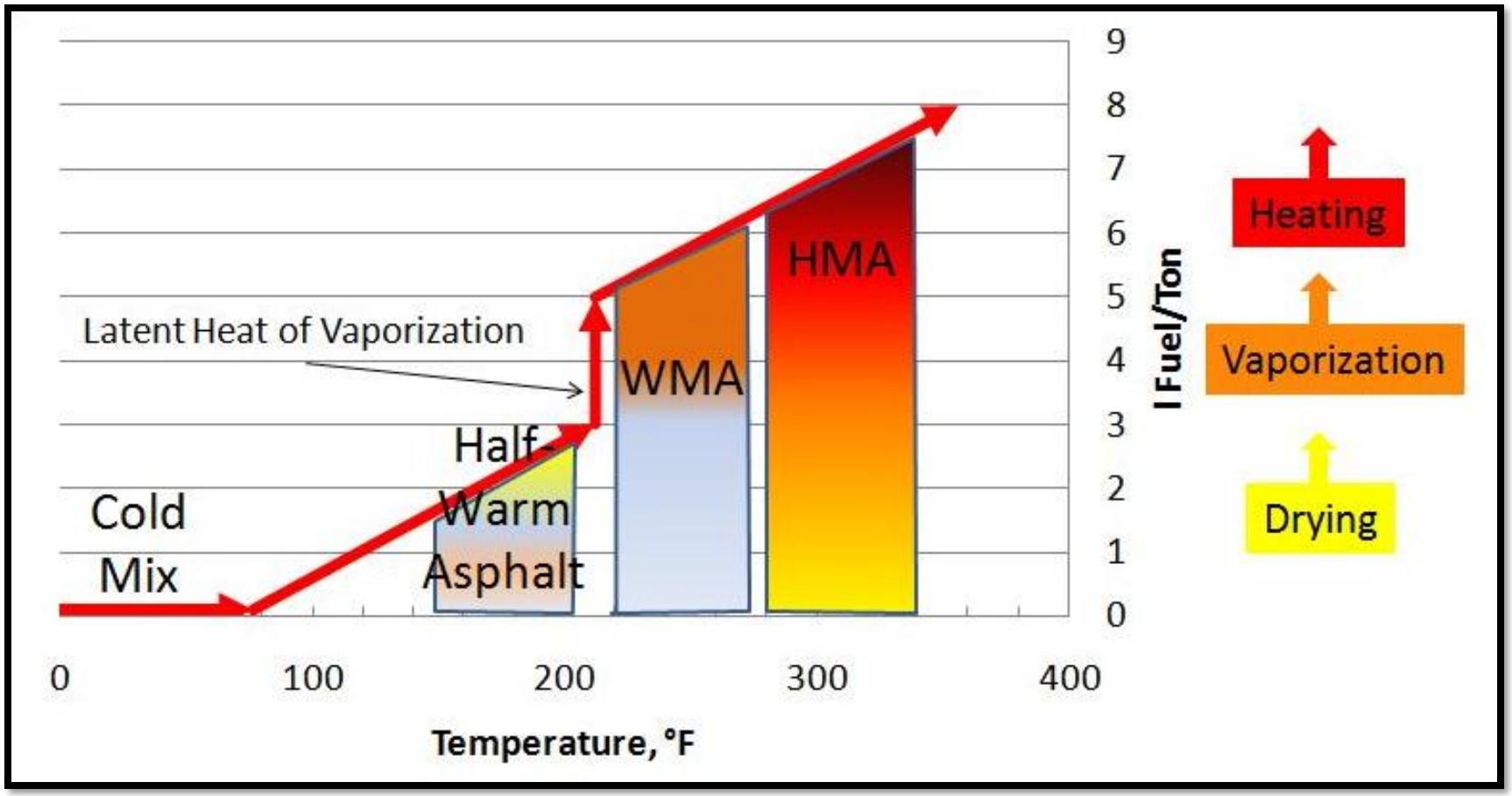
WMA: The five (5) primary Goals

- To meet existing standards for HMA specs.
- Similar durability as HMA
- Similar strength as HMA
- Use existing HMA plants
- Similar performance as HMA

WMA: Six (6) Environmental and Health Related Benefits



Comparison of WMA Benefits with respect cold, halfwarm and hot mix asphalt: (fuel/ton and other attributes)



WMA Technologies Approved for PRHTA Projects in Puerto Rico

WMA Technology	Process Type	WMA Supplier
Evotherm™ DAT	Chemical Additive	Mead Westvaco
Evotherm™ DAT	Chemical Additive	Mead Westvaco
Rediset™ WMX	Chemical Additive	Akzo Nobel Surfactants
Sasobit®	Organic Additive	Sasol Wax Americas

WMA Critical Issues

- The minimum temperatures for delivery, placement and compaction should be adjusted to accommodate the WMA reduced temperature and sacrifice workability and density requirements.
- WMA technology's ability to be placed and compacted at the reduced temperatures may be required.
- Minimum ambient paving temperature requirements may be lowered 20º F from normal temperature requirements.

WMA Initiative in Puerto Rico

ITE Annual Meeting, Puerto Rico Section
Centro Cultural Yolanda Guerrero, Guaynabo, Puerto Rico

WMA Initiative in Puerto Rico

Tasks Performed

- Laboratory Trials with WMA mixes
- Initial presentation of WMA technology
- WMA test section
- WMA and GTR workshop
- WMA specification development
- Modifying current HMA projects

Before and after WMA

WMA Initiative in Puerto Rico (Cont.)

Next Phase WMA

- Changes from HMA to WMA in on-going projects AC-520108
- Changes from HMA to WMA in on-going projects AC-520109
- Peer exchange: Site inspection to Florida DOT Projects

Before and after WMA

WMA Initiative in Puerto Rico (Cont.)

Task Performed (cont.)

- Laydown and compaction of WMA, Yauco, PR Betteroads Asphalt Corp. (April 8, 2011)
- PRHTA Project #200240
- Approximately 23,500 tons placed and compacted

Secretary DTPW, Eng. Rubén Hernández-Gregorat, Eng. Carlos Machado, FHWA and Betteroads officials

WMA Initiative in Puerto Rico (Cont.)

Task Performed (cont.)

- Laydown and compaction of WMA, Yauco, Puerto Rico-Betteroads Asphalt Corp. (April 8, 2011)

Laydown and compaction of WMA, Yauco, PR-Betteroads Asphalt Corp. (April 8, 2011)

WMA Initiative in Puerto Rico (Cont.)

Task Performed:
Robles Asphalt, Ponce, PR (cont.)

- Performing laboratory trials with WMA mixes using Kaomin 14 additive
- Comparative analysis of three (3) additives: Kaomin 14, Sasobit and Rediset

Eng. Moisés Estrada, Robles Asphalt and Eng. Freddie Salado, graduate research assistant, UPRM

Warm Mix Asphalt Initiative in Puerto Rico, 2011
Yauco, Puerto Rico, Project #200240
Super Pave Mix Design

Mezcla de Superpave - (NMAS 1/2"):

Descripción del Material	Gravedades Especificas (Bulk)	Porciento del Peso Total de Agregados (%)
Gravilla 5/8" – Cantera Estrella	2.6713	45
Polvillo 3/8" – Cantera Estrella	2.6613	35
Arena – Cantera HP	2.5369	13
Arena Gruesa – San Lorenzo Sand & Gravel	2.6479	7

Número de Tamiz (pulgadas)	JMF (Porciento Pasando) (%)
1"	100.0
3/4"	100.0
1/2"	96
3/8"	80
1/4"	54
#4	45
#8	31
#16	23
#30	17
#50	12
#100	8
#200	6.0

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Yauco, Puerto Rico, Project #200240
Super Pave Mix Design

Propiedades de la Mezcla	Resultado Reportado
Gravedad Específica Combinada de los Agregados (Blend) (Gsb)-(Bulk Dry)	2.6076
Gravedad Específica Efectiva de los Agregados (Gse)	2.6694
Porciento de Compactación de la Mezcla (Campo) (%)	94.0
Temperatura de Compactación de Laboratorio	298° F
Temperatura de Compactación de Campo	>250° F
Temperatura de Producción	320° F
Vanos de Aire (Va) (%)	4.0
Gravedad Específica Máxima (Gmm) @ Pb (diseño)	2.4313
Vanos en el Agregado mineral (VMA) (%)	15.45
Vanos llenos de Asfalto (VFA) (%)	74.27
Razón de Polvo y Asfalto Efectivo (DEAR)	1.19
Densidad (Lb / Ft^3), (Gmm x 62.4)	151.71
Resistencia a tensión AASHTO T-283 (Sin Condicionar - Dry) (PSI)	100
Resistencia a tensión AASHTO T-283 (Condicionado - Wet) (PSI)	85
Resistencia retenida en tensión (TSR) AASHTO T-283 (%)	85
Masa a 115 mm Altura	4,672.92

Parámetros de Aceptación para Compactación (%)
92 – 99

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Yauco, Puerto Rico, Project #200240
Super Pave Mix Design

Descripción del Material	Porciento del Peso Total de la Mezcla
PG 64-22, BTB Corp. (%)	6.2
Agregado (%)	93.8
Anti-Strip "Wetfix 312" (%)	.65
Gravedad Especifica del Binder (Gb)	1.035

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Yauco, Puerto Rico, Project #200240
Super Pave Mix Design

Superpave Asphalt Binder Grading Summary
AASHTO M320

Sample ID: **PG 64-22 Original Binder**
TK #10 Guayanilla Terminal

Original Binder				
Test, Method			**Test Results**	**Specification**
Rotational Viscosity @ 135°C, AASHTO T 316, PaS			0.618	≤ 3 PaS
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* / sinδ, kPa	
70	1.17	85.7	1.17	≥ 1.00 kPa
76	0.59	87.2	0.59	
Rolling Thin Film (RTFO) Aged Binder, AASHTO T 240				
Mass Change, %			-0.108	≤ 1.00%
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* / sinδ, kPa	
70	3.03	80.9	3.07	≥ 2.20 kPa
76	1.52	83.2	1.53	
Pressure Aging Vessel (PAV) Aged Binder, AASHTO R28				
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* sinδ, kPa	
22	6643	42.3	4471	≤ 5,000 kPa
19	9893	39.8	6327	
Bending Beam Rheometer (BBR) AASHTO T313				
Test Temperature, °C				
-12	Stiffness, Mpa		176	≤ 300 Mpa
	m-value		0.316	≥ 0.300
-18	Stiffness, Mpa		357	
	m-value		0.258	
True Grade	71.4 -23.7			
PG Grade	70 - 22			

Warm Mix Asphalt Initiative in Puerto Rico, 2011
Yauco, Puerto Rico, Project #200240
Super Pave Mix Design

Superpave Asphalt Binder Grading Summary
AASHTO M320

Sample ID: **PG 64-22 W/ 1.5% Rediset WMX Plant #21 Ponce**

Original Binder				
Test, Method			**Test Results**	**Specification**
Rotational Viscosity @ 135°C, AASHTO T 316, PaS			0.528	≤ 3 PaS
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* / sinδ, kPa	
70	1.45	83.8	1.46	≥ 1.00 kPa
76	0.74	85.0	0.74	
Rolling Thin Film (RTFO) Aged Binder, AASHTO T 240				
Mass Change, %			-0.206	≤ 1.00%
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* / sinδ, kPa	
70	2.70	81.4	2.73	≥ 2.20 kPa
76	1.36	83.4	1.37	
Pressure Aging Vessel (PAV) Aged Binder, AASHTO R28				
Dynamic Shear Rheometer AASHTO T 315				
Test Temperature, °C	G*, kPa	Phase Angle δ, °	G* sinδ, kPa	
25	4789	45.2	3398	≤ 5,000 kPa
22	8107	41.8	5407	
Bending Beam Rheometer (BBR) AASHTO T313				
Test Temperature, °C				
-12	Stiffness, Mpa		188	≤ 300 Mpa
	m-value		0.311	≥ 0.300
-18	Stiffness, Mpa		365	
	m-value		0.255	
True Grade	71.9 -23.2			
PG Grade	70 - 22			

Average Tensile Strengths from TSR Data

Mix ID	Conditioned Tensile Strength (psi)	Unconditioned Tensile Strength (psi)	TSR
WMA	82.9	103.9	0.797
HMA	87.3	110.8	0.788

TSR Testing Raw Data

Mix ID	Sample ID	Sample Air Voids (%)	Freeze-Thaw Cycles	Percent Saturation	Failure Load (lb)	Sample Flow (0.01 in)	Splitting Tensile Strength (psi)	TSR
WMA	A	7.0	1	79.6	2950	22.0	84.9	0.797
WMA	B	7.2	1	78.4	2790	16.5	80.3	
WMA	D	7.3	1	79.4	2900	16.5	83.4	
WMA	C	7.2	0	N/A	3610	10.0	103.9	
WMA	E	7.3	0	N/A	3575	14.5	102.9	
WMA	F	6.9	0	N/A	3650	15.0	105.0	
HMA	9	7.2	1	72.3	2925	25.0	84.2	0.788
HMA	10	7.3	1	71.7	2825	22.0	81.3	
HMA	12	7.1	1	75.0	3350	21.5	96.4	
HMA	11	7.2	0	N/A	3850	16.0	110.8	
HMA	13	7.3	0	N/A	3900	17.0	112.2	
HMA	14	7.0	0	N/A	3800	16.0	109.3	

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Super Pave Mix Design

Texas Hamburg Requirements

High PG Grade	Minimum Number of Passes at 0.5 inch Rut, 122°F
64 or lower	10,000
70	15,000
76 or higher	20,000

Hamburg Number of Passes to 12.5 mm Rut Depth

Sample ID	Average Cut Sample Air Voids (%)	Cycles to 12.5 mm Rut Depth	Passes to 12.5 mm Rut Depth	Average Passes	Standard Deviation Passes	COV Passes (%)
HMA - 2	7.2	6037	12074	9439	2311	24.5
HMA - 3	7.9	3879	7758			
HMA - 4	7.8	4242	8484			
WMA - G	7.3	4619	9238	8138	961	11.8
WMA - H	7.6	3731	7462			
WMA - I	7.5	3857	7714			

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Hamburg Stripping Inflection Points

Sample ID	Stripping Inflection Point (cycles)	Average SIP	Standard Deviation SIP	COV (%) SIP
HMA - 2	3750	2917	782	26.8
HMA - 3	2800			
HMA - 4	2200			
WMA - G	4000	3367	651	19.3
WMA - H	3400			
WMA - I	2700			

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Dynamic Modulus Master Curve Coefficients

Mix ID	Max E* (ksi)	Delta	Beta	Gamma	ΔE_A	R^2	S_e/S_y
WMA	3250.02	51.71	-0.3591	-0.5397	193148.307	0.994	0.06
HMA	3233.13	49.64	-0.3954	-0.5700	182834.4429	0.994	0.06

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Summary of Flow Number Results

Mix ID	Air Voids (%)		Francken Flow Number		
	Average	Standard Deviation	Average	Standard Deviation	COV (%)
HMA	5.83	0.06	268	53.1	19.8
WMA	5.83	0.15	156	8.5	5.4

Raw Flow Number Data

Mix ID	Sample ID	Air Voids (%)	Flow Number	Specimen Microstrain at Flow Number
HMA	1	5.9	287	26,082
HMA	2	5.8	309	25,196
HMA	3	5.8	208	23,799
WMA	A	5.8	148	27,569
WMA	B	6	165	27,649
WMA	C	5.7	156	22,115

WMA Initiative in USVI

ITE Annual Meeting, Puerto Rico Section
Centro Cultural Yolanda Guerrero, Guaynabo, Puerto Rico

WMA Tasks During the Next Quarter: Oct. 1 - Dec. 31, 2011, USVI

USVI Tasks for WMA

- Complete the technical specification entitled Section 418. Warm Mix Asphalt (WMA)
- Plan the WMA field pilot program to be implemented in January 2012

Conclusions

1. The WMA and Safety Edge implementation plan in Puerto Rico and USVI is progressing positively as expected.
2. Effective communications between PRHTA , VIDPW, FHWA, and PR-T2 Center officials has been a key factor for this success.
3. The collaboration of asphalt paving contractors in Puerto Rico and USVI has been instrumental in the EDC implementation process.
4. The exchange of knowledge and experience gained by undergraduate and graduate students from UPRM and Purdue University has motivated them to continue their professional career in transportation, does increasing the workforce in highway and transportation engineering.
5. ITE has the potential to be a key player in the different stages of the implementation and outreach program.

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PURDUE
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ITE Annual Meeting, Puerto Rico Section
Centro Cultural Yolanda Guerrero, Guaynabo, Puerto Rico

Good afternoon!

¡Buenas Tardes!