

## TABLE OF ASPHALT RESEARCH CONSORTIUM DELIVERABLES

(Note: Highlighted areas show changes)

Deliverable	Description	Draft Delivery Date	Final Delivery Date	ARC Partner	Staff Assignment	Notes
Overall Report	Summary Narrative Report on ARC members and accomplishments	1/31/2014	5/31/2104	All	All	
Summary Report	Comprehensive Summary Report (Level 1) (Report summarizing all work elements in significant detail to provide a single source documentation of ARC accomplishments)	8/31/2013	12/15/2013	TAMU	All	Reference level 2 and 3 deliverables for details
Report A	Summary report on Moisture Damage (Level 2)	Completed 1/31/2013	9/30/2013	TAMU	Masad	Sent to FHWA for review, Reference level 3 deliverables for details
Report B	Characterization of Fatigue Damage and Relevant Properties (Level 2)	8/15/2013	10/31/2013	TAMU	Bhasin	In final editing
Report C	PANDA: Pavement Analysis using a Nonlinear Damage Approach (Level 2)	8/31/2013	11/30/2013	TAMU	Darabi	Summary of PANDA methodology including descriptions of methods for identifying model parameters

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Report D	Characterization of Asphalt Binders using Atomic Force Microscopy (Level 2)	Completed 5/31/2013	10/31/2013	TAMU	Little	Summary report on methodology for characterizing the phases of asphalt binder with description of composite implications
Report E	Lattice Model and Continuum Damage to Fracture (Level 2)	5/31/2013	9/30/2013	NCSU	R. Kim	Comprehensive report on lattice model. In final editing by NCSU
Report F	Microstructure Cohesive Zone Modeling for Moisture Damage and Fatigue Cracking (Level 2)	Completed 1/31/2013	8/31/2013	UNL	Y.R. Kim	Sent to FHWA for review, Comprehensive report on cohesive zone model
Report G	Design System for HMA Containing a High Percentage of RAP Material	12/31/2013	3/31/2014	UNR	Sebaaly Hajj	
Report H	Critically Designed HMA Mixtures	9/30/2013	3/31/2014	UNR	Hajj Sebaaly	Comprehensive report describing the developed mechanistic-based approach for critically designed mixtures

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Report I	Thermal Cracking Resistant Mixes	8/31/2013	12/31/2013	UNR	Hajj Sebaaly	
Report J	Pavement Response Model to Dynamic Loads 3D Move	9/30/2013	12/31/2013	UNR	Hajj Sebaaly	Delayed. Research team focused on addressing and solving the various bugs reported by the users for newly released Ver. 2 of the software
Report K	Development of Materials Database	10/31/2013	3/31/2014	UNR	Hajj Ekedahl	
Report L	Development and Validation of the Bitumen Bond Strength Test (BBS)	Completed 10/31/11	9/30/2013	UWM	Hanz	Extended to incorporate new information from NCHRP 9-50
Report M	Development of Test Procedures for Characterization of Asphalt Binder Fatigue and Healing	Completed 10/31/11	10/30/2013	UWM	Tabatabaee	Final pending receipt of peer review comments
Report N	Guideline for Selection of Modification Techniques	9/30/2013	3/31/2014	UWM	Tabatabaee	On schedule
Report O	Characterization of Binder Damage Resistance to Rutting	9/30/2013	12/31/2013	UWM	Tabatabaee	Report under internal review
Report P	Quantifying the Impacts of Warm Mix Asphalt on Constructability and Performance	9/30/2013	12/31/2013	UWM	Hanz	Draft extended 6 months
Report Q	Improvement of Emulsion Characterization and Mixture Design for Cold Bitumen Applications	12/31/2013	3/31/2014	UWM	Hanz	Three month extension requested

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Report R	Studies on Tire-Pavement Noise and Skid Response	Completed 12/31/11	7/30/2013	UWM	Roohi	Extended to address comments
Report S	Molecular dynamics results for multiple asphalt chemistries	8/15/2013	12/31/2013	URI	Greenfield	
Report T	Progress Toward a Multi-scale Model of Asphalt Pavement- Including Test Methods for Model Input Parameters	9/30/2013	3/31/2014	WRI	Pauli	Delayed because of Delft finite element work
Report U	Design Guidance for Fatigue and Rut Resistance Mixtures	9/30/2013	3/31/2014	AAT	Bonaquist Christensen	NTIS format report with Technical Brief
Report V	Continuum Damage Permanent Deformation Analysis for Asphalt Mixtures (Level 2)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Sent to FHWA Reference appropriate level 3 deliverables
Report W	Characterization of Fatigue and Healing Properties of Asphalt Mixtures (Level 2)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Sent to FHWA Reference appropriate level 3 deliverables
Report X	Characterization of Field Cores of Asphalt Pavements (Level 2)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Sent to FHWA Reference appropriate level 3 deliverables
Report Y	Water Vapor Diffusion in Pavement and Its Effects on the Performance of Asphalt Mixtures (Level 2)	Completed 5/31/2013	11/30/2013	TAMU	Lytton/Luo	Sent to FHWA Reference appropriate level 3 deliverables

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Report Z	Effect of Extraction Methods on the Properties of Aggregates in Reclaimed Asphalt Pavement (NTIS format)	Completed 3/1/2013		UNR	Hajj Sebaaly	Final pending receipt of peer review comments
AASHTO Method	Simplified Continuum Damage Fatigue Analysis for the Asphalt Mixture Performance Tester	9/30/2013	3/31/2014	AAT	Bonaquist Christensen	Development documented in Report U
AASHTO Method	Wilhelmy Plate Test (Level 3)	Completed 1/31/2013	6/30/2013	TAMU	Bhasin	Sent to FHWA for review, Referenced in Reports A & B
AASHTO Method	Universal Sorption Device (Level 3)	Completed 1/31/2013	6/30/2013	TAMU	Bhasin	Sent to FHWA for review, Referenced in Reports A & B
AASHTO Method	Dynamic Mechanical Analysis (Level 3)	Completed 1/31/2013	6/30/2013	TAMU	Kassem	Sent to FHWA for review, Referenced in Reports A & B
ASTM Method	Automated Flocculation Titrimetric Analysis	Completed		WRI	Pauli	ASTM D-6703
AASHTO Method	Determination of Polymer in Asphalt	Completed		WRI	Harnsberger	
AASHTO Method	A Method for the Preparation of Specimens of Fine Aggregate Matrix of Asphalt Mixtures (Level 3)	Completed 1/31/2013	6/30/2013	TAMU	Kassem	Sent to FHWA for review, Referenced in Reports A & B
AASHTO Method	Measuring intrinsic healing characteristics of asphalt binders	Completed 1/31/2013	6/30/2013	TAMU/ UT	Bhasin	Sent to FHWA for review, Referenced in Report B

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AASHTO Method	Test Methods for Determining the Parameters of Material Models in PANDA (Pavement Analysis Using Nonlinear Damage Approach) (Level 3)	8/31/2013	2/28/2014	TAMU	Kassem Darabi	Referenced in Report C
Test Method & Model	Continuum Damage Permanent Deformation Analysis for Asphalt Mixtures (Level 3)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Referenced in Report V
Test Method & Model	Characterization of Fatigue and Healing Properties of Asphalt Mixtures (Level 3)	Completed 5/31/2013	9/30/2013	TAMU	Lytton/Luo	Referenced in Report W
Test Method Analysis Program	Nondestructive Characterization of Tensile Viscoelastic Properties of Undamaged Asphalt Mixtures (Level 3)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Referenced in Reports V & Y
Test Method & Model	Characterization of Field Cores of Asphalt Pavements (Level 3)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Referenced in Reports W & X
Test Method Analysis Program	Nondestructive Characterization of Anisotropic Viscoelastic Properties of Undamaged Asphalt Mixtures under Compressive Loading (Level 3)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Referenced in Report V
AASHTO Practice	Mix Design for Cold-In-Place Recycling (CIR)	12/31/2013		UNR	Sebaaly Hajj	Detailed in Report Q
AASHTO Practice	Mix Design for Cold Mix Asphalt	9/30/2013	3/31/2014	UWM	Hanz	On schedule
AASHTO Practice	Evaluation of RAP Aggregates	12/31/2012		UNR	Sebaaly	Detailed in Report G
AASHTO Practice	Identification of Critical Conditions for HMA mixtures	Completed 5/31/2013		UNR	Hajj Sebaaly	Detailed in Report H
AASHTO Method	Determining Thermal Crack Properties of Asphalt Mixtures Through Measurement of Thermally Induced Stress and Strain	Completed 5/31/2012		UNR	Hajj Tabatabaee	Detailed in Report I

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AASHTO Method	Determining Asphalt Binder Bond Strength by Means of the Bitumen Bond Strength Test ( BBS)	Completed	Completed 6/30/13	UWM	Hanz	Includes minimum of 3 months external peer review
AASHTO Method	Measurement of Asphalt Binder Elastic Recovery in the Dynamic Shear Rheometer (DSR )	Completed 1/31/2013	Completed 6/30/2013	UWM	Tabatabaee	Combined with BYET test
AASHTO Method	Estimating Fatigue Resistance of Asphalt Binders Using the Linear Amplitude Sweep (LAS)	Completed	9/30/2013	UWM	Tabatabaee	Final Delivery extended 3 month to accommodate ETG request
AASHTO Method	Binder Yield Energy Test ( BYET)	Completed 1/31/2013	Completed 6/30/2013	UWM	Tabatabaee	Submitted to AASHTO SOM by FHWA
AASHTO Method	Measurement of Rigden Voids for fillers	Completed 1/31/2013	Completed 6/30/2013	UWM	Hanz	Pending ETG comments
AASHTO Method	Measurement of Asphalt Binder Lubricity Using the Dynamic Shear Rheometer (DSR)	9/30/2013	12/31/2013	UWM	Hanz	Submittal delayed due to activities with other products
AASHTO Method	Procedure for Evaluation of Coating for Cold Mix Asphalt	Completed 4/30/2013	9/30/2013	UWM	Hanz	Pending ETG review
AASHTO Method	Cold Mix Laboratory Specimen Preparation Using Modified SGC Molds	8/30/2013	12/31/2013	UWM	Hanz	Standard under internal review
AASHTO Method Software	RAP Binder PG True Grade Determination	Completed 9/30/2012	Complete 6/30/2013	UWM	Hanz	Work with ETG as necessary
AASHTO Method	Measurement of Asphalt Binder Fracture Properties Using the Single Edge Notch Bending Test	Completed 9/30/2012	9/30/2013	UWM	Tabatabaee	Extended to provide additional information to ETG

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AASHTO Method	Test Method for Measurement of the Glass Transition Temperature of Asphalt Binders	Completed 1/31/2013	Completed 6/30/2013	UWM	Tabatabaee	Action pending FHWA/ETG comments
AASHTO Method	Test Method for Measurement of the Glass Transition Temperature of Asphalt Mixtures	4/30/2013	Completed 6/30/2013	UWM	Tabatabaee	Refer to UNR TSRST procedure for additional information
AASHTO Method Software	Analysis of Asphalt Mixture Aggregate Structure through Use of Planar Imaging and Image Processing & Analysis System (IPAS)	4/30/2013	9/30/2013	UWM	Roohi	Action pending ETG comments
AASHTO Method	Determining the Resistive Effort of Asphalt Mixtures during Compaction in a Gyratory Compactor using an Internal Device	Completed ASTM	9/30/2013	UWM	Hanz	Extended to address comments from ASTM
AASHTO Method	Micromechanical Properties of Various Structural Components in Asphalt using Atomic Force Microscopy (AFM) (Level 3)	Completed 3/31/2013	8/31/2013	TAMU	Little	Sent to FHWA for review, Referenced in Report D
AASHTO Method	Test Method for Fatigue of Binder and Mastics: A cyclic direct tension test that can provide direct evaluation of fatigue for binder and mastic. It can also provide model validation and model parameter inputs.	4/30/2013	10/31/2013	VT	Wang	
AASHTO Method	Evaluate Healing using Continuum Damage Approach (Level 3)	8/15/2013	8/31/2013	TAMU/UT	Bhasin	Appendix in Report B
Test Method & Analysis Program	Self-Consistent Micromechanics Models of Asphalt Mixtures (Level 3)	Completed 5/31/2013	10/31/2013	TAMU	Lytton/Luo	Referenced in Report W

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AASHTO Method & Analysis Program	Rutting Prediction of Asphalt Binder Considering Stress-Dependence of Creep Behavior (Level 3)	8/31/2013	9/30/2013	TAMU	Little	References to Dissertation & journal papers
AASHTO Method	Method to determine surface roughness of aggregate and fines based on AFM	9/30/2013	4/30/2014	WRI	Grimes	Will be subject of Tech. Pub.
AASHTO Method	A method to determine ductile-brittle properties via AFM measurements	10/30/2013	2/28/2014	WRI	Grimes	Will be subject of Tech. Pub.
AASHTO Method	AFM-based micro/nano-scale cyclic direct tension test	3/31/2013	10/31/2013	WRI	Grimes	Will be subject of Tech. Pub.
AASHTO Method	Measurement and Texture Spectral Analysis of Pavement Surface Profiles Using a Linear Stationary Laser Profiler (SLP)	Completed 9/30/2012	3/31/2013	UWM	Roohi	Pending FHWA review
Model	HMA Thermal Stresses in Pavement	3/31/2014		UNR	Hajj	Detailed in Report I
Software	Dynamic Model for Flexible Pavements 3D-Move	9/30/2013		UNR	Hajj Siddharthan	Detailed in Report J
Model & Test Method	Improved Oxygen and Thermal Transport Model of Binder Oxidation in Pavements (Level 3)	5/31/2013	10/31/2013	TAMU	Glover	Part of Report B & Summary Report References to Dissertations and Journal Papers
Model & Test Method	Pavement Air Voids Size Distribution Model for use in an Oxygen and Thermal Transport Model of Binder Oxidation in Pavements (Level 3)	5/31/2013	10/31/2013	TAMU	Glover	Part of Report B & Summary Report References to Dissertations and Journal Papers

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Model	Approaches to interpret MD simulation results and experimental data to quantify the composition and temperature dependence of free energy.	8/15/2013		URI	Greenfield	Detailed in Report S
Model and Software	Phase-Field Model of Asphalt Binder Fracture and COMSOL Code for Model	9/30/2013	3/31/2014	VT	Wang	Detailed in Report T
Software	PANDA Software (Pavement Analysis using a Nonlinear Damage Approach)	12/31/2013	6/20/2014	TAMU	Sun-Myung Kim	