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New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

CHRISTOPHER D. CLEMENT, SR.
COMMISSIONER

JEFF BRILLHART, P.E.
ASSISTANT COMMISSIONER

Bureau of Materials & Research
September 24, 2014

Her Excellency, Governor Margaret Wood Hassan
and the Honorable Council
State House
Concord, New Hampshire 03301

Sole Source

REQUESTED ACTION

1. Authorize the Department of Transportation to amend a **sole-source** Cooperative Project Agreement (CPA) with the UNH Sponsored Programs Administration (Vendor #177867) Durham, NH for research related to the evaluation of plant-produced, high-percentage recycled asphalt pavement (RAP) mixtures in the Northeast, by increasing the total project funding by $65,000 from $731,706 to $796,706 for an additional task that was not anticipated in the original scope of work, effective upon Governor and Council approval. 100% Federal Funds.

Funding is available as follows:

	FY 2015
04-96-96-962015-3036	
SPR Research Funds	$65,000
046-500463 Eng Consultants Non-Benefit	

2. Further, authorize to amend the contract completion date from December 31, 2014 to December 31, 2015.

EXPLANATION

The requested action is in furtherance of a long-standing cooperative relationship of transportation research between the Department of Transportation and the University of New Hampshire. This relationship has been mutually beneficial, culminating in savings to the State while enhancing work force development and maintaining New Hampshire's position on the leading edge of new technology.

On August 11, 2010, the original CPA was approved by Governor and Council (Item #65; copy of Resolution attached) with a funding allocation of $225,000/year for FYs 2011, 2012 and 2013, and $106,706 for FY 2014. This is a pooled-fund project, jointly funded by seven state DOTs and the Federal Highway Administration (FHWA). The research conducted under the agreement is investigating the performance of pavements containing high percentages of recycled asphalt pavement (RAP) and developing guidelines to optimize the use of RAP in New Hampshire.

On December 4, 2013, Governor and Council authorized an amendment to the Agreement (Item #89; copy of Resolution attached) reducing FY 2014 project funding by $50,000 from $106,706 to $56,706, due to decreased funding from FHWA and to extend the completion date from December 31, 2013 to December 31, 2014 because of the modified scope of remaining work and work previously postponed due to funding uncertainties.
The currently proposed amendment to the Agreement includes an additional task developed by the researchers, in consultation with the pooled-fund technical advisory committee overseeing the project, to continue with the evaluation to better quantify the effects of silo storage time on high RAP mixtures. The length of time the HMA mixture sits in storage prior to being transported to the site affects the degree of blending between the RAP and virgin binders, as well as the stiffness of the mix The additional work will be funded by five of the partner states (including New Hampshire) at a cost of $14,300/state for a total cost of $71,500 ($65,000 plus 10 percent indirect cost). The increase in fee as proposed is commensurate with the modified scope of work and the corresponding additional engineering and technical service to be furnished. The project funding is 100% Federal funds.

This amended Agreement has been approved by the Attorney General as to form and execution. The Department has verified that the necessary funds are available. Copies of the fully-executed amended Agreement are on file at the Secretary of State's Office and the Department of Administrative Services, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to amend the Agreement as outlined above.

Sincerely,

Christopher D. Clement, Sr.
Commissioner

Attachments

AMENDMENT #2 to
COOPERATIVE PROJECT AGREEMENT
between the
STATE OF NEW HAMPSHIRE, **Department of Transportation**
and the
University of New Hampshire of the UNIVERSITY SYSTEM OF NEW HAMPSHIRE

The Cooperative Project Agreement, approved by the State of New Hampshire Governor and Executive Council on **8/11/10**, item # **65**, for the Project titled "**Evaluation of Plant-Produced High-Percentage RAP Mixtures in the Northeast,**" Campus Project Director, **Dr. Jo Sias Daniel**, is and all subsequent properly approved amendments are hereby modified by mutual consent of both parties for the reason(s) described below:

Purpose of Amendment (Choose all applicable items):

☐ Extend the Project Agreement and Project Period end date, at no additional cost to the State.

☒ Provide additional funding from the State for expansion of the Scope of Work under the Cooperative Project Agreement.

☒ Other: Extend end date.

Therefore, the Cooperative Project Agreement is and/or its subsequent properly approved amendments are amended as follows (Complete only the applicable items):

- Article A. is revised to replace the State Department name of with and/or USNH campus from to .
- Article B. is revised to replace the Project End Date of **12/31/14** with the revised Project End Date of **12/31/15**, and Exhibit A, article B is revised to replace the Project Period of **Date of G&C approval – 12/31/14** with **Date of G&C approval – 12/31/15**.
- Article C. is amended to add Exhibit A by including the proposal titled, " ," dated .
- Article D. is amended to change the State Project Administrator to and/or the Campus Project Administrator to .
- Article E. is amended to change the State Project Director to and/or the Campus Project Director to .
- Article F. is amended to increase funds in the amount of **$65,000** and will read:

  Total State funds in the amount of **$796,706** have been allotted and are available for payment of allowable costs incurred under this Project Agreement. State will not reimburse Campus for costs exceeding the amount specified in this paragraph.

- Article F. is amended to change the cost share requirement and will read:

  Campus will cost-share % of total costs during the amended term of this Project Agreement.

- Article F. is amended to change the source of Federal funds paid to Campus and will read:

  Federal funds paid to Campus under this Project Agreement as amended are from Grant/Contract/Cooperative Agreement No. from under CFDA# . Federal regulations required to be passed through to Campus as part of this Project Agreement, and in accordance with the Master Agreement for Cooperative Projects between the State of New

Campus Authorized Official
Date 9/3/14

Hampshire and the University System of New Hampshire dated November 13, 2002, are attached to this document as **revised** Exhibit B, the content of which is incorporated herein as a part of this Project Agreement.

- Article G. is exercised to amend Article(s) of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, as follows:

  Article is amended in its entirety to read as follows:
  Article is amended in its entirety to read as follows:

- Article H. is amended such that:

  ☐ State has chosen **not to take** possession of equipment purchased under this Project Agreement.
  ☐ State has chosen **to take** possession of equipment purchased under this Project Agreement and will issue instructions for the disposition of such equipment within 90 days of the Project Agreement's end-date. Any expenses incurred by Campus in carrying out State's requested disposition will be fully reimbursed by State.

- ☒ Exhibit A is amended as attached.

- ☐ Exhibit B is amended as attached.

All other terms and conditions of the Cooperative Project Agreement remain unchanged.

This Amendment, all previous Amendments, the Cooperative Project Agreement, and the Master Agreement constitute the entire agreement between State and Campus regarding the Cooperative Project Agreement, and supersede and replace any previously existing arrangements, oral and written; further changes herein must be made by written amendment and executed for the parties by their authorized officials.

This Amendment and all obligations of the parties hereunder shall become effective on the date the Governor and Executive Council of the State of New Hampshire or other authorized officials approve this Amendment to the Cooperative Project Agreement.

IN WITNESS WHEREOF, the following parties agree to this **Amendment #2** to the Cooperative Project Agreement.

By An Authorized Official of:
University of New Hampshire
Name: Karen M. Jensen
Title: Manager, Sponsored Programs Administration
Signature and Date: 9/18

By An Authorized Official of:
Department of Transportation
Name: William J. Cass
Title: Director of Project Development
Signature and Date: 9/17/14

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name: John J. Comfort
Title: Assistant Attorney General
Signature and Date: 9/22/14

By An Authorized Official of: the New Hampshire Governor & Executive Council
Name:
Title:
Signature and Date:

EXHIBIT A

Campus Authorized Official KS
Date 9/3/14

A. Project Title: TPF 5(230): Evaluation of Plant Produced RAP Mixtures in the Northeast (Additional Task)

B. Project Period: Date of Governor and Executive Council approval through December 31, 2015.

C. Objectives: The objectives of this research task are to:

1. Measure the effect of silo storage time on companion virgin and RAP mixtures
2. Determine if any changes in stiffness of RAP mixtures with silo storage time are due to blending between RAP and virgin binder and/or the aging of these binders
3. Evaluate the impact of mix parameters (aggregate absorption, difference between RAP and virgin PG grades) on changes in stiffness with silo storage time

D. Scope of Work: The scope of work for this additional task includes testing on a set of four mixtures, pavement performance analysis on the four mixtures along with five previously tested mixtures, and reporting of all results.

Testing of Asphalt Binders and Mixtures

Binder Testing

Binders from the various RAP mixtures will be extracted and recovered. Testing will be done to determine the PG grading, including the critical cracking temperature determination, and partial binder master curve of the fully blended material. Testing will be also done on the virgin binder and the recovered RAP binder. The extracted aggregate gradation will be determined.

Mixture Testing

Plant produced mixtures were compacted at the plant to fabricate test specimens. Mixture testing will include dynamic modulus, SVECD fatigue, and TSRST. Volumetric properties of specimens compacted to the design number of gyrations will also be measured.

Pavement Performance Analysis

Pavement performance predictions for typical thick and thin pavement structures will be conducted using the LVECD software program developed at NCSU. These predictions will be performed for all nine mixtures to evaluate the impact of material property changes on expected field performance in terms of cracking.

E. Deliverables Schedule: The Campus will submit quarterly progress reports. Campus will submit a final report documenting the research effort and findings of this task. The Campus will prepare one or more presentations of this work for regional and national conferences and meetings. Papers summarizing the findings will also be prepared and submitted to technical journals and conferences.

F. Budget and Invoicing Instructions:

Budget Items	Original Budget	Increase this Amendment	New Project Total
1. Salaries & Wages	97,126	14,155	111,281
2. Employee Fringe Benefits	4,354	491	4,845
3. Travel	3,623	0	3,623
4. Supplies and Services	494,124	44,736	538,860
5. Equipment	52,977	0	52,977
6. Facilities & Admin Costs	79,502	5,618	85,120
Subtotals	731,706	65,000	796,706
Total Project Costs:			796,706

Campus Authorized Official KS

Date 9/3/14

89

New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION

12/4/2013
Item # 89

CHRISTOPHER D. CLEMENT, SR.
COMMISSIONER

JEFF BRILLHART, P.E.
ASSISTANT COMMISSIONER

Bureau of Materials & Research
October 24, 2013

Her Excellency, Governor Margaret Wood Hassan
and the Honorable Council
State House
Concord, New Hampshire 03301

REQUESTED ACTION

1. Authorize the Department of Transportation to amend a Cooperative Project Agreement (CPA) with the UNH Sponsored Programs Administration (Vendor #177867) Durham, NH for research related to the performance of high-percentage mixtures of recycled asphalt pavement (RAP) sections in NH by extending the completion date from December 31, 2013 to September 30, 2014, effective upon Governor and Council approval. The original CPA was approved by Governor and Council on July 14th, 2010, Item #92. Time extension only, no new funding.

2. Authorize the Department of Transportation to amend a Cooperative Project Agreement (CPA) with the UNH Sponsored Programs Administration (Vendor #177867) Durham, NH for research related to the evaluation of plant-produced, high-percentage recycled asphalt pavement (RAP) mixtures in the Northeast by extending the completion date from December 31, 2013 to December 31, 2014, effective upon Governor and Council approval. In addition, reduce total project funding by $50,000 from $781,706 to $731,706 and modify the scope of remaining work. The original CPA was approved by Governor and Council on August 11, 2010, Item #65, with a funding allocation of $225,000/year for FYs 2011, 2012 and 2013, and $106,706 for FY 2014.

FY 2014 funding is reduced as follows (100% Federal):

	FY 2014 (Orig.)	Reduction	FY 2014 (Amended)
04-96-96-962015-3036 State Planning and Research Funds 046-500463 – Engin. Consultants Non-Benefit	$106,706	($50,000)	$56,706

EXPLANATION

The research conducted under the above agreements is investigating the performance of pavements containing high percentages of recycled asphalt pavement (RAP) and developing guidelines to optimize the use of RAP in New Hampshire. The requested amendments are due to circumstances beyond either party's control, as summarized below.

1. The performance of high-RAP sections in NH - testing of RAP mixtures scheduled to be completed in 2013 was delayed because of electronic and mechanical issues with two pieces of equipment used for the work. In addition, recently-developed procedures from the Federal Highway Administration (FHWA) that allow the researchers to conduct full dynamic modulus and fatigue testing of field cores (not possible with the original setup) required changes to the test geometry, along with associated training and experience, which delayed completion of the project.

2. The evaluation of plant-produced, high-percentage RAP mixtures in the Northeast – this is a pooled-fund project led by NHDOT ($91,706 contribution) with financial participation from six other state DOTs ($90,000 each) and the FHWA. The original project budget assumed an FHWA contribution of $150,000. Uncertainty in actual, available funding from FHWA resulting in postponement of some work scheduled for 2012. In 2013, FHWA verified that only $100,000 is available for the work. The proposed amendment includes a modified scope of work developed by the researchers, in consultation with the pooled-fund technical advisory committee overseeing the project, to optimize the use of remaining funds in light of the $50,000 budget reduction.

The amended agreements have been approved by the Attorney General as to form and execution. Copies of the fully executed amended Agreement are on file at the Secretary of State's Office and the Department of Administrative Services, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to amend the Agreements as outlined above.

Sincerely,

Christopher D. Clement, Sr.
Commissioner

Attachments

AMENDMENT #1 to
COOPERATIVE PROJECT AGREEMENT
between the
STATE OF NEW HAMPSHIRE, **Department of Transportation**
and the
University of New Hampshire of the UNIVERSITY SYSTEM OF NEW HAMPSHIRE

The Cooperative Project Agreement, approved by the State of New Hampshire Governor and Executive Council on **8/11/10**, item # **65**, for the Project titled "**Evaluation of Plant-Produced High-Percentage RAP Mixtures in the Northeast,**" Campus Project Director, **Dr. Jo Sias Daniel**, is and all subsequent properly approved amendments are hereby modified by mutual consent of both parties for the reason(s) described below:

Purpose of Amendment (Choose all applicable items):

☐ Extend the Project Agreement and Project Period end date, at no additional cost to the State.

☐ Provide additional funding from the State for expansion of the Scope of Work under the Cooperative Project Agreement.

☒ Other: Decrease project funding, extend the Project End Date and modify the scope of work as outlined in attached Exhibit A.

Therefore, the Cooperative Project Agreement is and/or its subsequent properly approved amendments are amended as follows (Complete only the applicable items):

- Article A. is revised to replace the State Department name of with and/or USNH campus from to .
- Article B. is revised to replace the Project End Date of **12/31/13** with the revised Project End Date of **12/31/14**, and Exhibit A, article B is revised to replace the Project Period of **Date of G&C approval – December 31, 2013** with **Date of G&C approval – December 31, 2014**.
- Article C. is amended to add Exhibit A by including the proposal titled, " ," dated .
- Article D. is amended to change the State Project Administrator to and/or the Campus Project Administrator to .
- Article E. is amended to change the State Project Director to and/or the Campus Project Director to .
- Article F. is amended to decrease funds in the amount of **$(50,000)** and will read:

  Total State funds in the amount of **$731,706** have been allotted and are available for payment of allowable costs incurred under this Project Agreement. State will not reimburse Campus for costs exceeding the amount specified in this paragraph.

- Article F. is amended to change the cost share requirement and will read:

  Campus will cost-share % of total costs during the amended term of this Project Agreement.

- Article F. is amended to change the source of Federal funds paid to Campus and will read:

  Federal funds paid to Campus under this Project Agreement as amended are from Grant/Contract/Cooperative Agreement No. from under CFDA# . Federal regulations required to be passed through to Campus as part of this Project Agreement, and in

Campus Authorized Official
Date 10/15/13

accordance with the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, are attached to this document as **revised** Exhibit B, the content of which is incorporated herein as a part of this Project Agreement.

- Article G. is exercised to amend Article(s) of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, as follows:

  Article is amended in its entirety to read as follows:
  Article is amended in its entirety to read as follows:

- Article H. is amended such that:

  ☐ State has chosen **not to take** possession of equipment purchased under this Project Agreement.
  ☐ State has chosen **to take** possession of equipment purchased under this Project Agreement and will issue instructions for the disposition of such equipment within 90 days of the Project Agreement's end-date. Any expenses incurred by Campus in carrying out State's requested disposition will be fully reimbursed by State.

- ☒ Exhibit A is amended as attached.

- ☐ Exhibit B is amended as attached.

All other terms and conditions of the Cooperative Project Agreement remain unchanged.

This Amendment, all previous Amendments, the Cooperative Project Agreement, and the Master Agreement constitute the entire agreement between State and Campus regarding the Cooperative Project Agreement, and supersede and replace any previously existing arrangements, oral and written; further changes herein must be made by written amendment and executed for the parties by their authorized officials.

This Amendment and all obligations of the parties hereunder shall become effective on the date the Governor and Executive Council of the State of New Hampshire or other authorized officials approve this Amendment to the Cooperative Project Agreement.

IN WITNESS WHEREOF, the following parties agree to this **Amendment #1** to the Cooperative Project Agreement.

By An Authorized Official of:
University of New Hampshire
Name: Karen Jensen
Title: Manager, Sponsored Programs Administration
Signature and Date: 10/15/13

By An Authorized Official of:
Department of Transportation
Name: William J. Cass
Title: Director of Project Development
Signature and Date:

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name:
Title:
Signature and Date:

By An Authorized Official of: the New Hampshire Governor & Executive Council
Name:
Title:
Signature and Date:

Campus Authorized Official KJ
Date 10/15/13

EXHIBIT A

A. Project Title:

B. Project Period:

C. Objectives:

D. Scope of Work: Phase II testing has been fulfilled for mixes produced during 2011 construction season. Upon discussions between State and Campus, it is agreed that remaining testing shall be as described in Phase III scope below.

Northeast High RAP Pooled Fund – Phase III Testing Plan

The testing plan proposed for Phase III consists of a laboratory study of 8-10 mixtures to evaluate the impacts of asphalt binder grade and asphalt content on the mixture properties. The laboratory study is proposed to allow for better control of production variables (temperature, gradation, short term aging). NH Phase I mixtures were selected for comparison with plant produced mixtures tested previously. The conditions to be tested are shown in Table 1. The impact of a combination of changing binder grade and adding additional asphalt cement (conditions in parenthesis) will only be evaluated after examining the results of changing binder grade and increasing asphalt content independently.

Table 1. Laboratory Test Mixtures

Mixture	Asphalt content	RAP Content (total weight)		
		0	20	40
NH Pike Mixture from Phase I, 12.5 mm	optimum	PG 64-28	PG 64-28 PG58-28	PG 64-28 PG 58-28
	+0.5%	-	PG 64-28	PG 64-28 (PG 58-28)
	+1.0%	-	-	PG 64-28 (PG 58-28)

		Optimum	+0.5%	+1.0%
% binder replacement	20% RAP	16.8	15.5	-
	40% RAP	33.7	31.0	28.7
RAP credit	20% RAP	100	47.9	-
	40% RAP	100	74.0	47.9

Laboratory Procedures

All specimens will be fabricated in the UNH laboratory for consistency and to minimize shipping costs. Laboratory procedures are summarized:

- Aggregate stockpiles will be dried and sieved into individual size components for batching of individual specimen sizes.
- Aggregates will be heated to mixing temperature for at least 4 hours prior to mixing. The mixing temperatures used in the plant production will be used for heating the aggregate (approx. 330 F).

Campus Authorized Official
Date 10/15/13

- Asphalt cement will be heated to mixing temperature; it will be discarded after 3 hours at mixing temperature and will not be reheated once it has been heated to mixing temperature.
- RAP will be air dried on a flat sheet for 24 hours prior to mixing.
- RAP will be heated to 60C for 2 hours prior to being mixed with the virgin aggregate and asphalt.
- RAP, virgin aggregate, and asphalt will be mixed together for 2 minutes using a bucket mixer.
- Mixtures will be short-term oven aged for 2 hours at compaction temperature.
- Mixtures will be compacted to create specimens of appropriate geometry and air void content using a Superpave Gyratory Compactor.
- Specimens will be cored to appropriate diameter prior to being shipped.
- Testing labs will trim specimens to appropriate height.

Testing

Table 2. Binder Testing (Virgin & Extracted)			
Test/Test Parameter	**Test Method/Reference**	**Title**	**Lab**
Extraction and Recovery			Rutgers
Performance Grade	AASHTO R29 & AASHTO M320	Grading or Verifying the Performance Grade of an Asphalt Binder & Performance-Graded Asphalt Binder	Rutgers
Binder Modulus (G*) & Binder Master Curve			Rutgers
Critical Cracking Temperature	AASHTO R49-09	Determination of Low-Temperature Performance Grade (PG) of Asphalt Binders	Rutgers

Table 3. Mixture Testing			
Test/Test Parameter	**Test Method/Reference**	**Title**	**Lab**
Dynamic Modulus	AASHTO TP 62	Determining Dynamic Modulus of Hot Mix Asphalt Concrete Specimens	NCSU
Fatigue Test	Push-Pull Fatigue (S-VECD)	Proposed Standard Method of Test for Determining the Damage Characteristic Curve of Asphalt Concrete from Direct Tension Cyclic Fatigue Tests	NCSU
Permanent Deformation		Triaxial Stress Sweep	NCSU
Low Temperature Cracking		Thermal Stress Restrained Specimen Test (TSRST)	UMass

Material/Specimen Requirements

Campus Authorized Official KS
Date 10/15/13

Lab	Specimens	Target air void of final test specimen
NCSU	• 3 - |E*| 100 mm diam x 150 mm tall • 4 – SVECD 100 mm diam x 130 mm tall • 8 – TSS 100 mm diam x 150 mm tall	6%
UMass Dart	• 3 – TSRST 50 mm diam x 150 mm tall	6 %
Rutgers	• Compacted specimens to produce at least 1000g of asphalt • RAP • Virgin binders	n/a

E. Deliverables Schedule:

F. Budget and Invoicing Instructions:

Budget Items	State Funding	Cost Sharing	Total
1. Salaries & Wages	97,126	0	97,126
2. Employee Fringe Benefits	4,354	0	4,354
3. Travel	3,623	0	3,623
4. Supplies and Services	494,124	0	494,124
5. Equipment	52,977	0	52,977
6. Facilities & Admin Costs	79,502	0	79,502
Subtotals	731,706	0	731,706
Total Project Costs:			731,706

Campus Authorized Official KS
Date 10/15/13

G&C 8-11-10 ITEM #65

New Hampshire DOT
Department of Transportation

THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION
Bureau of Materials & Research

GEORGE N. CAMPBELL, JR.
COMMISSIONER

JEFF BRILLHART, P.E.
ASSISTANT COMMISSIONER

July 12, 2010

RECEIVED

JUL 20 2010

Bureau of Materials & Research
NH Dept. of Transportation

His Excellency, Governor John H. Lynch
and the Honorable Council
State House
Concord, New Hampshire 03301

Requested Action

Authorize the Department of Transportation to execute a sole-source Cooperative Project Agreement with the UNH Office of Sponsored Research, (VC#177867), Durham, NH, in the total amount of $781,706 for transportation research services related to plant-produced, high-percentage recycled asphalt pavement (RAP) mixtures, from Governor and Council approval through December 31, 2013. 100% Federal Funds.

Funding is available as follows for Fiscal Year 2011. Funding for Fiscal Years 2012, 2013, and 2014 is contingent upon the availability and continued appropriation of funds.

04-96-96-962015-3036	FY 2011	FY 2012	FY 2013	FY 2014
State Planning and Research Funds	$225,000	$225,000	$225,000	$106,706
046-500463 – Engin. Consultants Non-Benefit				

EXPLANATION

The requested action is in furtherance of a long-standing cooperative relationship of transportation research between the Department of Transportation and the University of New Hampshire. This relationship has been mutually beneficial, culminating in savings to the State while enhancing work force development and maintaining New Hampshire's position on the leading edge of new technology.

Research services are required to investigate the performance of plant-produced asphalt pavement mixtures containing high amounts of recycled asphalt pavement (RAP). This is a pooled-fund project whereby the Federal Highway Administration pays 100% of the project cost utilizing State Planning and Research (SPR) funds from a number of state DOTs in the northeast U.S.

Production of HMA mixtures with higher percentages of recycled asphalt pavement (RAP) is gaining increased attention as a way to save money and more efficiently utilize existing resources. Many state DOTs and contractors are very comfortable using RAP percentages of 10-15%. However, questions about low temperature performance and the need to soften binder grades limit the amount of HMA produced with greater than 15-20% RAP in many areas of the northeast US.

The Northeast Asphalt User/Producer Group (NEAUPG) is a non-profit association made up primarily of State DOTs and Industry, with the mission of improving the quality and performance of asphalt pavement applications in the region. The NEAUPG RAP Task Group has proposed a pooled-fund study to expand on work conducted last year during a joint NHDOT/UNH/Pike Industries study. This project will include the evaluation of higher-RAP mixtures produced by drum and batch plants in the region and will be conducted in two phases: Phase I will focus on evaluating the effects of binder grade and plant type on the properties of mixtures with various percentages of RAP. Phase II will be geared towards evaluating the amount of blending that occurs between the virgin and RAP binders and the impact of higher RAP percentages on material properties and performance. The testing will also evaluate moisture susceptibility of the mixtures containing RAP. The total cost of the two-phase study is $781,706.

The New Hampshire DOT has agreed to serve as the Lead Agency for the pooled-fund study. In March 2010 the Department solicited the American Association of State Highway and Transportation Officials (AASHTO) member states to identify partners wanting to participate in this research. To date, commitments of support totaling $450,000 ($90,000 per state) have been received from the state Departments of Transportation of Maryland, New Jersey, New York, Pennsylvania, and Virginia. New Hampshire's share in the proposed research is also $90,000 ($30,000/yr for 3 years, 100% Federal funds). In addition, the Federal Highway Administration has committed $150,000 of their own funding, and decisions are pending in several other states. In accordance with FHWA pooled-fund procedures, the NHDOT's federal-aid research apportionment will be increased by the amount contributed by participating agencies, enabling the Department to enter into an agreement with the University if New Hampshire for the total project amount using 100% Federal funds.

Sufficient funding exists to proceed with Phase I of the Agreement. The sources and quantity of mixtures tested in Phase II will be dependent on the total funding received, i.e. actual project costs will be limited to the total funds available. Contractors from participating states will provide plant-produced mix for testing, and will prepare specimens of each mix for the research. The contractors will also provide detailed data and information related to the production of each mixture. UNH will be responsible for coordinating the research, performing testing on lab specimens and field cores, data analysis, report preparation, and presentation of findings. UNH will contract with, oversee the work of, and incorporate the findings from three subcontractors as follows: UMass-Dartmouth and Rutgers University will be responsible for a portion of the binder testing, mixture testing, and data analysis, and they will assist in final report preparation. North Carolina State University will be responsible for refining the fatigue failure criteria for RAP mixtures.

The Department's Federal-aid research program includes a blend of in-house and contracted research. For some contracted studies, particularly where private industry or out-of-state organizations can best provide the necessary expertise and resources to perform the work, it is appropriate to utilize the Department's *Consultant Selection and Service Agreement Procedures* to identify and select an appropriate organization to perform the research. In other cases however, the specialized nature of the research does not lend itself to that process and it is in the Department's and the State's best interest to assign work directly to the University of New Hampshire. The study included in this requested action meets this description. The study involves a unique partnership with asphalt producers in the northeast and brings together some of the most experienced and talented professionals experienced with recycled asphalt pavements in the country. The Principal Investigator has extensive experience in recycled asphalt pavements and is a nationally recognized expert in this field.

The use of Cooperative Project Agreements, including allowable costs, is outlined in the *Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire*, approved by the Governor and Council on November 13, 2002. The Department of Transportation considers the above-stated fee to be fair and reasonable for this work. The Agreements have been approved by the Attorney General as to form and execution. The Department has verified that the necessary funds are available for FY 2011. Copies of the fully executed Agreements are on file at the Secretary of State's Office and the Department of Administrative Services, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to enter into a Cooperative Project Agreement for the transportation research service as outlined above.

Sincerely,

George N. Campbell, Jr.
Commissioner

GNC/ADR/ger

COOPERATIVE PROJECT AGREEMENT
between the
STATE OF NEW HAMPSHIRE, Department of Transportation
and the
University of New Hampshire of the UNIVERSITY SYSTEM OF NEW HAMPSHIRE

A. This Cooperative Project Agreement (hereinafter "Project Agreement") is entered into by the State of New Hampshire, Department of Transportation, (hereinafter "State"), and the University System of New Hampshire, acting through University of New Hampshire, (hereinafter "Campus"), for the purpose of undertaking a project of mutual interest. This Cooperative Project shall be carried out under the terms and conditions of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, except as may be modified herein.

B. This Project Agreement and all obligations of the parties hereunder shall become effective on the date the Governor and Executive Council of the State of New Hampshire approve this Project Agreement ("Effective date") and shall end on 12/31/13. If the provision of services by Campus precedes the Effective date, all services performed by Campus shall be performed at the sole risk of Campus and in the event that this Project Agreement does not become effective, State shall be under no obligation to pay Campus for costs incurred or services performed; however, if this Project Agreement becomes effective, all costs incurred prior to the Effective date that would otherwise be allowable shall be paid under the terms of this Project Agreement.

C. The work to be performed under the terms of this Project Agreement is described in the proposal identified below and attached to this document as Exhibit A, the content of which is incorporated herein as a part of this Project Agreement.

Project Title: **Evaluation of Plant-Produced High-Percentage RAP Mixtures in the Northeast**

D. The Following Individuals are designated as Project Administrators. These Project Administrators shall be responsible for the business aspects of this Project Agreement and all invoices, payments, project amendments and related correspondence shall be directed to the individuals so designated.

State Project Administrator	Campus Project Administrator
Name: Glenn E. Roberts	Name: Kelly J. Marti
Address: NHDOT Bureau of Mat'ls & Research PO Box 483, 5 Hazen Drive Concord, NH 03302-0483	Address: UNH Office of Sponsored Research 51 College Road, Service Building Durham, NH 03824
Phone: 271-3151	Phone: 862-1221

E. The Following Individuals are designated as Project Directors. These Project Directors shall be responsible for the technical leadership and conduct of the project. All progress reports, completion reports and related correspondence shall be directed to the individuals so designated.

State Project Director	Campus Project Director
Name: Denis M. Boisvert	Name: Jo Sias Daniel
Address: NHDOT Bureau of Mat'ls & Research PO Box 483, 5 Hazen Drive Concord, NH 03302-0483	Address: UNH Department of Civil Engineering Kingsbury Hall, 33 College Road Durham, NH 03824
Phone: 271-3151	Phone: 862-1428

Campus Authorized Official
Date 7-9-10

F. Total State funds in the amount of $781,706.00 have been allotted and are available for payment of allowable costs incurred under this Project Agreement. State will not reimburse Campus for costs exceeding the amount specified in this paragraph.

Check if applicable

☐ Campus will cost-share % of total costs during the term of this Project Agreement.

☒ Federal funds paid to Campus under this Project Agreement are from Grant/Contract/Cooperative Agreement No. n/a from State Planning & Research Part 2 under CFDA# 20-205. Federal regulations required to be passed through to Campus as part of this Project Agreement, and in accordance with the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, are attached to this document as Exhibit B, the content of which is incorporated herein as a part of this Project Agreement.

G. Check if applicable

☐ Article(s) of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002 is/are hereby amended to read:

H. ☒ State has chosen not to take possession of equipment purchased under this Project Agreement.

☐ State has chosen to take possession of equipment purchased under this Project Agreement and will issue instructions for the disposition of such equipment within 90 days of the Project Agreement's end-date. Any expenses incurred by Campus in carrying out State's requested disposition will be fully reimbursed by State.

This Project Agreement and the Master Agreement constitute the entire agreement between State and Campus regarding this Cooperative Project, and supersede and replace any previously existing arrangements, oral or written; all changes herein must be made by written amendment and executed for the parties by their authorized officials.

IN WITNESS WHEREOF, the University System of New Hampshire, acting through the **University of New Hampshire** and the State of New Hampshire, **Department of Transportation** have executed this Project Agreement.

By An Authorized Official of:
University of New Hampshire
Name: Victor G. Sosa
Title: Manager of Sponsored Research
Signature and Date: 7-9-10

By An Authorized Official of:
New Hampshire Dept. of Transportation
Name: William J. Cass
Title: Director of Project Development
Signature and Date: 7/15/10

By An Authorized Official of: the New Hampshire Office of the Attorney General
Name: JOHN VINSON
Title: ATTORNEY
Signature and Date: 7/28/2010

By An Authorized Official of: the New Hampshire Governor & Executive Council
Name:
Title:
Signature and Date:
AUG 11 2010
DEPUTY SECRETARY OF STATE

Campus Authorized Official
Date 7-9-10

EXHIBIT A

A. **Project Title:** Evaluation of Plant-Produced High-Percentage RAP Mixtures in the Northeast

B. **Project Period:** Date of Governor and Executive Council approval through December 31, 2013.

C. **Objectives:** See proposal, attached.

D. **Scope of Work:** See proposal, attached. This study is being conducted as a pooled-fund project and includes participation from several State DOTs and the Federal Highway Administration (FHWA). Following the completion of Phase I, the Principal Investigator shall coordinate a meeting(s) and/or conference call(s) with participating agencies to discuss the work performed to date and to develop a strategy for proceeding with Phase II. The scope of Phase II (e.g. number of tests, material sources, etc.) will be finalized in consultation with the participating agencies based on the results of Phase I and available project funds, not to exceed the amount specified in Article F of this Agreement.

E. **Deliverables Schedule:** A written status report shall be submitted by Campus to State at the end of each quarter summarizing the work completed to date and identifying tasks to be performed during the following quarter. Status reports shall include a statement addressing the validity of the project completion date along with an explanation of any circumstances potentially impacting the project schedule.
A draft Interim report shall be prepared and provided to the State Project Director for review at the completion of Phase I. A draft Final report for the project shall be prepared and provided to the State Project Director for review by October 1, 2013. The report shall be stand-alone (i.e. a student thesis is not sufficient) and shall have undergone a complete grammatical and editorial review prior to submittal to allow reviewers to focus only on the technical aspects of the report. The report shall include, in addition to any deliverables specified in the proposal, an executive summary, project objectives, data collected, analyses performed, conclusions, and recommendations. The final report shall be provided in electronic format ready for publication within 30 days of the completed review by the State. In addition to the technology transfer activities included in the proposal, the Principal Investigator shall prepare a poster suitable for display at regional and national transportation research conferences in coordination with the NHDOT Research office.

F. **Budget and Invoicing Instructions:** See funding note in Scope of Work, above.

Salaries & Wages	120,273
Employee Fringe Benefits	3,933
Travel	6,000
Supplies and Services	509,430
Equipment	65,000
Facilities & Admin Costs	77,070

Total Cost: $781,706

Campus will submit invoices to State on regular Campus invoice forms no more frequently than monthly and no less frequently than quarterly. Invoices will be based on actual project expenses incurred during the invoicing period, and shall show current and cumulative expenses by major cost categories. State will pay Campus within 30 days of receipt of each invoice. Campus will submit its

Campus Authorized Official
Date 7-9-10

final invoice not later than 75 days after the Project Period end date. Total payments will not exceed 90% until receipt of a final report acceptable to State.

G. State and FHWA Inspection: It is mutually agreed that all portions of the work covered by this AGREEMENT, including fiscal records outlined in Article 10 of the Master Agreement for Cooperative Projects, shall be subject to the inspection of duly-authorized representatives of the STATE and Federal Highway Administration, United States Department of Transportation, at such time or times as the STATE or Federal Highway Administration deems appropriate.

The location of the office where the work will be available for inspection by STATE and Federal Highway Administration representatives is Kingsbury Hall, 33 College Road, Durham, NH 03824.

It is further mutually agreed that any party, including the duly-authorized representatives of the Federal Highway Administration, may request and obtain conferences, visits to the site, and inspection of the work at any reasonable time.

Campus Authorized Official
Date 2-9-10

EXHIBIT B

This Project Agreement is funded under a Grant/Contract/Cooperative Agreement to State from the Federal sponsor specified in Project Agreement article F. All applicable requirements, regulations, provisions, terms and conditions of this Federal Grant/Contract/Cooperative Agreement are hereby adopted in full force and effect to the relationship between State and Campus, except that wherever such requirements, regulations, provisions and terms and conditions differ for INSTITUTIONS OF HIGHER EDUCATION, the appropriate requirements should be substituted (e.g., OMB Circulars A-21 and A-110, rather than OMB Circulars A-87 and A-102). References to Contractor or Recipient in the Federal language will be taken to mean Campus; references to the Government or Federal Awarding Agency will be taken to mean Government/Federal Awarding Agency or State or both, as appropriate.

Special Federal provisions are listed here: ☒ None or

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Date 7-9-10

Proposal - Pooled Fund Project

Evaluation of Plant Produced RAP Mixtures in the Northeast

Introduction

Production of HMA mixtures with higher percentages of RAP is gaining more attention as a way to save money and more efficiently utilize existing resources. Many state agencies and contractors are very comfortable using RAP percentages of 10-15%. However, questions about low temperature and the need to bump binder grades limit the amount of HMA that is produced with greater than 15-20% RAP in many areas of the northeast US. Fatigue performance and possible increased moisture susceptibility are also issues in some regions. In the winter of 2009, the NHDOT and Pike Industries, Inc (PII) collaborated to perform an evaluation of extracted binder properties for various batch plant produced HMA mixtures containing 0-25% RAP. The results of that study will be published in the Transportation Research Record (TRB Journal) in 2010 and were also presented at the 2009 NESMEA meeting. The general conclusion was that binder bumping was not necessary at the 20% RAP level for the mixtures evaluated.

The research project outlined here will expand on the initial work by PII and NHDOT by including higher RAP percentages, drum and batch plants, and mixture testing. The previous study was limited to testing of recovered binder properties which represent the fully blended condition between the RAP and virgin binder. Testing of plant-produced mixtures will allow for evaluation of blending and the impact of higher RAP percentages on material properties and performance with respect to low temperature and fatigue cracking. Mixture testing will also be expanded to evaluate moisture susceptibility of the mixtures containing RAP.

This project will add to the body of knowledge and types of RAP mixtures that are currently being evaluated in an FHWA project by the North Central Superpave Center and in other research projects across the country. Ultimately, the industry needs to understand how RAP interacts with the virgin materials in a mixture so that the proper techniques and procedures can be developed and used to design and construct RAP mixtures that equal or better performance than all virgin mixtures.

Proposed Pooled fund participants

The NHDOT has volunteered to lead the pooled fund study. States in the Northeast region of the U.S. will be invited to participate.

Research Objectives

The objectives of this research project are to:

1. evaluate the performance in terms of low temperature cracking, fatigue cracking, and moisture sensitivity of plant produced RAP mixtures in the laboratory and field
2. establish guidelines on when it is necessary to bump binder grades with RAP mixtures
3. provide further understanding of the blending that occurs between RAP and virgin binder in plant-produced mixtures

Research Plan

The research plan is broken down into two phases. Phase I will focus on evaluating the effects of binder grade and plant type on the properties of mixtures with various percentages of RAP. Phase II of the study will be geared towards evaluating the amount of blending that occurs between the virgin and RAP binders. The testing and results of Phase I will be used to inform the testing matrix and final plan to be developed for Phase II.

The following tasks will be required to achieve the research objectives for both phases of this project:

1. Producing Plant Mixtures
2. Testing and Analysis of Asphalt Binders and Mixtures
3. Construction and Evaluation of Field Test Sections
4. Reporting

Task 1: Producing Plant Mixtures

The proposed matrix for the plant produced mixtures is shown in Table 1 below. The target will be to obtain mixtures from a combination of batch plants and drum plants for each cell. There will be some cells with more mixtures than other cells; the budget for this project is based on testing a total of approximately 60 mixtures. The number of mixtures and budget may be adjusted based on available funding and participation. Mixtures will be limited to 9.5 mm or 12.5 mm surface course mixtures.

Table 1. Proposed Mixture Types

Binder Grade	RAP Percentage					
	0%	20%	30%	40%	50%	>50%
PG xx-22	x	x	x	x	x	x
PG xx-28	x	x	x	x	x	x
PG xx-34	x	x	x	x	x	x

Contractors from participating states will be asked to provide plant produced mix for testing. Table 2 shows a summary of producers that have already volunteered to participate in this study and detail on the mixtures they are willing to produce. Additional producers will be solicited to ensure that at least one producer from each participating state is represented. Participating plants should be able to produce mixtures with up to 30-40% RAP. Several plants with the capability to produce 50% RAP and higher will be included as well. It is recommended that each plant produce an adequate amount of mix prior to sampling to ensure a consistent operation and representative material. Sampling of the mixtures will be from a truck at the plant and samples will be stored in sealed five gallon buckets. Contractors will be asked to compact ten specimens of each mix in a gyratory compactor to the design number of gyrations and provide those samples to the research team; these will be used to determine the plant produced volumetrics and for comparison to lab reheated and compacted specimens. The research team will also be working with contractors to compact test specimens at the plant to avoid reheating of the

mixtures as much as possible. The contractors will also sample the RAP stockpile, virgin binder, and virgin aggregates. The following minimum samples will be requested:

- RAP: 3 five-gallon buckets
- Loose Mix: 15 five-gallon buckets per mix.
- Liquid: 3 one-gallon paint cans of each virgin asphalt binder
- Aggregates: 3 five-gallon buckets of each stockpile
- Compacted samples: minimum 10 per mix

The contractors will be asked to provide information on maximum theoretical specific gravity of each mix, binder content, gradation, plant type and any RAP processing techniques used. It is anticipated that the contractors will perform a complete mix design on one mixture, then alter the binder grade or aggregate/RAP stockpile percentages to produce the other mixtures. These alternate mixes will be verified with a one point mix design, at a minimum.

Additionally, contractors will be requested to supply the research team with detailed information on the production of each mixture. This will include information such as:

- Moisture contents of aggregate and RAP stockpiles
- Production temperatures (including discharge)
- Type of drum/batch plant (i.e., counter flow, etc.)
- Whether the material was silo-ed or not and for how long (basically, how long was the RAP and virgin materials together at elevated temperatures)
- MTV used for remixing (this would provide additional shearing/agitation of RAP and virgin materials for continual blending)

In Phase I, a subset (approximately 20) of mixtures will be selected to strategically evaluate the effect of plant type and binder grade on the properties of the RAP mixture. Mixtures with different PG grade asphalts from the same plant at particular RAP percentages will be collected for direct evaluation of the effect of binder grade. This will be done for both batch and drum plants. These mixtures will be collected and tested in the first year of the project (2010 construction season). The results of this testing will be used to refine the testing matrix for Phase II of the project.

Mixtures produced in Phase II will be selected to evaluate the amount of blending that occurs between the RAP and virgin binder. Select mixtures containing a constant amount of RAP will be produced with different amounts of added virgin binder. The intent is to evaluate to what degree the increase in stiffness seen with higher RAP percentages is due to the aged RAP binder blending with the virgin binder or due to an apparent "under asphalted" condition due to the RAP acting like a black rock. Additional types of mixtures needed to fill in gaps identified during the Phase I testing will also be produced and evaluated during Phase II. Phase II mixtures (approximately 40) will be produced during the 2011 and 2012 construction seasons.

Table 2. Current Volunteer Producer List

Producer Name:	Type of plant*	Location	plant capacity TPH	RAP processing describe**	NMSA	Virgin Binder Grade	RAP Percentages
Pike Industries, Inc	Counter flow - drum-Astec	Poland Maine	400	3/8" minus or millings	9.5	64-28	0,20,30,40,45 or 50
Pike Industries, Inc	Gencor Counter flow	Portsmouth	400	3/8" minus	9.5	64-28	0,20,30,40,45 or 50
Pike Industries, Inc	Gencor Counter flow	W. Lebanon	325	3/8" minus	9.5	58-28	0,20,30,40,45 or 50
Pike Industries, Inc	1966 HB 5 ton	Williston, VT	210	1/2" minus	12.5	58-28 52-34	0,20,30,40 (30 & 40 with 52-34)
Pike Industries, Inc	1965? HB batch/drum	Northfield	240 - Batch 325-ODM	3/8" & millings	12.5	58-28 58-34	0,20,30,40,45 or 50
Tilcon, NJ	ASTEC(counter flow)	TBD	300	Crush and screen millings (surface) to '- 1/2"	9.5	64-22	0, 20, 30, 40
Tilcon, CT	ASTEC(counter flow)	New Britain CT	600	crushed minus 1/2"; 1/2" 3/8" #4 for 40 & 50%	9.5 and/or 12.5	64-22 58-28	0, 20, 30, 40 , 50 (0, 20, 30 with 64-22)
Callanan Industries	Standard Havens(counter flow)	Cordell Road Colonie, NY	450	Crush and screen millings (surface) to - 3/4"	9.5 or 12.5 mm	64-22, 58-28	0, 20, 30, 40 & 50* (30, 40 & 50* w/58-28)
Suit-Kote Corp.	counter flow drumw/external mixing drum	Polkville, NY	400 tph	crushed to minus 3/8"	9.5	64-22 58-28	any
GOH Inc		Pleasant Gap, PA	600 tph		9.5	76-22 64-22	0, 20, 30

Note: this table is not meant to be comprehensive. Additional producers will be solicited based on the interest of various states and the project needs.

Task 2: Testing and Analysis of Asphalt Binders and Mixtures

Binder Testing

Binders from the various RAP mixtures will be extracted and recovered. Testing will be done to determine the PG grading, including the critical cracking temperature determination, and partial binder master curve of the fully blended material. The asphalt binder cracking device (ABCD) will also be used to evaluate the low temperature properties of the binder. Testing will be also done on the virgin binder and the recovered RAP binder. The partial binder master curve will be used to compare with the measured master curves of the mixtures to evaluate the amount of blending.

Mixture Testing

Plant produced mixtures will be sampled and then compacted at the plant to fabricate test specimens whenever possible. Mix will also be reheated in the laboratory following an established procedure to fabricate additional laboratory test specimens when necessary. Mixture testing will include dynamic modulus, fatigue, low temperature creep compliance and strength, AASHTO T283, and the Hamburg Wheel Tracking Device (HWTD). The fatigue testing will include push-pull testing following a draft AASHTO protocol being developed by North Carolina State University (NCSU) through FHWA and the Mixture and Construction ETG. The failure criteria for RAP mixtures using the NCSU method will be refined as part of this project. The overlay tester will be conducted to provide additional information on the mixtures and also to evaluate the test itself. The asphalt concrete cracking device (ACCD) and/or TSRST testing will be performed on a subset of the mixtures to evaluate these tests and provide additional information on the mixtures. Mixture testing will allow for the evaluation of the fatigue and low temperature properties and blending of the RAP mixtures. The HWTD will follow AASHTO T32404 'Standard Method of Test for Hamburg Wheel-Tracking Testing of Compacted Hot-Mix Asphalt (HMA) will be used to evaluate the adhesion and moisture properties of the various mixtures.

Additionally, the UMass Dartmouth workability device will be used to test the effect of higher percentages of RAP on the workability of the mixtures. This will be done on selective mixtures only (control and the mixtures with the highest percentage RAP).

Task 3: Construction and Evaluation of Field Test Sections

Locations for field test strips containing higher (>25%) RAP percentages will be sought. Ideally, four to six test strips containing various RAP percentages will be constructed and monitored for performance. In all cases where the produced mixture is placed on a project, field cores will be requested. Field cores will undergo dynamic modulus and creep testing in indirect tensile mode for comparison with laboratory fabricated specimens.

Task 4: Reporting

The research team will prepare quarterly progress reports for the duration of the project. A final report documenting the research effort and findings will be prepared at the end of the project. The research team will prepare one or more presentations of this work for NESMEA/NBAUPG and the RAP ETG. Papers summarizing the findings will also be prepared and submitted to technical journals and conferences.

Collaboration

The research team will collaborate with other research groups across the country conducting similar projects. Most notably are the North Central Superpave Center project described previously and a similar effort underway at UMass Dartmouth funded by MassDOT. Data will be shared among the various groups.

Benefits

This research will be very beneficial to both agencies and industry as they establish guidelines and best practices for the use of higher RAP percentages in HMA. It is important to note that the testing will be conducted on plant-produced mixtures, so the results will be representative of actual field conditions. The project also includes batch plants and drum plants, which are both common in the northeast. The results of this project will help practitioners to identify optimal RAP usage from a material property perspective. Guidelines for determining when it is necessary to bump binder grades will also be established. Analysis of the testing data will enhance the understanding of the blending that occurs between the virgin and RAP binder in both batch and drum plant-produced mixtures. Also, the failure criteria in the current fatigue model will be refined to more accurately handle RAP mixtures, providing a better overall tool for the industry.

Project Personnel

This project will be conducted by the University of New Hampshire, Rutgers University, UMass Dartmouth, and North Carolina State University. Dr. Jo Sias Daniel at UNH will serve as the Principal Investigator and will oversee the research, perform data analysis, prepare reports, and present the findings. UNH will perform IDT and TSRST testing and dynamic modulus and IDT testing on the contractor produced gyratory specimens and field cores. Dr. Tom Bennert at Rutgers will serve as a co-PI and will be responsible for the dynamic modulus testing, Hamburg testing, T283 testing, a portion of the binder testing, and analysis of the data and will assist in report preparation. Dr. Walaa Mogawer at UMass Dartmouth will also serve as a co-PI and will be responsible for a portion of the binder testing, the ABCD binder testing, the ACCD mixture testing and Hamburg testing and analysis of the data and will assist in report preparation. Dr. Richard Kim at North Carolina State University will serve as a subcontractor on this project and will be responsible for refining the fatigue failure criteria for RAP mixtures.

Budget & Timeline:
$781,706 over 3 years

Year 1: Production of Phase I mixtures, laboratory testing, data analysis, construction of field test sections
Year 2: Phase II mixtures produced, continuation of testing, data analysis, monitoring and construction of field sections
Year 3: Final Phase II mixtures produced, completion of testing, monitoring field sections, data analysis and synthesis, preparation of final report