

# Program Progress Performance Report

Submitted to

**Office of the Assistant Secretary for Research and Technology (OST-R)  
United States Department of Transportation  
Washington, D.C. 20590-0001**

By

Grant No. DTRT13-G-UTC44

University Transportation Center for Highway Pavement Preservation



Dr. Karim Chatti, Director  
[chatti@egr.msu.edu](mailto:chatti@egr.msu.edu)  
(517) 355-6534

April 30, 2017

DUNS #193247145

EIN# 38-6005984

Michigan State University  
426 Auditorium Road, Room 301  
East Lansing, MI 48824

September 30, 2013 through September 30, 2018

Reporting period ending March 31, 2017

Semi-annual

Karim Chatti, Director, Center for Highway Pavement Preservation

## TABLE OF CONTENTS

Progress Report.....	3
1. Accomplishments.....	3
Program Major Goals and Objectives.....	3
Goal Accomplishments.....	3
Training and Professional Development Opportunities.....	3
Results Dissemination and Methods.....	8
Planned Activities for Next Reporting Period.....	8
2. Products.....	12
Publications, Conference Papers, and Presentations.....	12
Website or Other Internet Site.....	13
Technologies or Techniques.....	13
Inventions, Patent Applications, and / or Licenses.....	13
Other Products.....	13
3. Participants and Collaborating Organizations.....	16
Partner Organizations.....	16
Collaboration among University Partners.....	16
External Collaborations.....	16
4. Impact.....	16
Development of Principal Discipline(s).....	16
Other disciplines.....	17
Development of Human Resources.....	18
Physical, Institutional, and Information Resources.....	18
Technology Transfer.....	18
Society beyond Science and Technology.....	18
5. Changes/Problems.....	19

## LIST OF TABLES

Table 1 CHPP Major Goals and Objectives.....	4
Table 2 Students Involved in CHPP-related Research.....	6
Table 3 List of Professional and Academic Meeting Attendees.....	9
Table 4 High School Students Involved in CHPP-related Research.....	10
Table 5 List of Planned Professional and Academic Meeting Attendees.....	11
Table 6 CHPP Research Projects and Assignments.....	14
Table 7 Projects selected for cycle 3.....	15
Table 8 Organizations Involved in CHPP Activities.....	17



# PROGRESS REPORT

## 1. Accomplishments

### Program Major Goals and Objectives

Table 1 lists the major goals and objectives outlined in the Center for Highway Pavement Preservation (CHPP) scope of work.

### Goal Accomplishments

Currently, all CHPP activities are either in progress or in the planning stages as indicated in the “% Complete” and “Status” columns of Table 1.

### Training and Professional Development Opportunities

As indicated in Table 1, multiple opportunities for training and professional development have been implemented and/or are scheduled for future growth and sustainability of the center. During the period October 1, 2016 – March 31, 2017, CHPP provided the following training and professional development opportunities:

- CHPP Short Course Development and Implementation for High School and College Students,
- Middle and High School Engineering Day,
- Open houses,
- Other CHPP professional development activities.

A brief summary of these activities is provided below.

### K-12 Outreach

#### 1. Annual Science and Engineering Enrichment for Deaf Students (SEEDS) Program at NCA&TSU

##### Program Description:

CHPP organized a workshop on Sustainable Pavements for middle school and high school students on March 21, 2017 during the SEEDS event (Science and Engineering Enrichment for K-12 Deaf Students). The workshop was mainly designed to cover various aspects of pavement construction and preservation while providing students with some hands on experience. Student teams made their miniature pavement to help understand concepts such as structural adequacy, aggregate interlocks, interface and adhesion. The workshop schedule involved two main sections including short description and demos followed by hands-on activities. The workshop was attended by twenty middle school deaf students and their six instructors. At the end of the program students received a program completion certificates.

#### 2. VEX Robotics State Championship at Michigan State University - February 19, 2017

##### Program Description

Sixty VEX Robotics teams, including those from Battle Creek, Belding, Bloomfield Hills, Detroit, DeWitt, Grandville, Haslett, Pontiac, Traverse City, Utica, and other Michigan cities competed at the state tournament. There were 26 middle school teams and 48 high school teams. Winners advanced to the 2016-17 VEX Robotics World Championship in April in Louisville, KY. The MSU K-12 outreach office, with the help of the CHPP faculty, organized the event. This state tournament was a wonderful and exciting way to challenge future engineers and designers to strengthen their skills in Science, Technology, Engineering and Mathematics (STEM). It helped middle and high school students learn the basics of engineering and how to work together as a team. One CHPP faculty member participated as a judge and two CHPP graduate students volunteered for the event. The event featured hands-on displays and demonstrations to educate high school students on basic concepts related to pavement materials, structures, and sensor technology and to showcase the center research.



**Table 1 CHPP Major Goals and Objectives**

<b>Overall</b>		<b>Status</b>	<b>% Complete</b>
	Kick-off meeting with USDOT, Steering Committee and Advisory Board	Complete	100
	Sub-award contracts in place	Complete	100
	Request for problem statements	Complete	100
	Evaluation and ranking of problem statements	Complete	100
	Request for Proposals	Complete	100
	Proposals and Budgets under External Review	Complete	100
	Research Projects under Contract	On Schedule	100
	Library Resources Posted/Linked on Website	On Schedule	100
<b>Leadership Activities</b>			
	Partner with NCPP to work with regional partnerships	Complete	100
<b>Educational and Outreach Activities</b>			
K-12	Middle and High School Engineering Day	On Schedule	100
	Participate in the activities of Middle and high schools STEM clubs	On Schedule	100
	High School Engineering Institute	On Schedule	100
	Metro Detroit Youth Day	On Schedule	100
	Developing Highway Pavement Preservation short courses for HS students	On Schedule	100
	Preview Day of Highway Pavement Preservation related research	On Schedule	100
	Research Experiences for Teachers	On Schedule	100
	Training camps for high school students	On Schedule	100
	Science and Engineering Enrichment Program for Deaf	On Schedule	100
	Engineering Teacher Workshop	On Schedule	100
Grad/Undergrad	CHPP Course Development & Implementation	On Schedule	50
	Summer Research for undergraduates	On Schedule	100
	CHPP/CUTC student of the Year Program - Annually @ TRB	On Schedule	100
	Transportation student Chapter (ITE/ASCE/etc.) related activities	On Schedule	100
	CHPP student symposium	On Schedule	100
	Summer Research for college Students - Annually	On Schedule	100
<b>Technology Transfer Activities</b>			
	Website for disseminating UTC related activities	Complete	100
	Publish newsletters and synthesis reports	On Schedule	100
	Disseminate technology and results to agency and industry	On Schedule	60
	Training Courses for professionals	On Schedule	100
	Be represented at conferences and meetings	On Schedule	100
<b>USDOT RITA: Reporting</b>			
	Website developed and running	Complete	100
	Posting directory of key center personnel	Complete	100
	Posting research projects description	Complete	100
	Federal financial reports (quarterly)	On Schedule	100
	UTC Program Progress Performance Reports (biannually)	On Schedule	100
	Annual Performance Indicators Report	On Schedule	100



### **3. Engineering Open House at UIUC**

#### **Program Description**

A team of UIUC students participated at an engineering open house on campus aimed at K-12 students. The team demonstrated the importance of pavements with some example demonstrations using marshmallows, syrup, and cookies. The team was awarded the EOH Theme Embodiment prize presented by Exxon Mobil.

## **Undergraduate / Graduate Outreach**

### **1. CUTC Outstanding Student of the Year Award – January 8, 2017**

#### **Program Description**

For the past 24 years, the USDOT has honored an outstanding student from each UTC at a special ceremony held during the TRB Annual Meeting. The ceremony took place as part of the CUTC annual banquet on Saturday, January 7, 2017. Each student awardee received \$1,000 plus the travel cost to the 96th Annual TRB Meeting from his/her Center. This year CHPP nominated Katelyn Freeseaman, a Ph.D. student from the University of Minnesota under the supervision of Dr. Lev Khazanovich. Ms. Freeseaman is currently a Post-doctoral researcher at the Iowa State University.

### **2. Graduate Symposium at NCA&TSU**

#### **Program Description:**

A poster session on Innovation in Transportation (January 27, 2017) was organized at NCA&TSU, in which several local industry professionals and state officials participated. As part of the poster session, which was open to all NC A&T's graduate and undergraduate students, we received fifteen posters all related on sustainable materials and pavement preservation; seven of which were specifically on sustainable pavements and preservation practices and were either fully or partially supported by UTC projects.

### **3. Engineering Graduate Research Symposium at MSU**

#### **Program Description:**

The Engineering Graduate Research Symposium was held on March 30, 2017 and featured research posters and presentations from MSU Engineering graduate students. It was an opportunity for faculty, students, alumni and industry professionals to explore connections between research and practice. The Symposium was free and open to the public. All the center students participated at this event with a poster presentation on their research findings.

### **4. Winter Research for Undergraduates and Under-represented Students**

#### **Program Description:**

The CHPP affiliates at the University of Texas at Austin in partnership with another Tier 1 UTC Center, D-STOP, organized a 4-week winter internship program for promoting graduate studies in Highway and Transportation Engineering. During this program undergraduate students were invited to participate in the various center activities. The winter program is open only to local students while the summer program is open to any US student that qualifies. During the program students get involved in current research projects, field and laboratory experiments, data processing and analysis and they present their findings during their last week of the internship.

### **5. Education and Training at the Undergraduate and Graduate Levels**

#### **Program Description:**

Students are introduced to the concepts of sustainability i.e., preserving natural resources, managing a network of pavements within fiscal constraints, and reducing greenhouse emissions. The research findings are disseminated through regular department seminars during each semester, publication in scientific journals, presentations, and mini-symposia at major conferences. Table 2 lists the names of the undergraduate and graduate students and their corresponding advisor involved in the CHPP related research projects.



**Table 2 Students Involved in CHPP-related Research**

<b>Student Name</b>	<b>Level</b>	<b>Hosting Institutions</b>	<b>Advisor</b>
Haibin Yu	Undergraduate	Michigan State University	Syed W. Haider
Sebastián Muñiz	Undergraduate	Michigan State University	Syed W. Haider
Xiaoyu Chen	Undergraduate	Michigan State University	Syed W. Haider
Pranav Shah	Undergraduate	Michigan State University	Syed W. Haider
John Gondek	Undergraduate	Michigan State University	Syed W. Haider
Derek Hibner	Undergraduate	Michigan State University	M. Emin Kutay
Eric Kastellic	Undergraduate	Michigan State University	M. Emin Kutay
Anne Heidelberg	Undergraduate	Michigan State University	M. Emin Kutay
Sahira Melo	Undergraduate	Michigan State University	Nizar Lajnef
Jared Linze	Undergraduate	Southern Illinois University	Karim Chatti & Imen Zaabar
Asha Patel	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Lance Rothlanc	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Miguel Labrador	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Briana Wendland	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Mponyana Mayangamutse	Undergraduate	Michigan State University	Imen Zaabar, Nizar Lajnef & Karim Chatti
Charlotte Fung	Undergraduate	Michigan State University	Imen Zaabar & Karim Chatti
Bonni Saust	Undergraduate	University of Hawaii at Manoa	Adrian Ricardo Archilla
Ryan Yeargin	Undergraduate	North Carolina A&T State University	Ellie Finie
Taylor Hawkins	Undergraduate	North Carolina A&T State University	Taher Abu-Lebdeh
Acacia Hines	Undergraduate	North Carolina A&T State University	Taher Abu-Lebdeh
Daniel Folley	Undergraduate	North Carolina A&T State University	Taher Abu-Lebdeh
Joshua Caleb Tilley	Undergraduate	North Carolina A&T State University	Taher Abu-Lebdeh
Grant Gorman	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Michael Blake	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Andres Sanchez	Undergraduate	University of Texas at Austin	Jorge Prozzi
Seth Haber	Undergraduate	University of Texas at Austin	R. Longoria
Michael Blake	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Armando Maldonado	Undergraduate	University of Texas at Austin	Jorge Prozzi
Luis Arruti	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Emily Bassel	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Hansel Beckmann	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Gus Boehme	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Andres Sanchez	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Abigail Thompson	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Sena Esrefoglu,	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Jacob Watts	Undergraduate	University of Texas at Austin	Jorge Prozzi & Andre de Fortier Smit
Tom Van Deusen	Undergraduate	University of Minnesota	Lev Khazanovich
Dennis Melamed	Undergraduate	University of Minnesota	Lev Khazanovich
Juan Pablo Mendéz Ruiz	Undergraduate	University of Illinois at Urbana-Champaign	Jeffery Roesler
Ronell Joseph Eisma	M.S.	Michigan State University	Karim Chatti, Syed Haider & Imen Zaabar
Muhammad Masum	M.S.	Michigan State University	Syed Haider
Shardula Gawankar	M.S.	Michigan State University	Imen Zaabar, Nizar Lajnef & Karim Chatti
Ugurcan Ozdemir	M.S.	Michigan State University	M. Emin Kutay
Saeed Yadolahi	M.S.	Michigan State University	Nizar Lajnef
Nagesh Ananthakrishna	M.S.	Michigan State University	Nizar Lajnef
Grant Karr	M.S.	University of Hawaii at Manoa	Adrian Ricardo Archilla
Ahmed Lamarre	M.S.	North Carolina A&T State University	Ellie Finie
Yillian Rivera	M.S.	North Carolina A&T State University	Ellie Finie
Mehdi Zadshi	M.S.	North Carolina A&T State University	Albert Hung
Dometrious Gordine	M.S.	North Carolina A&T State University	Ellie Finie
Felix Smith Buabeng	M.S.	North Carolina A&T State University	Sassan Aflaki
Daniel Oldham	M.S.	North Carolina A&T State University	Ellie Finie
Shahrazad Hosseinneshad	M.S.	North Carolina A&T State University	Ellie Finie
Kuan-Yu Chen	M.S.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Natalia Zuniga	M.S.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Franco Di Biase	M.S.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
John Kulikowski	M.S.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi & Hasan Ozer
Daniel King	M.S.	University of Illinois at Urbana-Champaign	Jeffery Roesler
Aniruddha Baral	M.S.	University of Illinois at Urbana-Champaign	Jeffery Roesler



**Table 2 Students Involved in CHPP-related Research (Continued)**

Katelyn Freeseaman	M.S.	University of Minnesota	Lev Khazanovich
Aziz Assodollahi	M.S.	University of Minnesota	Lev Khazanovich
Abbas Booshehrian	M.S.	University of Minnesota	Lev Khazanovich
Dean Mikulik	M.S.	University of Minnesota	Lev Khazanovich
Shabnam Rajaei	Ph.D.	Michigan State University	Karim Chatti & Roozbeh Dargazany
Danilo Balzarini	Ph.D.	Michigan State University	Karim Chatti & Imen Zaabar
Amir Alavi	Ph.D.	Michigan State University	Nizar Lajnef & Karim Chatti
Hassene Hasni	Ph.D.	Michigan State University	Nizar Lajnef & Karim Chatti
Yogesh Shamsunder Kumbarger	Ph.D.	Michigan State University	M. Emin Kutay
Aksel Seittlari	Ph.D.	Michigan State University	M. Emin Kutay
Jose Corrales-Azofeifa	Ph.D.	University of Hawaii at Manoa	Adrian Ricardo Archilla
Mohammadreza Hashemi	Ph.D.	University of Hawaii at Manoa	Adrian Ricardo Archilla
Alireza Samieadel	Ph.D.	North Carolina A&T State University	Ellie Finie
Abdou Salami Yaya	Ph.D.	North Carolina A&T State University	Ellie Finie
Pedro Serigos	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Sareh Kouchaki	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Moo-Yeon Kim	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Prasad Buddhavarapu	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Heena Dhasmana	Ph.D.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi
Punit Singhvi	Ph.D.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi & Hasan Ozer
Ibrahim Abuawad	Ph.D.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi
Sushobhan Sen	Ph.D.	University of Illinois at Urbana-Champaign	Jeffery Roesler
Lucio Salles	Ph.D.	University of Sao Paulo	Lev Khazanovich

## **Professional Development Activities, Conferences, and Workshops**

### **1. Poster Session at the National Pavement Preservation Conference in Nashville, TN**

#### **Program Description:**

The National Pavement Preservation Conference is designed to provide an extensive presentation of the latest practices and developments in the pavement preservation field. It also provides an excellent forum to establish new contacts within the pavement preservation community and strengthen existing ones. Concurrent presentation sessions were scheduled throughout the conference along four technical tracks. Each of the tracks offered an opportunity to hear from experts in the pavement preservation field on topics of national importance. Live demonstrations were also scheduled where industry representatives applied preservation treatments and showcased pavement repair techniques. The program was formed to provide resources that support the adoption of preservation treatments, disseminate information about emerging technologies and best practices, and foster information exchange between agencies, contractors, suppliers, manufacturers, consultants, and academics. Since the conference is one of the largest events in the pavement preservation area, the CHPP researchers participated to showcase the practical findings of their research in a poster session. The following poster presentations were showcased by the CHPP researchers from the different consortium partners:

1. *Developing a Test Method to Investigate Water Susceptibility of Joint and Crack Sealants*, Elham Fini, North Carolina A&T State University.
2. *Mechanistic Characterization for Thin Asphalt Overlays for Pavement Preservation using Finite Element Modeling Approach*, Heena Dhasmana, Jaime A. Hernandez, Hasan Ozer, and Imad Al-Qadi, University of Illinois, Urbana- Champaign.
3. *Performance Evaluation and Environmental Assessment of Hot In-place Recycled Asphalt Pavement*, Imad Al-Qadi, Hasan Ozer and Punit Singhvi, University of Illinois, Urbana- Champaign.
4. *Nondestructive Detection of Surface Damage in Concrete Pavements*, Katelyn Freeseaman, Kyle Hoegh, and Lev Khazanovich, University of Minnesota.



5. *Incorporating Micro-texture to Estimate Pavement Friction*, Jorge Prozzi, University of Texas, Austin.
6. *Field performance of surface treatments using survival analysis*, Jorge Prozzi, University of Texas, Austin.
7. *Image Processing Techniques for Determination of Aggregate Embedment Depth in Chip Seals*, Ugurcan Ozdemir, Derek Hibner, M. Emin Kutay and Michele A. Lanotte, Michigan State University.
8. *Guidelines for Developing Performance-related Specifications for Rigid Pavement Preservation Treatments*, Syed W. Haider, Karim Chatti, Gopikrishna Musunuru and Ronell J. Eisma, Michigan State University.

## Results Dissemination and Methods

All CHPP activities are in the implementation or planning phase for the next performance period. Electronic distribution, social media, and professional meetings have been the primary means for dissemination. PowerPoint presentations have also been given. The CHPP member universities also supported student and faculty travel to academic and professional meetings to promote and discuss the goals, objectives and research themes of the Center. Table 3 lists CHPP attendees of professional development opportunities pursued by faculty and staff over the reporting period.

Dr. Karim Chatti (MSU), CHPP Director, gave a one-hour presentation entitled “Towards a More Mechanistic Approach to Pavement Preservation” to a group of MSU alumni on October 31, 2016, as part of the “Coffee with the Profs” series, which is one of the MSU Alumni Association’s long-standing featured offerings, that highlights research and work done by some of the university’s finest faculty and staff. The lecture was followed by a 30-minute Q&A session. About 30 alumni attended the event. The lecture and Q&A session were also livestreamed.

(<https://alumni.msu.edu/learn/online/livestream-and-video-content/video-content-details.cfm?id=9>).

Dr. M. Emin Kutay (MSU), who is one of the center faculty, made an invited presentation at the Association of Modified Asphalt Producers (AMAP), St Petersburg, FL. showcasing the results of the CHPP project.

Dr. Lev Khazanovich (UMN), who is one of the center faculty, was invited to conduct two short courses entitled “Pavement design theory” and “Innovative pavement design” at Vilnius Gediminas Technical University (VGTU), Vilnius, Lithuania October 17- October 28, 2016.

## Planned Activities for Next Reporting Period

There will be no change in the agency-approved application for this effort. Implementation of the activities in Table 1 above for all research, education, workforce development, and technology transfer projects will continue on schedule. A brief summary of new activities planned for next reporting period is provided below.

### K-12 Outreach

#### 1. University of Hawaii at Manoa, Manoa Experience

##### Program Description

On April 11, 2017, a large group of 500 to 700 students will visit the College of Engineering and participate in a half-day event filled with engineering exhibits, games, and competitions. The Pavement Engineering Laboratory at UH Manoa will be open to the attendees. The research activities related to pavement preservation as part of CHPP’s outreach activities will be part of the program.

#### 2. Engineering Day at UH Manoa

##### Program Description

During the Engineering Day, the Pavement Engineering Laboratory at UH Manoa will be open to the prospective and current undergraduate students on April 15, 2017. The research activities related to pavement preservation as part of CHPP’s outreach events will be part of the program. During this event, CHPP will collaborate with different student organizations such as AISES (American Indian Science and Engineering Society), ASCE (American Society of Civil Engineers), ECUH (Engineer's Council at the University of





Hawaii), HKN (Eta Kappa Nu), IEEE (Institute of Electrical and Electronics Engineers) and SWE (The Society of Women Engineers).

**Table 3 List of Professional and Academic Meeting Attendees**

Name	Destination	Conference Name	Dates	University
Karim Chatti	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Karim Chatti	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 7-8, 2017	Michigan State University
Syed W. Haider	Nashville, TN	National Pavement Preservation Conference (NPPC)	October 11-14, 2016	Michigan State University
Syed W. Haider	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Imen Zaabar	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Imen Zaabar	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 7-8, 2017	Michigan State University
M. Emin Kutay	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
M. Emin Kutay	Nashville, TN	NPPC	October 11-14, 2016	Michigan State University
Larry Galehouse	Nashville, TN	NPPC	October 11-14, 2016	Michigan State University
Larry Galehouse	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Neal Galehouse	Nashville, TN	NPPC	October 11-14, 2016	Michigan State University
Neal Galehouse	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Neal Galehouse	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 7-8, 2017	Michigan State University
Patte Hahn	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Patte Hahn	Nashville, TN	NPPC	October 11-14, 2016	Michigan State University
Danilo Balzarini	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Shabnam Rajaei	Washington D.C.	TRB	January 8-12, 2017	Michigan State University
Jorge Prozzi	Washington D.C.	TRB	January 8-12, 2017	University of Texas at Austin
Jorge Prozzi	Nashville, TN	NPPC	October 11-14, 2016	University of Texas at Austin
Jorge Prozzi	San Diego, California,	28th Annual Road Profile Users' Group Meeting	November 1-4, 2016	University of Texas at Austin
Pedro Serigos,	Washington D.C.	TRB	January 8-12, 2017	University of Texas at Austin
Natalia Zuniga,	Washington D.C.	TRB	January 8-12, 2017	University of Texas at Austin
Wilfrido Martinez,	Washington D.C.	TRB	January 8-12, 2017	University of Texas at Austin
Sareh Kouchaki	Washington D.C.	TRB	January 8-12, 2017	University of Texas at Austin
Ellie Finie	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Sassan Aflaki	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Ahmed Lamarre	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Ryan Yeargin	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Shahrazad Hosseinneshad	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Alireza Samieadel	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Yillian Rivera	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Daniel Oldham	Washington D.C.	TRB	January 8-12, 2017	North Carolina A&T
Adrian Ricardo Archilla	Washington D.C.	TRB	January 8-12, 2017	University of Hawaii at Manoa
Adrian Ricardo Archilla	Patagonia, Argentina	CILA	November 16-20, 2016	University of Hawaii at Manoa
Hasan Ozer	Washington D.C.	TRB	January 8-12, 2017	UIUC
Imad Al-Qadi	Washington D.C.	TRB	January 8-12, 2017	UIUC
Punit Singhvi	Washington D.C.	TRB	January 8-12, 2017	UIUC
Rebekah Yang,	Washington D.C.	TRB	January 8-12, 2017	UIUC
Heena Dhasmana	Washington D.C.	TRB	January 8-12, 2017	UIUC
Jeffery Roesler	Washington D.C.	TRB	January 8-12, 2017	UIUC
Daniel King	Washington D.C.	TRB	January 8-12, 2017	UIUC
Sushobhan Sen	Washington D.C.	TRB	January 8-12, 2017	UIUC
Lev Khazanovich	Washington D.C.	TRB	January 8-12, 2017	University of Minnesota
Katelyn Freeseaman	Washington D.C.	TRB	January 8-12, 2017	University of Minnesota
Dean Mikulik	Washington D.C.	TRB	January 8-12, 2017	University of Minnesota
Lucio Salles	Washington D.C.	TRB	January 8-12, 2017	University of Minnesota
Lauren Linderman	Minneapolis, Minnesota	CTS Infrastructure Research Council – Annual Meeting	December 6, 2016 February 15, 2017	University of Minnesota

#### 4. Summer Internship Program for High School Students at UH Manoa

##### Program Description

The UH Pavement Laboratory will host a high school student during the Summer Internship Program. This is a highly competitive six-week program that allows high school juniors (heading into their senior year) to have hands-on experience in the College of Engineering research laboratories. Along the way, interns also will participate in group activities and a field trip to local engineering companies. At the end of the program, they will present about their learning experience. Table 4 lists the names of the students and their faculty advisors from the center.

**Table 4 High School Students Involved in CHPP-related Research**

Student Name	Level	Hosting Institutions	Advisor
Matthew Watanabe	High School - Maryknoll School	University of Hawaii at Manoa	Adrian Ricardo Archilla & Jose Corrales

#### 5. Research Experiences for Teachers (RET) at MSU

##### Program Description:

Through the partnership with schools in Lansing, Detroit, and Grand Rapids, and in cooperation with the all-girls Regina High School, the program will recruit teachers from schools in Mid- and Southeast regions in the State of Michigan, especially with a focus on those serving socioeconomically challenged populations and students from groups traditionally under-represented in science and engineering. Teachers will attend a 6-week summer institute, to participate in cutting-edge research on transportation-related areas, with mentoring from engineering faculty at CHPP. Working with PIs, faculty mentors and a curriculum development specialist, teachers will develop innovative, standards-compliant curriculum modules and will participate in a number of professional development activities. This activity will enrich the professional development of a number of future leaders in STEM education, about half being females with a similar ratio for minorities.

#### 6. Girls Summer Camp at MSU

##### Program Description:

One session for high school girls will be conducted at MSU on July 17-20, 2017 in collaboration with the MSU Women In Engineering (WIE). The session will involve about twenty-five (25) national and international High school girl students. The program will be designed to expose 9-12th grade girls to engineering. During the session, the students will make "chocolate asphalt cookies" as a lesson in civil engineering. This unique and fun hands-on activity parallels the procedures used to produce asphalt pavement while introducing students to basic engineering principles. The process of making these cookies parallels the procedures used to produce asphalt pavements. The similarities between making cookies and preparing pavement include using a hot liquid added to a variety of dry ingredients and mixed together, which when cooled hardens and gains strength.

#### 7. MSU High School Engineering Institute (HSI)

##### Program Description:

Sessions for HSI will be conducted at MSU. Each session will involve about forty-three (43) national and international high school students. The program will be designed to give in-depth experiences in civil engineering majors. Students will spend a half day with an engineering faculty member, graduate and undergraduate students, and participate in short lectures, demonstrations, hands-on experiments, and team-based problem solving. The class lectures will emphasize social and environmental relevance of basic science and engineering subject matter. Emphasizing the strong societal impact and creation of multi-disciplinary teams is crucial to attract female and under-represented minorities to the STEM field.

#### 8. Metro Detroit Youth Day with a Transportation and Pavement Theme

##### Program Description

The [Metro Detroit Youth Day](#), the largest youth event in the State of Michigan, was formulated to bring together Metro Detroit area youth from all walks of life for a day of sports, fun, and constructive activities. On July 12, 2017, the CHPP will showcase not only transportation and pavement-related research but also all



aspects of the STEM field (e.g., Science, physics and mathematics). The activities will introduce approximately 34,000 children to innovative and inspiring engineering designs and projects through hands-on experiments. CHPP will collaborate with STEM teachers during the event. The teachers' institutions are: Robotics Engineering for Better Life and Sustainable Future Math and Science Center at MSU, Cass Tech High School, East Lansing McDonald Middle, Haslett Middle School, Kalamazoo Area Math and Science Center, Pershing High School, and Regina High School.

## **Undergraduate / Graduate Outreach**

### **1. Summer Research for Undergraduates and Under-represented Students**

#### **Program Description:**

CHPP offers summer research opportunities for high-achieving undergraduates. The objective of this multi-disciplinary program is to attract young talent to increase the quality, number, and diversity of professionals entering the transportation sector. The program will offer the selected undergraduate students the opportunity to gain firsthand experience in conducting highway and transportation research and actively participate in transportation related studies under the supervision of CHPP faculty members.

## **Results Dissemination and Methods**

Electronic distribution and social media will primarily be utilized for dissemination of CHPP activities. PowerPoint presentations will also be given. The CHPP member universities will support students and faculty travel to professional meetings, which attract transportation professionals from across the country to promote and discuss the goals, objectives and research themes of the Center. Table 5 lists CHPP attendees of the upcoming professional development opportunities planned by staff and faculty during the next reporting period.

**Table 5 List of Planned Professional and Academic Meeting Attendees**

<b>Name</b>	<b>Destination</b>	<b>Conference Name</b>	<b>Dates</b>	<b>University</b>
Karim Chatti	Athens, Greece	International Conference on the Bearing Capacity of Roads, Railways and Airfields	June 28-30, 2017	Michigan State University
Karim Chatti	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University
Karim Chatti	Buffalo, NY	CUTC Annual Summer Meeting	June 19-21, 2017	Michigan State University
Syed W. Haider	Baveno, Italy	World Conference on Pavement and Asset Management	June 12-16, 2017	Michigan State University
Syed W. Haider	Philadelphia, PA	International Conference On Highway Pavements & Airfield Technology (&DI)	August 27-30, 2017	Michigan State University
Imen Zaabar	Baveno, Italy	World Conference on Pavement and Asset Management	June 12-16, 2017	Michigan State University
Danilo Balzarini	Baveno, Italy	World Conference on Pavement and Asset Management	June 12-16, 2017	Michigan State University
Hasan Ozer	Athens, Greece	International Conference on the Bearing Capacity of Roads, Railways and Airfields	June 28-30, 2017	UIUC
Hasan Ozer	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University
Imad Al-Qadi	Athens, Greece	International Conference on the Bearing Capacity of Roads, Railways and Airfields	June 28-30, 2017	UIUC
Imad Al-Qadi	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University
Punit Singhvi	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University
Daniel King	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University
Sushobhan Sen	Champaign, IL	Pavement LCA Symposium	April 11-13, 2017	Michigan State University



## 2. Products

### Publications, Conference Papers, and Presentations

During this reporting period, CHPP researchers prepared and produced several conference and journal papers based on the research being conducted as part of the center. In addition, presentations were also made at various appropriate venues and meetings. The following is a list of publications and presentations related to different CHPP research projects.

1. Zadshir, M., D. Oldham, Sh. Hosseinnzhad, E. Fini, “Investigation of Efficacy of Asphalt Rejuvenation Using Biobased Additives,” Transportation Research Board, January, 8-12, 2017, Washington D.C., paper #17-06415
2. Samiadel, Alireza, D. Oldham, E. Fini, “Multiscale Characterization of Wax-Doped Asphalt Binder”, Transportation Research Board, January, 8-12, 2017, Washington D.C., paper # 17-05898
3. Ozdemir, U., Hibner, D., Kutay, M. E., and Lanotte, M. (2017-accepted) “Image Processing Techniques For Determination of Aggregate Embedment Depth in Chip Seals”, the 96th Transportation Research Board Annual Meeting, January 8-12, 2017, Washington, D.C.
4. Syed W. Haider, Gopikrishna Musunuru, and Karim Chatti, “Effect of Lot and Sublot Sizes on PWL based on IRI as the Acceptance Quality Characteristic”. The 96th TRB Annual Meeting, January 8-12, 2017, Washington, D.C.
5. Syed W. Haider, Karim Chatti, Gopikrishna Musunuru, and Ronell J. Eisma, “Guidelines for Developing PRS for Rigid Pavement Preservation Treatments — Diamond Grinding”, the 96th TRB Annual Meeting, January 8-12, 2017, Washington, D.C.
6. Syed W. Haider, Karim Chatti, Gopikrishna Musunuru, and Ronell J. Eisma, “Guidelines for Developing PRS for Flexible Pavement Preservation Treatments — Micro-surfacing”, the 96th TRB Annual Meeting, January 8-12, 2017, Washington, D.C.
7. Syed W. Haider, Gopikrishna Musunuru, and Karim Chatti, “Impact of Lot and Sublot Sizes on IRI-based Percent within Limit”, paper submitted in the Canadian Journal of Civil Engineering (CJCE), December 2016.
8. E. Coleri, J. Harvey, I. Zaabar, K. Chatti, L. Arghavan, “Model Development, Field Section Characterization, and Model Comparison for Excess Vehicle Fuel Use Attributed to Pavement Structural Response”. Transportation Research Record: Journal of the Transportation Research Board. No. 2589. pp. 40-50. (2016).
9. D. Balzarini, I. Zaabar and K. Chatti, “Impact Of Concrete Pavement Structural Response On Rolling Resistance And Vehicle Fuel Economy”, Proceedings of the TRB 96th Annual Meeting, TRB, January 2017(In-Press).
10. P. Singhvi, H. Ozer, and I. Al-Qadi, “Field Performance and Laboratory Characterization of Hot In-Place Recycled Materials and Treatments”, Proceedings of the TRB 96th Annual Meeting, TRB, January 2017.
11. Sushobhan Sen, and Jeffery Roesler (2017). “Microscale heat island characterization of rigid pavements”. TRR. In Press.
12. Sushobhan Sen, Aniruddha Baral, and Jeffery Roesler (2017). “Use-phase sustainability through preservation”. 10th International Conference on Road and Airfield Pavement Technology, Hong Kong. In Press.
13. Sushobhan Sen, and Jeffery Roesler (2017). “An uncoupled pavement-urban canyon model for heat islands”. International Symposium on Pavement Life Cycle Assessment, Champaign, IL. In Press.
14. Daniel King (2016). *Surface and microstructural properties of photocatalytic cements for pavement applications*. University of Illinois at Urbana-Champaign, Urbana, IL, Master’s Thesis.
15. Sushobhan Sen (2015). *Impact of pavements on the urban heat island*. University of Illinois at Urbana-Champaign, Urbana, IL, Master’s Thesis.
16. Sushobhan Sen, Juan Pablo Ricardo Mendez Ruiz Fernandez, and Jeffery Roesler (2016). “Pavement Albedo Distribution: Impact on Microscale Heat Island Modeling”. Presented at the TRB Annual Meeting, 2017.
17. Serigos, P. and J. A. Prozzi, “Performance of Preventive Maintenance Treatment in Texas”, Civil Engineering Conference in the Asian Region CECAR7, Honolulu, Hawaii, August 30-September 2, 2016.



18. Zuniga-Garcia, N. and J. A. Prozzi, "Incorporating Micro-Texture to Estimate Pavement Friction", 2016 National Pavement Preservation Conference, Nashville, Tennessee, October 11-14, 2016.
19. Serigos, P. and J. A. Prozzi, "Field Performance of Surface Treatments Using Survival Analysis", 2016 National Pavement Preservation Conference, Nashville, Tennessee, October 11-14, 2016.
20. Martinez, W., N. Zuniga-Garcia, A. Smit and J. A. Prozzi, "Life-Cycle Cost Analysis of Pavement Preservation Techniques in Texas", 96th Annual Meeting of the TRB, Washington, DC, January 8-12, 2017.
21. Kouchaki, S., A. Smit and J. A. Prozzi, "Assessment of Using Inertial Profilers to Measure Ride Quality on Short Projects", 96th Annual Meeting of the Transportation Research Board, Washington, DC, January 8-12, 2017.
22. Freeseaman, K., K. Hoegh, B. Izevbekhai, and L. Khazanovich, "Effect of Early Age Loading on Concrete Ultimate Strength". 96th Annual Meeting of the Transportation Research Board, Washington, DC, January 8-12, 2017.
23. De Salles, L., R. Conway, L. Khazanovich, R. Barnes, K. Hoegh, D. Pereira, and T. Burnham, "Portland Cement Concrete Pavement Thickness and Shear Wave Velocity Variation Versus Observed Pavement Distresses."
24. Tompkins, D., L. Khazanovich, D. Mikulik, S. Dai, K. Hoegh, T. Yu, "Agency Experience Using 3-D Ground-Penetrating Radar for Pavement Evaluation."
25. Tompkins, D., D. Franta, L. Khazanovich, K. Hoegh, "Investigation of Slab Curvature in LTPP SPS-2 Experiment Using Empirical Mode Decomposition of Pavement Profilometer Data."
26. Izevbekhai, B., L. Khazanovich, V. Voller, "Deployment of Next-Generation Concrete Surface in Minnesota."
27. Short course by Prof. Khazanovich " Pavement design theory " at Vilnius Gediminas Technical University (VGTU), Vilnius, Lithuania October 17- October 28, 2016.
28. Short course by Prof. Khazanovich " Innovative pavement design " at Vilnius Gediminas Technical University (VGTU), Vilnius, Lithuania October 25, 2016.

## Website or Other Internet Site

The CHPP's website can be accessed at [www.chpp.egr.msu.edu](http://www.chpp.egr.msu.edu). By capitalizing upon the knowledge acquired over the past two years, we are able to make our homepage engaging, relevant, and resourceful for our viewers by posting courses, presentations and reports on the website.

## Technologies or Techniques

All current research and workforce development activities are being implemented. Under the UTC Program grant, the University of Texas has developed a system and methodology to measure and quantify micro- and macro-texture. This development may be conducive to the application of a patent. This project was a twining project with a similar project sponsored by the Texas Department of Transportation (TxDOT) on monitoring and measuring micro- and macro-texture, noise and skid resistance in the field. While the UTC project focused on developing methodology, the TxDOT project focused on applying the developed methodologies in the field. TxDOT has also created the Center for Accelerating Innovation in Partnered Pavement Preservation to support UT Austin participation in the CHPP Center.

## Inventions, Patent Applications, and / or Licenses

All current research and workforce development activities are being implemented.

## Other Products

### Research Projects

A total of thirteen (13) research ideas were selected in cycles 1 and 2. All the cycles 1 and 2 projects are completed and are in the final stages for publishing. Table 6 shows progress of the research projects until the end of the reporting period. In addition, the completed final reports were uploaded on the required databases. The cycle 3 projects were finalized and awarded during the reporting period after a rigorous technical review of the proposals. The key criteria for review





included: (a) relevance of proposed project to the theme of the center, (b) feasibility i.e., accomplishment of the objectives within the given resources, (c) technical quality of the idea, (d) innovation, and (e) potential impact of research findings. During the project identification and selection process, emphasis was given to a balanced portfolio for the research topics. Table 7 shows the progress of cycle 3 research projects. The split between advanced and applied research projects is about 50% (advanced=5, applied=5). Summary of findings from a sample of completed projects are highlighted below.

**Table 6 CHPP Research Projects and Assignments**

No.	University	Project Title	PI/Assignment	Research Category	Progress
1	MSU	Feasibility of Early Damage Detection Using Surface Mounted Sensors on Existing Pavements	Lajnef/Chatti (MSU)	Advanced	98%
2	MSU	Pavement Surface Characterization for Optimization of Trade-off between Grip and Rolling Resistance	Dargazany/Chatti (MSU)	Advanced	100%
3	MSU	Development of an Acceptance Test for Chip Seal Projects	Kutay (MSU)	Applied	100%
4	UIUC	Environmental and Functional Benefits and Trade-offs of Hot In-Place Recycling Treatment Techniques	Al-Qadi (UIUC)	Applied	100%
5	UIUC	Mechanistic Characterization of Thin Asphalt Overlays for Pavement Preservation using Finite Element Modelling Approach	Al-Qadi (UIUC)	Advanced	100%
6	UIUC	Multi-Functional Concrete Pavement Inlays	Roesler (UIUC)	Advanced	100%
7	UTA	Designing Quieter Pavement Surfaces	Prozzi (UTA)	Applied	98%
8	UTA	Determination of Field Performance of Thin Overlays Relative to Alternative Preservation Techniques	Prozzi (UTA)	Applied	98%
9	UTA	Evaluation of Pavement Surface Micro- and Macro-Texture	Prozzi (UTA)	Advanced	100%
10	UTA	Quantification of Surface Micro- and Macro-Texture	Prozzi (UTA)	Applied	95%
11	UMn	Development of Objective Methods for Determining Damage Accumulation in Pavements Prior to Visual Distress Becoming Apparent	Khazanovich (UMn)	Advanced	100%
12	NCA&TSU	Developing a Test Method to Investigate Water Susceptibility of Joint and Crack Sealants	Fini (NCA&T)	Advanced	100%
13	UH	Performance Monitoring of Preservation Treatments in Honolulu	Archilla (UH)	Applied	98%

*A Mechanistic-Empirical Approach for Evaluating the Effect of Diamond Grinding and Thin Overlay on Predicted Pavement Performance*

Advancements in pavement management practice require evaluating the performance of pavement preservation treatments using performance-related characteristics. However, state highway agencies face the challenge of developing performance-based relationships between quality characteristics of pavement preservation treatments and expected pavement performance. The objective of this study is to develop and evaluate a mechanistic-empirical procedure which can be used to relate the performance of surface smoothing pavement preservation treatments to a roughness-related, profile-based index. The profiles for pavement sections treated with diamond grinding and thin overlay treatments were obtained and the impact of these treatments on roughness was evaluated using the International Roughness Index (IRI) and the Dynamic Load Index (DLI). The effects of these treatments on the pavement profile, the dynamic loads experienced by the pavement, and predicted pavement performance were also observed. Using the proposed mechanistic-empirical procedure, the results of this study demonstrate that it is possible to relate changes in IRI and DLI, as a result of surface smoothing treatments, to the expected pavement performance. The performance-based relationships obtained from this procedure can be used in the development of performance-related specifications.

**Table 7 Projects selected for cycle 3**

No	University	Project Title	PI/Assignment	Research Category	Progress
1	MSU	Incorporation of Pavement Preservation Treatments in Pavement-ME Analysis and Design	Haider/Chatti	Applied	25 %
2	MSU	Investigation of the Relationship between Fuel Consumption, Dynamic Load, and Roughness of Pavement Preservation Treatments	Zaabar/Chatti	Advanced	25 %
3	MSU	Estimation of the Rolling Resistance performance of a pavement in view of the roughness profile	Dargazany/Chatti	Advanced	25 %
4	MSU	Remote Detection and Characterization of Field Aging of Asphalt Pavements	Lajnef/Chatti	Advanced	25 %
5	UIUC	Development of a Preservation Sustainability Framework and Tool	Al-Qadi	Applied	25 %
6	UMN	Development of a Low-Cost Conductive Measurement Technique to Augment Objective Methods for Damage Detection in Concrete Pavements	Linderman/Khazanovich	Advanced	25 %
7	NCA&T	Investigating Merits of Bio-Rejuvenation to Extend Pavement Service Life	Fini	Advanced	25 %
8	UH	Quantifying Friction and Texture of Pavement Preservation Treatments in Honolulu	Archilla	Applied	25 %
9	UTA	Optimizing the Relationship between Friction and Noise of Preservation Treatments	Prozzi	Applied	25 %
10	UTA	Segmentation of Highway Networks for Maintenance Operations	Prozzi	Applied	25 %

#### *Pavement Surface Characterization for Optimization of Tradeoff between Grip and Rolling Resistance*

Understanding the contact deformation behavior between pavement and tires within the contact patch is of great significance in revealing the mechanism of rolling resistance, grip and sound analysis. The concepts and mechanisms behind pavement friction are quite involved and not easily understood. Moreover, because there are many factors that affect friction, it is more of a process than an inherent characteristic of the pavement. A brief literature survey on methods of pavement surface characterization, friction, and rolling resistance prediction are presented. The surface texture is then characterized by different means, e.g. statistical parameters and fractal techniques. It has been found that statistical parameters are scale dependent and they change by sample size. Therefore, fractal techniques is a better way for surface representation. A surface is then generated successfully using Fourier transform. Focusing on effect of surface micro-texture on tread rubber energy loss, a finite element model is generated using commercial software ABAQUS. Common assumptions and finding of contact mechanics models are then validated and the energy loss due to predefined surfaces are calculated. In addition, a UMAT subroutine code has been prepared for characterizing the rubber material properties.

#### *Performance Modelling of Preventive Maintenance Treatments for Flexible Pavements*

Highway infrastructure systems provide a crucial service to society and constitute a major asset with a significant maintenance and rehabilitation cost, highway pavements comprising a major component of the total cost. The increasing need for greater capital investment, in the face of ever-decreasing federal funding to maintain highway infrastructure, highlights the importance of developing and implementing effective methods for managing pavement assets. A key for the success of pavement management is to accurately predict the future condition of the pavements in the network. This research study proposes a mixture of regression models to capture the systematic differences in pavement performance not explained by variables typically available in pavement management systems. This approach assumes that the heterogeneous pavement performance, which results from the combined effect of the several unobserved factors and interactions, is manifested through a finite number of latent groups. The estimation of the proposed model allows for defining the parameters of the group-specific models while clustering the observations into the latent groups. The insights provided by the model-based clustering of performance data can also be incorporated into the design of maintenance and rehabilitation strategies, as clustering of sections according to their deterioration rate allows for identifying pavements in the network with structural deficiencies and tailoring actions in response. The gain in model fit, along with the insights



provided by the proposed methodology for the unsupervised model-based clustering of pavement performance was demonstrated using experimental data. In addition, the proposed mixture model was applied to develop a Bayesian pavement roughness model specified with variables from an existing pavement management system, plus climatic and preventive maintenance variables, and estimated using nationwide field data from the Long-Term Pavement Performance program.

### **3. Participants and Collaborating Organizations**

#### **Partner Organizations**

During the current reporting period, CHPP has worked with unique organizations across the United States to develop the research, education, workforce development, and technology transfer activities that are currently underway at the center. The organizations and their locations are listed in Table 8 along with information describing specific areas or capacities in which the respective organizations have committed to support the center.

#### **Collaboration among University Partners**

CHPP offered summer research opportunities for high achieving undergraduates. The intent of this program is to encourage students from all consortium partners (MSU, UT-Austin, UIUC, NCA&TSU, and UH) to: (a) pursue graduate degrees; (b) provide an early opportunity to involve in research activities. The undergraduate and graduate students are encouraged to apply for summer internships at any university from the consortium.

Also, as part of cycle 3 projects, University of Texas at Austin, University of Hawaii at Manoa, and the City of Honolulu collaborated to perform research on thin overlays as a preventive treatment measure.

UIUC and MSU are currently collaborating on a research project entitled “Development of a Preservation Sustainability Framework and Tool”. This project aims at developing a preliminary tool to perform sustainability assessment in a pavement network. The preservation sustainability assessment preliminary tool (PSAT) will have two major functions: (1) Develop a long-term preservation program for a network that may have consisted of interstate and non-interstate routes; and (2) Provide recommendations at the project level in selection of a preservation alternative.

#### **External Collaborations**

Dr. Archilla spent two months at the Laboratorio Nacional de Materiales y Modelos Estructurales (LANAMME), University of Costa Rica (UCR). During his stay at the university, he collaborated with LANAMME researchers in back-calculation analysis using non-linear finite element analysis of their HVS sections and developing a statistical model to predict dynamic moduli of HMA by combining data from Hawaii and Costa Rica, including explanatory variables such as binder type (unmodified PG64-22, and modified PG70-22 and PG76-22), gradation parameters, additives such as fibers (Hawaii) and antistripping agents (Lime and Magnabond from UCR database), effects of confinement level (Hawaii databases), air voids, and effective binder content by volume and using joint estimation.

### **4. Impact**

#### **Development of Principal Discipline(s)**

Activities conducted during the current reporting period are expected to have short- and long-term impacts on the transportation engineering discipline through better understanding of pavement preservation benefits. The results from a number of research projects are being incorporated into short courses for the public and students that will shape future knowledge of specific transportation- related technologies.



**Table 8 Organizations Involved in CHPP Activities**

<b>CHPP Program</b>	<b>Organization Name</b>	<b>City</b>	<b>State</b>	<b>Financial Support</b>	<b>In-Kind Support</b>	<b>Contribute Facilities</b>	<b>Collaborative Research</b>	<b>Personal Exchange</b>
Research	Steve Bower	Michigan DOT	MI	X	X			X
Research	Jim Moulthrop	FP2	TX		X			X
Research	Judith Corley-Lay	North Carolina DOT	NC		X			X
Research	Maureen Jensen	Minnesota DOT	MN		X			X
Research	Magdy Mikhail	Texas DOT	TX		X			X
Research	Cyndy Aylett	City and County of Honolulu	HI		X			X
Research	Alicia Pitlik	Illinois Toll way	IL		X			X
K-12	Leyf Pierce	TeachEngineering.org	VA				X	X
K-12	Okemos High School	Okemos	MI		X	X		X
K-12	MacDonald Middle school	East Lansing	MI		X	X		X
K-12	East Lansing High School	East Lansing	MI		X	X		X
K-12	Haslett High School	Haslett	MI		X	X		X
K-12	Regina High School	Warren	MI		X	X		X
K-12	Union High School	Grand Rapids	MI		X	X		X
K-12	Kaimuki High School	Honolulu	HI		X	X		X
K-12	Wilson Elementary School	Honolulu	HI		X	X		X
K-12	Stevenson Middle School	Honolulu	HI		X	X		X
K-12	Chiefess Kamakahalei Middle School	Honolulu	HI		X	X		X
K-12	Halau Ku Mana School	Honolulu	HI		X	X		X
Tech Transfer	National Center for Pavement Preservation	Okemos	MI		X	X	X	X
Summer program	Michigan State University	East Lansing	MI	X	X			
Summer program	University of Hawaii at Manoa	Manoa	HI	X	X			
K-12	North Carolina A&T	Greensboro	NC	X	X			
Tech Transfer	North Carolina DOT	Raleigh	NC		X	X		X
Education	Michael Dreznes, International Road Federation (IRF)	Washington DC	DC		X		X	X
Education	MSU student chapter of the Institute of Transportation Engineers (ITE)	East Lansing	MI		X		X	X

## Other disciplines

Four (4) of the center research projects involve other disciplines: (1) Feasibility of early damage detection using surface mounted sensors on existing pavements, (2) Development of objective methods for determining damage accumulation in pavements prior to visual distress becoming apparent, (3) Remote detection and characterization of field aging of asphalt pavement, and (4) Pavement surface characterization for optimization of trade-off between grip and rolling resistance. The first two research topics are investigating the early damage detection in concrete and asphalt pavements. This effort involves experts from electrical engineering to evaluate the abilities of nondestructive testing and structural health monitoring. The objective of the third project is to design and implement a low cost, easy to install, and implementable in the field, sensing system. The process is based on the inclusion of chemical compounds into the material that exhibit similar oxidation kinetics properties as to the used asphalt binder. The system will characterize the levels of oxidation in a particular location where the engineered compounds have been added, and will be interrogated using remote imaging analysis. This effort involves experts from chemical engineering to evaluate the abilities of nondestructive testing.

The fourth project is looking for an optimal method to characterize the pavement surface properties that yield the least rolling resistance without sacrificing grip and safety. In order to achieve these objectives, the surface profile of the pavement will be represented as a spectrum of spatial frequencies using the fractal surfaces technique. If findings are promising, this could lead to new pavement preservation treatment mix design specifications that will contribute to a better balance between safety and sustainability. This effort involves experts from mechanical engineering and material science to understand the behavior of tires in multi-scales.

## **Development of Human Resources**

Some highway agencies still continue to assign their highest priorities to reconstructing or rehabilitating their worst roads. However, this practice of “worst first” is a proven downward spiral strategy because reconstruction and rehabilitation are the most expensive ways to maintain or restore serviceability of the infrastructure. Furthermore, rarely are sufficient funding levels available to sustain such a wasteful strategy. The mission of CHPP focuses on providing a new platform for accelerating innovations in highway pavement preservation area. The center will assist in meeting the increasing demand for highway pavement preservation research and practice, and will further assist industry and highway agencies in increasing the reliability and performance of the nation’s highways. Clearly, adequate and trained human resources will remain a continuing challenge in meeting future transportation needs. Therefore, encouraging the best and brightest to pursue degrees in transportation-related engineering disciplines is a big priority for CHPP. Such actions are exemplified by the Center’s emphasis on students’ research and pre-professional involvements. The effort is thus focused on showcasing the challenges, opportunities, and, most importantly, the rewards of pursuing a college degree in a transportation-related area. Existing efforts such as the CHPP summer research program for undergraduate/graduate students, and the education and training at the undergraduate and graduate levels program, are designed to extend opportunities while enhancing interests and skills. Moreover, it is anticipated that K-12 students participating in our outreach programs will benefit significantly. The interdisciplinary lessons and activities surrounding these programs enhance students’ conceptual and practical skills related to math, science, and technology. Also, the Research Experience for Teachers (RET) program described above is expected to enrich the professional development of a number of future leaders in STEM education, about half being females with a similar ratio for minorities. It will also result in innovative curricula for science and technology courses, and increase the interest of middle and high school students in scientific inquiry, specifically related to transportation areas. Through partnerships with local schools, the program will positively influence the learning and career paths of young students, especially students from under-served districts and under-represented groups in Michigan and beyond for years to come, thus contributing to a technology-savvy workforce that is much needed for keeping the U.S. infrastructure sustainable and efficient.

## **Physical, Institutional, and Information Resources**

Nothing to report.

## **Technology Transfer**

Various technology transfer activities by the center focused on a wide spectrum of relevant audience. The knowledge of pavement preservation was transferred to young potential work force and current practitioners. It is anticipated that the trained personnel will better understand the benefits and sustainability aspects of pavement preservation and will assist in bringing the gap between preservation practices and implementation of such choices in the field.

## **Society beyond Science and Technology**

The national need to protect the massive national highway infrastructure investment is recognized by Congress and clearly cited in “Moving Ahead for Progress in the 21st Century Act” or the “MAP-21”. The establishment of CHPP is consistent with the U.S. Secretary of Transportation’s strategic goal of “State of Good Repair”. The mission of CHPP seeks to provide a new platform for accelerating innovation in highway pavement preservation. The center will assist in meeting the increasing demand for highway pavement preservation research and will further the goal of increasing the



reliability and performance of the nation's highways. In addition, the research targeted by CHPP provides an ideal platform to emphasize social and environmental relevance of basic science and engineering subject matter. It is known that minorities and women have a lower representation in the science and engineering programs of universities. Several reasons suggested for this disconnect are lack of knowledge and emphasis on the societal value and relevance of science, mathematics and engineering subject matters as well as the lack of multi-disciplinary project teams. The lack of a connection between subject material and life applicability has been shown to affect the retention of women in engineering. The strong societal impact and creation of multi-disciplinary teams will be crucial to attract female and under-represented minorities for the graduate and undergraduate student positions supported by this research. CHPP is reaching out to high school students, females and minorities in particular, mainly through summer camps and open house activities, as described above, and will continue to do so in the future.

## **5. Changes/Problems**

Nothing to Report.

