Program Progress Performance Report for University Transportation Centers

Submitted to: Office of the Assistant Secretary for Research and Technology U.S. Department of Transportation 1200 New Jersey Avenue, SE Washington, DC 20590

Project Title: Tier 1 University Transportation Center for Environmentally Sustainable Transportation in Cold Climates (CESTiCC)

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Reporting Period End Date: September 30, 2016

Report Term: Semi-annual PPPR #6

Signature: [Signature]
Abbreviations

- ACI – American Concrete Institute
- AKDOTPF – Alaska Department of Transportation and Public Facilities
- ASCE – American Society of Civil Engineers
- ASOCRETO – Asociacion Colombiana de Productores de Concreto (Columbian Association of Concrete Producers)
- ATTAP – Alaska Tribal Technical Assistance Program
- CEM – College of Engineering and Mines
- CRS – Central Recycling Services
- EPA – Environmental Protection Agency
- ISO – International Standards Organization
- LCA – Life Cycle Assessment
- MDOT – Montana Department of Transportation
- MnDOT – Minnesota Department of Transportation
- NDOT – Nevada Department of Transportation
- MSU – Montana State University
- RAHI – Rural Alaska Honors Institute
- Rip – Research in Progress
- STEM – Science, Technology, Engineering and Math
- STI – Summer transportation institute
- SWANA – Solid Waste Association of North America
- TRB – Transportation Research Board
- TRC – Transportation Research Congress
- WSU – Washington State University
- UAA – University of Alaska Anchorage
- UAF – University of Alaska Fairbanks
- USDOT – United States Department of Transportation
- UTC – University Transportation Center
- WSDOT – Washington State Department of Transportation
- WSU – Washington State University
1. Accomplishments

**What are the major goals and objectives of the program?**

The major goals and objectives of the CESTiCC program are to systematically engineer environmentally sustainable transportation infrastructures in cold climates, considering the entire life cycle of transportation planning, design, materials selection, construction, maintenance and operations, preservation, and recycling through the collaboration of academia, industry and other stakeholders by cross-disciplinary research, education, and technology transfer activities.

**What was accomplished under these goals?**

During the past six months of the project:

- **Regular email announcements and website updates**
  A CESTiCC emailing contact list has been regularly updated. The Center announcements have been distributed through emails to professionals in the transportation and engineering communities. Activities have been posted to the website in a timely fashion as reflected by Research, News, Webinars, Publications, Workforce development, and other links on the CESTiCC website.

- **Monthly webinar series**
  Starting in September 2014, CESTiCC has hosted monthly webinar series that invites internationally recognized researchers to discuss Environmentally Sustainable Transportation in Cold Climates. The seminar series is free and open to all transportation professionals and engineering communities. Since the last reporting period, CESTiCC has hosted six webinars: An Empirical Model for Optimal Highway Durability in Cold Regions, Planning and Preparation for an Academic Career, Environmentally Responsive Pavement Materials, Environmentally Friendly Pervious Concrete for Treating Deicer-Laden Stormwater (Phase 1), 2016 CESTiCC Summer Workshop Lectern Sessions, and Performance of Multiaxial Paving Interlayer-Reinforced Asphalt Pavement. Additionally, all webinars have been recorded and posted on our website.

- **E-newsletters**
  Starting in December 2014, CESTiCC has sent out E-newsletters. The newsletters give our subscribers the opportunity to see what we have been up to and any upcoming events. CESTiCC published two newsletters (spring and summer) during this reporting period. PDF files of each newsletter can be found on the CESTiCC website under Publications.

- **Research projects**
  Detailed project information is available on our website at cem.uaf.edu/cesticc/research. The research progress during this reporting period is summarized as follows.

  - Three new research projects officially started in this reporting period. Including these, there are currently 25 ongoing projects, and six completed projects. Of these,
one was completed in this reporting period. 13 projects are in the process of set up and will begin early in the next reporting period. Final project reports were reviewed, revised, and posted on http://cem.uaf.edu/cesticc/research.aspx, and sent to TRID.

- Quarterly reports have been collected and reviewed in a timely fashion to keep track of progress, accomplishments and future goals.
- PIs continue to conduct and disseminate research through professional meetings and other venues, and details can be found in the products section on pages 7 -12 of the PPPR.
- A provisional patent has been filed for the project Bio-based Renewable Additives for Anti-Icing Application. The patent information is as follows: X. Shi, A peony-leaves-derived liquid corrosion inhibitor for protecting carbon steel from chlorides. Provisional Patent 62/374,466 filed on 08/12/2016.
- Project progress update meetings were held for active projects in July and August, 2016. The presentations and recordings of these meetings have been posted on the CESTiCC website: cem.uaf.edu/cesticc/research

- Outreach, technology transfer, and workforce development
CESTiCC co-organized a STI with ATTAP in Fairbanks, AK in June and organized a Summer Workshop at our MSU consortium location in August. A workforce development page has been added to the Center’s website to better disseminate presentations and posters from Center organized and sponsored workforce development programming. In addition, CESTiCC has actively participated in various outreach activities and technology transfer to promote environmental sustainability in transportation. Please see details in the “What opportunities for training and professional development . . .” section on pages 3-4, “How have the results been disseminated . . .” section on pages 4-6 and the “Impact” section on pages 14-16.

- Sponsorship
CESTiCC sponsored a number of events during this reporting period to promote the UTC program. The Center sponsored the following: the Imagine Tomorrow competition in Washington; the UAF Steel Bridge team; the 2016 TRC held in June, 2016 in Beijing, China; the 2016 TRB ADC60 Committee on Resource Conservation and Recovery summer workshop in Asheville, North Carolina; the 2016 International Conference on Transportation Infrastructure and Material in Xian, China; and the 2016 Moolin Seminar – Environmentally Sustainable Construction Practices in Cold Regions, to be held on October 31 in Anchorage, Alaska.

What opportunities for training and professional development has the program provided?
- J. Alloway, Communication skills: Making the leap from liberal arts to STEM, Intercultural Communication lecture, April 13, 2016.
- Y. Zhanping, J. Han, B. Huang, X. Yu, & J. Huang, Planning and Preparation for an Academic Career, CESTiCC webinar series, April 26, 2016.
• STI co-organized by CESTiCC and ATTAP, STI, June 6-8, 2016.
• 2016 CESTiCC Summer Workshop, Bozeman, Montana, August 12-13, 2016.

**How have the results been disseminated? If so, in what way? (Please provide links or examples for website use.)**

CESTiCC staff and researchers have been actively involved in various professional meetings and outreach activities to promote the UTC program, enhance public understanding and increase interest in learning and transportation careers.

**Research**

- Research information through RiP, Website, quarterly reports, and Gotomeetings. Research project information was available at the TRB’s RiP database and the Center’s website. Research progress was updated to funding agencies through quarterly reports and Gotomeetings. One project has been updated to “complete” in RiP and a final project report was sent for review to TRID during this reporting period.

- Professional Meetings
  During this reporting period, CESTiCC members have given many presentations and invited talks at various professional venues all over world such as:
  1. Transportation Research Congress, Beijing, China, June 6-8, 2016.
  2. International Workshop on the Genome of Stone-based Civil Infrastructure Materials, Beijing, China, June 8-9, 2016.
  5. International Conference on Transportation Infrastructure and Materials, Xi’an, China, July 17, 2016.
  6. TRB ADC60 and AFP40 summer workshop in Asheville, NC, July 26-29, 2016.
  7. CESTiCC Annual project progress update meetings, July and August, 2016.
  9. CESTiCC summer workshop at MSU, Bozeman, MT, August 12, 2016.
  10. 27th Biennial Western States and Provinces Pronghorn Antelope Workshop, Fairmont Hot Spring, MT, August 29, 2016.
13. CESTiCC and Alaska ACI presented to the student chapter of ASCE at UAF, Fairbanks, AK, September 22, 2016.

For more details please review the product section found on pages 7-12.

Outreach

- **Spring SWANA meeting**, April 15, 2016
  CESTiCC attended and presented at the Spring SWANA meeting in Anchorage, AK, hosted by CRS. More than 30 members were in attendance, representing local and state government, business owners and the EPA.

- **Kids2College**, April 27, 2016
  CESTiCC presented workshops and lab tours to groups of 6th graders at the annual Kids2College event. CESTiCC introduced transportation infrastructure concepts to the students and encouraged them to study math and science in order to become transportation engineers one day. CESTiCC hosted two sessions of about 20 students each.

- **Math Day on Campus**, April 28, 2016
  CESTiCC staffed two stations to teach local 6th grade students how math is used every day in the world of transportation using examples from current research. CESTiCC taught sessions to approximately 80 students.

- **Pearl Creek Elementary Transportation Day**, May 9, 2016
  CESTiCC presented an interactive transportation lesson and activity to 2nd and 3rd graders at Pearl Creek. The activity challenged students to think or how best to build roads and which materials would be best for vehicles driving the roads.

- **Imagine Tomorrow**, May 20-23, 2015
  Imagine Tomorrow challenges 9th through 12th graders to seek new ways to support the transition to alternative energy sources. The students research complex topics related to renewable energy, innovate technologies, designs, or plans to mobilize behavior. CESTiCC sponsored this outreach event, and Associate Director Liv Haselbach planned and oversaw all judging activities for the competition. More than 400 students attended this event.

- **Summer Transportation Institute**, June 6-9, 2016
  For the second year in a row, CESTiCC co-organized the STI, which is an annual training workshop focused on rural transportation. CESTiCC researchers and staff assisted by providing classes, lab tours, and lectures focused on transportation infrastructure. This workshop was attended by approximately 25 people. Presentations and materials are available on the Center’s Workforce Development page.
• **Tanana Valley State Fair, August 9, 2016**
For the second year in a row, CESTiCC worked with UAF Admissions to meet the Fairbanks community at the Tanana Valley State Fair. Outreach Coordinator Joe Alloway worked with Admissions’ Amy Bristor at this event during UAF Day at the fair.

• **Researcher featured on TV Time KREM2, August 18 & September 1, 2016**
Dr. Marcel Huijser’s research project, *Reliability and Meta-Analyses of the Effectiveness of Animal Detection Systems in Reducing Vehicle Speed and Collisions with Large Animals* was featured on TV Time KREM2 twice.

• **Teaching Assistant training session, August 26, 2016**
Outreach Coordinator Joe Alloway worked with the UAF graduate school to lead a “best practices” session for incoming graduate teaching assistants and to introduce the Center to this new group of students, many of whom fell under the umbrella of STEM. Approximately 40 teaching assistants attended this training.

• **College of Engineering and Mines Engineering Activities Fair, September 9, 2016**
Joe Alloway tabled at an activity fair on the UAF campus to promote CESTiCC to new and continuing Engineering Students. This event was attended by approximately 200 people.

• **UAF ASCE and ACI meeting, September 22, 2016**
UAF ASCE, Alaska ACI and CESTiCC held a joint meeting on September 22 to promote the creation of a student chapter of ACI on the UAF campus. This event was attended by approximately 25 people.

**What do you plan to do during the next reporting period to accomplish the goals and objectives?**

We will follow the implementation plan to ensure that all the CESTiCC funded research, education, and outreach activities move forward as scheduled.

• CESTiCC will be wrapping up most of the year 1 and 2 projects, which will result in final reports and project close-up meetings.
• CESTiCC researchers will continue to get students involved in research and disseminate results in a timely manner.
• CESTiCC will continue monthly webinar series to promote the Center’s research.
• CESTiCC will continue to participate in various activities on outreach, technology transfer and other activities to publicize the Center.
• The website will continue to be updated with news, products and research. We will also continue producing our E-newsletters, which will then be posted on our website in pdf format.
• CESTiCC will begin work with UAF Summer Sessions on the planning or participation in the UAF Summer Lecture Series.
• CESTiCC will begin work with RAHI to plan the ways in which the Center will support that program in summer, 2017.
2. Products

Publications, conference papers, presentations, websites, lectures, seminars, workshops, invited talks

Publications

• Journal Publications
• T.M. McGuire, A.P. Clevenger, R. Ament, & R. Callahan, Cost reduction opportunities associated with the design and construction of wildlife overpass structures, TRB 2017 (under review).
• A. Muthumani, X. Shi, Effectiveness of Liquid Agricultural By-Products and Solid Complex Chlorides for Snow and Ice Control, ASCE Journal of Cold Regions Engineering, 2016, DOI: 10.1061/(ASCE)CR.1943-5495.0000112.
• N. Xie, X. Shi, Y. Zhang, Deicer Impacts on Concrete: A Comparative Study of Potassium Acetate and Sodium Chloride, ASCE Journal of Materials in Civil Engineering, 2016, DOI: 10.1061/(ASCE)MT.1943-5533.0001754.

• Reports
  • J. Liu, Characterization of Alaskan Hot-Mix Asphalt Containing Reclaimed Asphalt Pavement Material, Project Report, CESTiCC and AKDOT&PF, June 1, 2016.

• Conference papers


• Presentations
  • R. Ament, Effectiveness of Mitigation Measures to Reduce the Impacts of Transportation on Wildlife Movement and Mortality, 27th Biennial Western States and Provinces Pronghorn Antelope Workshop, Fairmont Hot Springs, Montana, August 29 to September 1, 2016.
  • R. Ament, Roads, fences and pronghorn, oral presentation, plenary session, 27th Biennial Western States and Provinces, Pronghorn Workshop, August 29 – September 1, 2016.
  • S. Du, X. Shi, Y. Ge, Water Absorptivity and Permeability of High Volume Fly Ash Mortars with Various Chemical Admixtures, Poster for the Transportation Research


- G. Xu, *Graphene Oxide Modified Pervious Concrete with Fly Ash as a Sole Binder*, International Conference on Transportation Infrastructure and Materials, Xi’an, China, July 17, 2016.


• M. Yekkalar, Impacts of a Pervious Concrete System on Neighboring Clay Soils in Warm-Dry Months, CESTiCC Summer Workshop, Bozeman, Montana, August 12, 2016.
• X. Zhang, Rapid Characterization of Stress-Strain Behavior for Unsaturated Soils, CESTiCC Summer Workshop, Bozeman, Montana, August 12, 2016.
• S. Zhao, Characterization of Alaskan Hot-Mix Asphalt containing Reclaimed Asphalt Pavement Material, CESTiCC Summer Workshop, Bozeman, Montana, August 12, 2016.

• Other Products

• Website Updates
  • CESTiCC Website: http://ine.uaf.edu/cesticc/
  • CESTiCC Workforce Development: http://cem.uaf.edu/cesticc/workforce-development.aspx
  • CESTiCC Facebook Page: https://www.facebook.com/cesticc

• Lectures/Seminars/Workshops/Invited Talks
  • Invited Talk. X. Shi, Emerging Challenges and Recent Advances in Sustainable Highway Winter Operations, Invited by the 1st Transportation Research Congress, Beijing, China, June 5, 2016.
  • Workshop. Various presenters with various presentations (see above), CESTiCC Summer Workshop, Bozeman, Montana, August 12-13, 2016.

3. Participants & Collaborating Organizations

What organizations have been involved as partners?
Collaborative research and financial support
A Total of 25 ongoing research projects are funded by CESTiCC and the following agencies:

- AKDOTPF
- ACPA Northwest Chapter
- ADEC
- Alyeska
- BP Exploration Alaska
- Clear Roads
- Decagon Devices Inc.
- Idaho DOT
- Integrated Capital Management
- KVRI
- Midwest Industrial Supply, Inc.
- MnDOT
- MDOT
- NDOT
- PreMix of Pullman, Washington
- Sloan Security Technologies, Inc.
- Tencate Geosynthetics
- The City of Spokane, Washington
- Washington State Department of Ecology
- WSDOT

Have other collaborators or contacts been involved?
Tele-conferences and Gotomeetings were held during the reporting period to discuss research ideas and broad collaborations on research, education, workforce development, and outreach activities between CESTiCC and various collaborators:

- Research collaborators:
  - Apun LLC, Anchorage, AK
  - Alaskans for Litter Prevention and Recycling (ALPAR)
  - Aurora Consortium
  - Brookings Institute
  - Brookside Woolen Mill
  - Central Environmental Inc.
  - Global Fiberglass Solutions, Inc.
  - Insulfoam
  - MnDOT
  - Ramy Turf Products, LLC
  - RMC Research & Education Foundation
  - Sugarloaf Wool Mill
  - University of Tennessee, Knoxville
  - University of Idaho
  - University of New Hampshire
  - RMC Research & Education Foundation
• The Wilburforce Foundation

• Education and outreach collaborators:
  • ASCE Construction Institute
  • ASCE Fairbanks Chapter
  • ACI Alaska Chapter
  • ASPE
  • Alaska Concrete Alliance
  • Alaska Asphalt Alliance
  • Alaska Space Grant Program
  • Alaska Tribal Technical Assistance Program Center
  • Alaska Local Technical Assistance Program Center
  • Environmental UTCs Network
  • Explore Fairbanks
  • Frontiers of Structural and Civil Engineering
  • Infrastructure & Climate Network (ICNet)
  • International Association of Chinese Infrastructure Professionals
  • Louisiana Transportation Research Center
  • PacTrans
  • Pearl Creek Elementary School
  • RE-CAST
  • UAF Office of Admission and the Registrar and Graduate School

4. Impact

• *What is the impact on the development of the principal discipline(s) of the program?*
  Through our research, CESTiCC has made great impacts in the areas of advancing innovative sustainable materials and design, managing stormwater runoff, reducing environmental impacts during construction, operations and preservation, and improving the sustainability and conservation of ecosystems to maximize environmental sustainability in transportation. A couple of examples are highlighted as follows.

The *Bio-Based Renewable Additives for Anti-Icing Applications* project concluded during this period. The US uses 20 million tons of salt every year to control snow and ice on pavements. However, using salt as a deicer has a variety of disadvantages: metallic corrosion in motor vehicles, compromised integrity of pavements and bridge decks, and the potential for long term environmental damage. In this project, Dr. Shi developed innovative anti-icing formulations by engineering a zero-waste process which chemically and biologically derive the “green” chemicals out of various waste materials, such as waste sugarbeet leaves, dandelions, and Kentucky bluegrass, and other “green” anti-icers using materials such as fruit pomace and chicken manure. A provisional patent has been filed to protect intellectual property created through this research.

Recycled Asphalt Pavement (RAP) is the most widely recycled material in the US, at more than 100 million tons/year. Using RAP diverts material from the waste stream and preserves virgin aggregate resources. To facilitate the increasing use of RAP in Alaskan
paving projects, the study entitled Characterization of Alaskan Hot-Mix Asphalt Containing Reclaimed Asphalt Pavement Material provided a comprehensive data set of HMA performance with RAP, which will be used for pavement performance prediction and comparison, and mechanistic empirical pavement design. According to a preliminary cost analysis, a rough estimate of $13.30/ton saving can be reached if a 25% RAP is used in an HMA paving job in Alaska. The research will enable pavement designers to perform more reliable engineering and life-cycle cost analyses.

- **Other Disciplines** –
  Another new project, Are Heated Airport Runways Economically Viable? seeks to create a model which will predict the feasibility of installing heated runways in airports in various locations throughout the United States. Airports experiencing cold weather and significant snow accumulation could substantially increase cancellations and delays related to snowfall. Compared to other options such as chemical deicers, plows and sweepers, installing heated runways ensures ice and snow free pavement surfaces without potentially negative impacts on airplanes and environments or a slow-down of airport operations. The decision to install a heated runway will be based on whether it would increase economic welfare, accounting for the benefits to travelers and airlines and also the costs of installation and operation. This research will conduct cost-benefit analyses for investing in a heated runway at both large and small airports in the US.

- **What is the impact on the development of transportation workforce development?**
  CESTiCC has impacted the development of transportation workforce development through many interactions with agencies, the transportation professional community and broad general communities. For example, in June, CESTiCC worked with ATTAP to hold a STI for rural Alaskan transportation workers. In August, CESTiCC held its annual summer workshop in Bozeman Montana. The Center has given more than 40 presentations at professional meetings during this reporting period, and continues to offer monthly webinars. Presentations from these workforce development events are available on the Center website for transportation professionals and broad communities. Additionally, we have continued to contribute to the development of the future transportation workforce through educational and community outreach events as highlighted above.

- **What is the impact on physical, institutional, and information resources at the university or other partner institutions?**
  CESTiCC currently has 25 ongoing research projects and CESTiCC PIs have completed six research projects, one of which was in this reporting period. The projects continue to produce innovative and valuable results, which can be used as physical, institutional, and information resources at universities and our partner institutions. For example, as mentioned earlier, the project Characterization of Alaskan Hot-Mix Asphalt Containing Reclaimed Asphalt Pavement (RAP) has created data results and recommendations for the use of RAP in Alaskan infrastructure and its potential for both environmental and economic sustainability. The research will inform further research into the use of RAP in Alaska and similar cold climates, which will be very useful for AKDOTPF and northern states.
In addition, CESTiCC researchers have been active in research disseminations, collaboration, and exchange through numerous professional outlets. For example, CESTiCC organized its 2016 Summer Workshop in Bozeman, Montana, which was attended by researchers from all three consortium universities, their students, and other researchers from states such as Texas and Tennessee. CESTiCC also gave an invited presentation at the spring meeting of SWANA in Anchorage, Alaska in April and worked to create awareness and begin to move toward a more sustainable Alaska. All of these institutions or industry entities expressed strong interests in further collaboration with CESTiCC. Through various outreach, technology transfer, and workforce development activities, CESTiCC has provided information and resources on environmental sustainability in transportation to professional societies, K-12 students, and the public community.

- **What is the impact on technology transfer?**
  CESTiCC actively engages the public with its research through various means such as free monthly webinars, presentations, newsletters, seminars, workshops, and symposiums as mentioned in earlier sections. During this reporting period, CESTiCC has produced 22 journal publications, seven conference papers, 42 conference presentations, six invited talks/lectures/workshops/keynote presentations, three reports and hosted six webinars. The Center also updates its website in a timely manner with news, publications, webinar announcements and current research information.

CESTiCC strives to make its research accessible to the public. Project information, including project update presentations, project reports, news, webinars, and workforce development information are available on our website to share with anyone who is interested.

- **What is the impact on society beyond science and technology?**
  CESTiCC has made it a Center priority to go beyond science and technology by continuously participating in educational outreach opportunities, specifically with K-12 ages, professional societies, and the broad public community. CESTiCC has hosted many student groups, camps, and classes to expose them to the positive impacts civil engineers can have in the world. Examples can be referred from previous ‘outreach’ section on pg 5-6.

5. **Changes**
   Nothing to Report.