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

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Reporting Period End Date: March 31, 2017
Report Term: Semi-annual PPPR #7

Signature: 

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Abbreviations

- ACI – American Concrete Institute
- AGCA – Associated General Contractors of Alaska
- AKDOTPF – Alaska Department of Transportation and Public Facilities
- ASCE – American Society of Civil Engineers
- AS&G – Anchorage Sand & Gravel
- ASPE – Alaska Society of Professional Engineers
- ATTAP – Alaska Tribal Technical Assistance Program
- CEM – College of Engineering and Mines
- EPA – Environmental Protection Agency
- FNSB – Fairbanks North Star Borough
- FNSBSBD – Fairbanks North Star Borough School District
- GCI – General Communication Incorporated
- IACIP – International Association of Chinese Infrastructure Professionals
- ITE – Institute of Transportation Engineers
- MDOT – Montana Department of Transportation
- MnDOT – Minnesota Department of Transportation
- MOVES – MOtor Vehicle Emission Simulator
- NDOT – Nevada Department of Transportation
- MSU – Montana State University
- RiP – Research in Progress
- RMC – Ready Mix Concrete
- STEM – Science, Technology, Engineering and Math
- TRB – Transportation Research Board
- WSU – Washington State University
- UAA – University of Alaska Anchorage
- UAF – University of Alaska Fairbanks
- UAF OAR – University of Alaska Fairbanks, Office of Admission and the Registrar
- UH – University of Hawaii
- 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 seven webinars: Pervious Concrete Performance in Eastern Washington, The Role of Cementitious Materials in the Next Decade, Energy Harvesting and Self-powered Monitoring System for the Next Generation Smart Roadways, Planning and Preparation for an Academic Career (II), Turning Waste Peony Leaves into Green Chemicals: an Exploratory Study, A Bio-Wicking System to Mitigate Capillary Water in Base Course, and Toward Performance Specifications for Concrete Durability. 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 one newsletters (fall) 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.
• 14 new research projects officially started in this reporting period. Including these, there are currently 36 ongoing projects, and 11 completed projects. Of these, 5 were completed in this reporting period. Final project reports were reviewed, revised, and posted on [http://cem.uaf.edu/cesticc/research](http://cem.uaf.edu/cesticc/research), 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 6 -12* of the PPPR.

• **Outreach, technology transfer, and workforce development**

  A workshop was held on March 1-2 at the AKDOTPF, Fairbanks as an extension of the project *Developing Guidelines for 2-Dimensional Hydraulic Model Review and Acceptance (Phase 1: Research)*, the products of which were posted of the Center’s workforce development page, which continues to be maintained on 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 2016 Moolin Seminar – Environmentally Sustainable Construction Practices in Cold Regions, Anchorage, Alaska; Two-Dimensional Modeling Using HEC-RAS and SRH-2D workshop with AKDOT&PF; Alaska Academic Decathlon; the UAF Steel Bridge and Concrete Canoe teams.

What opportunities for training and professional development has the program provided?


• A. Nanni, *The Role of Cementitious Materials in the Next Decade*, CESTiCC webinar series, jointly sponsored by CESTiCC, RE-CAST and ACI Alaska Chapter, November 9, 2016.

• Z. You, J. Han, J. Liu, & L. Wang, *Planning and Preparation for an Academic Career (II)*, CESTiCC webinar series, co-sponsored by IACIP, November 15, 2016.


How have the results been disseminated? (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, websites, 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. Five projects have been updated to “complete” in RiP during this period and final project reports were 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:

For more details please review the products section found on pages 6-12.

*Outreach*
- UAF Inside Out, October 28, 2016
CESTiCC researcher Srijan Aggarwal led the engineering class for UAF’s preview event, Inside Out. The subject of the class was air pollution and was attended by more than 50 prospective engineering students.
• **Air Quality presentations at Pearl Creek Elementary School**, December 8, 2016
CESTiCC researcher Srijan Aggarwal and Outreach Coordinator Joe Alloway presented sessions on air quality in interior Alaska and what students and their families can do to protect themselves and the environment at Pearl Creek Elementary.

• **Future Cities Competition**, January 14, 2017
Center researcher Somayeh Nassiri co-chaired the regional Future Cities competition at WSU’s Pullman campus.

• **Pearl Creek Elementary STEM Night**, February 2, 2017
CESTiCC staffed a table on road construction and design for elementary school students at Pearl Creek Elementary School’s annual STEM night.

• **Alaska Academic Decathlon**, February 22-24, 2017
Outreach Coordinator Joe Alloway presented, tabled, and judged at the Alaska Academic Decathlon competition to promote studies and careers in the field of transportation to the young scholars and their coaches.

• **UAF Engineering Open House**, February 25, 2017
CESTiCC presented a NeoTracks roads construction activity at UAF CEM’s Engineering Open House on the UAF campus. Participants learned fundamental geometry and road design by building their tracks and trying to get their cars over prepared pavement slabs.

• **UAF Major Mania**, March 10, 2017
CESTiCC staffed a table at UAF’s Major Mania in March to promote careers in transportation, with an emphasis on environmental sustainability. Both current and prospective students stopped by the table and learned about the field.

• **Intercultural Communication Presentation**, March 21, 2017
Outreach Coordinator Joe Alloway gave a presentation on pursuing careers in transportation and STEM fields for an Intercultural Communication class at UAF. The lecture focused on skill sets that human science students have that translate well to the world of STEM, as well as areas which are likely to create difficulty for students coming from a human or social science background.

• **Lathrop High School Chemistry presentations**, March 24 and 27, 2017
Center PI Srijan Aggarwal gave two invited talks to chemistry students at Lathrop High School in Fairbanks, Alaska on air quality in interior Alaska. The presentations highlighted Dr. Aggarwal’s work on traffic’s impacts on air quality, and were arranged by CESTiCC, the FNSBSD and the FNSB Air Quality unit.

• **Pearl Creek Elementary School “Force and Motion in Transportation” presentations**, March 29-30, 2017
Outreach coordinator Joe Alloway presented a workshop on force and motion for students at Pearl Creek elementary in March. The presentation explained various factors which can
affect roads and how we use them. The students were then challenged to make their own roads using asphalt sample and tracks, including various obstacles.

**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.

- 17 projects from proposal years 1-3 are set to conclude in the next reporting period. Final reports and products will be posted on the Center’s research page and in TRID. Project close-up meetings will also be held.
- Project progress update meetings will be held for active projects in July and August, 2017. The presentations and recordings of these meetings will be posted on the CESTiCC website: cem.uaf.edu/cesticc/research
- The annual CESTiCC Summer Workshop will be held at WSU’s Pullman campus on August 10-11, 2017. The landing site, registration and abstract solicitations are available on the Center’s Workforce Development page.
- Researchers will continue to get students involved in research and disseminate results in a timely manner.
- Will continue monthly webinar series to promote the Center’s research.
- Will continue to participate in various activities on outreach, technology transfer and other activities to publicize the Center.
- Will continue to update the website and Facebook page with news, products and research. We will also continue producing E-newsletters, which will then be posted on our website in pdf format.

**2. Products**

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

**Publications**

- **Journal Publications**


• B. Werner, & L. Haselbach, *Temperature and testing impacts on surface infiltration rates of pervious concrete*, Special Issue on Environmental Sustainability of Transportation Infrastructure in Cold Climates, ASCE Journal of Cold Regions Engineering (Accepted), 2017.


**Reports**


**Conference papers**


**Presentations**


• A. Muthumani, L. Fay, & X. Shi, *Agricultural By-Products Weaken the Snow/Ice Bond to Pavement and Improve Sunlight Absorbance and Longevity on Road,


• G. Xu, & X. Shi, Graphene Oxide Modified Pervious Concrete, Poster Presentation, PacTrans Region 10 Transportation Conference, Seattle, Washington, October 14, 2016.


• X. Zhang, Use of H2Ri to Dehydrate Road Embankments for Better Performance, Transportation Infrastructure Conference, Rolla, MO, November 18, 2016.

• Other Products

• Website Updates
  • CESTiCC Website: cem.uaf.edu/cesticc/ (new content)
  • CESTiCC Webinar page: cem.uaf.edu/webinars (archive feature added)
  • CESTiCC Workforce Development: cem.uaf.edu/cesticc/workforce-development.aspx (new content)
  • CESTiCC Facebook Page: https://www.facebook.com/cesticc (new content)

• Lectures/Seminars/Workshops/Invited Talks
  • Invited Talk. J. Liu, & X. Schlee, High Abrasion-Resistant and Long-Lasting Concrete, Greater Fairbanks Chamber of Commerce Transportation Infrastructure Committee meeting, October 6, 2016


3. **Participants & Collaborating Organizations**

**What organizations have been involved as partners?**

- Collaborative research and financial support
- A Total of 36 ongoing research projects are funded by CESTiCC and the following agencies:
  - AKDOTPF
  - ACPA Northwest Chapter
  - ADEC
  - Alyeska
  - AS&G
  - Aurora Consortium
  - BP Exploration Alaska
  - The City of Spokane, Washington
  - Clear Roads
  - Decagon Devices Inc.
  - Emulsion Product Co.
  - Global Fiberglass Solutions
  - Idaho DOT
  - Integrated Capital Management
  - KVRI
  - Midwest Industrial Supply, Inc.
  - Local Roads Research Board
  - MnDOT
  - MDOT
  - MSU Department of Land Resources and Environmental Sciences
  - NDOT
  - PreMix of Pullman, Washington
  - RMC Research and Education Foundation
  - Sloan Security Technologies, Inc.
  - TenCate Geosynthetics
  - UH Manoa
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)
  - Brookings Institute
  - Brookside Woolen Mill
  - Central Environmental Inc.
  - Insulfoam
  - MnDOT
  - Ramy Turf Products, LLC
  - Sugarloaf Wool Mill
  - University of Tennessee, Knoxville
  - University of Idaho
  - University of New Hampshire
  - 13 Mile Lamb and Wool Company

- 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
  - FNSB
  - FNSBSD
  - GCI
  - Infrastructure & Climate Network (ICNet)
  - IACIP
  - Louisiana Transportation Research Center
  - PacTrans
  - Pearl Creek Elementary School
  - UAF Academic Advising
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.

Frost heave and thaw weakening cause extensive damage to transportation infrastructure in cold areas such as Alaska. The key to eliminate or at least minimize this issue is to drive water out of soil. However, conventional drainage systems can only drain gravity water but not capillary water. Dr. Xiong Zhang introduced one innovative wicking fabric to be placed in subsoil areas, which has unique hydrophilic and hygroscopic material that provides wicking action to effectively suck water away. In his recently concluded study *A Bio-Wicking System to Prevent Frost Heave in Alaskan Pavements*, he and his team further improved the design by introducing a bio-wicking system. In this bio-wicking system, the relatively smaller channels in the grass roots further ensures water moving from H2Ri geotextile, transporting through the stems of grass, and eventually evapo-transpiring into the air at the leaf-air interfaces. It addressed the potential issues that the original design may encounter: (1) H2Ri ultraviolet degradation, (2) H2Ri mechanical failure, (3) loss of drainage function under high suction, and (4) clogging and salt concentration. Both elemental level and full-scale test results indicated that the bio-wicking system is more effective in draining capillary water within the base courses compared with the original design. The Center’s February webinar to disseminate the results of this research was well received by the engineering community, which has led to a new collaborative effort between the institution, industry and the PI and his team for further field implementation and monitoring.

Complimentary air quality studies of *Impact of Cold Climates on Vehicle Emissions: Cold Start Air Toxics Pulse* and *Modeling Impacts of Cold Climates on Vehicle Emissions* target vehicle cold start and idling issues in winter time. Idling vehicles in winter bring about higher levels of particulate matter and carbon monoxide from their emissions. The research team measured cold start emissions including benzene, formaldehyde, acetaldehyde, as well as toluene and C2-alkylbenzenes from four gasoline and diesel engine vehicles during the winter months in their engine testing building, using a proton transfer reaction mass spectrometer. They identified vehicle cold starts as a significant source of air toxic compounds in cold winter environments due to the rapid increase in mass emission rates with decreasing temperature. Emission profiles were also compared with the EPA’s MOVES2014 model. Results suggest that emission of the air toxics acetaldehyde and, likely, formaldehyde is significantly underestimated in wintertime by the MOVES2014 model. Very little emissions data currently exists for cold starts in cold climates, and the models produced by this project will be of particular use for the EPA’s cold start emission simulations for cold climates.
• Other Disciplines –
Nothing to report at this time.

• 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 October, CESTiCC sponsored the 2016 Moolin Seminar which was arranged by Center PI Robert Perkins based on his CESTiCC project entitled Sustainable Construction in Remote Cole Regions. In November, Center director Jenny Liu gave an invited talk for the UAA College of Engineering’s Professional Development Seminar series entitled “Sustainable Materials and Design for Alaskan Pavements”. In March, CESTiCC sponsored a 2-D modeling workshop with AKDOTPF. The materials for the workshop were created by Center PI Horacio Toniolo based on his ongoing project, Developing Guidelines for 2-dimensional Hydraulic Model Review and Acceptance. Additionally, the Center has given 8 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 36 ongoing research projects and CESTiCC PIs have completed 11 research projects, 5 of which were 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 webinar for the completed project A Bio-Wicking System to Prevent Frost Heave in Alaskan Pavements has raised a lot of interests from local engineering community. An engineer from UAF’s Facility Services office who later approached Dr. Zhang about collaborating for further field implementation and monitoring of the material on the UAF campus, which has led to a new research proposal. Additionally, state DOTs have been match sponsors for many of the Center’s years 1 and 2 projects, and have been satisfied with the results of the research and their implications for implementation. To illustrate this faith in the Center, state DOTs continue to serve as match sponsors for several round 3 projects, many of which began in this reporting period.

In addition, CESTiCC researchers have been active in research disseminations, collaboration, and exchange through numerous professional outlets. For example, CESTiCC sponsored a 2017 training workshop for AKDOT&PF employees who work in fields related to hydrology in March, 2017. The training was attended by AKDOT&PF employees and university students studying the field. CESTiCC also gave an invited presentation for the UAA College of Engineering’s Professional Development Seminar Series in November. Each of these groups 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 34 journal publications, 4 conference papers, 26 conference presentations, 7 invited talks/lectures/workshops/keynote presentations, 5 reports and hosted 7 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, 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 4-6.

5. **Changes**

   Nothing to Report.