

Program Progress Performance Report for University Transportation Centers

Submitted to: Office of the Assistant Secretary for Research and Technology
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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, 2016

Report Term: Semi-annual PPPR #5

Signature: 

Abbreviations

- ACPA – American Concrete Pavement Association
- ADEC – Alaska Department of Environmental Conservation
- AGC – Associated General Contractors
- ASCE – American Society of Civil Engineers
- ATTAP – Alaska Tribal Technical Assistance Program
- CEM – College of Engineering and Mines
- CESTiCC – Center for Environmentally Sustainable Transportation in Cold Climates
- KVRI – Kootenai Valley Resource Initiative
- LCA – Life Cycle Assessment
- MSU – Montana State University
- STEM – Science, Technology, Engineering and Math
- TRB – Transportation Research Board
- TRC – Transportation Research Congress
- WSU – Washington State University
- UAF – University of Alaska Fairbanks
- USDOT – United States Department of Transportation
- UTC – University Transportation Center
- 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 and then forwarded to professionals in the transportation and engineering communities by CESTiCC partners. Activities have been posted to the website in a timely fashion as reflected by *News, Webinars*, 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 five webinars: *Measurement and Modeling of Vehicle Cold Start Emissions*, *Pervious Concrete Performance*, *Evaluation of Effectiveness and Cost-Benefits of Woolen Roadside Reclamation Products*, *Sustainable Practices in Highway Winter Operations: A Renewed Perspective*, and *Observation Method for Bridge Scour and Meander Migration*. 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. We published an end-of-year newsletter for 2015 and will be publishing a spring newsletter at the end of April. 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.

The research progress during this reporting period is summarized as follows.

- 10 new research projects officially started early of this reporting period. So far there are 23 ongoing projects, and 5 completed projects. Of these, two were completed in this 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.
 - The final research product from the completed project entitled *Transportation Life Cycle Assessment Synthesis* are a total of 27 modules available in the *Environmental Life Cycle Assessment (LCA) Learning Module Series*, 12 of which were developed in this reporting period. The modules are in PowerPoint format with narration and will automatically play the audio and advance slides when put in presentation mode. Each module is approximately twenty minutes long. They are intended to be used for personal education, short background workshops or as components for more detailed classes.
- *Effective communication and exchange*
Meetings with state agencies, industry experts, private sectors, and other institutions were held to discuss ideas and collaborate on research, education, workforce development, and outreach activities.
 - *Sponsorship*
CESTiCC sponsored a number of events during this reporting period to promote the UTC program. During this reporting period, the center sponsored first Future City competition at Washington State University in which middle school students were tasks with designing a future for 100 years in the future, the UAF Steel Bridge, Ice Arch, and Concrete Canoe teams; the Cross USA Lecture of the Geo-Institute of ASCE in March, 2016 in collaboration with Fairbanks ASCE and ASPE; the 2016 TRC to be held in June, 2016 in Beijing, China; and, the 2016 International Conference on Transportation Infrastructure and Material in Xian, China.
 - *Outreach and technology transfer*
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 4-5, “*How have the results been disseminated . . .*” section on pages 5-7 and the “*Impact*” section on pages 15-17.

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

- CESTiCC hosted three visiting professors (Drs. Rongtao Yan, Zhibing Wang, and Zhaotian Zeng) from Guilin University of Technology, Guilin, China during this

- period. They were working with Dr. Xiong Zhang's group on research topics on modeling and monitoring soil behavior for environmental considerations.
- CESTiCC researchers and students attended the 95th annual Transportation Research Board meeting from January 10-14, 2016. CESTiCC participated in lectern, poster and workshop presentations as well as professorial meetings.
 - L. Haselbach, "Strategies for Including Principles of Sustainability in Civil Engineering", national ASCE webinar: eLearning Webinar, Nov 3, 2015.
 - L. Haselbach, "Pervious Concrete Design", Bruce Podwal Seminar Series, City College of New York in Manhattan, Nov. 12, 2015.
 - S. Chung, and T. Jobson, "Measurements and Modeling of Vehicle Cold Start Emissions", CESTiCC webinar series, October 13, 2015.
 - L. Haselbach, "Pervious Concrete Performance", CESTiCC webinar series, November 18, 2015.
 - R. Ament, "Evaluation of Effectiveness and Cost-Benefits of Woolen Roadside Reclamation Products", CESTiCC webinar series, December 10, 2015.
 - S. Xianming, "Sustainability Practices in Highway Winter Operations", CESTiCC webinar series, February 17, 2016.
 - J.L. Briaud, "Observation Method for Bridge Scour and Meander Migration", Cross USA Lecture of the Geo-Institute of ASCE and CESTiCC webinar series. March 3, 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 Research in Progress (RiP) database and the Center's website. Research progress was updated to funding agencies through quarterly reports and Gotomeetings. Three projects have been updated to "complete" in RiP and final project reports were sent for review to TRID during this reporting period.
- Professional Meetings
During this reporting period CESTiCC members have given numerous presentations and invited talks at various professional venues all over world such as:
 1. ASCE Fairbanks Chapter. Fairbanks, Alaska
 2. 6th Asian-Pacific Conference on Unsaturated Soils. Guilin, China
 3. 3rd International Conference on Best Practices for Concrete Pavements. Bonito Brazil
 4. 57th Brazilian Conference on Concrete. Bonito, Brazil
 5. ASCE Inland Empire Branch Meeting. Spokane, Washington

6. Civil Engineering Department at the City College of New York. New York City, New York.
7. Alaska Asphalt Summit Meeting. Anchorage, Alaska.
8. ACI Alaska Chapter. Fairbanks, Alaska.
9. 95th Transportation Research Board annual meeting. Washington, D.C.
10. ASCE and TRB committee meetings.
11. ASCE Construction Institute (CI) Summit Meeting. Orlando, Florida.
12. Washington State University's annual research fair. Pullman, Washington.

For more details please review the *product section found on page 7 – 13*.

Outreach

- Major Mania, October 23, 2015
CESTiCC participated in UAF Academic Advising Center's Major Mania. CESTiCC hosted a table with students and staff to answer questions about Engineering and to introduce some of the exciting and innovative research and opportunities in the field of sustainable transportation and infrastructure.
- Future City Competition, January 16, 2016
Liv Haselbach and Somayeh Nassiri, CESTiCC PIs volunteered at the Future City Competition on the Pullman Campus on January 16th, 2016. Approximately 80 students attended, in addition to more than 20 judges etc.
- Pearl Creek Elementary STEM Night, February 4, 2016
CESTiCC presented an interactive booth at the annual STEM night of Pearl Creek Elementary School. CESTiCC introduced transportation through a hands on road building activity which taught young engineers about transportation, road engineering and geometric design.
- Engineering Open House, February 27, 2016
CESTiCC students and researchers participated in UAF CEM's Engineering Open House on the UAF campus. CESTiCC presented a Hot Wheels RC Derby course which attracted many community members. Participants learned fundamental geometry and road design by building their tracks, racing cars and measuring their car's performance in a variety of circumstances. Approximately 550 community members visited the CESTiCC table and learned about transportation in general and sustainable transportation in particular.
- Cross USA Lecture of the Geo Institute of ASCE, March 3, 2016
CESTiCC and the local chapters of ASCE and ASPE co-sponsored the Cross USA Lecture of the ASCE Geo Institute in Fairbanks, AK. Dr. Briaud gave his lecture on *Observation Method for Bridge Scour and Meander Migration*. The lecture was also available for online attendees through gotowebinar.

- Fairbanks Career Expo and Job Fair, March 22, 2016
CESTiCC participated in the Fairbanks Career Expo and Job Fair to introduce people about the exciting developments happening within the field of sustainable transportation and help direct them to sources of information that can lead them to working within the field.

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 projects, which will result in final reports and project close-up meetings.
- Project progress update meeting will be held for all on-going project in summer, 2016.
- CESTiCC will select new research projects for year 3 research, and will continue to update RiP and Center website in a timely fashion.
- CESTiCC researchers will continue to get students involved in research and disseminate results in a timely manner.
- CESTiCC will continue monthly webinar series by working with various partners. The seminar series will be open to all transportation professionals and presentations will be posted on the Center's website after the seminar.
- 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-newsletter, which will then be posted on our website in pdf format.
- CESTiCC will hold project progress update meetings for all 23 ongoing projects in July of 2016. During the meetings, PIs present to the CESTiCC Directors and staff, Advisory Board and other funding agencies the work completed, ongoing work, work to be completed and will express any concerns or issues. All presentations will be uploaded on the CESTiCC website to make it available to the public.
- CESTiCC and ATTAP will co-organize the Gravel Roads Summer transportation institute from June 6-9, 2016 for tribe council representatives.
- CESTiCC will organize an annual one-day workshop at Montana State University on Friday, August 12th. The workshop will highlight and showcase CESTiCC research through poster and lectern sessions. A post-workshop field trip will be arranged as well to tour the test sites of several CESTiCC projects.

2. Products

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

Publications

- *Journal Publications*

- L. Haselbach, and Q. Langfitt, “Incorporating Pre-recorded Environmental Life Cycle Assessment Modules in a Classroom Setting”, revisions submitted to the ASCE Journal of Professional Issues in Engineering Education and Practice (submitted), March 2016.
- C. Davidson, B. Allenby, L. Haselbach, M. Heller and W. Kelly, “Educational materials on sustainable engineering: Do we need a repository?” *Elementa: Science of the Anthropocene*, 2016. DOI 10.12952/journal.elementa.000089.
- M.P Huijser, E.R. Fairbank, W. Camel-Means, J. Graham, V. Watson, P. Basting, and D. Becker, “Effectiveness of short sections of wildlife fencing and crossing structures along highways in reducing wildlife-vehicle collisions and providing safe crossing opportunities for large mammals”, *Biological Conservation*, No. 197: 61-68, 2016.
- Q. Langfitt, and L. Haselbach, “Coupled oil analysis trending and life cycle cost analysis for vessel oil change interval decisions”, *JMET Journal of Marine Engineering and Technology*, Taylor and Francis Online, 2016. DOI 10.1080/20464177.2015.1126468.
- L. Li and X. Zhang, “A New Approach to Measure Shrinkage Curves of Cohesive Soils”, *ASTM Geotechnical Testing Journal*, (under review) 2016.
- L. Li, X. Zhang, G. Chen, and R. Lytton, “Measuring Unsaturated Soils Deformations during Triaxial Testing using a Photogrammetry-Based Method”, *Canadian Geotechnical Journal*, 53(3): 472-489, 2016.
- L. Li, and X. Zhang, “A New Triaxial Testing System for Unsaturated Soil Characterization”, *ASTM Geotechnical testing Journal*, 38(6), 823-839, 2015.
- L. Li, and X. Zhang, “Modified Unconfined Compression Testing System to Characterize the Stress-Strain Behavior of Unsaturated Soils at Low Confining Stresses”, *Journal of the Transportation Research Record*, No. 2510: 54-64, 2015.
- P. Li, S. Zhao, J. and Liu, “Characterizing Stress-strain Relationships of Asphalt Treated Base”, *ASCE Journal of Materials in Civil Engineering*, 2015, 10.1061/(ASCE)MT.1943-5533.0001549, 04016045
- P. Li, J. Liu, and S. Zhao, “Performance of Multi-Axial Paving Interlayer Reinforced Asphalt Pavement”, *ASCE Journal of Materials in Civil Engineering*, 2016, 10.1061/(ASCE)MT.1943-5533.0001543, 04016039.
- C. Lin, J. Liu, and X. Zhang, “Development of Innovative Antifreeze Grout Mortar for Anchor Application in Cold Regions”, *Transportation Research Record: Journal of the Transportation Research Board*, No. 2508, 1-12, 2015, DOI 0.3141/2508-01.
- J. Liu, S. Zhao, A. Mullin, and J. Rein, “Use of the Micro-Deval Test for Assessing Alaska Aggregates”, *Frontiers of Structural and Civil Engineering* (accepted), 2016.
- J. Liu, S. Zhao, P. Li, and S. Saboundjian, “Variability of Composition, Volumetric and Mechanic Properties of Hot Mix Asphalt for Quality Assurance”, *ASCE Journal of Materials in Civil Engineering*, 2015, 10.1061/(ASCE)MT.1943-5533.0001481, D4015004.
- 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* (accepted), 2016.

- F. Stewart, N. Heim, A.P. Clevenger, J. Paczkowski, J. Volpe, J. Fisher. “Wolverine behaviour varies spatially with anthropogenic footprint: implications for conservation and inferences about declines”, *Ecology and Evolution* 6(5):1493-1503, 2016.
- S. Zhao, B. Huang, and X. Shu, “Quantitative Evaluation of Blending and Diffusion in High RAP and RAS Mixtures”, *Materials & Design*, 89, 1161-1170, 2016.
- S. Zhao, J. Liu, P. Li, and T. Burritt, “Asphalt Binder Adaption for Climatic Conditions in Cold Regions—Alaska Experience”, *ASCE Journal of Materials in Civil Engineering* (under review), 2016.
- N. Xie, Y. Dang, A. Pace, X. Shi, “Up-cycling of waste materials: A ‘green’ binder prepared with pure coal fly ash”, *ASCE Journal of Materials in Civil Engineering*. 2015. 04015138.
- *Reports*
 - L. Haselbach, “Environmental Life Cycle Assessment (LCA) Learning Module Series”, CESTiCC report, March 2016.
 - R. Perkins, “Sustainable Construction in Remote Cold Regions”, Final project report submitted to CESTiCC and TRB, December, 2015.
 - J. Yan, “An Empirical Model for Optimal Highway Durability in Cold Regions”, Final project report submitted to CESTiCC and TRB, March, 2016.
- *Conference papers*
 - J. Han, X. Zhang, & C. Lin, “The Effect of Soil Particle Size on Geotextile Drainage Behavior”, *Geotechnical & Structural Engineering Congress*, Phoenix, February 14-17, 2016.
 - L. Haselbach, V. Dutra, P. Schwetz, and L.C.P. Silva Filho, “Laboratory Evaluations of Long-term Hydraulic Performance and Maintenance Requirements for Pervious Concrete Mixes: A Case Study in Southern Brazil”, Accepted for proceedings and presentation at the 2016 International Conference on Transportation and Development, Houston, Texas, June 26-29.
 - W. Kelly, J.P. Mohsen, and L. Haselbach, “The UN 2015-2030 Sustainable Development Goals: The Role of Civil Engineering”, Accepted for Proceedings for ASEE June 2016 meeting in New Orleans.
 - Q. Langfitt, and L. Haselbach, “Rubric-Based Energy Literacy Assessment of Student Posters: Effects of Extended Calibration and Addition of Raters”, Accepted for proceedings and presentation ASEE Conference June 2016, New Orleans.
 - J. Liu, and S. Zhao, “Characterization of Hot-Mix Asphalt containing Reclaimed Asphalt Pavement Material in Cold Climate: An Alaskan Experience”, 4th international conference in Sustainable Construction Materials and Technologies, Las Vegas, NV, 2016.

- *Presentations*
 - X. Zhang, “Problems Associated with Determination of Yield Curves for Unsaturated Soils”, 6th Asian-Pacific Conference on Unsaturated Soil, Guilin, China, October 23-26, 2015.
 - X. Zhang, “Failure of Divide-and-conquer Approach in the Characterization of Unsaturated Soils”, 6th Asian-Pacific Conference on Unsaturated Soil, Guilin, China, October 23-26, 2015.
 - R. Perkins, and L. Bennett, “Sustainable Construction Methods for Remote Cold Regions”, Alaska Department of Transportation and Public Facilities Central Region: Central Region’s Quarterly Design Meeting, Anchorage, Alaska, October 27, 2015.
 - L. Haselbach, “Field Data for Heat Island Mitigation by Pervious Concrete in Porto Alegre”, 3rd International Conference on Best Practices for Concrete Pavements, Bonito, Brazil, October 29, 2015.
 - L. Haselbach, V.P. Dutra, P. Schwetz, and L.C.P. Silva Filho, “A Pervious Concrete Mix Design Based on Clogging Performance in Rio Grande do Sul”, 3rd International Conference on Best Practices for Concrete Pavements, Bonito, Brazil, October 29, 2015.
 - L. Haselbach, “Pervious Concrete Design and Testing”, Civil Engineering Department at the City College of New York, New York City, New York, November 12, 2015.
 - L. Haselbach, “Pervious Concrete Performance”, Eastern Washington, ASCE Inland Empire Branch Meeting, Spokane, Washington, November 19, 2015.
 - L. Haselbach, “Pervious Concrete: Concrete Magic”, Brazilian Conference on Concrete, Bonito, Brazil, Oct. 28, 2015.
 - A. Lorenzi, L. Haselbach, and L.C. Pinta da Silva Filho, “Field Data for Heat Island Mitigation by Pervious Concrete in Porto Alegre”, Brazilian Conference on Concrete, Bonito, Brazil, Oct. 29, 2015.
 - L. Haselbach, V. Pasa Dutra, P. Schwetz, L.C. Pinta da Silva Filho, “A Pervious Concrete Mix Design Based on Clogging Performance in Rio Grande do Sul”, Brazilian Conference on Concrete, Bonito, Brazil, Oct. 29, 2015.
 - L. Haselbach, “LCA Learning Modules”, ASCE Construction Institute Bituminous Materials Committee, Washington D.C., January 10, 2016
 - J. Liu, “Advances in Pavement Design, Construction, Preservation, and Assessment”, ASCE CI Summit, Orlando FL., March 10, 2016.
 - L. Haselbach, and B. Werner, “Temperature related climatic impacts on the surface infiltration rates of pervious concrete”, Washington State University’s annual research fair, Pullman WA., March 24, 2016.
 - L. Haselbach, and Q. Langfitt, “Transportation Life Cycle Assessment (LCA) Synthesis: Life Cycle Assessment Learning Module Series”, Center for Environmental Sustainable Transportation in Cold Climates, January 2016. [http://cem.uaf.edu/cesticc/research/transportation-life-cycle-assessment-\(lca\)-synthesis.aspx](http://cem.uaf.edu/cesticc/research/transportation-life-cycle-assessment-(lca)-synthesis.aspx)
 - R. Ament, “Mitigating road impacts in wildlife habitat”, Oral presentation at a meeting sponsored by the Henry’s Fork Legacy Project, Island Park, January 5, 2016

- L. Fay, A. Kroon, D. Jones, K. Skorseth, and R. Reid, “Converting Paved Roads to Unpaved”, NCHRP Synthesis 485, Washington, D.C., January, 2016.
- A. Narayan, O.O. Awoleke, M. Ahmadi, and J. Liu, “An Investigation into the Cold Heavy Oil Production with Sand Process Using Synthetic Cores and Designed Experiments”, SPE Western Regional Meeting, Anchorage, AK, 2016.
- L. Haselbach, “Environmental Life Cycle Assessment Learning Module Series, ASCE”, BMC Annual Meeting, Washington D.C., Jan 10th, 2016.
- L. Haselbach, B. Werner, V. Dutra, P. Schwetz, L.C.P. Silva Filho, R. Batezini, F. Curvo, and J. Balbo, “Nondestructive Method for Estimating Porosity of In-Situ”, Pervious Concrete, Poster presentation at TRB, January 2016.
- X. Shi, and G. Xu, “Exploratory Investigation into Upcycling of Coal Fly Ash as Sole Binder for Mortars, The 6th IACIP Annual Workshop, Washington D.C., January 10, 2016.
- X. Shi, Y. Ge, and S. Du, “Laboratory investigation into the mix design of high-volume fly ash mortars”, The 6th IACIP Annual Workshop, Washington D.C., January 10, 2016.
- L. Li, and X. Zhang, “Evaluation of Accuracy of Photogrammetry-Based Deformation Measurement Method”, Poster Session 321 - Unsaturated Geomaterials in Highway Embankment Design, Sponsored by Standing Committee on Engineering Behavior of Unsaturated Soils (AFP60), Washington D.C., Jan 11, 2016.
- S. Du, and X. Shi, “Electron Probe Microanalyzer Investigation into High-Volume Fly Ash Mortars”, Poster Session 314 - Select Papers on Basic Research and Emerging Technologies Related to Concrete, Sponsored by Standing Committee on Basic Research and Emerging Technologies Related to Concrete (AFN10), Task Force on Nanotechnology-Based Concrete Materials (AFN15T), and Standing Committee on Structural Fiber Reinforced Polymers (AFF80), Washington D.C., Jan 11, 2016.
- G. Xu, and X. Shi, “Exploratory Investigation into Upcycling of Coal Fly Ash as Sole Binder for Mortars”, Poster Session 317 - Concrete: Materials to Workability to Curing, Sponsored by Standing Committee on Concrete Materials and Placement Techniques (AFN40), Washington D.C., Jan 11, 2016.
- M.H. Nazari, X. Shi, E. Jackson, Y. Zhang, and Y. Li, “Effectiveness of Salt Removers and Sugarbeet Byproduct in Protecting Metals from Corrosion by Magnesium Chloride Deicer”, Lectern Session 417 - Infrastructure Corrosion Prevention Techniques, Sponsored by Standing Committee on Corrosion (AHD45), Washington D.C., January 11, 2016.
- X. Zhang, “Dehydration of Roadway Embankment Using a Wicking Fabric”, Lectern Session 495 - Influence of Seasonal Climatic Effects on Pavements, Sponsored by Standing Committee on Seasonal Climatic Effects on Transportation Infrastructure (AFP50), Washington D.C., January 12, 2016.
- L. Li, and X. Zhang, “Simultaneous Determination of Water Retention and Shrinkage Curves of Unsaturated Deformable Soils”, Lectern Session 496 - Modeling and Monitoring Volume Change of Unsaturated Geomaterials, Sponsored by Standing Committee on Engineering Behavior of Unsaturated Soils

- (AFP60), and Standing Committee on Geotechnical Instrumentation and Modeling (AFS20), Washington D.C., January 12, 2016.
- X. Zhang, H. Lu, and L. Li, “Use of Odometer Equipped with High-Suction Tensiometer to Characterize Unsaturated Soils”, Lectern Session 496 - Modeling and Monitoring Volume Change of Unsaturated Geomaterials, Sponsored by Standing Committee on Engineering Behavior of Unsaturated Soils (AFP60), and Standing Committee on Geotechnical Instrumentation and Modeling (AFS20), January 12th, 2016, Washington D.C.
 - X. Shi, M.H. Nazari, D. Bergner, and L. Fay, “Best Practices for the Prevention of Corrosion on Vehicles and Equipment Used by Transportation Agencies for Snow and Ice Control”, Invited Presentation by the Standing Committee on Maintenance Equipment (AHD60), Washington D.C, January 12th, 2016.
 - B. Werner, and L. Haselbach, “Temperature-Related Climatic Impacts on Surface Infiltration Rates of Pervious Concrete”, Poster Session 725 - Surface Transportation Weather and Its Effects on Traffic Networks, Sponsored by Standing Committee on Surface Transportation Weather (AH010), Washington D.C., January 12th, 2016.
 - X. Shi, “Best Practices for the Prevention of Corrosion to DOT Equipment: A User’s Manual”, Lectern Session 818 - Critical Issues in Snow Removal Equipment and Operations: Pathways toward Safety and Efficiency, Sponsored by Standing Committee on Maintenance Equipment (AHD60), Washington D.C., January 12th, 2016.
 - L. Fay, “Use of Equipment Lighting During Snowplow Operations: Identified Best Practices”, Lectern Session 818 - Critical Issues in Snow Removal Equipment and Operations: Pathways Toward Safety and Efficiency, Sponsored by Standing Committee on Maintenance Equipment (AHD60), Washington D.C., January 12th, 2016.
 - B. Werner, and L. Haselbach, “Temperature related climatic impacts on the surface infiltration rates of pervious concrete”, Poster presentation at TRB, Washington D.C., January 2016.
 - R. Ament, “2 forums on wildlife connectivity and state highways”, Workshop Facilitator, California Department of Transportation, San Diego/Marysville, CA., 26-28 January, 2016 .
 - D.L. Barnes, and B.G. Connor, “Dust Management”, Alaska Forum on the Environment, Anchorage, Alaska, February 10, 2016.
 - S. Nassiri, “Establishing Thermal Conductivity of Pervious Concrete, The Climate, Land Use, Agriculture and Natural Resources: Activities in Interdisciplinary Research”, Education and Outreach poster session, Pullman WA, February 25, 2016.
 - R. Ament, “Effects of roads on ecological connectivity and their solutions”, Oral presentation/panel member, High Divide Collaborative Workshop, Western Montana University, Dillon, MT, March 15-16, 2016.
 - L. Haselbach & B. Werner, Temperature related climatic impacts on the surface infiltration rates of pervious concrete, Poster Session, Washington State University’s annual research fair, Pullman WA, March 24, 2016.

- *Other Products*
 - A complete series of Life Cycle Assessment modules on CESTiCC website.
- *Websites*
 - Life Cycle Assessment Education Module: cem.uaf.edu/cesticc/publications/lca.aspx
 - CESTiCC Website: <http://ine.uaf.edu/cesticc/>
 - CESTiCC Facebook Page: <https://www.facebook.com/cesticc>
- *Lectures/Seminars/Workshops/Invited Talks*
 - **Invited Talk.** J. Liu. “The Who and What of CESTiCC, ASCE Fairbanks Chapter October Meeting”, Fairbanks, Alaska. October 23, 2015.
 - **Workshop.** R. Perkins, and L. Bennett, “Sustainable Construction Methods for Remote Cold Regions”, Alaska Department of Transportation and Public Facilities, Anchorage, Alaska, October 27, 2015.
 - **Invited Talk.** L. Haselbach, “Pervious Concrete”, IBRACON: Keynote Speaker at the 57th Congresso Brasileiro do Concreto, Bonito, Brazil, October 28 – 30, 2015.
 - **Invited Talk.** L. Haselbach, Invited Participant: Sustainability Summit Engineers in Partnerships Creating a Sustainable World, A Summit Convened by the American Society of Civil Engineers Dulles Hyatt, Herndon, VA., January 7 -9, 2016.
 - **Invited Talk.** X. Shi, M.H. Nazari, D. Bergner, and L. Fay, “Best Practices for the Prevention of Corrosion on Vehicles and Equipment Used by Transportation Agencies for Snow and Ice Control”, Invited by the TRB Maintenance Equipment Committee. Transportation Research Board 95th Annual Meeting, Washington, D.C., January 13, 2016.
 - **Lecture.** L. Haselbach, “Pervious Concrete Performance Eastern Washington”, presentation to the Inland Empire Chapter of ASCE, Spokane WA, February 18, 2016.
 - **Invited Talk.** X. Shi, “Sustainability Practices in Highway Winter Operations: A Renewed Perspective”, Invited by the Center for Environmentally Sustainable Transportation in Cold Climates, February 17, 2016..
 - **Invited Talk.** J. Liu, “Advances in Pavement Design, Construction, Preservation, and Assessment”, ASCE CI Summit, Orlando FL, March 10, 2016.
 - **Keynote Speaker.** L. Haselbach, “Pervious Concrete”, 57th Brazilian Conference on Concrete, Bonito, Brazil, October 28, 2015.

3. Participants & Collaborating Organizations

What organizations have been involved as partners?

- Collaborative research and financial support
Ten research projects began in this reporting period funded by CESTiCC and the following agencies:
 - Alaska Department of Transportation and Public Facilities

- ACPA Northwest Chapter
- ADEC
- BP Exploration Alaska
- Clear Roads
- Decagon Devices Inc.
- Idaho Department of Transportation
- KVRI
- Midwest Industrial Supply, Inc.
- Minnesota Department of Transportation
- Montana Department of Transportation
- PreMix of Pullman Washington
- Sloan Security Technologies, Inc.
- Tencate Geosynthetics
- The City of Spokane, Washington
- Washington State Department of Ecology
- Washington State Department of Transportations

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)
 - Insulfoam
 - Central Environmental Inc.
 - University of Tennessee, Knoxville
 - Brookings Institution
 - University of Idaho
 - University of New Hampshire
- Education and outreach collaborators:
 - ASCE Fairbanks Chapter
 - ASPE
 - ACI Alaska Chapter
 - Alaska Concrete Alliance
 - Alaska Asphalt Alliance
 - Explore Fairbanks
 - Alaska Tribal Technical Assistance Program Center
 - Alaska Local Technical Assistance Program Center
 - Environmental UTCs Network
 - PacTrans
 - Infrastructure & Climate Network (ICNet)
 - Louisiana Transportation Research Center
 - International Association of Chinese Infrastructure Professionals
 - ASCE Construction Institute

- Frontiers of Structural and Civil Engineering

4. Impact

- *What is the impact on the development of the principal discipline(s) of the program?*
Through our research, CESTiCC has made 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 few examples are highlighted as follows.

The *Sustainable Construction in Remote Cold Regions* project concluded during this period. The project sought to address gaps in the academic literature with regard to construction in cold climates as opposed to warm climates. The researchers interviewed 22 engineers and construction manager with experience on cold region and remote construction projects. The research resulted in a set of preliminary guidelines which were then presented to AGC and Alaska DOT&PF. The final set of guidelines was used to create a module for UAF's construction management classes, although it would also be applicable in other venues.

The LCA process is now internationally recognized for cradle to gate/grave/cradle assessment of environmental and resource impacts of a product, process or constructed element. In the project entitled *Transportation LCA Synthesis*, CESTiCC Associate Director Liv Haselbach and PhD student Quinn Langfitt created and published modules in the LCA Learning Module that are intended for personal education, short background workshops or as components for more detailed classes. There are 27 modules in eight groups available on our website.

Another CESTiCC project, *Bio-based Renewable Additives for Anti-Icing Applications*, was focused on developing liquid anti-icing formulations for snow and ice control on roadways, using bio-based compounds (beet sugar extract and dandelion extract), rock salt, sodium metasilicate and sodium formate. After extensive testing in various freeze-thaw environments, the team succeeded in formulating an innovative bio-based snow and ice control chemical which can significantly reduce the cost of winter maintenance operations. The study will lead to further investigation of ways to optimize greener anti-icers using renewable sources.

- *Other Disciplines –*
Another CESTiCC project, *An Empirical Model for Optimal Highway Durability in Cold Regions* approached its research question from an economic perspective. The research team assembled a data set of all highway construction and maintenance projects in Arizona and Washington from 1990-2014. Using the data, the researchers determined that highway maintenance costs and duration depend on pavement thickness and traffic loading. From there, the team calibrated the impact of different deicers on durability and thus maintenance costs. The final model can effectively be

used by planners to make effective decisions for highway pavement and winter operations. The purpose of the model is to be used by engineers, economists, and Department of Transportation managers and workers to lessen the cost of highway winter maintenance.

- *What is the impact on the development of transportation workforce development?*
CESTiCC has impacted the development of the transportation workforce through many means, but most notably through collaboration with local professional societies such as ASCE and ASPE. In March, CESTiCC co-sponsored a cross-USA lecture of the Geo-Technical Institute of ASCE. The presentation brought renowned scholar Jean-Louis Briaud to Fairbanks, Alaska to give his presentation, *Observation Method for Bridge Scour and Meander Migration*.

CESTiCC staff have given more than 30 presentations at professional meetings and hosted numerous workshops during this reporting period.

Additionally, we have continued to contribute to the development of the future transportation workforce through educational and community outreach events. For example, during this reporting period, CESTiCC attended the UAF College of Engineering and Mines Open House event and shared information about Transportation Infrastructure and Design with more than 500 community members.

- *What is the impact on physical, institutional, and information resources at the university or other partner institutions?*
CESTiCC currently has 23 ongoing research projects and CESTiCC PIs have completed 5 research projects, two 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 Transportation LCA Synthesis project produced a total of 27 modules that can be used for educational purposes and led to the launch of a three credit graduate course at WSU entitled CE507 Sustainability: Life Cycle Assessment, in addition to a completed one credit course at Universidade Federal do Rio Grande do Sul in Porto Alegre, Brazil.

In addition, CESTiCC researchers have been very active in research disseminations, collaboration, and exchange through numerous professional occasions. For example, CESTiCC hosted three visiting professors from Guilin University of Technology, Guilin, China during this reporting period. CESTiCC also hosted visitors from China Communications Construction Company LTD. Drs. Xiong Zhang and Xianming Shi were invited to give many talks in various universities in China. All of these institutions or industry companies 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 is actively engaging the public with its research through various modes such as E-books, free monthly webinars, presentations, newsletters, seminars, workshops, and symposiums as mentioned in earlier sections. For example, during this reporting period, CESTiCC has produced 18 journal publications, 5 conference papers, 39 conference presentation, 9 invited talks/lectures/workshops/keynote presentations, 3 reports and hosted 5 webinars. The center also updates the CESTiCC website in a timely manner with news, publications, webinar announcements and current research information.

CESTiCC strives to make its research accessible to the public. As an example, we have held and will continue to hold program progress update meetings with all PIs. Each presentation was and will be recorded and uploaded to our website for the advisory board, funding agencies, CESTiCC staff, and interested personnel to review.

- *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. CESTiCC has hosted numerous student groups, camps, and classes to expose them to the positive impacts civil engineers can have in the world. For instance, CESTiCC researcher Somayeh Nassiri co-organized the Future City competition in Januray, 2016. The competition brought a group of 6th, 7th, and 8th grade students to Washington State University to learn about technological literacy and engineering. The program tasks students with designing a city for 100 years in the future and this year's theme was "Waste not, want not." More than 130 students participated in the event.

5. Changes

Nothing to Report