Future Foundations: Darrow, Metzger, and GAM

Geotechnical Assets—things like rock and soil slopes, bridge foundations, shore protection, embankments, retaining walls, and other structures literally touch or impact every other physical asset within Alaska’s transportation system. As such, Geotechnical Asset Management (GAM) has become one piece of the broader movement toward Transportation Asset Management in Alaska, and two AUTC researchers have been central to this effort.

To gain a foundation in GAM, ADOT&PF engineers need more scientific research to better grasp how factors like soil stability impact infrastructure. Unstable soils, thawing permafrost, and other subsurface dynamics cause geotechnical assets to lose their integrity, leading to landslides and structural failure.

Margaret Darrow, Assistant Professor of Geological Engineering at UAF, brings two unique resources to this endeavor. First, her research focuses on frozen ground engineering, frost heave, unfrozen water in frozen soil, and slope stability in frozen ground. Secondly, she has professional experience in this subject that includes working for ADOT&PF’s Northern Region Materials Section—geographical and topical knowledge she has brought to five different AUTC projects on frozen ground interaction with highway embankments.

She is currently working on a study using automated instruments to measure ground movement near infrastructure. Titled “Evaluating In-Place Inclinometer Strings in Cold Regions,” the study uses automated in-place inclinometer strings (AIMIS) to measure vertical and horizontal ground movement in an effort to monitor slope instability, which can be applied to existing and newly constructed embankments. AIMIS have not previously been employed in cold regions; Darrow’s work will provide meaningful feedback to ADOT&PF about deploying these instruments in the future.

In a similar project, Darrow is examining how road embankments are impacted by instability associated with warming and thawing permafrost. Titled “Impact of Groundwater Flow on Permafrost Degradation and Transportation Infrastructure Stability,” this study investigates the interactions among groundwater flow, permafrost degradation, and embankment stability.

Last month, Darrow completed a project entitled “A Study of Unstable Soil Slopes in Permafrost Areas: Alaskan Case Studies Used as a Training Tool.” Assisting planners and engineers at ADOT&PF’s Northern Region, she created a multi-media training presentation that assesses three of their problem slope areas and suggests possible mitigation approaches. She also provided a comprehensive review of existing research on slope stability in permafrost regions, highlighting successful and unsuccessful techniques.

Left: Margaret Darrow, Assistant Professor of Geological Engineering at UAF, installs ground deformation monitoring equipment near a road embankment. (Photo Courtesy: M. Darrow)
Director's Notes

It seems that funding for transportation continues to go down while costs go up. State agencies constantly hear “Do more with less.” Unfortunately, the ability to “do more with less” has essentially reached an end. States must now decide how to put the available dollars where they will do the most good, and they must decide to let some things go. This inevitable strategy will require new techniques for deciding how to best allocate funding effectively among competing needs. How do you decide whether to spend money repairing a pothole or replace a stop sign? Or, is it more important to rebuild an intersection to improve safety, or to add another lane to a freeway to reduce congestion?

For many years now, states, with the aid of universities, have developed several management systems such as Bridge Management, Pavement Management and Maintenance Management. These have served decision-makers well because federal funding streams were specifically aimed at these activities. Now states are being asked to allocate reduced funding amongst the same needs.

Currently Transportation Asset Management (TAM) is considered the salvation. TAM looks at the desired outcomes and recommends funding strategies to meet these outcomes. The key word is “recommends.” The decisions are still left to state management. However, TAM can provide management with an understanding of what results may arise from the decisions they make. For example, if more money is allocated to sign repair, at the expense of pavement preservation, safety may increase, but public complaint and traffic congestion may go up. TAM can supply an answer to the question “What are the impacts of budget changes?”

As discussed in this newsletter, AUTC is working with the Alaska Department of Transportation and Public Facilities to develop TAM for Alaska. We recognize the difficulties, some technical and some political. However, we recognize the advantage of helping maximize the benefits of the money spent on transportation.

Our work is broken into two parts—Geological Asset Management (GAM) and the overall TAM project. We’ve already talked about TAM. GAM’s focus is slopes and other geological features, assessing their potential risk of adversely impacting the transportation infrastructure. Based on the information collected, decision-makers can assess which features are most at risk and whether to address an identified issue now, later, or not at all. GAM is rapidly gaining national interest.

We at AUTC appreciate the confidence that ADOT&PF has placed in our abilities to help them move forward with TAM. The path ahead will be difficult, but as they say, “Champions seek out challenges.” Stories in this newsletter highlight our efforts to develop the knowledge and processes that will best serve Alaska’s transportation systems.
Each year, AUTC collects nominations from faculty and researchers across the College of Engineering and Mines for its Student of the Year (SOY) award. Weighing diverse criteria—technical and research merit, academic performance, professionalism, and leadership—AUTC typically has many well-qualified students. This year was no different.

Sifting through a pile of applications, the committee found a candidate with strong qualifications. Among his credentials is a background in both applied and theoretical engineering with experience in some of AUTC’s innovative research projects. The student, a familiar face around the Duckering Building, is Travis Eckhoff.

With a B.S. in Civil Engineering from the University of New Hampshire, Eckhoff is pursuing an M.S. in Environmental Engineering at UAF. His thesis project, “Determining Dust Palliative Longevity on Gravel Roads and Runways,” is tied to AUTC’s ongoing dust reduction research in rural Alaska, led by Professor David Barnes, Chair of the Department of Civil and Environmental Engineering.

Eckhoff’s work on this project began in 2009, examining palliative performance on unpaved runways and roads—key infrastructure in Alaska’s remote regions. As these rural communities struggle with quality of life and public health issues stemming from fugitive dust, Barnes’ research team has applied and tested dust reduction palliatives to help remedy these problems. Eckhoff has been central to this effort.

For graduate students and seasoned researchers alike, Alaska is a tough place for field research. Overcoming environmental and field-based measurement challenges, Eckhoff helped the team develop instruments and methods to better determine palliative performance. The team created a vehicle-mounted air measurement instrument known as the DUSTM, and used it to monitor palliatives in over thirty remote Alaska communities. A distinct, innovative tool, the DUSTM was featured in past AUTC newsletters (see Volume 4, Number 1). The instrument is rugged and portable, and can be mounted on the back of an ATV to measure dust levels on unpaved roads and runways. While other researchers have developed different instruments to measure fugitive dust from unpaved surfaces, no one—until now—has developed a portable and repeatable methodology.

Eckhoff traveled to far-flung villages to deploy the DUSTM. He coordinated with ADOT&PF counterparts and local village leadership to arrive, acquire ATVs, and take measurements during time frames required for the study’s precise data collection. Learning to deal with harsh weather and difficult environmental constraints independently, Eckhoff proved invaluable in managing these complicated logistics while using a unique piece of research equipment. His contributions also supported AUTC’s broader effort to better understand the role that palliatives play in reducing a significant inhibitor to quality of life in rural Alaska.

Understanding how dust palliatives perform and degrade over time, Eckhoff and Barnes hope to develop dust-control strategies to improve local air quality and increase the longevity of Alaska’s gravel transportation infrastructure. This work is becoming more significant to Alaska’s local and state transportation officials.

In the least densely populated of all U.S. states, roughly 82 percent of Alaska’s communities are not serviced by roads, making dust-reduction advances beneficial to those who use or live near the more than 250 state-owned rural airports. In addition, the kind of local planning efforts underway require data on levels of fugitive dust that arrive from controllable and uncontrollable sources. Through his work on the fugitive dust projects, Eckhoff’s contributions have helped community planners make better informed decisions about public health.

As AUTC’s student of the year, Eckhoff received a $1,000 scholarship and a trip to the Transportation Research Board’s 91st Annual Meeting, where he was recognized at the Council of University Transportation Centers’ banquet on January 21.

Travis Eckhoff, winner of the 2012 AUTC Student of the Year Award. Eckhoff is pursuing an M.S. in Environmental Engineering at UAF. His thesis project, “Determining Dust Palliative Longevity on Gravel Roads and Runways,” is tied to AUTC’s ongoing dust reduction research in Rural Alaska. (Photo Courtesy: T. Eckhoff)
Traffic congestion is a preeminent challenge for transportation planners across the country. US DOT estimates that traffic congestion costs America more than $87 billion in wasted fuel and productivity annually. The department calls it a “major threat to economic prosperity and our citizens’ quality of life.”

In Alaska’s largest city, rapid population growth has led to traffic congestion that will only grow in coming years. Anchorage has ballooned by more than 100,000 residents since 1980 and has maintained a 9% growth rate since 2000. Coupled with an anticipated doubling of freight volume by 2020, this growth will only increase the number of vehicles on the roads.

**Intelligent Transportation System Technology**

As transportation planners are well aware, they cannot eliminate traffic congestion. Instead, they must manage traffic flow. According to the US DOT, Intelligent Transportation System (ITS) technology is the ideal means of addressing this dilemma. ITS gives better information to planners and travelers to improve decision-making.

ITS systems combine communications technology, data, and transportation infrastructure to supply city planners and other decision-makers with information on how and when traffic moves. Integral to Transportation Asset Management, ITS research is helping Anchorage take a pro-active approach to congestion.

Leading this effort, AUTC researcher Jeff Miller, Associate Professor of Computer Systems Engineering at UAA, is managing multiple projects to help Anchorage implement ITS.

**Data for Drivers and Planners**

Miller’s work begins and ends with data. Several years ago, Anchorage planners needed more timely and accurate information about travel conditions. The city had minimal data collection and was limited in the variety of information it could obtain. The data offered only a snapshot view of traffic on arbitrary dates, instead of a more comprehensive, real-time picture that included days, weeks, and seasons.

Since then, Miller and his research team transformed the city’s data collection, analysis, and accessibility. They created a unique vehicle-to-infrastructure (V2I) system and installed tracking devices in 65 vehicles, enabling them to monitor a car’s speed, distance, and location at various intervals to deduce travel times on main roads during certain periods of the day. The team can now identify and predict major congestion areas, and display this information in real time on the Internet through a publicly available interface called FreeSim (available at http://www.freewaysimulator.com).

Through this interface, destination travel time and average speed on a specific roadway will appear when a user puts the mouse over that roadway. Roads are color-coded to assist the user: red roads mean that traffic is moving at less than 25% of the speed limit; orange roads, 25–50% of the speed limit; yellow roads, 50–75% of the speed limit; and green roads, more than 75% of the speed limit. This is a first-of-its-kind technology for ADOT&PF.

Excited about this advancement, Miller’s team expanded the project’s data collection and transportation applications. A project titled “Assessment of Traffic Congestion in Anchorage Utilizing Vehicle-Tracking Devices and Intelligent Transportation System Technology” began tracking new information on vehicles. The team utilized the On-Board Diagnostics (OBD) ports in tracked vehicles to gain access to
more than 300 different types of data, such as revolutions per minute (RPM), fuel consumption, acceleration/deceleration rates, engine/cabin/outside temperature, and tire pressure and tire rotation. They want to scale and expand this data for public entities, researchers, planners, and the public.

V2I: How it works

The team’s V2I system receives data collected from vehicle OBD ports via text messages. These messages travel through a cellular telephone network to a server database. The team then analyzes the data and packages it for the public and other stakeholders online.

The applications are numerous. Based on the continuous data flow, Miller’s team learned about traffic patterns, traffic delays, seasonal traffic variations, how drivers circumvent traffic congestion, and whether route changes to avoid congestion actually save travel time. They also used this data to identify Anchorage’s major traffic chokepoints. The team studied traffic data between the time ranges of 7:00-9:00 am and 4:00-6:00 pm during weekdays. They compared average vehicle speeds with posted speed limits and discovered several frequently congested intersections.

East 36th Avenue and the Seward Highway, a major intersection next to the Old Seward highway, was one. They found another at the intersection of Lake Otis Parkway and East Tudor Road. A third appeared where Tudor crosses Boniface Parkway. Because of its proximity to major shopping areas, a 2.5 mile stretch of Diamond Boulevard between Minnesota Drive and the Seward Highway also suffered congestion during the holiday season.

New Information for Decision-makers

Miller’s team is continuing to answer specific questions for municipal planners. Miller was recently invited to present his work to Anchorage’s Mayor, City Council, and other stakeholders discussing the city’s 2025 transportation plan at the quarterly meeting of the Anchorage Metropolitan Area Transportation Solutions (AMATS).

Miller is designing a protocol to help agencies quickly identify winter road hazards. By monitoring tire slippage rates, the V2I system can find slick spots and alert drivers through web interface or text messages. It can also notify public works facilities to dispatch snowplows or sand trucks at specific locations. Other travel safety issues also gain from Miller’s work. The Alaska State Troopers have recently been in contact with Miller to discuss potential applications of this data to aid in highway safety efforts.

Miller’s work with AUTC is quickly gaining attention among ITS organizations. In addition to having multiple papers in progress and submitted papers under review, Miller has numerous upcoming presentations including one at an intelligent vehicle symposium in June. In the fall, he will chair the Institute of Electrical and Electronics Engineers Intelligent Transportation Systems Conference in Anchorage, which will draw hundreds of professionals and researchers from around the world.

As Anchorage, AUTC, and the State of Alaska continue to expand their efforts with ITS, Miller will be an imperative research resource. And as Transportation Asset Management becomes an emerging priority for Alaska, the information and applications of this work will surely help the state’s busiest municipality keep pace with its growth.
With Alaska’s growing interest in Transportation Asset Management, ADOT&PF is gathering the administrative tools to implement a statewide pavement preservation program. Supporting this effort, an AUTC study recently produced a draft Pavement Preservation Guide for Alaska. In it, researchers evaluate cold-region preservation techniques and give decision-makers guidelines and matrices to choose the most attractive treatments for Alaska.

Alaska spends up to $140 million a year on surface maintenance. Studies show that active pavement preservation programs save more than 50% in costs over a pavement system’s 20-year life cycle. These figures suggest a fully implemented pavement preservation system could save ADOT&PF as much as $350 million in a five-year period.

Before implementing such a system, ADOT&PF needs better information. Although experienced with numerous pavement preservation treatments, the state has yet to fully implement a comprehensive system. Many unknowns remain.

What pavement treatments are available? Which are most attractive from a cost perspective? Which ones best maximize pavement life-cycle? What are other cold regions doing? What treatments is ADOT&PF already using?

To answer these questions, a study (“Developing Guidelines for Pavement Preservation Treatments and for Building a Pavement Program for Alaska”) surveyed technical literature, cold region transportation experts, and numerous site locations to recommend treatments for Alaska. Led by AUTC’s Jenny Liu and Gary Hicks of the California Pavement Preservation Center (CP2C), the project completed a draft Pavement Preservation Guide in January that presents their findings. They also created a database of Alaska-specific projects available online at: https://sites.google.com/site/alaskap2/.

The Guide identifies 11 commonly-used pavement treatments for use in Alaska’s management system. These include crack sealing, patching, fog seals, chip seals, slurry seals, AST/BST, microsurfacing, thin overlays, bonded wearing courses, interlayers, and in-place recycling. Average service life for these different treatments ranges between 3 and 12 years. The guide also supports continuing two techniques currently used in Alaska—crack sealing and patching. In addition, it suggests the state research and evaluate the effectiveness of slurry surfacing and pre-saw cut joints, techniques used in other cold regions.

It also specifies which techniques perform well in terms of costs and life-cycle enhancement.

When it comes to cost-effectiveness, crack sealing was the least costly of these at $.75 to $1.50 per foot. Slurry sealing ($.75 to $1.00/yd²) was the second least costly method, and single-course microsurfacing ($1.50 to $3.00/yd²) tied with conventional single-course chip seal ($1.50 to $2.00/yd²) for third. Conversely, the techniques that most significantly enhance service-life are microsurfacing and thin overlays.

So what is the most attractive treatment for Alaska? Generally speaking, the guide shows that microsurfacing is commonly used in cold regions, has a long service life, and is inexpensive. The study also notes that hot mix asphalt overlays, various chip seals, and crack sealing are the most widely used treatments in Alaska to date. While the study stops short of endorsing one or two ‘best practices,’ it offers an entire preservation strategy selection guide for ADOT&PF.
In another area of significance to Alaska’s GAM efforts, Andrew Metzger, Assistant Professor of Civil and Environmental Engineering at UAF, is leading a team aimed at providing ADOT&PF with an implementation ‘road map’ for GAM. They are developing a framework for addressing GAM-related challenges that can be integrated with other asset management systems. To do this, the team will facilitate dialogue on Alaska’s geotechnical assets with the Transportation Commissioner, his deputies, members of Alaska’s TAM Executive Oversight Committee, and each regional director to help define geotechnical assets and assist with implementation. They will highlight key challenge areas, such as maintenance performance, unpredictable service life, financial accounting complexities, and other common obstacles to managing geotechnical assets. Currently, Metzger is working with ADOT&PF counterparts to conduct a series of discussions with department stakeholders for feedback on this effort.

Looking into the future of GAM in Alaska, Metzger is leading a new Marine North research program at INE. As Alaska’s arctic maritime infrastructure becomes an increasingly important national topic, decision-makers are drawing on his expertise in this area. Metzger recently spoke at a Fairbanks gathering of the American Society of Civil Engineers and gave an invited presentation at the U.S. Senate Commerce Subcommittee on Oceans, Atmosphere, Fisheries, and Coast Guard last July.

The new guide stresses that multiple factors influence pavement treatment selection: pavement age, condition, traffic levels, expected future plans, available funding, and agency policy. The selection guide also includes matrices for evaluating both crack and non-crack related preservation strategies. While they depend upon an existing level of pavement condition evaluation, these matrices include numerous variables, assessment levels, and treatment categories.

While the draft Pavement Preservation Guide undergoes internal review, Liu and her ADOT&PF counterparts will soon begin a series of workshops, starting with the Alaska Asphalt Pavement Alliance’s upcoming meeting, and another using the Go To Meeting format. Through these forums, they will convey many of the guide’s take-away lessons to the professionals who deal with pavement preservation issues every day across Alaska.

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A new pavement preservation guide will contribute to ADOT&PF implementation of a statewide pavement preservation program.