Alaska’s unusually remote and lightly populated villages find roadway dust control to be a particularly difficult problem. Fugitive dust is troublesome both because it is a serious health concern for people with breathing impairment (such as asthma), and because it is a visible symptom of road degradation through the loss of fine particles from the surface course. The annoying road dust which accumulates on surfaces throughout one’s house is supposed to remain bound up in the aggregate road surface, helping it withstand the passage of cars, trucks and all-terrain vehicles.

DOT&PF has used dust palliatives for decades on a few roads to reduce airborne dust and improve local road performance. Calcium chloride provides a relatively thrifty means to tighten up and seal an unpaved gravel road surface, but in recent times it has fallen out of favor due to concern over the addition of chloride salts into the environment. Leaders and citizens from Alaska’s villages are concerned with the possibility of contamination of any sort, and several communities have opted to find and use water and/or chemical palliatives other than calcium or magnesium chloride to limit dust releases and protect their streets.

Unfortunately, there are no clear, modern dust-control “best management” guidelines that detail how to identify which palliatives can be expected to work well, and be acquired cost-effectively, given the particular attributes presented by rural Alaskan villages. Years of research and studies have tested how various products work (or not) at specific locations, but only recently is DOT&PF – in partnership with AUTC, the Federal Aviation Administration, and the Denali Commission – making progress in accurately measuring dust releases at many sites. Now that we can evaluate the longevity of dust suppression applications all across northern Alaska and quantitatively confirm palliative performance, we can move forward with some village dust palliative trials, documenting costs and determining which products provide serviceable, thrifty dust control results given specific local conditions (such as geology, average daily traffic amounts, vehicle speeds, predominant types of vehicles using the treated roads, availability of equipment to maintain the village roads, and weather effects.

The key “yardstick” that makes this case-by-case fugitive dust release evaluation possible is the UAF Dust Monitor, the UAF-DUSTM, created and assembled by UAF researchers, led by Dr. David Barnes of the Civil & Environmental Engineering Department. This portable device, which can be transported easily in a small airplane, is attached to the rear of an ATV and used to measure the amount of loftable dust (that is, coarse particulate matter, defined by the EPA as PM-10) disturbed by
Dust Control: Measuring and Improving Palliative Effectiveness under Rural Alaska Conditions

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There are no clear, modern dust-control “best management” guidelines that detail how to identify which palliatives can be expected to work well, and be acquired cost-effectively given the particular attributes presented by rural Alaskan villages.

We must find solutions within the constraints we have. These solutions don’t have to be precise to several decimal places; they only have to be effective.

Some claim you have a better chance of running into a moose than another vehicle in Alaska. But in the last decade Anchorage has quietly developed into a metropolis with satellite bedroom communities bringing significant traffic into Alaska’s biggest little city.

In northern regions, soils are frozen throughout the winter months. Frozen soil affects lateral stiffness of foundations, particularly pilings. This experiment explores and quantifies stiffness change for a sixteen-inch diameter steel jacketed reinforced concrete piling.

AUTC students enter the workforce with experience in project planning, field work, lab testing, report preparation, and meetings with stakeholders and other end-users. They have already contributed to national-level publications and presented their research to a professional audience.
Those who work with me often hear me ask, “How’s this research going to change the answer?” Too often that simple question is answered with silence. I’m not about adding decimal places to the answer unless those decimal places will change the outcome.

Transportation professionals – those who fund transportation and those who are using our transportation system – are looking for solutions. The ‘lack of resources’ argument for allowing the continued degradation of our infrastructure and its performance is simply no longer acceptable. We, as researchers and practitioners alike, must find solutions within the constraints we have. The solutions don’t have to be precise to several decimal places; they only have to be effective.

The articles in this newsletter represent projects that are nearing completion. Each of them has made a difference almost from the beginning. While we’ve featured our dust management efforts before, Clark Milne’s article gives us insight from a user’s viewpoint. Clark has been Alaska DOT&PF’s champion for dust control on rural airports. Through our partnership with Clark, DOT&PF has provided us with test tracks, palliative-treated airports and – perhaps more importantly – encouragement to continue our work on managing dust. As a result, we know dust can be managed at an affordable cost using low-tech applicators. Since everything has to be flown into most rural Alaska communities, simplicity and size are always issues. For Rural Alaska, the answer has changed. Thanks to Clark for pushing us along to a practical solution.

Ming Lee’s Dowling Roundabout study is another study born of necessity. The Dowling Roundabout has given us the unique opportunity to look at a roundabout operating at capacity. What we have learned from this effort will allow us to evaluate roundabout performance and driver behavior when any given roundabout is at capacity. The video records obtained in this study will provide data for researchers for many years to come.

The final article, on Leroy Hulsey’s “Lateral Resistance of Pipe Piles in Thawed vs. Frozen Ground” project, discusses a completed study that compares lateral loadings on pilings for thawed and frozen soils. Our goal is to understand seismic loadings during both conditions. We found that each case must be evaluated separately since the reaction is completely different when the soil is frozen. Our current techniques are based on thawed soils. From this research, we know that effect of frozen soil will alter the design of laterally loaded piles in any area that has a foot or more of seasonal frost. We can no longer assume the northern tier states can ignore these impacts in their designs.

Again, our research is changing the existing paradigm. So, if I ask you “How’s your research going to change the answer?”, I hope you have the answer.
Many newcomers imagine Alaska as “the last frontier,” as a majestic landscape with no end, and certainly no traffic. Some would even claim that you have a better chance of running into a moose than another vehicle.

To the contrary, in the last decade the state’s largest city, Anchorage, has quietly developed into a metropolis with satellite bedroom communities bringing significant traffic into Alaska’s biggest little city.

Much to the dissatisfaction of the locals, many traffic hot spots have been developing in Anchorage. One such spot, the pair of multilane roundabouts at the ramp terminals of the Dowling Road and New Seward Highway interchange, afforded traffic engineers an opportunity to study the operational performance of multilane roundabouts in a way that has never been achieved on the national scene.

**Anchorage Hotspot**

Currently, the Dowling roundabouts operate smoothly for most of the day. However, for approximately 15 to 20 minutes during the evening peak hour (from 5 to 6 p.m.), the roundabouts operate at capacity, with queues of more than five vehicles on three (eastbound, southbound, and northbound) of the four entrance approaches during the entire rush-hour period.

On the eastbound entrance approach, the queue can extend over 1,600 feet (about half a kilometer), occasionally blocking the upstream intersection between the Old Seward Highway and East Dowling Road. These extended queues prompted the Alaska Department of Transportation and Public Facilities and AUTC to sponsor research on the performance of the Dowling roundabouts. This study was designed to measure the operating performance and safety performance of the multilane roundabouts.

**Performance Analysis of the Dowling Road Multilane Roundabouts**

The most unique aspect of our research was the use of multiple video cameras to capture vehicle turning movements in the roundabouts and the progression of vehicle queues at the entrances. Two camcorders were mounted at vantage points of approximately 15 to 20 feet above traffic level (that is, on the high ground by the Seward Highway) to record the circulating and entering vehicles at both roundabouts.

For each queued approach, we mounted a camcorder at 100-200 feet intervals to fully capture queue progression for its entire length. For the eastbound (EB) approach with the longest queue, we used a total of eight camcorders to cover a 1,600 foot span. With the resulting video records, we were able to accurately count the number of vehicles in the queues at any single minute during the peak hour.

No existing roundabout studies ever recorded and analyzed such extended queues with the spatial and temporal resolution we were able to achieve with the collected videos.
Putting Data to Practical Use

After data collection, turning movements as well as queue length and delay at the roundabouts were counted. The field-measured delay and queue length were compared to the numbers predicted by the two software packages and other available roundabout design guides. Based on the data extracted from the video records, we found that the extended queue on the EB approach of the west roundabout was a result of the unbalanced flow pattern at the roundabouts; the EB entering flow rate was substantially higher than the other three entrances. The unbalanced flow pattern also created a high circulating flow in front of the NB entrance to the east roundabout. The high circulating flow for the NB entrance explains why this approach to the east roundabout had such low capacity and high delay and queue values.

Meeting National Needs

To explore potential measures for reducing the queue and delay at the EB approach of the west roundabout, we designed a series of VisSim (a modeling program for multi-modal traffic flow simulation) runs to study how much reduction in vehicle flow on the EB entrance approach will result in an acceptable level of delay and queue. The simulation results showed that reducing the EB upstream flow to 70% of the original flow can result in acceptable levels of delay and queue length.

In 2007 The National Cooperative Highway Research Program published a report (Report 572) on roundabout performance and safety analysis in the US. This report noted that there was a lack of data from capacity-saturated multilane roundabouts in the US for performance analysis. Our study at the Dowling Road roundabouts offers much-needed data for traffic engineers who study multi-lane roundabout performance in the US. Our work will provide an opportunity to actually see how performance measurements predicted by software applications compare to actual measurements in the field. The results of our analysis can also assist the Alaska DOT&PF in determining whether, where and how to construct additional multi-lane roundabouts.
Lateral Resistance of Pipe Piles in Thawed vs. Frozen Ground

by J. Leroy Hulsey, PhD, Professor of Civil & Environmental Engineering, and graduate students Jacob Horazdovsky and Duane Davis

Over the past two years AUTC and the Alaska Department of Transportation and Public Facilities (DOT&PF) jointly funded studies that examine how laterally loaded piles respond in thawed (summer) conditions and in frozen (winter) conditions.

In the past, engineers have designed pile foundations by assuming an approximate depth below ground level at which the soil firmly holds a pile. This pseudo-“depth of fixity” has been extensively studied for summer conditions. There are essentially no guidelines for designing pile foundations for performance in winter (frozen) soils.

In northern regions, soils are frozen throughout the winter months. Undoubtedly the frozen soil has an effect on lateral stiffness of foundations, particularly in pilings. This experiment explores and quantifies stiffness change for a sixteen inch diameter steel-jacketed reinforced concrete piling. More specifically, two different types of tests were conducted over a two-year period of time:

- a) Free vibration tests as a function of season; and
- b) Cyclically increasing static lateral load tests applied until pile failure was reached.

**Free Vibration Tests**

Typically three free vibration tests were conducted during each season (summer, spring, fall and winter). On each testing day, three piles were tested for static loads up to nearly 5 kip. Each test consisted of two parts. First, static load vs. above-ground displacements were performed. Second, at about 5 kips, the load was released using a quick release mechanism and free vibration was monitored. The three piles were 16-inch diameter reinforced concrete with steel jackets (one north and one south) and a 24-inch diameter steel-jacketed reinforced concrete reaction pile.

Observed changes in effective length (pseudo depth of fixity) are a measure of change in system stiffness (soil-structure interaction) due to change in soil stiffness. Both static test results and effective length determined for a free vibration response showed that for a given lateral load the depth of fixity was substantially shorter when the soil was frozen than when the soil was unfrozen. While displacements are primarily a non-linear soil deformation in thawed soils, in frozen soils, displacement is primarily a linear structure deformation.
Failure Tests:

Two test 16-inch diameter piles were driven into silty soil at a test site in the summer of 2008. In the fall of 2009 while the soil was still unfrozen, the north pile was laterally loaded until failure. This failure was controlled by ground movement; that is, the force required to move the pile about 6 inches at the ground surface was 50 kips. Failure of the soil-pile system occurred in the soft soil and the pile was left undamaged. After testing the north pile, the soil around the pile was rehabilitated and the pile was returned to an upright position. In the middle of January when frost depth was about 4.5 feet; this same north pile was again tested. The force required to move the pile laterally about 0.5 inches at the point of applied load was 150 kips. During that loading, researchers found that the loading capacity for the test system was limited. The pile-soil system was too stiff to be tested to failure.

The final pile failure test was conducted on the second (south) pile in the spring of 2010. At this spring test, frost depth was almost 7.5 feet. The soil-pile system was again extremely stiff. It took almost 150 kips to move the pile approximately 1 inch at the ground line. Testing continued and the pile failed at nearly 200 kips. The frozen soil surrounding the pile was so strong the pile itself experienced a loss of strength approximately 1.5 feet below ground surface.

Preliminary Results

In the Fairbanks silt, the depth of fixity is between 8 and 11 feet below the ground line in the summer. It is about one pile diameter below the ground surface when the soil is frozen.

UAF-DUSTM improves Palliative Choices (continued from page 1)

the ATV moving along an unpaved roadway or village street in accordance with a fixed test protocol. By capturing and documenting repeatable, statistically significant, dust release results, the UAF-DUSTM data from a palliative-treated portion of road surface can be compared with a similar, but untreated, road surface and a “percentage of dust reduction” value calculated.

UAF-DUSTM data collection on dozens of DOT&PF gravel airports and gravel highways during the fall of 2008 and summer 2009 has shown that several readily available dust control products show results ranging from 65% to 99% dust reduction, with most of the modern chemical palliatives usually accomplishing at least a 90% reduction for one or two years. DOT&PF is now specifying mandatory dust reduction performance requirements when it purchases dust suppression products for its FAA-funded Surface Maintenance program. The agency plans to expand the library of dust reduction test data during 2010 by testing another 15 to 25 roads and airports, while recording the other applicable site attributes and working toward correlation of the palliatives’ dust reduction successes and the various challenging Alaskan site conditions.

Even more valuable in determining a life-cycle cost will be the re-testing of some roads and airports where UAF-DUSTM data was collected and evaluated in 2009. An accurate and unbiased measurement of the long-term (post-winter) dust reduction performance and efficacy of different palliatives will be possible, and virtually unique amongst the past research performed.

Finally, AUTC is aiding the DOT&PF in developing new dust control project specifications for both road and airport construction work; this will allow us to establish and meet specific dust suppression goals at our construction sites. In addition to a healthier and safer work area, we anticipate that dramatically increasing the retention of aggregate fines in the road/airport surfacing will extend the safe, serviceable life of the unpaved surface course and save future maintenance and repair or rehabilitation costs.

UAF-DUSTM can be used as a measure to determine when repeat applications of dust suppression products are needed, and protect both public health and the valuable infrastructure that roads and airports represent.
Spring 2010 is a milestone for AUTC; with pride we present the largest group of graduates supported on research projects since our program began. Each student has finished with an advanced degree from the UAF College of Engineering and Mines, and each has gained priceless practical experience by working on various AUTC research projects.

In addition to their classroom studies, these students gained experience in project planning, field work, lab testing, report preparation, and meetings with end-users and other stakeholders that will be valuable in their future careers.

They have specialized in finding practical solutions to transportation needs in arctic and subarctic communities, both urban and rural. They have already presented their research through national-level publications and professional conferences.

AUTC has benefitted from their hard work and individual talents, and they will be a valuable asset to the transportation community wherever they go.

To learn more about our graduate programs, visit CEM’s student pages at http://www.alaska.edu/uaf/cem/prospective/.

Davis and Horavdovsky photos by INE staff. Zhang photo by Todd Paris, UAF. Other photos courtesy of each student.