UAF INE AUTC

Transportation safety, security, and innovation in cold regions

Herbicide Attenuation in Alaskan Soils

by David L. Barnes, Will Rhodes, Stacey Frutiger, Shane Billings, Steve Seefeldt, and Larry Johnson

Wetblade mower cutting vegetation and applying herbicide simultaneously at the Delta Junction, Alaska field site. Photo by Daniel Debord.

AUTC researcher and Civil & Environmental Engineering professor David Barnes is working hand in hand with the Alaska Department of Transportation & Public Facilities and the US Department of Agriculture to develop an integrated plan for roadside vegetation control.

Traditional mowing methods have become too expensive to be effective in providing the sight distances necessary to avoid vehicle-animal collisions. Currently AKDOT&PF spends about $2 million annually on mowing. Roughly 150 “moose vs. car” accidents occur in Alaska every year, at an estimated cost of around $1 million annually. In many cases, mowing, which creates an enticing smorgasbord of young willow sprouts, only attracts moose.

This research team is evaluating new strategies for managing tall, growing woody species (like willows) as well as for discouraging non-native invasive species (such as dandelions, vetch, and sweet clover).

Strategies include combining some mechanical and chemical control methods. Researchers are conducting a controlled field test in Delta Junction, Alaska to determine how effective a combination of mechanical brush cutting (mowing) and herbicide application might be in controlling vegetation.

Stacey Frutiger & Will Rhodes conduct field and soil sample testing in support of this project. Photo by Todd Paris.

One big question is how herbicides behave once they enter our sub-arctic soils. Where do they go, and how long does it take for these chemicals to dissipate? As AKDOT&PF and USDA evaluate the overall effectiveness of each control method, this study seeks to quantify the fate of the herbicides used in the field test.

Researchers are currently focusing on two different herbicides, triclopyr (3,5,6-trichloro-2-pyridyloxacetic acid) and 2,4-D (2,4-dichlorophenoxy acetic acid), and two different application methods, standard broadcast spraying and a relatively new technology called wetblade mowing. Wetblade mowing applies the herbicide onto the cut stem of the vegetation as the blade cuts the stem; this greatly reduces the amount of herbicide that falls to the ground surface.

Determining the fate of these herbicides involves applying them to two different field sites. These sites are representative of climatic conditions common in the sub-arctic, which is very different from other climatic zones, where other researchers have conducted similar tests. After application, researchers collect soil samples over time to determine their fate and, ultimately, the attenuation rate (the rate at which the concentration of the chemicals diminishes in the soil).

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"Over 30 years, the temporary timber wearing surface has been replaced several times, and another replacement is scheduled for the spring of 2007."

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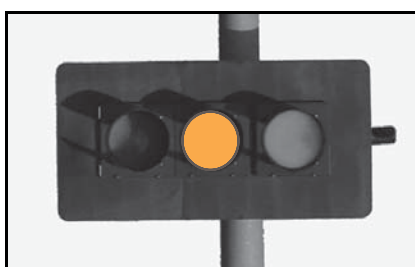
"It appears that I'm stopped about 12 minutes per day, or about 100 hours per year. So my delays are a total of about 225 hours per year, or almost 20 working days."



"Twelve thousand engineers all in a small area makes for an interesting bunch."

Director's Notes

Over the past year, the Alaska University Transportation Center staff have been hard at work getting our program up and running. While our legs are still a bit wobbly, we are fully functional. This last year has been quite exciting.

We completed our strategic plan, our guide into the future. We also held our first Governing Board Meeting, which provided the details for this year's project selection.

Finally, we selected our research projects for 2006-2007. We received 65 proposals totaling about $12 million. From that we selected 18 projects totaling about $3.78 million.

In addition, we've appointed three associate directors, one from each campus (UAF, UAA, and UAS); hired four transportation faculty in Fairbanks; made an offer to one transportation faculty in Anchorage; and hired our grant administrator and program assistant.

With a deep breath, we move on. In the next few months, the selected projects will be underway. We at AUTC are fully committed to ensuring that the quality of each project remains high and that each project is delivered on time. To that end, we are assembling peer review teams for each project and tracking systems for monitoring both spending and project progress. We are also providing training to each Principal Investigator in project management and fiscal responsibility. While this level of oversight may be new to some of our researchers, it is the best practice to ensure their success.

We are already beginning preparations for the next Request for Proposals, to be offered in September, 2007. If the last RFP is any gauge, we will have our hands full.

On the educational side, AUTC is working with all three campuses and with local industry to improve the transportation curriculum. This has proven to be a challenge. In order to balance the number of course offerings with the number of available students, we must investigate alternate delivery methods, extending our learning forums to video classrooms, webcasting, and online training in addition to traditional classrooms. AUTC has also been working with other universities throughout the northwest to find ways of sharing classes and expertise.

As you can see, AUTC has come a long way in the last year. I'm looking forward to an even more exciting year to come. As our projects begin to yield results we will be posting them on our web site (http://www.uaf.edu/ine/AUTC/) and highlighting them in our newsletter. The two projects featured in this inaugural newsletter should give you an idea of what to expect.

The AUTC Newsletter is published semi-annually by the **Alaska University Transportation Research Center**, Institute of Northern Engineering, University of Alaska Fairbanks, to inform our readers about our research and outreach activities.

AUTC addresses issues related to research and technology themes as identified in the Highway Research and Technology Report (April, 2002), including: the impact of climate change on permafrost, reducing construction and maintenance costs of transportation infrastructure, improving air quality during the winter months, and other measures to address multi-modal issues facing Alaska and the nation's transportation community.

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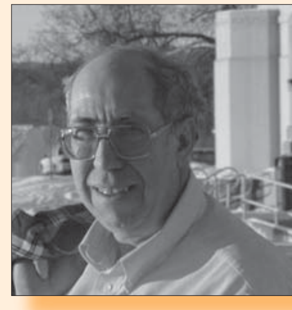
UAF UNIVERSITY OF ALASKA FAIRBANKS

Evaluating Wearing Surfaces for the Yukon River Bridge

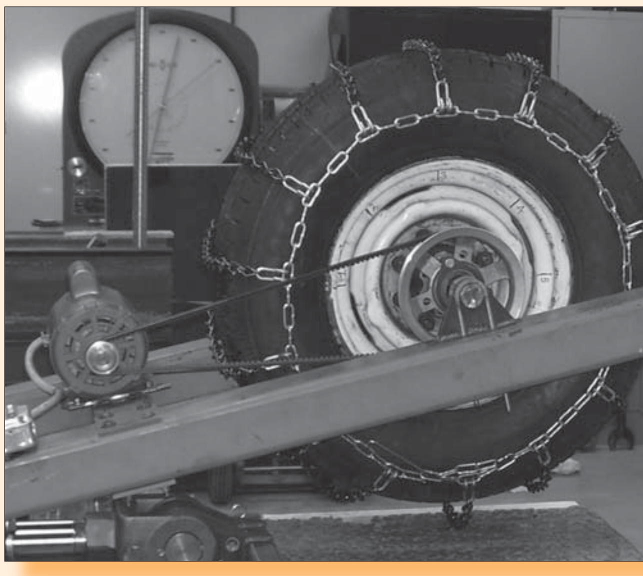
by Leroy Hulsey



Leroy Hulsey, AUTC Assoc. Director (UAF). Photo by S. Schiewer.

Two UAF structural engineering graduate students are researching alternative wearing surface materials for use on what most Alaskans call "the Yukon River Bridge", also known as the E.L. Patton Bridge.

This 1976 award-winning bridge carries the two-lane Dalton Highway and the Trans-Alaska oil pipeline across the river at a 6% grade. It is 30 feet wide, with 6 spans; it was designed to withstand -60 degrees Fahrenheit temperatures, huge ice loads from the river, truck loads hauling supplies to the oil fields, the oil pipeline, and, in the future, a gas line.



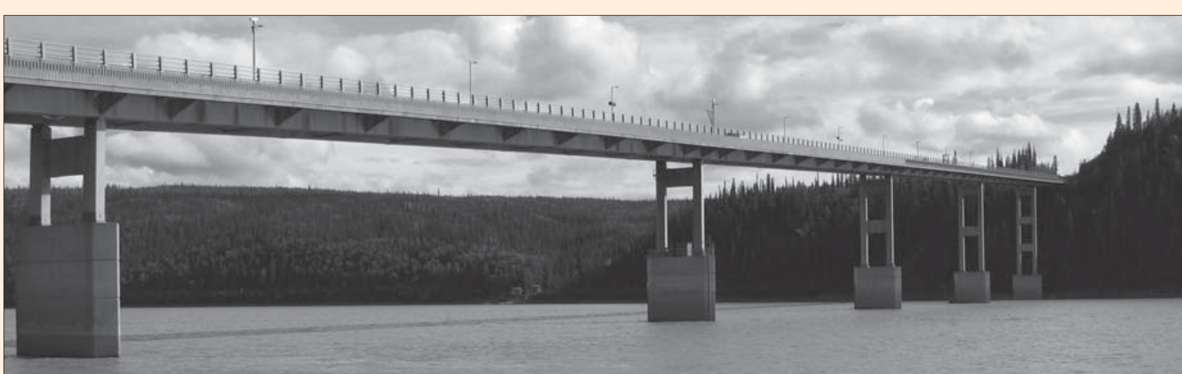
In the early 1970s, the Alaska Department of Transportation and Public Facilities designed this bridge with an eye toward the future. Their design was based on a state-of–the-art orthotropic steel deck. Although far stronger than a concrete structure, and capable of spanning far longer distances, this design did not allow for the weight of a permanent wearing surface such as asphalt. To meet weight limitations, the bridge was decked with layers of strong, light, Douglas fir.

A 6% grade may not sound like much, until you imagine driving a fully loaded tractor trailer up it on a slick, icy, winter day. Truckers often use tire chains to cross the bridge, and AKDOT&PF maintenance crews have found that tire chains and snow removal operations damage the wooden wearing surface and reduce traction quickly.

Over a thirty year period, the timber decking has been replaced several times -- in 1981, 1992, and 1999, and another replacement is already scheduled for the spring of 2007. The trees that produced the original decking were massive old-growth firs, strong and close-grained. Subsequent decking has come from younger trees, which produce softer wood. As timber quality has decreased, time between replacements has also decreased, while material costs always increase. It's time to find more cost-effective, lightweight alternatives.

Dr. Hulsey, Associate Director of AUTC and a structural engineering professor at UAF, is leading a research study that will evaluate alternative wearing surfaces for the Yukon River Bridge. Two graduate students, Zachary Jerla and Wilhelm Muench, are testing state-of-art materials, looking for the one that can stand up to the every day abuse Alaskans dish out.

This team started by reviewing the literature on tire chain damage; surface traction measurements for materials with wet, dry and icy surfaces; and material performance as it relates to the stiffness of the Patton's



Left: The E.L. Patton Bridge, which carries the Dalton Highway across the Yukon River; photo courtesy of AKDOT&PF.

Center: The Muench Machine kitted out to test for tire chain damage. Photo by Zach Jerla.

steel structure. As is often the case for construction in the High North, they found no previous research that described similar testing. It was time to blaze a new trail.

Wilhelm Muench designed a special traction testing machine (see photo at the bottom of the page) that mimics the load and friction created by a truck crossing the bridge.

Muench's machine uses two rams and two load cells to measure the influence of a truck load on a test specimen. One ram applies a vertical load, while the other is used to push or pull the wearing surface under the wheel.

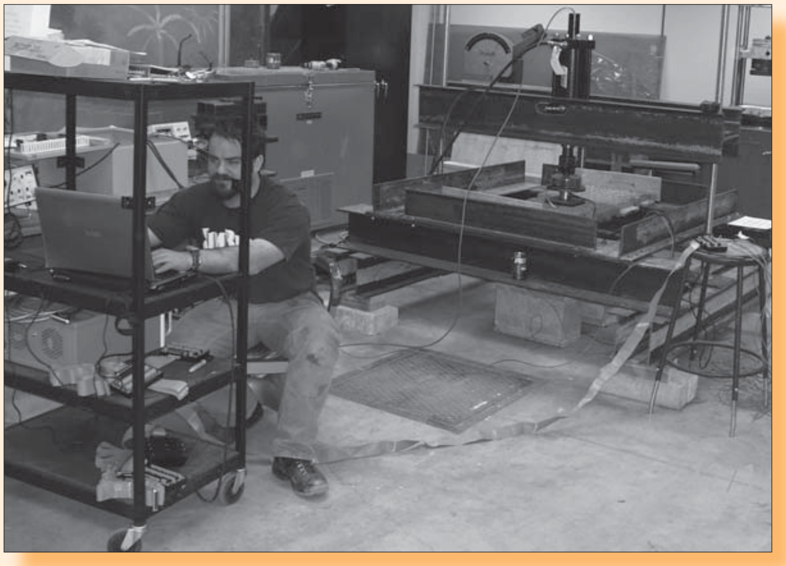
The team uses the Muench Machine to test 18"x 24" samples under three conditions: *Traction.* This is done by locking the wheel, applying a vertical load and measuring drag force as the wearing surface is moved under the wheel. In the photo below, the traction tester operates with a smooth (no chains or studs) tire. *Rolling surface damage* and damage caused by the *tire chain impact* are also measured, recorded, and compared against results for all samples (see the photo opposite, in the middle of the page).

Another innovative trail blazer, graduate student Zachary Jerla, developed a load frame to test the structural flexibility of the various materials considered as possible wearing surfaces.

Jerla's equipment performs two types of tests, both static and dynamic loading: In one, *a concentrated load (single point)* is applied while strains and deflections are measured; in the other, a *load simulating dual truck tires* is applied while displacements and strains are measured.

Both students are evaluating how several different composites behave under various loading conditions.

This study is considering seven different systems: wood on wood, wood on UHMW (ultra high molecular weight polyethylene; this same material is used for applications ranging from snow boards to boat bottoms), UHMW on wood, UHMW alone, FRP (fiber



Zach Jerla operates the load frame he developed for exploring damage caused by load and friction on possible decking samples. Photo by Wilhelm Muench.

reinforced polymer) sandwich panels, FRP cellular panels, and COBRA-X (a brand of Natural High Density Polyethylene material, often used for railroad crossings).

Both the timber and the COBRA-X are considered benchmark materials. The timber has been used since the bridge opened in 1976, and a section (54 feet) of the COBRA-X was installed as an experimental feature in 1991. Although the COBRA-X has endured fairly well, vehicle traction in wet weather has been an issue. Additional studies include evaluating the mechanical properties of these materials and conducting a mathematical approximation for these test samples. The team is conducting both sets of studies at room temperature and at -20F.

Experimental results to date indicate that a composite system made of all polyethylene or FRP performs better than the bridge's original wood/wood system in all testing areas.

Product performance tests will be conducted in the next year, and these should provide us with the data needed to make design decisions regarding which materials will keep people and oil crossing the bridge for the foreseeable future.

To learn more about this project, visit our web site for ongoing research:

http://www.uaf.edu/ine/AUTC/ProjectPages/

Wilhelm Muench uses the traction testing machine he developed to collect data on how a smooth tire performs on various decking samples. Photo by Zach Jerla.

New Research Projects in the Pipeline

AUTC's first call for proposals yielded a flood of thoughtful ideas, ranging from controlling road dust to improving engine efficiency with nanofluids. Researchers working all over the northwest submitted preliminary proposals, representing estimated project costs of around $12 million.

The Phase One proposal call was a whirlwind process. At the end of January, AUTC posted its Request for Proposals, asking faculty on all three University of Alaska campuses and at our partner universities to submit project ideas, which could address research, education, workforce development, technology transfer or any combination of these areas.

In the next two weeks, UAF Associate Director J. Leroy Hulsey logged quite a few air miles, traveling to different campus sites to host workshops on AUTC's goals and process for audiences of potential proposers.

Sixty-five Phase One proposals flooded AUTC's e-mail, most beating the 28 February deadline by the narrowest of margins.

A selection committee, with AUTC's Strategic Plan and the Governing Board's priorities in mind, read, discussed, and ranked each bright idea to enhance and develop transportation in cold regions, then made their recommendations for funding. The committee included the center director and assistant directors as well as recognized leaders in transportation from the northwest and the Federal Highway Administration (FHWA). Each of the 18 successful applicants must document 1:1 cost sharing by 30 April 2007, and submit a full proposal by 15 June.

The AUTC Executive Board will make the final funding selections and forward these to the Research Innovation and Technology Administration (RITA) for approval.

Approved projects will be assigned an expert task group, a team which will provide technical input, help keep the project moving forward, and, finally, review and accept the final project results.

All the new projects should be in full swing by the end of July. Watch our Project Page (http://www.uaf.edu/ine/AUTC/AUTCprojectpage.html) for summaries and reports, and be ready for the next RFP, which will be posted in early September 2007.

Winning Phase One Proposals Included:

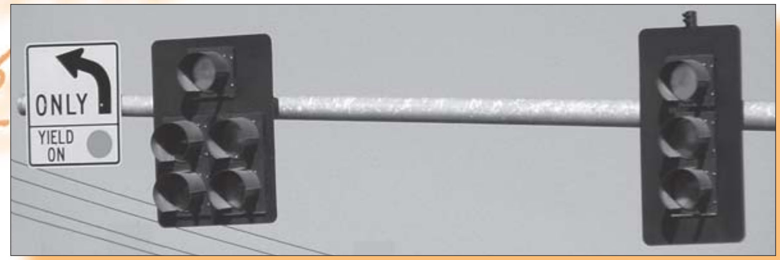
- "Dust Measurement to Determine Effectiveness of Rural Dust Strategies" and "Integrated Vegetation Management Along Alaska's Highways" by D. Barnes
- "Reducing the Size of the Heat Transfer Mechanism in Pollutant Emission and Improving Engine Efficiency with Nanofluids" by D. Das
- "Study of Concrete Maturity Methods in Very Cold Weather" by Y. Dong
- "Evaluating Liquefaction Resistance in Degrading Permafrost and Seasonally Frozen Ground" by K. Hazirbaba & J.L. Hulsey.
- "Seasonally Frozen Ground's Effect on the Seismic Response of Highway Bridges" by J.L. Hulsey
- "Characterization of Asphalt-treated Base Course Material" and "Fines Content Impact on Resilient Modulus Reduction of Base Courses during Thawing" by J. Liu
- "Developing Ambient PM2.5 Management Strategies" by R. Johnson
- "Methodology for RR Freight Forecasts" by P. Metz
- "Developing Ice and Snow Control Plans for Urbanized Areas in the Cold Regions" by M. Lee and D. Barnes
- "Guidelines for Risk Analysis in Construction Contract Changes" by R. Perkins
- "Smart FRP Composite Sandwich Bridge Decks in Cold Regions" by P. Qiao and D. McLean
- "Alaska Bridge Bent Pushover Software, Including Concrete Confinement Effects" by M.H. Scott
- "Preservation of the Alaska Highway" by Y. Shur
- "Calibration of LRFD Design of Deep Foundations in Alaska" by X. Zhang
- "Effects of Permafrost and Seasonally Frozen Ground on the Seismic Response of Transportation Infrastructure Sites" by Z. Yang

Herbicide Attenuation *(from p.1)*

These study results will support AKDOT&PF's efforts to develop an integrated vegetation management plan that is both cost-effective and environmentally safe. In addition, this project is providing hands-on research experience for two undergraduate Civil & Environmental Engineering students, Stacey Frutiger and Will Rhodes. To learn more about this project, visit www.uaf.edu/AUTC/ ProjectPages/.

Twenty Days: Meditations at a Traffic Light

by Billy Connor



I recently installed a navigation system in my vehicle. Like any gadget lover, I had to find a way to justify my new toy, so I went for a drive around town. One great feature of this device is that it will provide information about average moving speed, average overall speed, total time, time moving, and time stopped.

Fairbanks is not a large community, nor do we typically think Fairbanks has a congestion problem. So I was a bit surprised that in that in one hour's drive, I spent 22% of my time for stop lights, stopped at stop signs, or waiting for someone to turn left on a busy street.

Armed with that bit of information, I allowed my navigation system to collect data over a month. During that time, I drove 1,830 miles, mostly between my home in North Pole and work at the University of Alaska Fairbanks, approximately 21 miles.

My route begins with 4 miles of two-lane roadway; the speed limit is posted at 40 mph. The next segment is 12 miles of divided four-lane posted at 55 (though most drive about 60). The third segment is 3 miles of expressway posted at 55 and punctuated by three stoplights. The final leg, about 2 miles, is a four-lane undivided urban roadway with three lights. This segment is posted at 40 mph.

Based on the weighted average of the trip, I calculated that I should be able to travel about 51 mph. However, according to my navigation system, my average moving speed over this period was consistently 39 mph (this includes only moving time, not time stopped).

Assuming I go to and from work only once per day, and subtracting weekends and holidays, I make about 240 round trips per year. Slowing from 51 to 39 mph increases actual driving time to about 63.5 hours per year; again, this doesn't include time stopped.

Unfortunately, I do not have good long term information about time stopped on these trips. Winters are harsh in Alaska (average minimum temperature for the month of February was about -19°F), and we tend to warm our vehicles before traveling. The navigation system logs the time when the engine runs and the car is stationary; it doesn't distinguish between my driveway and the highway. However, a couple of trips to and from work indicate that my "stop light value" is about 6.5 minutes, or 10% of the time.

Using that data, it appears that I'm stopped about 12 minutes per day or about 100 hours per year. So my delays (reduced speed and stopped time together) total about 163 hours per year, or almost 20 work days.

Translate this to the larger delays common in Los Angeles, Chicago, or Houston and you can appreciate why congestion is a major focus of SAFTEA-LU. With the Safe, Accountable, Flexible, Efficient Transportation Equity Act, Congress has challenged the transportation industry to make a difference in our daily commute.

Of course, there is no simple solution. Vehicle miles traveled continues to grow in the US despite increasing fuel costs. At the same time, available money for transportation improvements continues to decrease. All the while, commuter patience is growing thin.

We must get creative together, and there are good ideas for change. Some businesses have either moved or created satellite offices closer to housing areas. Some people are buying two homes, one in the city to use during the week and a weekend home. The public, where possible, often tries to adjust travel times to off-peak hours, working with their employers to establish flex-time schedules, and more people work at home for at least part of their day.

While mass transit can make a huge impact in highly populated areas, these gains diminishes as population density decreases. Pressures to carpool have shown little effect on commuter choices.

There are other promising technological possibilities as well. On a systems level, using traffic simulations provides highway operators with the data necessary to identify and reduce choke points.

Dynamic network optimization of traffic signals can also offer relief. By monitoring changes in vehicle flow, including accidents and weather conditions, engineers can alter signal timing to improve traffic patterns.

Providing in-vehicle traffic information to in-vehicle navigation systems (like mine) could give these systems the capacity to reroute drivers over less congested paths.

No single approach can solve our congestion problems across the nation. After all is said and done, we really have only two solutions: reduce the number of vehicles on the road and move vehicles more efficiently. Finding a solution falls on all of us. Transportation officials cannot do it alone.

AUTC's Outstanding Student

by Sandra Boatwright

Wilhelm Muench won this year's AUTC Outstanding Student Award, which allowed him to attend the Transportation Research Board 86th Annual Meeting held in Washington, D.C. on 21-25 January, 2007.

"Twelve thousand engineers all in a small area makes for an interesting bunch," says Muench, who spent four days attending presentations on structures and bridges. His favorite was "Load and Resistance Design of Concrete Bridge Superstructures." Muench says this type of structural design appeals to him because it allows an engineer to sketch out so many possible creative solutions (the sketch behind this article is one of Muench's designs). Although many designs are based on simple assumptions about stress and shear, "in reality, what's happening in a beam is very complicated." Many structural details common to bridge abutments, for instance, require more complex designs.

According to session presenter Shrinivas Balkrishna Bhide, Muench notes, "managers will hate this design method, because you can give the same problem to 20 engineers, and they'll all give you different, correct answers."

Muench, who is from Ketchikan, Alaska, will complete his M.S. in Civil Engineering this summer. In the future, he says, "what I should do is get a job in Fairbanks doing structural engineering, but I may run away and go surveying."

Every University Transportation Center awards an Outstanding Student; this group shot of the nation's best was taken at the 86th TRB Annual Meeting by the Mineta Transportation Institute. Upper left, AUTC award winner Wilhelm Muench. Photo by Kala Hansen.

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