2011 | 2012

Biannual Report

Alaska Department of Transportation & Public Facilities; Research, Development, & Technology Transfer

Facilitating Continuous Success of Alaska's Transportation Infrastructure

Research, Development, and Technology Transfer
Alaska Department of Transportation and Public Facilities

This is a report of research, development, and technology transfer activities carried out by the Alaska Department of Transportation and Public Facilities and its partners. These projects and services are funded through a combination of state funds and funding from various programs of the Federal Highway Administration (FHWA), U.S. Department of Transportation. This report includes all research, development, and technology transfer activities funded by FHWA's State Planning and Research Program. This report covers federal fiscal years 2011 and 2012, beginning October 1, 2010, and ending September 30, 2012.

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January 2013

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Left to right: Logan Stolpe, college intern; David Waldo, technology transfer manager; Jim Sweeney, R&D engineer; Rosemary Bierfreund, administrative assistant; Rob Harper, communications specialist; Angela Parsons, R&D engineer; Clint Adler, chief of RD&T2; Simon Howell, training specialist.

A Message from the Section Chief

There are many ways to improve the way transportation infrastructure in Alaska is planned, designed, constructed, and maintained for greater efficiency and sustainability. The urgency to take advantage of these opportunities is underscored by the facts:

- Current practices for financing public transportation infrastructure in America and in Alaska are unsustainable over the long run.
- Technology is changing, providing many opportunities to increase efficiency.
- The needs and expectations of the transportation workforce are evolving.
- Existing transportation infrastructure is aging and requires increasing investments in maintenance and/or renewal.

These factors underscore the need for transportation professionals to continuously develop and deploy improved practices for delivering and sustaining Alaska's transportation system so the Alaska economy can continue to prosper. I believe that the Research, Development, & Technology Transfer (RD&T2) section exists to help the Alaska Department of Transportation & Public Facilities (AKDOT&PF) meet this need for continuous improvement. Allow me to share just a few examples of how we've been doing that.

We're Helping AKDOT&PF Achieve Its Vision

During federal fiscal years 2011 and 2012, the commissioner of the AKDOT&PF articulated a strategic direction for the department that emphasized Excellence as a core value—defined as "personal and department commitment to continually improve superior service and products." This strategic direction also highlighted a vision for the department "to create more efficiencies in our current system and develop new corporate and public partners." This strategic direction uniquely emphasized the importance of our role and positioned us well to facilitate and promote new initiatives such as Transportation Asset Management (TAM), the second Strategic Highway Research Program (SHRP2), and the Federal Highway Administration's "Every Day Counts" initiative. Our training and workforce development efforts are nationally recognized for their effectiveness, and our staff proactively promote transportation careers to the next generation of transportation professionals through personal interaction with pre-college students.

We're Building Partnerships

We took this strategic vision and direction to heart. Since 2010, RD&T2 has nearly doubled its research and training efforts through partnerships with the Alaska University Transportation Center, National Highway Institute, other states, and industry. We are also embarking on a new partnership with PacTrans, a new regional consortium of departments of transportation and university transportation centers in the Pacific Northwest states of Alaska, Washington, Oregon, and Idaho. We've already completed one pooled-fund study within this partnership to study opportunities and challenges posed by regional climate change. We also facilitated the development of an interagency agreement to improve coordination, planning, and implementation of efforts to improve safety and reduce conflicts associated with wildlife on roadways. Such agreements foster problem solving earlier in transportation project development, when issues are far easier to resolve, promising faster delivery of Alaska's transportation projects.

These are just a few examples of the value that RD&T2 provides to Alaska's transportation professionals who work very hard to keep Alaska moving through service and infrastructure.

Introduction

The Department of Transportation and Public Facilities Research Development and Technology Transfer Section (RD&T2) receives funding from the Federal Highway Administration's State Planning and Research Program, Local Technical Assistance Program, Surface Transportation Program, and State matching funds.

The RD&T2 Mission

RD&T2's mission is to help the Alaska Department of Transportation and Public Facilities and Alaska's transportation infrastructure organizations achieve continuous success.

This section's core services include:

- technical and professional training
- technical assistance
- research & technology library and information services
- research & technology development
- research management
- research & technology deployment assistance

Our primary goals are to:

- deploy of beneficial research results and technologies
- provide needed, effective, and timely training
- enhance capacity to adapt to new demands
- reduce negative and inefficient practices

R&D Engineer on Team Nominated for Governor's 2012 Denali Peak Performance Award

In 2012 the SiteManager development and implementation team was nominated for the Governor's Denali Peak Performance Award for exceptional performance of a team. Jim Sweeney, P.E., a team member and one of our two R&D engineers, was instrumental in providing guidance and leadership necessary for the success of this team.

SiteManager is an electronic construction management program that provides for data entry, tracking, reporting, and analysis of contract data from contract award through project completion. It is used by all levels of construction personnel, such as field inspectors, technicians, project managers, clerks, auditors, lab personnel, management, contractors, and the FHWA. This is the first use of paperless administration of a construction contract by the State of Alaska. As a result of hard work by the team, the Northern Region construction section began using SiteManager on all FHWA funded projects beginning 2012. With SiteManager, the Northern Region will reduce time needed to reconcile material quantity amounts and contract payments for construction projects, add efficiency to administration of construction contracts, and centralize project records. It will also increase transparency of the department by providing clear audit trails and ease of access to project records for stakeholders.

Congratulations to the team for their foresight in recognizing a better way to do business and their hard work in developing and implementing a change that improves the department.

Research Project Reports Completed in Federal Fiscal Years 2011 and 2012

Project Title	Project No.	Report Title	Report Number	Date Published
Aggregate Abrasion Using Nordic Ball Mill Test	T2-04-01	Assessing Repeatability and Reproducibility of Laboratory Data for the Nordic Ball Mill Test	FHWA-AK-RD-11-02	January 2011
Use of Rubber in Hot Asphalt Concrete to Reduce Rutting	T2-04-02	Use of Rubber-Modified Hot-Mix Asphalt to Reduce Studded Tire Wear and Plastic Deformation	FHWA-AK-RD-10-03	June 2010
Optimizing Implementation of Civil Rights Requirements for Vessel Construction	T2-06-08	Optimizing Implementation of Civil Rights Requirements for Vessel Construction	FHWA-AK-RD-11-05	October 2011
Characterization of Asphalt Treated Base Material	T2-06-09	Characterization of Asphalt Treated Base Course Material	FHWA-AK-RD-10-07	June 2010
Steel Column to Steel Cap Beam Bridge Pier Connection Improvements	T2-07-03	Ductility of Welded Steel Column to Steel Cap Beam Connections	FHWA-AK-RD-10-04	February 2010
Development of Construction Dust Control Protocols	T2-07-05	Construction Dust Amelioration Techniques	FHWA-AK-RD-12-02	April 2012
Evaluation of Alternatives for Integrated Vegetation Management for AKDOT&PF	T2-07-06	Attenuation and Effectiveness of Triclopyr and 2,4-D Along Alaska Highway Rights-of-Way in a Continental and a Coastal Subarctic Environment	FHWA-AK-RD-12-04	December 2009
Demonstration of Non-intrusive Traffic Data Collection Devices in Alaska	T2-07-09	Demonstration of Non-intrusive Traffic Data Collection Devices in Alaska	FHWA-AK-RD-10-10	May 2010
Environmental Impact of Creosote-Treated Alaska Marine piles	T2-07-11	Creosote Treated Timber in the Alaskan Marine Environment	FHWA-AK-RD-09-08	August 2009
Alaska Bridge Bent Pushover Software, Including Concrete Confinement	T2-07-14	Alaska DOT&PF Pile Extension Pier Pushover Software Version 1.0 Installation Instructions and Theory Documentation	FHWA-AK-RD-11-03	February 2011
Seasonally Frozen Ground Effects on the Seismic Response of Highway Bridges	T2-07-15	Seasonally Frozen Ground Effects on the Seismic Response of Highway Bridges	FHWA-AK-RD-12-15	December 2011

Research Project Reports Completed in FFY 2011 & 2012 (cont.)

Project Title	Project No.	Report Title	Report Number	Date Published
Effects of Permafrost and Seasonally Frozen Ground on the Seismic Responses of Transporation Infrastructure Sites	T2-07-16	Effects of Permafrost and Seasonally Frozen Ground on the Seismic Responses of Transporation Infrastructure Sites	FHWA-AK-RD-10-02	February 2010
Seismic Design of Deep Bridge Pier Foundations in Frozen Ground	T2-07-17	Seismic Design of Deep Bridge Pier Foundations in Seasonally Frozen Ground	FHWA-AK-RD-12-05	December 2010
Guidelines for Risk Analysis in Construction Contract Changes	T2-07-20	Evaluation of Risk in Change Orders Report for AKDOT Construction Staff	FHWA-AK-RD-12-16	June 2009
Embankment and Foundation Soils Temperature Monitoring	T2-08-04	Measurement of Temperature and Soil Properties For Finite Element Model Verification	FHWA-AK-RD-12-06	August 2010
Performance Analysis of the Dowling Multilane Roundabouts	T2-08-05	Performance Analysis of the Dowling Multi-lane Roundabouts in Anchorage, Alaska	FHWA-AK-RD-12-08	July 2010
Bridge Deck Runoff: Water Quality Analysis and Best Management Practice Effectiveness	T2-08-11	Bridge Deck Runoff: Water Quality Analysis and BMP Effectiveness	FHWA-AK-RD-12-13	December 2010
Warm Mix Asphalt	T2-08-21	Evaluation of Warm Mix Asphalt for Alaska Conditions	FHWA-AK-RD-12-12	April 2010
Field Study to Compare the Performance of Two Designs to Prevent River Bend Erosion in Arctic Environments	T2-09-07	Study to Compare the Performance of Two Designs to Prevent River Bend Erosion in Arctic Environments	FHWA-AK-RD-12-11	September 2010
Pavement Marking Systems Demonstration	T2-10-03	Nighttime Visibility of In-Service Pavement Markings, Pavement Markers, and Guardrail Delineation in Alaska (With and Without Continuous Lighting)	FHWA-AK-RD-11-04	March 2011

All research reports are available in full text electronically in our online research library at: http://www.dot.state.ak.us/stwddes/research

Summary of 2011–2012 Research Projects

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Aggregate Abrasion Using Nordic Ball Mill Test	T2-04-01	James Sweeney, P.E.	AKDOT&PF regional materials engineers	$65,000 (SP&R)	Completed
Use of Rubber in Hot Asphalt Concrete to Reduce Rutting	T2-04-02	James Sweeney, P.E.	Steve Saboundjian & Newt Bingham, AKDOT&PF	$70,000 (SP&R)	Completed
Experimental Features: Sasobit and Foamed Warm Mix Asphalt Techniques	T2-06-04	James Sweeney, P.E.	Leo Woster, Bruce Brunette, Steve Saboundjian, AKDOT&PF	$134,000 (SP&R)	December 2012
Optimizing Implementation of Civil Rights Requirements for Vessel Construction	T2-06-08	James Sweeney, P.E.	E. W. Morris & Associates	$50,000 (SP&R)	Completed
Characterization of Asphalt Treated Base Material	T2-06-09	James Sweeney, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$75,000 (SP&R)	Completed
Development of GPS Survey Data Management Protocols and Policy	T2-07-02	James Sweeney, P.E.	James Sweeney, P.E. & construction staff AKDOT&PF	$80,000 (SP&R)	December 2012
Steel Column to Steel Cap Beam Bridge Pier Connection Improvements	T2-07-03	Angela Parsons, P.E.	Dr. Mervyn Kowalsky, NCSU	$174,200 (SP&R)	Completed
Development of Construction Dust Control Protocols	T2-07-05	James Sweeney, P.E.	Dr. Robert Perkins, UAF, AUTC	$50,000 (SP&R)	Completed
Evaluation of Alternatives for Integrated Vegetation Management for AKDOT&PF	T2-07-06	Angela Parsons, P.E.	Dr. David L. Barnes, UAF, AUTC	$63,600 (SP&R)	Completed
Demonstration of Non-Intrusive Traffic Data Collection Devices in Alaska	T2-07-09	Angela Parsons, P.E.	Erik Minge, P.E., SRF Consulting	$76,100 (SP&R)	Completed
Environmental Impact of Creosote-Treated Marine Piles	T2-07-11	James Sweeney, P.E.	Dr. Robert Perkins, UAF, AUTC	$85,00 (SP&R)	Completed
Development of Design Criteria for Vegetated Riprap	T2-07-12	James Sweeney, P.E.	Michael Knapp & regional hydrologists, AKDOT&PF	$80,000 (SP&R)	Terminated
Alaska Bridge Bent Pushover Software, Including Concrete Confinement	T2-07-14	Angela Parsons, P.E.	Dr. Michael Scott, OSU, UAF, AUTC	$40,000 (GF)	Completed
Seasonally Frozen Ground Effects on the Seismic Response of Highway Bridges	T2-07-15	Angela Parsons, P.E.	Dr. Leroy Hulsey, UAF, AUTC	$47,600 (SP&R) + $200,000 (GF)	Completed

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Effects of Permafrost and Seasonally Frozen Ground on the Seismic Responses of Transportation Infrastructure Sites	T2-07-16	Angela Parsons, P.E.	Dr. Zhaohui "Joey" Yang, UAA, AUTC	$60,000 (GF) + $12,700 (SP&R)	Completed
Seismic Design of Deep Bridge Pier Foundations in Frozen Ground	T2-07-17	Angela Parsons, P.E.	Sri Sritharan, ISU, UAF, AUTC	$110,000 (GF)	Completed
Guidelines for Risk Analysis in Construction Contract Changes	T2-07-20	James Sweeney, P.E.	Dr. Robert Perkins, UAF, AUTC	$20,000 (SP&R)	Completed
Analysis of AKDOT&PF Pile Driving and Dynamic Pile Testing Results	T2-08-01	Angela Parsons, P.E.	Stephen Dickenson, New Albion Geotechnical	$80,000 (SP&R)	October 2012
Plastic Strain Limits for Reinforced Concrete	T2-08-02	Angela Parsons, P.E.	Dr. Mervyn Kowalsky, NCSU	$300,000 (SP&R)	June 2013
Embankment and Foundation Soil Temperature Monitoring	T2-08-04	Angela Parsons, P.E.	Dr. Margaret Darrow, UAF, AUTC	$58,800 (SP&R)	Completed
Performance Analysis of the Dowling Multi-Lane Roundabouts	T2-08-05	Angela Parsons, P.E.	Dr. Ming Lee, UAF, AUTC	$32,000 (SP&R)	Completed
Evaluation of the Overheight Detection System at the Eklutna Overcrossing Bridge	T2-08-06	Angela Parsons, P.E.	Dr. Ming Lee, UAF, AUTC	$58,500 (SP&R)	October 2012
The Response of Pile-Guided Floats Subjected to Dynamic Loading	T2-08-08	James Sweeney, P.E.	Dr. Andrew Metzger, UAF, AUTC	$100,000 (SP&R)	December 2012
Feasibility Study of RFID Technology for Construction Load Tracking	T2-08-09	James Sweeney, P.E.	Dr. Oliver Hedgepeth, Morgan Henri, UAA, AUTC	$53,000 (SP&R)	December 2012
LiDAR Testing under Heavy Tree Canopy and in Steep Terrain	T2-08-10	James Sweeney, P.E.	Tim Reed, AKDOT&PF	$40,000 (SP&R)	December 2012
Bridge Deck Runoff: Water Quality Analysis and Best Management Practice Effectiveness	T2-08-11	James Sweeney, P.E.	Dr. Robert Perkins, UAF, AUTC	$37,500 (SP&R)	Completed
Frequency and Potential Severity of Red Light Running in Anchorage	T2-08-13	Angela Parsons, P.E.	to be determined	$200,000 (SP&R)	To be determined
Analysis of Electromat At-Grade Moose Crossings	T2-08-14	Angela Parsons, P.E.	David Bryson, ElectroBraid	$270,000 (SP&R)	Terminated August 2012

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Updated Precipitation Frequency Estimation for the State of Alaska	T2-08-15	James Sweeney, P.E.	Douglas L. Kane, Svetlana Stuefer, Dr. Amy Tidwell, UAF, AUTC	$232,549 (SP&R)	December 2012
Application of a Nontraditional Soil Stabilization Technology: Lab Testing of Geofibers and Synthetic Fluid	T2-08-16	James Sweeney, P.E.	Billy Connor, UAF, AUTC	$200,000 (SP&R)	December 2012
Life Cycle Cost Analysis for Alaska Bridge Componenets	T2-08-18	James Sweeney, P.E.	Dr. J. Leroy Husley, UAF, AUTC	$150,000 (SP&R)	December 2012
Using Shallow Anchors and an Anchored Mesh System for Cut Slope Protection in Ice-rich Soils	T2-08-20	James Sweeney, P.E.	Dr. Xiong Zhang, UAF, AUTC	$150,000 (SP&R)	December 2012
Warm Mix Asphalt	T2-08-21	James Sweeney, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$75,000 (SP&R)	Completed
Seismic Performance of Bridge Foundations in Liquefied Soils	T2-09-01	Angela Parsons, P.E.	Dr. Zhaohuri "Joey" Yang, UAF, AUTC	$86,000 (SP&R)	October 2012
Alaska Rural Airport Inspection Program	T2-09-02	Clark Milne & Angela Parsons, P.E.	Dr. David L. Barnes, UAF, AUTC	$80,000 (M&O)	November 2012
Load Environment of Washington State Ferry and Alaska Marine Highway Landings	T2-09-03	James Sweeney, P.E.	Dr. Andrew Metzger, UAF, AUTC	$107,000 (SP&R)	December 2012
Evaluation of In-place Inclinometer Strings in Cold Regions	T2-09-06	Angela Parsons, P.E.	Dr. Margaret Darrow, UAF, AUTC	$222,000 (SP&R)	May 2013
Field Study to Compare the Performance of Two Designs to Prevent River Bend Erosion in Arctic Environments	T2-09-07	James Sweeney, P.E.	Dr. Horacio Toniolo, UAF, AUTC	$33,500 (SP&R)	Completed
Alaska Hot Mix Asphalt Job Mix Formula Verification	T2-09-08	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$130,250 (SP&R)	October 2012
Inclusion of Life Cycle Cost Analysis in Alaska Flexible Pavement Design Program	T2-09-09	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$65,000 (SP&R)	October 2012
Dust Palliative Performance Measurements on Nine Rural Airports	T2-09-10	Clark Milne & Angela Parsons, P.E.	Dr. David L. Barnes, UAF, AUTC	$75,617 (GF)	June 2013

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Foamed Warm Mix Asphalt Lab Testing: Experimental Features in Highway Construction	T2-10-01	James Sweeney, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$26,986 (SP&R)	December 2012
Pavement Marking Systems Demonstration	T2-10-03	Angela Parsons, P.E.	Paul Carlson, TTI	$50,000 (FHWA)	Completed
Phase II: Development of an Unstable Slope Management Program Research	T2-10-04	Dave Stanley, C.P.G.	Landslide Technology, Inc., & R&M Consultants, Inc.	$4,000,000 (STIP)	December 2017
Ductility of Welded Steel Columns to Cap, Part II	T2-10-05	Angela Parsons, P.E.	Dr. Mervyn J. Kowalsky, NCSU, UAF, AUTC	$180,000 (SP&R)	December 2012
Effect of Load History on Performance Limit States of Bridge Columns	T2-10-06	Angela Parsons, P.E.	Dr. Mervyn Kowalsky, NCSU, UAF, AUTC	$167,000 (SP&R)	October 2012
Testing and Screening Surfacing Materials for Alaska's Yukon River Bridge	T2-10-07	James Sweeney, P.E.	Dr. J. Leroy Hulsey, UAF, AUTC	$46,000 (SP&R)	December 2012
Using the Micro-Deval Test to Assess Alaska Aggregates	T2-10-08	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$60,000 (SP&R)	October 2012
Shake Table Experiments of Bridge Foundations in Liquefied Soils	T2-10-09	Angela Parsons, P.E.	Dr. Zhaohui "Joey" Yang, UAA, AUTC	$53,000 (SP&R)	October 2012
Characterization of Alaska Hot Mix Asphalt Mixtures with the Simple Performance Tester	T2-10-10	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$90,000 (SP&R)	October 2012
Stabilization of Erodible and Thawing Permafrost Slopes with Geofibers and Synthetic Fluid	T2-10-11	James Sweeney, P.E.	Dr. J. Leroy Hulsey & Xiong Zhang, UAF, AUTC	$132,000 (SP&R)	December 2012
Performance of Dust Palliatives on Unpaved Roads in Rural Alaska	T2-10-12	James Sweeney, P.E.	Dr. David L. Barnes, UAF, AUTC	$40,000 (SP&R)	December 2012
Selecting Preservatives for Marine Structural Timbers in Herring Spawning Areas	T2-10-13	James Sweeney, P.E.	Dr. Robert Perkins, UAF, AUTC	$72,000 (SP&R)	December 2012
Guidelines for Pavement Preservation	T2-10-14	Angela Parsons, P.E.	Dr. Gary Hicks, California Pavement Preservation Center; Dr. Juanyu "Jenny" Liu UAF, AUTC; Hannele Zubeck, UAA	$91,000 (SP&R)	October 2012

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Experimental Feature: Agreement for Evaluation of AASHTO Ware Products	T2-10-15	James Sweeney, P.E.	Frank Ganley, AKDOT&PF	$10,000 (SP&R) + $94,500 (Construction)	April 2013
Geosynthetic Design Guidelines and Construction Specifications Review and Update	T2-11-02	Angela Parsons, P.E.	Eli Cuelho, MSU, WTI	$73,500 (GF) + $16,000 (SP&R)	March 2013
Strain Limits for Concrete-Filled Steel Tubes in AASHTO Seismic Provisions	T2-11-03	Angela Parsons, P.E.	Dr. Mervyn J. Kowalsky, NCSU, UAF, AUTC	$168,000 (SP&R)	May 2013
Frozen Soil Lateral Resistance for the Seismic Design of Highway Bridge Foundations	T2-11-04	Angela Parsons, P.E.	Dr. Zhaohui "Joey" Yang, UAA, AUTC	$114,000 (SP&R)	December 2012
Experimental Study of Various Techniques to Protect Ice-rich Cut Slopes	T2-11-05	James Sweeney, P.E.	Dr. Xiong Zhang, UAF, AUTC	$85,000 (SP&R)	December 2012
Field Evaluating of Crack Sealing of Asphalt Concrete Pavements in Alaska	T2-11-06	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$90,000 (SP&R)	December 2012
Develop Locally Sourced Salt Brine Additive for Anti-icing	T2-11-07	James Sweeney, P.E.	Xianming Shi, MSU, WTI, Dr. Juanyu "Jenny" Liu, UAF, AUTC	$140,000 (SP&R)	December 2012
Structural Health Monitoring and Condition Assessment of Chulitna River Bridge	T2-11-08	Angela Parsons, P.E.	Dr. J. Leroy Hulsey, UAF, AUTC	$483,000 (SP&R)	December 2013
Knowledge Transfer Needs and Methods	T2-11-09	Clint Adler, P.E.	Dr. Robert Perkins, UAF, AUTC; Lawrence Bennett, consultant	$36,000 (SP&R)	December 2012
Geotechnical Asset Management	T2-11-10	Angela Parsons, P.E.	Dr. Andrew Metzger, UAF, AUTC	$80,000 (SP&R)	December 2012
Economic Impact of Fines in the Unbound Pavement Layers	T2-11-11	Angela Parsons, P.E.	Dr. Juanyu "Jenny" Liu, UAF, AUTC	$90,000 (SP&R)	December 2012
Scientific Framework for Turbity Monitoring	T2-11-12	James Sweeney, P.E.			Cancelled
Alaska Bald Eagles and Highway Construction Projects	T2-11-13	James Sweeney, P.E.	Ben White, AKDOT&PF	$50,000 (SP&R)	June 2013

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
FY 11 CTIP Unstable Slope Management Program (USMP), WFL	T2-12-01	Dave Stanley, C.P.G.	Dave Stanley, C.P.G., AKDOT&PF; Landslide Technology	$80,000 FHWA Western Federal Lands	December 2013
Video Documenting Best Practices for Mitigating Frost Damage to Transportation Infrastructure	T2-12-05	Clint Adler, P.E.	Billy Connor, P.E., UAF, AUTC	$20,958 (SP&R)	December 2012
Whittier Tunnel Signal System Investigation	T2-12-07	Michael San Angelo, P.E.	DOWL HKM & Thomas L. Moses, Jr., P.E., consultant	$150,000 (SP&R)	December 2014
Development of Transportation Asset Management Program (TAMP)	T2-12-08	Victor Winters, P.E.	Paul D. Thompson, Consultant	$80,000 (SP&R)	December 2014
Strategic Communications Assessment	T2-12-09	Clint Adler, P.E.	to be determined	$40,000 (SP&R)	September 2013
Whittier Tunnel Operations Study	T2-12-10	Robert Wright	DOWL HKM & Thomas L. Moses, Jr., P.E., consultant	$150,000 (SP&R)	December 2014
Estimating Future Flood Frequency and Magnitude in Basins Affected by Glacier Wastage	T2-12-11	James Sweeney, P.E.	Anna Liljedahl, UAF, AUTC	$80,000 (SP&R)	June 2013
Investigation of High-mast Light Pole Anchor Bolts	T2-12-12	Angela Parsons, P.E.	Dr. Scott Hamel, UAA, AUTC	$80,000 (SP&R)	December 2013
Maintenance Decision Support System (MDSS)	T2-12-13	Ocie Adams	Billy Connor, P.E., UAF, AUTC	$225,000 (SP&R)	December 2015
Improving Passing Lane Safety and Efficiency for Alaska's Rural Nondivided Highways	T2-12-14	Angela Parsons, P.E.	Billy Connor, P.E. UAF, AUTC; Dr. Ahmed Abdel-Rahim, ISU	$60,000 (SP&R)	March 2013
Use of Lidar to Evaluate Slope Safety	T2-12-15	Angela Parsons, P.E.	Dr. Andrew Metzger, UAF, AUTC	$115,000 (SP&R)	November 2013
Cordova Sectional Barge Study	T2-12-16	James Sweeney, P.E.	Dr. Andrew Metzger, UAF, AUTC	$45,000 (SP&R)	December 2012
Monitoring and Analysis of Frozen Debris Lobes, Phase I	T2-12-17	James Sweeney, P.E.	Dr. Margaret M. Darrow, UAF, AUTC	$60,000 (SP&R)	December 2012

Summary of 2011–2012 Research Projects (cont.)

Project Name	Project No.	Project Manager	Principal Investigator	Total Current Project Funding	Completed or Est. Completion Date
Review of Power Sources for Alaska DOT Road Weather Information Systems, Phase I	T2-12-18	Angela Parsons, P.E.	Dr. Richard W. Wies, Jr., UAF, AUTC	$40,000 (SP&R)	December 2013
A Design for an Interface Board between a MRC Thermistor Probe and a Personal Computer	T2-12-19	James Sweeney, P.E.	Dejan Raskovic, UAF, AUTC	$30,000 (SP&R)	October 2012
Improving Engineering Education Delivery	T2-12-20	Clint Adler, P.E.	Dr. Robert A. Perkins, UAF, AUTC	$30,000 (SP&R)	December 2013
Geotechnical Asset Management Program	T2-12-21	Dave Stanley, C.P.G.	Dave Stanley, C.P.G.	$1,350,000 STIP	September 2015
DOT&PF Leadership Academy Development	T2-12-22	Clint Adler, P.E.	Dr. Robert A. Perkins, UAF, AUTC	$50,000 (SP&R)	June 2014
Assessment of Implementation of SAFETEA-LU Section 6004	T2-12-23	Clint Adler, P.E.	Ben White, AKDOT&PF	$80,000 (SP&R)	June 2014
Geophysical Investigation at Mile 9 Dalton Highway	T2-12-24	James Sweeney, P.E.	Kevin Bjella, Ph.D., CRREL	$23,000 (SP&R)	December 2012
Research for Material Site Inventory/ Management Program		Dave Stanley, C.P.G.	R & M Consultants, Inc.	Material Site Inventory	December 2013
Experimental Feature: Tencate Mirafi H2Ri Wicking Fabric for Inclusion in MP 197-209 Rehabilitation Project		James Sweeney, P.E.	Jeff Currey, AKDOT&PF	$25,000 (SP&R)	August 2015

Federal Fiscal Year 2011 and 2012 RD&T2 Fiscal Summary

	2011	2012
Revenues		
SP&R Program Funds (STIP ID#6451)	$2,053,840	$1,614,880
Western Lands		$80,000
State Project Funds	$100,000	$130,000
NHI Funds (STIP ID#6452)	$350,000	$350,000
Unstable Slope Management Program (STIP)		$4,000,000
Geotechnical Asset Management (Fed #SP000S [902])		$1,350,000
State Match Funds	$513,460	$513,720
Reinvested Project Closures	$170,889	$139,975
Total	$3,188,189	$8,178,575

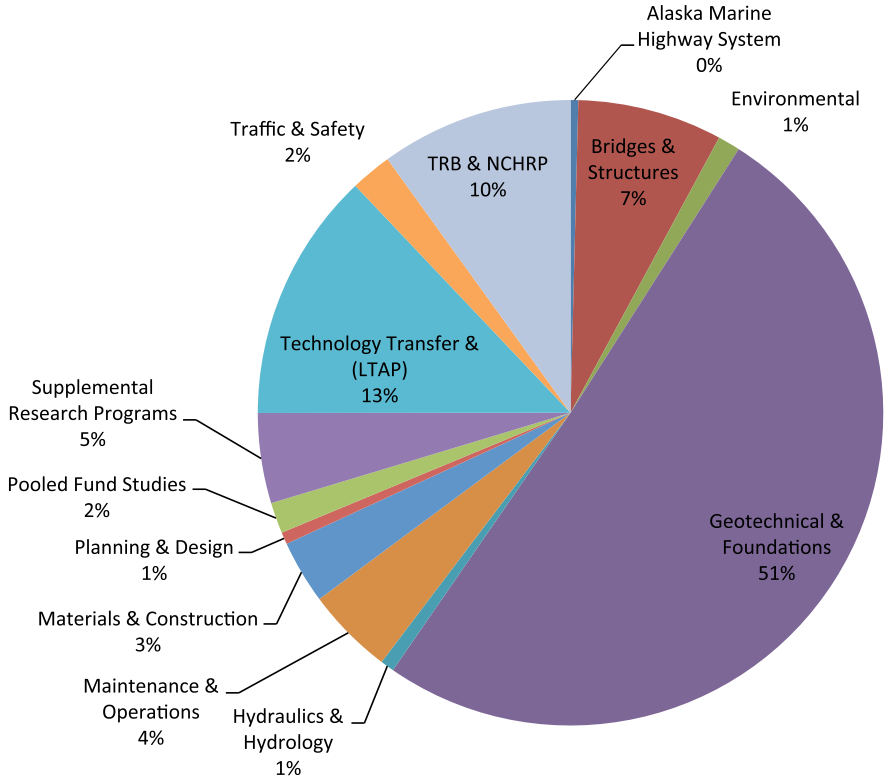
Expenditures and Obligations

	2011	2012
NCHRP Dues	$470,853	$443,631
TRB Core Services	$99,325	$108,955
Pooled Fund Studies	$80,000	$100,000
Technology Transfer/Training	$730,000	$730,000
Research Project Programming (Obligations)	$1,807,999	$1,235,559
Other Research Programming (Obligations)		$5,560,000
Total	$3,188,177	$8,178,145

Research Funding Distribution

Category	Total	2011	2012
Administration & Policy	$206,000	$36,000	$170,000
Alaska Marine Highway System	$45,000		$45,000
Bridges & Structures	$845,000	$765,000	$80,000
Environmental	$130,000	$50,000	$80,000
Geotechnical & Foundations	$5,708,000	$80,000	$5,628,000
Hydraulics & Hydrology	$80,000		$80,000
Maintenance & Operations	$510,000	$230,000	$280,000
Materials & Construction	$369,500	$354,500	$15,000
Planning & Design	$70,000		$70,000
Pooled Fund Studies	$180,000	$80,000	$100,000
Supplemental Research Programs	$525,600		$525,600
Technology Transfer & (LTAP)	$1,460,000	$730,000	$730,000
Traffic & Safety	$240,000		$240,000
TRB & NCHRP	$1,122,764	$570,178	$552,586
Grand Total (33)	$11,491,864	$2,895,678	$8,596,186

Research Programming FFY 2011 & 2012



Acronyms

AKDOT&PF . . Alaska State Department of Transportation and Public Facilities
AUTC . . . . . Alaska University Transportation Center
CCREL . . . . . Cold Regions Research and Engineering Laboratory
FHWA. . . . . Federal Highway Administration
GF . . . . . (State of Alaska) general fund
ISU . . . . . Idaho State University
LTAP. . . . . Local Technical Assistance Program
M&O. . . . . Maintenance and Operations
MSU . . . . . Montana State University
NCHRP . . . . . National Cooperative Highway Research Program
NCSU . . . . . North Carolina State University
NHI. . . . . National Highway Institute
OSU . . . . . Oregon State University
RD&T2. . . . . Research, Development, and Technology Transfer
SP&R . . . . . (FHWA) State Planning and Research
STP . . . . . (FHWA) Surface Transportation Program
TRB. . . . . Transportation Research Board
TTI . . . . . Texas Transportation Institute
UAA . . . . . University of Alaska Anchorage
UAF. . . . . University of Alaska Fairbanks
WTI . . . . . Western Transportation Institute

T2-06-08 Optimizing Implementation of Civil Rights Requirements for Vessel Construction

Principal Investigator: E. W. Morris & Associates, Inc.
Funding: $50,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: December 2010

The research goal is to determine how to effectively implement the Disadvantaged Business Enterprise (DBE), On the Job Training (OJT), and Equal Employment Opportunity (EEO) requirements for contracting on Alaska Marine Highway System (AMHS) ship projects. These contracts do not adapt well to out-of-state shipyards when let with in-state DBE goals and OJT and EEO requirements. In addition, shipyards have difficulty understanding FHWA civil rights implementation requirements.

The research examines practices in other states with ferry systems such as Washington, California, and New York. AMHS and AKDOT&PF Civil Rights Office personnel explained the problems they have encountered in meeting federal civil rights contracting requirements in contracts for AMHS refurbishment and new vessel construction. In instances where projects are funded by only one agency, monitoring contractors' compliance with contract provisions is relatively straightforward. However, when multiple agencies (in this case the FHWA and the Federal Transportation Administration) are involved, civil rights requirements and other guidance may diverge or conflict. Adding to the complexity of the matter is the fact that neither agency's requirements address shipbuilding.

Benefits to the State

The goal of the research is to develop improved bid and contract specifications and a plan to effectively implement DBE requirements of 49 CFR 26 and the AKDOT&PF's federally approved DBE program.

T2-11-09 Knowledge Transfer Needs and Methods

Principal Investigators: Dr. Robert A. Perkins, P.E. (UAF & AUTC, and Lawrence Bennett, Consultant)
Funding: $36,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: December 2012

The objective of this project is to enhance knowledge transfer at AKDOT&PF to more effectively meet its mission to provide for the safe movement of people and goods and the delivery of State services.

Benefits to the State

This research will produce a set of implementable recommendations to help AKDOT&PF capture and transfer many types of knowledge from senior managers and technical experts to those who can use this knowledge to perpetuate the department's ongoing efforts.

T2-12-08 Development of Transportation Asset Management Program (TAMP)

Principal Investigator: Paul D. Thompson, Consultant
Funding: $80,000 (SP&R)
Project Manager: Victor Winters, P.E.
Estimated Completion Date: December 2014

Develop a Transportation Asset Management Plan (TAMP) for AKDOT&PF. The research will synthesize current data, resources, tools, and practices to assess current status of transportation asset management practices and develop a work plan and schedule for improvements.

Benefits to the State

The TAMP is nationally recognized (AASHTO Transportation Asset Management Guide, January 2011, Chapter 4) as an

essential management tool that integrates business processes and stakeholders, internal and external, to achieve a common understanding and commitment for effective and efficient management of public transportation assets. AKDOT&PF will use this tactical-level document to focus its resources most efficiently and ensure that strategic objectives are achieved.

T2-12-09 Strategic Communications Assessment

Principal Investigator: TBA
Funding: $40,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: September 2013

The purposes of this project are to:

1. Improve internal and external communications for AKDOT&PF,
2. Assess effectiveness of investment in organizational communication strategies and techniques, and
3. Develop improved communication approaches and strategies as warranted.

These tasks will be used to assess the effectiveness of the department's external communications and customer satisfaction surveys, recommend improvements, and assess the effectiveness of these improvements.

Benefits to the State

AKDOT&PF's leaders and managers will use the recommendations from this research to improve the effectiveness of their communications with staff and external stakeholders.

T2-12-20 Improving Engineering Education Delivery, Phase I

Principal Investigator: Dr. Robert A. Perkins (UAF & AUTC)
Funding: $30,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: December 2013

The purpose of this project is to evaluate and enhance the effectiveness of various education materials and techniques for delivering academic education programs for transportation professionals.

Benefits to the State

The University of Alaska will use the results of this research to improve the effectiveness of their education offerings for transportation professionals.

T2-12-22 AKDOT&PF Leadership Academy Development

Principal Investigator: Dr. Robert A. Perkins (UAF & AUTC)
Funding: $50,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: June 2014

Investigate the feasibility of developing a cohesive series of training experiences for the AKDOT&PF personnel to prepare them for leadership roles appropriate to their level of responsibility. The research will include literature review, interviews with expert organizations, curriculum development, assessment, and evaluation.

Benefits to the State

This project will identify a feasible strategy for ensuring a sustainable and effective transportation workforce in Alaska.

T2-07-11 Environmental Impact of Creosote-Treated Alaska Marine Piles

Principal Investigator: Dr. Robert A. Perkins (UAF & AUTC)
Funding: $85,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: June 2010

AKDOT&PF is responsible for many structures that incorporate wood pilings and other timber in Alaska waters. Most are treated with preservatives to repel marine borers that quickly destroy unprotected wood. Creosote is generally the most economical and frequently used preservative, but there are growing restrictions on its use because of chemicals it contains.

To develop updated recommendations for preserving structures, this project reviewed current science and regulations on creosote use in marine waters. Even with best management practices, hydrocarbons from new creosote-coated timber leach into marine environments. However, results from the study show their effects may only be temporary. Creosote behavior tests verified that pollutants from marine piles in the water column became negligible after the first few weeks. Researchers found that with several factors—timber treated to best practices, nonanoxic sediments, nonstagnant waters, and no previous contamination—creosote marine timbers were unlikely to pose significant long-term environmental effects.

Further testing indicated that effects were confined to a region close to the structures. These findings greatly helped transportation engineers and decision makers better understand the benefits and limitations of a key structural preservative.

Benefits to the State

Research showed that creosote may still be the best option for wood preservation in marine waters. The main drawback of the creosote, hydrocarbon leaching, becomes negligible within weeks.

T2-08-08 Response of Pile-Guided Floats Subjected to Dynamic Loading

Principal Investigator: Dr. Andrew Metzger (UAF & AUTC)
Funding: $100,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Pile-guided floats are docks that boats and other sea vessels attach to so both ship and dock can move as water levels vary. Pile-guided floats provide an alternative to stationary docks.

AKDOT&PF is considering using floating piers at certain stops along the Alaska Marine Highway System (AMHS). These ocean ports are subject to daily tide height changes. The floats also undergo other forces, such as wind, waves, and the weight of cargo and people as ships load and unload.

There is little design information available concerning how dynamic loading will affect the floats. This project will develop a rational basis for estimating the dynamic response of floating pile-guided structures.

Researchers will develop a model for two different systems. Both models will include functions that represent wave action and vessel loading over time. At the project's end, AMHS and AKDOT&PF will have a validated and ready-to-implement model with good design criteria for both floats and guide-piles.

Benefits to the State

This detailed understanding of the forces acting on pile-guided floats will result in better designs that avoid under and overdesigning. The resulting designs will be more economical and less likely to fail.

T2-09-03 Load Environment of Washington State Ferry and Alaska Marine Highway Landings

Principal Investigator: Dr. Andrew Metzger (UAF & AUTC)
Funding: $107,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

As Pacific commerce and travel grow, docking structures become more important from both an economic and public safety standpoint—especially as new shipping lanes are created by melting trends in northern waters. This project's goal is to mitigate uncertainty about load demands on ferry landing structures. The lack of information about the magnitude of these loads or how they may be determined forces design engineers to make assumptions. These assumptions can lead to costly over-engineering.

Dolphin structures at Homer ferry landing. Photo: Russ Mitchell

For Alaska Marine Highway System (AMHS) facilities, loads imposed on dolphin structures and mooring lines are of most concern. Dolphin structures are marine facilities that rise above the water but are not connected to shore. They are used to extend piers, serve as ship cushions, or display information such as directions or warning lights. Mooring lines are the rope ties that connect ships to docks. They can be damaged by tension from ferry movement in docking, tides, and waves.

The Washington State Ferry System (WSFS) also confronts these uncertainties, specifically in the design of wing wall structures. Wing walls are V-shaped walls that guide a ferry into docking position.

While the structures used by AMHS and WSFS have fundamental differences, the metrics needed to determine appropriate design criteria are the same. The instruments used to monitor these facilities are also similar. This presents an opportunity for a cooperative ccost-sharing project in which AKDOT&PF and WSFS benefit from a much more comprehensive project than either might be able to support individually. The project should hopefully strengthen ties in an already integrated system.

The project team will acquire a robust statistical sample of the metrics needed to define the design criteria. The data will be gathered by monitoring the in-service facilities at the AMHS terminal at Auke Bay near Juneau, Alaska, and the WSFS Seattle terminal in Washington.

So far, the team has completed fieldwork in Auke Bay and Seattle, and has presented portions of its research at the 2011 Coastal Engineering Practice Conference.

Benefits to the State

This project will improve the design parameters for docking structures, making them safer. It also promotes interstate cooperation, sharing resources and technology for mutual benefits.

T2-10-13 Selecting Preservatives for Marine Structural Timbers in Herring Spawning Areas

Principal Investigator: Dr. Robert A. Perkins (UAF & AUTC)
Funding: $72,000 (SP&R)
AKDOT&PF Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Marine harbors and docking facilities are a central piece of Alaska's commerce, trade, and tourism industries. They are key travel conduits in vast regions of the state that lack connected inland roads. Alaska marine harbors use wood for many structures that come in contact with salt water, including piles, floats, and docks. It is economical to buy and maintain. The problem is that wood immersed in salt water is prone to attack by marine borers—various types of marine invertebrates that can destroy a wood structure in only a few years.

Only two wood preservatives are currently recommended for use in Alaska's waters: ACZA (ammoniacal copper zinc arsenate) and creosote. Both have side effects. ACZA is a water-based preservative that leaches copper, which is toxic to both marine invertebrates and other species, into the marine environment. Creosote, an oil-based preservative made from coal tar, leaches hydrocarbon chemicals into the water.

While some research has been conducted on these chemicals, we still have more to learn. For example, some research indicates that copper leaching from ACZA is slight after a year or so, while creosote leaches polycyclic aromatic hydrocarbons (PAH) at a declining rate over time but is still measurable after many years. Previous researchers had difficulty narrowing their searches to these two preservatives because harbors are frequently contaminated with many other chemicals. Determining how these wood preservatives alone impact marine life over time is difficult.

This study will test the toxicity of marine structural preservatives to herring eggs under a variety of conditions common in Alaska marine waters, focusing on Southeast Alaska. It will also compare the durability of creosote-treated versus ACZA-treated marine timbers under comparable climatic and service conditions. Information from this project will help AKDOT&PF make selections of wood structural materials for the marine environment, concentrating on the selection of wood-preserving methods. So far, Perkins has performed toxicity tests on thousands of herring eggs and larvae that were in contact with creosote marine timbers. Over the next year, he will examine chemistry data and take samples near existing creosote structures.

Benefits to the State

Research results will help structural engineers and other marine specialists make better-informed choices about wood preservatives that are both economical and environmentally sound.

T2-12-16 Cordova Sectional Barge Study

Principal Investigator: Dr. Andrew Metzger (UAF & AUTC)
AKDOT&PF Funding: $45,000 (SP&R)
AKDOT&PF Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

This project will help AKDOT&PF's engineers to evaluate the effectiveness and accuracy of the structural design for pile-guided floats for the ferry landing in Cordova.

Benefits to the State

This research will improve or validate structural designs and plans for ferry landings on the Alaska Marine Highway System.

T2-07-03 Steel Column to Steel Cap Beam Bridge Pier Connection Improvements

Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU)
Funding: $174,200 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: February 2010

A common bridge structural system used in Alaska consists of steel pipe columns welded to a steel cap-beam that is comprised of standard HP-shapes. The advantage of such a system is that it is easily constructible. However, there are concerns regarding the ductility capacity of this type of system. Since Alaska is located in a very active seismic region, structures must be capable of deforming to at least a displacement ductility of 6 or more. Past practice has typically used a simple fillet weld to complete the connection between the pile and cap beam. But given the field conditions that often occur during construction, AKDOT&PF bridge design engineers questioned if these bridges would achieve their design ductility level.

The North Carolina State University researchers conducted six full-scale bridge bent tests to evaluate the performance of the system when subjected to simulated seismic loading. The two main goals of the research were to first evaluate the behavior of the system with a simple fillet weld connection and second to improve performance by investigating alternative weld configurations and connection details.

The results indicate that the use of a simple fillet weld led to premature connection failure. Subsequent tests showed that the use of other weld configurations improved the capabilities of the system but were still inadequate for higher seismic regions. However, promising results were obtained from a connection in which the flexural hinge region was relocated away from the pile to cap beam connection weld.

AKDOT&PF implemented these research results by funding the NCSU researchers to conduct a follow-up project to optimize the column capital design. Project T2-10-05, Ductility of Welded Steel Columns to Cap – Part II, is currently underway to fabricate and perform structural testing (including shake table) of nine full-scale bent tests based on the promising configuration resulting from this project and additional connection designs proposed by AKDOT&PF engineers.

Benefits to the State

The recommendations and guidelines produced by these two columns to cap beam connection improvement projects will be used by AKDOT&PF engineers to ensure that Alaska's bridges and marine structures remain safe in major earthquakes.

T2-07-14 Alaska Bridge Bent Pushover Software, Including Concrete Confinement

Principal Investigator: Dr. Michael Scott (OSU, UAF, & AUTC)
Funding: $40,000 (State GF)
Project Manager: Angela Parsons, P.E.
Completion Date: December 2010

The American Association of State Highway and Transportation Officials (AASHTO) is developing new recommendations for bridge designs that can better withstand earthquakes. These new guidelines use pushover analysis, a computer model of a structure is subjected to increasing lateral loading until its components fail. Pushover analysis is an effective way to highlight any weakness in a bridge's performance in an earthquake.

No single, easy-to-use program has been available to design engineers. No programs have focused on the bridge bent design (sometimes called a pier design) most commonly used in Alaska. In the bent design, steel shells encase reinforced concrete columns to improve seismic performance. This project developed software customized for pushover analysis of Alaska-style bridge bents.

Benefits to the State

AKDOT&PF bridge design engineers have implemented this software on several projects and found it to function well. Having software customized for bridge styles common to Alaska will make their work more efficient and save design costs.

T2-07-15 Seasonally Frozen Ground Effects on the Seismic Response of Highway Bridges

Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $47,600 (SP&R) + $200,000 (State GF)
Project Manager: Angela Parsons, P.E.
Completion Date: December 2011

How does frozen ground affect bridge performance? Seasonally frozen ground is stiffer than unfrozen ground. Although we think of bridges as solid and unbending, every bridge will—and should—flex a little under the right conditions, for example during an earthquake. Bridges built on deep pier foundations seem to become less flexible in winter.

This project studied the influence of seasonal change on pier structures, measuring how structures responded to seasonal changes and how bridge stiffness changed over time. Two field experiments were conducted. A bridge was instrumented to monitor its seismic performance and assess the impact of seasonally frozen soil on the overall performance. Two test piles were constructed and tested to failure in both summer and winter conditions to assess the effects of seasonally frozen soils on the lateral performance of single piles.

The team also analyzed computer models of bridge structures under seismic loading and monitored temperatures at test sites to determine the depth and seismic resistance of these structures.

Analysis of the pile test data resulted in recommendations for simplified design parameters based on the equivalent cantilever approach, including depth of fixity, depth-to-maximum bending moment, and length of plastic hinge. The research resulted in simplified design parameters for the equivalent cantilever approach and the frozen silt P-y curve for pile foundation design for seasonally frozen soil–pile interaction during seismic events.

Benefits to the State

This project's results will contribute to AKDOT&PF efforts to enhance the design of Alaska bridges to improve safety and reliability.

T2-08-02 Plastic Strain Limits for Reinforced Concrete

Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU)
Funding: $300,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: June 2013

AKDOT&PF's bridge design engineers are challenged by many unknowns when designing reinforced concrete transportation structures to withstand Alaska's seismic loads. They must use concrete and steel strain limit states that have minimal experimental or theoretical basis. And while the strain limits that are typically used attempt to account for cyclic loading, there is no current basis for their selection. Furthermore, the strain limits typically proposed do not consider the effects of temperature. Lastly, while strain limits that occur early in the nonlinear range are well established, the strain limits that define maximum structural capacity are less well defined.

In design, engineers relate strains to displacement via monotonic section analysis; however, earthquakes impose cyclic loading on structural systems. As a result, strain limits that are currently used can be correlated to different displacement limits, depending on the load history the structure is subjected to.

The objectives of this research project are to propose strain limit states that account for low temperature effects and regional seismic load histories and to develop an approach to allow AKDOT&PF bridge design engineers to easily relate proposed strain limits to target displacements for design.

This project involves the use of analytical, numerical, and physical modeling to investigate plastic strain limits used for designing reinforced concrete structures. For typical AKDOT&PF reinforced concrete circular column sections, the researchers are

studying the role that load history plays on the selection of strain limits for key performance limit states such as serviceability, damage control, maximum load, and collapse.

A determination will then be made if the strain limits are affected by seismic load history and temperature. These criteria will be considered in order to recommend strain limits and how the limits can be used for displacement-based seismic design of bridges to achieve pre-defined levels of seismic performance under pre-defined levels of seismic hazard typical for Alaska.

Benefits to the State

The researchers will provide design recommendations and examples of application for both a force-based approach (current practice) and a displacement-based approach. A workshop will be conducted at the conclusion of this project that will transfer knowledge and assist the AKDOT&PF to improve the safety and reliability of Alaska bridges.

T2-08-18 Life Cycle Cost Analysis for Alaska Bridge Components

Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $150,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Decaying infrastructure and limited renewal funds are moving our national transportation system toward crisis. Which bridges are past their service life? Which could function safely for another decade? What will it cost to replace them? The U.S. Department of Transportation has asked every state to develop a long-range plan (through 2030) for bridge replacement.

To meet this goal, Alaska must create a priority list and a plan to replace its own aging infrastructure. The accepted design life for a bridge is 75 years, but this arbitrary number does not take into account new building techniques, seasonal stresses, or variations in frequency and size of vehicles supported, to say nothing of environmental stresses like scouring, ice damage, and earthquakes. Bridges deteriorate in different ways, at different rates. A more accurate way to determine an existing bridge's service life is essential to the state's plan.

For this project, the research team is collecting data on environmental conditions, material aging processes, repair records, and current costs. Results are contributing to a process for conducting life-cycle cost analyses for highway bridges in Alaska.

Benefits to the State

This project will provide state planners and engineers the tools to estimate an average cost per bridge, as well as the upper and lower bounds of maintenance and/or damage costs.

T2-09-01 Seismic Performance of Bridge Foundations in Liquefiable Soils

Principal Investigator: Dr. Zhaohui "Joey" Yang (UAA & AUTC)
Funding: $86,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

What happens to a bridge foundation during an earthquake? What if the bridge foundation sits on a frozen crust of ground over a layer of soil that behaves as a liquid during an earthquake? How can engineers make bridges strong enough to withstand these natural forces? These are serious safety questions unique to the Arctic, but there are no seismic analysis guidelines to explain how frozen-ground crust affects bridge foundations at liquefiable sites.

This project addresses this knowledge gap by offering the first explanation of how bridge foundations withstand stress loads from a frozen crust disturbed by liquefaction and lateral spreading.

Researchers began this work by constructing a model capable of simulating soil liquefaction. They used the model to simulate how a typical Alaska bridge pile foundation—one embedded in liquefiable soils—would respond to seismic activity. Preliminary results showed that bridge piles were very sensitive to crust conditions. The bridge pile's internal forces changed by roughly

50% as the crust froze. This observation highlights the need for further research into this phenomenon.

Because simply relying on numerical simulations seemed insufficient for this work, researchers wanted to supplement it with an experimental component. The experimental component involved large-scale shake-table experiments conducted in collaboration with counterparts at China's University of Science and Technology in Beijing. Test data, including soil responses and pile internal forces, were used to validate the computer simulation results.

Benefits to the State

The results of this study are improving how engineers design arctic highway bridge foundations in areas threatened by seismic activity. Better seismic performance of Alaska's bridges will increase transportation safety and reduce maintenance and reconstruction costs following a seismic event. The international collaboration developed during this research project could also lead to further collaboration and technology sharing between countries with similar transportation needs.

T2-10-05 Ductility of Welded Steel Columns to Cap, Part II

Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU, UAF, & AUTC)
Funding: $180,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2012

Seismic activity occurs frequently throughout the state, particularly in the Interior, Southcentral, and Coastal regions, where population centers and commercial activity are most abundant. Many bridges and the welded steel piles that support them are strained by these recurring seismic forces.

This research project seeks ways of strengthening bridges by improving their ability to absorb energy. Researchers are looking at ways to improve ductility, the ability of a structure to deform repeatedly without significant loss of strength or stiffness. The project is a continuation of ongoing work to investigate how bridge and marine structures are designed. The project also aims to improve connection design to increase ductility and energy-absorbing capacities.

In the first round of this study, researchers improved construction methods. They proved several existing methods inadequate, such as the current practice of fillet-welding the cap beam to the pile. They also confirmed that a new method of using a plastic hinge-relocating concept was more successful. This new approach shifted force from the welds onto the pile itself, displacing energy that might otherwise degrade the structure.

Benefits to the State

The results of this research should lead to design methods for piles that will make them more durable and resistant to damage from shaking, requiring less maintenance and improved lifespan.

T2-10-06 Effect of Load History on Performance Limit States of Bridge Columns

Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU, UAF, & AUTC)
Funding: $167,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Bridges are crucial, sensitive, and expensive pieces of infrastructure. Earthquakes have the potential to put a lot of force on bridges. This project investigates the impact of seismic loading history on the design of reinforced concrete bridge piles typically used in Alaska, evaluating the amount of strain that can be put upon a structure before it breaks.

Strain limit states are used by researchers when calculating the amount of stress that can be put upon a structure like a concrete bridge column or a steel reinforcement beam. Structural engineers currently use concrete and steel strain limit states in seismic design that have only minimal experimental or theoretical basis.

The team proposed strain limits that accounted for seismic force histories specific to Alaska, using results from experiments that simulate the ground shaking from an earthquake. They applied this force, with similar characteristics that occur in Alaska, to the same kind of piles used for bridge construction in Alaska.

Benefits to the State

The research team will provide AKDOT&PF engineers with tools to refine bridge designs, optimizing for regional seismicity and ensuring that bridges in Alaska remain safe in major earthquakes and serviceable in smaller earthquakes. This advancement, in turn, may improve the reliability of bridges, decrease maintenance costs, and improve safety.

T2-10-09 Shake Table Experiments of Bridge Foundations in Liquefied Soils

Principal Investigator: Dr. Zhaohui "Joey" Yang (UAA & AUTC)
Funding: $53,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Soil liquefaction occurs when stress, usually caused by an earthquake, causes soil to act more like a liquid, losing stiffness and strength. Chinese and American engineers have teamed up to examine how earthquake-associated liquefaction threatens bridge foundations in cold regions. This research is a collaboration with Professor Yulin Yang, an engineer at China's University of Science and Technology in Beijing. The Chinese researcher will share the cost of two large-scale shake table tests, which will integrate physical testing with an ongoing simulation project.

Liquefaction and associated ground failures are common in major earthquakes across Alaska and can cause extensive infrastructure damage. Lateral spreading—a subsurface soil shift that often rips apart fixed infrastructure above ground—is particularly damaging if a nonliquefiable crust rides on top of liquefied soil during an earthquake.

This project examines liquefaction-induced ground failures and their consequences for highway bridge substructures and also aims to validate the results of computer modeling. A key area of interest is how frozen ground layers behave. The physical properties of a crust of frozen ground change drastically in the winter. Stiffness and strength increases and permeability decreases. The force put on a bridge foundation when soils liquefy under a frozen crust is unknown.

Benefits to the State

The knowledge gained from this project will lead to improvements in seismic design of highway bridge foundations in Alaska. The research will reduce the tremendous costs and safety risks created by potential large-scale destruction of key infrastructure during an earthquake. The project also represents a fruitful partnership between two nations that are increasingly dependent upon infrastructure innovations to further their commercial, transportation, and domestic energy needs.

T2-11-03 Strain Limits for Concrete-Filled Steel Tubes in AASHTO Seismic Provisions

Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU, UAF, & AUTC)
Funding: $168,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: May 2013

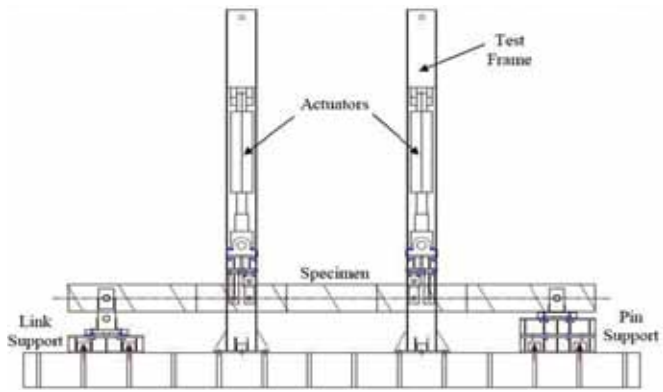
Steel piles are a key infrastructure component. The state's transportation infrastructure uses concrete-filled steel piles because of their strength and simple construction. Research on concrete-filled tubes has only dealt with piles without internal reinforcement and only on a small scale. Important questions are still unanswered about how using these reinforced piles will improve transportation infrastructure in Alaska.

This project addresses several structural questions about the reinforced piles: the impact of the ratio of pile diameter to pile wall thickness and also an analysis of methods to predict how much force it takes to damage the piles.

The NCSU team is conducting two tests in their environmental chamber to capture the effects of low temperatures (–40°C) on structural behavior and performance. Results will provide construction guidance in Alaska by contributing to a concise design manual appropriate for AKDOT&PF use.

Benefits to the State

Knowing the structural limitations of the reinforced piles will help engineers design structures that are efficient and safe.



Structural engineers at North Carolina State University are testing the structural limitations of reinforced concrete-filled steel pipe piles commonly used by AKDOT&PF bridge designers. These images show a schematic of the full-scale testing equipment (above) and a test specimen being subjected to cyclic pushing and pulling (below). Images taken from the project status presentation in April 2012 and Test 8 summary report October 2012 as submitted by NCSU/AUTC to AKDOT&PF.

T2-11-04 Frozen Soil Lateral Resistance for the Seismic Design of Highway Bridge Foundations

Principal Investigator: Dr. Zhaohui "Joey" Yang (UAA & AUTC)
Funding: $114,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2012

Alaska's position on a tectonic plate boundary makes it particularly susceptible to earthquakes. State highway bridge designers must take this into account for public safety and asset longevity.

AKDOT&PF partnered with researchers at UAA to improve the seismic design of highway bridges in Alaska. UAA researchers examined two seismic resistance designs, a fixity-depth and a lateral-resistance approach.

Knowledge about lateral resistance of frozen soils, particularly seasonally frozen soils at shallow depths, will help improve pile foundation design in Alaska. Researchers are conducting experiments to examine seismic effects on frozen soils to construct a model for designers. Few stress-strain behavior studies have focused on small strains (rather than catastrophic failures). This is important for managing assets for long-term use. Also, few studies have made use of naturally frozen samples (as opposed to samples frozen in the lab).

These soil parameters are necessary for predicting the formation and location of plastic hinges and internal loads in bridge pilings embedded in frozen soils. As they develop more information, this team will hold a workshop for bridge design engineers to discuss their findings and how to apply them in the seismic design of bridges.

Benefits to the State

Information on the effect of routine seismic activity on bridge foundations will help the State of Alaska's bridge designers increase the longevity of state bridges.

T2-11-08 Structural Health Monitoring and Condition Assessment of Chulitna River Bridge

Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $483,000.00 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2013

Bridge safety and performance are national transportation priorities and are important challenges for AKDOT&PF as well. New research on innovative structural health monitoring (SHM) technologies currently underway at AUTC is helping address these challenges. This research will focus on SHM protocol development for bridges in cold, remote locations. The project will improve the maintenance and repair of critical bridge structures, potentially extending their service life.

Through remote monitoring and on-site evaluations, the research team is examining the Chulitna River bridge, near milepost 133 on the Parks Highway. This bridge is regularly used by heavy overload vehicles and is an essential link in the safe and efficient movement of people and commerce within Alaska. In 2011 a load rating and structural assessment of this bridge performed by the consulting firm HDR found that although the bridge inspected well, it rated more poorly than expected and recommended it for further analysis using a SHM system.

The team is developing SHM instrumentation and protocol for use on this bridge, with an eye toward extending this approach to bridges throughout Alaska. This SHM system will use a variety of sensors to measure and monitor structural and environmental conditions, providing the information necessary to continuously evaluate the safe performance of the Chulitna River bridge. The system will monitor the behavior of defects or irregularities, collecting and relaying data on the bridge's structural integrity and safety. The data will provide reliable information to improve decision-making about timely maintenance, repair, and closure needs.

Improving safety performance by providing more reliable information quickly on the structural health of any monitored bridge, the system will provide a new safety and management tool along with monitoring capabilities that complement traditional bridge inspection methods.

Benefits to the State

More effective bridge SHM systems can provide structural response data and enable the development of better decision-making tools; augment visual assessment; improve inspection credibility and subsequent rating; help with transportation asset management efforts to assess long-term bridge performance; optimize inspection schedules, maintenance schedules, and dollars; and increase structure reliability.

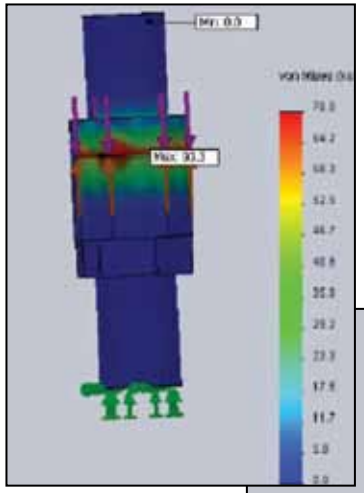
Development of an effective bridge structural health management system will help improve the structural conditions of certain Alaska bridges that are both regionally and nationally critical. For example, bridges such as those on the Dalton and Richardson highways support commercial traffic on the supply routes from North Slope oil and gas resources to Interior and Southcentral Alaska and from there to continental markets.

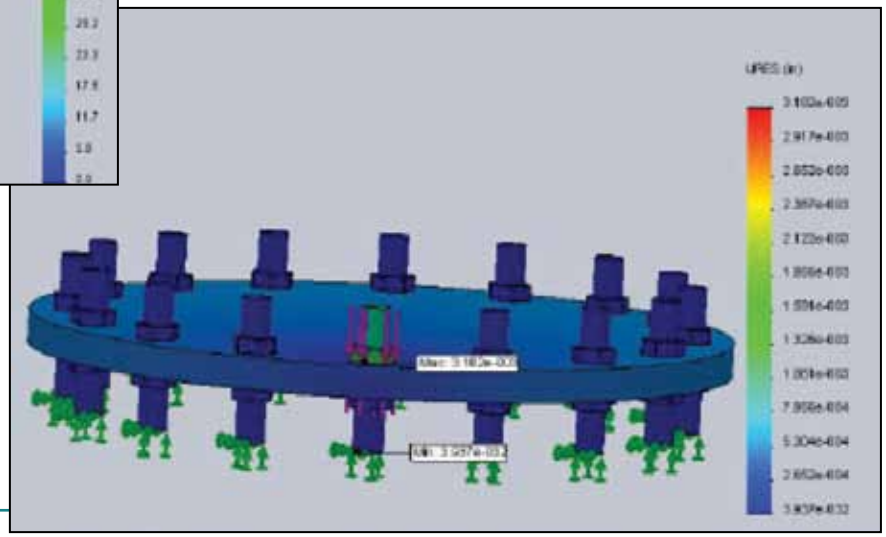
AUTC/UAF researchers and AKDOT&PF (M&O and Bridge Management) team up to begin installation of the fiber-optic-based structural health monitoring (SHM) system on the Chulitna River bridge on the Parks Highway at milepost 132.7. Photos: AUTC.

The SHM system allows researchers and engineers to remotely monitor the status of the bridge. This includes automatic alerts sent via email or text if sensors detect extreme or abnormal movements or conditions within the bridge's structural members.

Top left: Locations of the 112 high-mast light poles in Southcentral Alaska.

Bottom left: The foundation of the high-mast light pole at the Glenn Highway weigh station that will be instrumented and studied to determine why the anchor bolts loosen. Photo: AKDOT&PF.





Right (both): Preliminary modeling results from the research team's August 2012 progress report.

T2-12-12 Investigation of High-Mast Light Pole Anchor Bolts

Principal Investigator: Dr. Scott Hamel (UAA & AUTC)
Funding: $80,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2013

The goal of this project is to reduce the risk of a high-mast light pole failure due to the inability to maintain proper tightness of the anchor bolt nuts at the base of AKDOT&PF's high-mast light poles. Research tasks include observing, measuring, and modeling the structural behavior of these fastening systems. The researchers will characterize the potential failure modes and recommend implementable actions to correct current installations and properly design future installations.

Benefits to the State

Increased safety and reliability of high-mast lighting structures in Alaska and reduced maintenance costs associated with currently necessary monitoring and tightening procedures.

T2-08-11 Bridge Deck Runoff: Water Quality Analysis and Best Management Practice Effectiveness

Principal Investigator: Dr. Robert A. Perkins, P.E. (UAF & AUTC)
Funding: $37,500 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: September 2010

The State of Alaska manages more than 700 bridges; most of them span a body of water. Rain, snowmelt, and storm water runoff from bridge decking flows into these underlying water bodies. Engineers must consider the water quality and regulatory implications of the bridge deck runoff.

The researchers sought to establish a useful set of guidelines for engineers to deal with runoff issues on all of Alaska's bridges. From the precipitation and snowmelt parameters, a rating was developed for each bridge. Engineers then used this rating, together with certain regulatory thresholds, to determine the kind of best management practices necessary for a particular bridge. The results of the investigation were a database of all Alaska bridges and the parameters used to address storm water runoff.

For some bridges, state or federal statutes outline best management practices to help guide engineers. With other bridges, existing guidelines were less clear. The researchers formulated a way of determining what best practices are needed for a specific bridge by eliminating a variety of ambiguous, unclear, or overlapping best practices and safety regulations.

Researchers inventoried Alaska's bridges, focusing on economic and regulatory implications of best management practices, and sought international expertise from other areas with cold region runoff issues. Transportation departments in Norway, Canada, and the northern U.S. were surveyed to identify additional economical and practical best management practices for bridge deck runoff.

Benefits to the State

Best management practices for bridge deck runoff will help engineers design, build, and maintain bridges. It will ensure the wetlands and water systems around Alaska's bridges stay free of contamination.

University Avenue bridge, Fairbanks. Photo: Dr. Robert A. Perkins, P.E.

T2-11-12 Scientific Framework for Turbidity Monitoring

Principal Investigators:
Funding: $160,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: Project Cancelled

The objective of this research was to develop a set of guidelines and procedures that would insure that AKDOT&PF is in compliance with water quality (National Pollutant Discharge Elimination System) permits for construction activities. These guidelines would be specific to turbidity.

This state research effort was cancelled because the National Cooperative Highway Research Program (NCHRP) project 10-90 "Guidance for Complying with EPA Effluent Limitation Guidelines for Construction Runoff" will accomplish this objective.

Benefits to the State

This effort will help state departments of transportation comply with federal water quality requirements on transportation construction projects.

T2-11-13 Alaska Bald Eagle and Highway Construction Projects

Principal Investigator: Ben White, Statewide Environmental Manager
Funding: $50,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: June 2013

In May 2007 the U.S. Fish and Wildlife Service (USFWS) established new national bald eagle management guidelines as a result of the bald eagle being delisted from the threatened and endangered species list. On September 11, 2009, the USFWS published new regulations that included a new bald eagle permit process and two permits that could be applied for prior to construction projects that may impact bald eagle nests. These new regulations and permits have been difficult to follow and the permits are very difficult to obtain.

Monitoring for three years may be required for permits, and there will be an annual reporting requirement. Alaska has a very high population of bald eagles and managing these stocks based on national guidelines does not work well here. Permits can take 60 to 90 days to obtain. The Southeast Region has been working closely with the USFWS on developing a monitoring effort to establish impacts associated with chip-seal maintenance of roads in Southeast. This research project would use the Southeast Region example and expand on it to develop a monitoring program for bald eagles within road corridors.

There are two objectives with this project:

1. Work with the USFWS to update their database on known active bald eagle nests within highway corridors.
2. Develop a review of available literature and project-specific monitoring reports that have been developed by the department over the last few years indicating which activities actually affect bald eagles in Alaska.

Benefits to the State

The development of a programmatic approach to dealing with bald eagles for highway and airport projects would streamline the permit process and allow AKDOT&PF to start construction projects sooner and at a better time of the year to further reduce impacts to bald eagles.

Eagle nest close to the Sterling Highway at Homer. Photo: Jothika Thivakaren, AKDOT&PF.

T2-12-23 Assessment of Implementation of SAFETEA-LU Section 6004

Principal Investigator: Ben White, Statewide Environmental Manager
Funding: $80,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: June 2014

This project will assess the effectiveness of the AKDOT&PF implementation of the SAFETEA-LU Section 6004 provisions and identify improvements. The research will include interviews with other states and a literature review to identify and evaluate best practices and make recommendations.

Benefits to the State

This research will identify some opportunities to streamline transportation project delivery.

T2-07-16 Effects of Permafrost and Seasonally Frozen Ground on the Seismic Responses of Transportation Infrastructure Sites

Principal Investigator: Dr. Zhaohui "Joey" Yang (UAA & AUTC)
Funding: $60,000 (State GF) + $12,700 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: February 2010

Transportation engineers are eager to learn about how permafrost changes infrastructure's ability to withstand seismic force, like that generated during an earthquake. This interdisciplinary project combined seismic data recorded at bridge sites with computer models to identify how highway bridges built on frozen ground behave during an earthquake.

Two sites—one in Anchorage and another in Fairbanks—were selected for seismic testing. In assessing seismic motion in frozen soil, researchers considered the thickness of seasonally frozen soil, depth and thickness of permafrost, and depth of the bedrock.

Results showed that the presence of frozen soil, particularly permafrost, significantly changes ground motion characteristics.

Benefits to the State

The study's results will contribute to new guidelines that help engineers design better highway bridges, ideally identifying how to account for permafrost effects in a simpler manner. These guidelines will help designers create more durable, long-lasting transportation corridors and reduce maintenance and safety risks.

T2-07-17 Seismic Design of Deep Bridge Pier Foundations in Frozen Ground

Principal Investigator: Dr. Sri Sritharan (ISU, UAF, & AUTC)
Funding: $110,000 (State GF)
Project Manager: Angela Parsons, P.E.
Completion Date: December 2010

Solid foundations are essential for structural integrity when applying extreme loads. This project developed design methods for pier foundations that are customized for Alaska's bridges supported by soils that are subject to extreme seasonal temperatures.

Researchers tested how reinforcing steel, concrete, and soil all behave under warm and cold conditions. They demonstrated how cold temperatures impact the behavior of reinforced concrete and, most importantly, the behavior of the soil-foundation-structure interaction. The team established procedures to perform material tests at cold temperatures. They discovered that temperature effects on steel reinforcement caused different behaviors from what previous research described for comparable steel.

Researchers also discovered the inadequacy of the existing methods proposed for seismic design of drilled shafts. They developed a more rational design methodology for drilled shafts in cohesive soil. Project results included a review of the state-of-the-art on seismic design of drilled shafts. These findings were used to establish a new design methodology tailored to seismic regions subjected to seasonal freezing, especially relevant to Alaska bridge designers.

Benefits to the State

Research into the dynamics of pier foundations in frozen soils may increase durability of bridges by helping engineers design and build bridges more resistant to earthquakes.

T2-08-01 Analysis of AKDOT&PF Pile Driving and Dynamic Pile Testing Results

Principal Investigator: Dr. Stephen Dickenson (New Albion Geotechnical, Inc.)
Funding: $80,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

In 2000, the Federal Highway Administration and AASHTO set a transition date of October 1, 2007, after which all new bridges must be designed by the load and resistance factor design (LRFD) method. AASHTO recommends that the resistance factors should be obtained from a probability approach based on risk of failure in order to make sure that the design is neither excessively conservative nor unsafe.

While no load test data is available for Alaska pile foundations, a large number of pile driving records and dynamic pile test results had been collected over the years. Dynamic load testing and analysis is commonly required by the AKDOT&PF to confirm the axial capacity of piles in the difficult (interlayered, predominantly cohesionless) soils encountered in Alaska. AKDOT&PF foundation and geotechnical engineers needed this information to be compiled and available electronically and then analyzed to provide a perspective regarding past pile design experience.

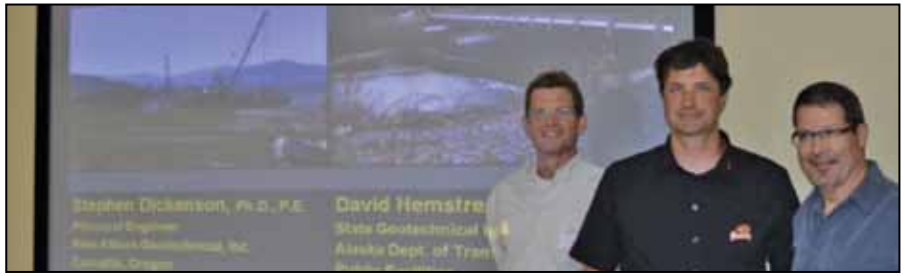
The project's principal investigator created a database of historic pile driving and dynamic pile testing information (68 piles at 32 project sites) that AKDOT&PF can easily maintain in the future. This database includes information such as site location, geologic conditions, pile characteristics, hammer and driving system, driving resistance, and pile driving analyzer (PDA) data. Also included are the results of analysis from the Case Pile Wave Analysis Program (CAPWAP) and case method along with correlations between the CAPWAP-derived capacity and the results of four common dynamic formulae.

Because of the lack of static load test data from AKDOT&PF projects, the researcher used this extensive collection of dynamic load test data to develop PDA/CAPWAP-based correlations for static axial capacity. Two practice-oriented methods making use of the PDA database are proposed from the research. This investigation highlights the uncertainty inherent in pile capacity estimation procedures applied to cohesionless soils in Alaska and provides additional tools for refining capacity dynamic methods making use of field pile driving records. The proposed methods have been developed for predominantly cohesionless soil deposits in Alaska and provide correlation to the static axial capacity of open-ended steel pipe piles derived from dynamic analysis. Therefore they inherently reflect the same limitations that may be associated with CAPWAP estimates for the pipe piles making up the database (diameters of 18 to 48 inches with embedment lengths of 23 to 170 feet).

The researcher also provides a design example to illustrate the recommended procedures for bracketing the likely range of axial capacity for open-ended pipe piles using the proposed PDA-Based method and Effective Stress method.

Benefits to the State

Benefits are in the safety and economic advantages gained from improved estimation of pile length. The resulting database of historic pile driving records will be easy to update and an important knowledge source.



Left to right: researcher Stephen Dickenson and AKDOT&PF's Dave Hemstreet (statewide foundation engineer) and Dave Stanley (chief engineering geologist) present the Analysis of AKDOT&PF Pile Driving and Dynamic Pile Testing Results at the 37th Northwest Geotechnical Workshop in Washington state, August 2012. Dr. Dickenson was recognized for making the best technical presentation at this workshop.

T2-08-04 Embankment and Foundation Soil Temperature Monitoring

Principal Investigator: Dr. Margaret Darrow (UAF & AUTC)
Funding: $58,800 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: December 2010

This study sought to develop ways of stabilizing embankments to reduce permafrost thawing, which severely damages roads and other structures. AKDOT&PF personnel use a program called TEMP/W to conduct thermal modeling of various embankments to reduce the thawing of ice-rich permafrost through thermally stable embankment designs. The study's goal was to verify the thermal modeling results produced by TEMP/W. Temperatures and soil properties were measured at two different sites underlain by permafrost in Interior and Southcentral Alaska.

While historic air temperature data provided an approximation of the regional climate, the data produced model results that were too cold by several degrees. Using air temperatures measured at each site resulted in models that closely matched the measured soil temperatures and either matched or overestimated active layer depths. Using the overestimated active layer depth for design purposes would result in a more conservative embankment construction, which is best if a warming climate is considered. This realization helped refine the current use of TEMP/W, giving engineers a clearer picture of the thermal interaction between permafrost and overlying embankments.

Benefits to the State

Accurately modeling permafrost layers and designing embankment to keep them frozen is crucial. A thawing permafrost embankment can cause damage and higher maintenance costs to a road. Erosion from the thawing embankment can also cause damage to any streams or wetlands in the area.

T2-08-20 Using Shallow Anchors and an Anchored Mesh System for Cut Slope Protection in Ice-Rich Soils

Principal Investigator: Dr. Xiong Zhang (UAF & AUTC)
Funding: $150,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Permafrost soils present problems to building infrastructure in Alaska. When permafrost ground is cut to make way for a road, the soil may thaw and slump or collapse, damaging the road. As many as six years may pass before new vegetation restabilizes a cut bank. Engineers can design embankments to compensate for these soil changes and protect roadways, but eroding soils impact water quality and fish habitat. Engineers are looking for new designs to protect the immediate environment, meet federal guidelines, and remain economically viable.

This project, in partnership with AUTC, is investigating how shallow anchors perform in frozen soils. Project outcomes include designing an anchored wire mesh system to protect and stabilize ice-rich cut slopes. Anchor creep tests have been completed in the laboratory, and field tests and simulation analyses continue. The findings will be useful for other types of mitigation strategies, including highway retaining walls, and for addressing rockslide areas.

Benefits to the State

These improved strategies will help control maintenance costs and water resource concerns that often come with thawing permafrost.

T2-09-06 Evaluation of In-Place Inclinometer Strings in Cold Regions

Principal Investigator: Dr. Margaret Darrow (UAF & AUTC)
Funding: $222,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: May 2013

In Alaska, subsurface movement of frozen ground impacts transportation infrastructure, threatening roads, bridges, runways, railways, and other vital structures. Knowledge about the subsurface is essential for transportation planners in Alaska. Researchers are striving to better understand how these forces work.

This study is an effort to improve how inclinometers—tools used to measure ground movement—perform in cold regions. Inclinometers measure vertical and horizontal ground movement on slopes, bridges, and other structures.

Current inclinometer technology presents some drawbacks. Since data acquisition requires manual measurements, workers may face expensive and potentially dangerous travel. Weeks or months often pass between manual readings due to budget considerations, causing workers to interpolate the recorded data. Accurate data collection varies depending on the care and skill level of the person taking measurements. The inclinometer casing has limited flexibility and can shear when excessive ground movement occurs. In addition, the inclinometer probe length limits the amount of ground movement it can measure.

A new type of geotechnical instrumentation will allow for remote electronic sensors together with the inclinometer. These accelerometers are more flexible and can withstand greater ground movement. When the installation is accompanied by a remote power supply and a telemetry link, they can provide nearly continuous observation of ground movement without frequent field trips. Moreover they are potentially reusable.

This technology is new and has not been fully evaluated, especially in cold regions. The durability of the system at subfreezing temperatures needs to be evaluated.

Researchers are comparing this and the existing methodology, evaluating its cold region versatility and accuracy, and testing its ease of use and recoverability. The project will also evaluate applications for the technology in Interior Alaska. Fieldwork and data analysis will allow researchers to develop a set of best practice guidelines for using applications of the technology.

Benefits to the State

Technology like this will help AKDOT&PF monitor and manage its transportation infrastructure with more accuracy and less manpower. Ground movement data will also allow give designers a better idea of how to design infrastructure against environmental challenges.

T2-10-04 Phase II: Development of an Unstable Slope Management Program

Principal Investigators: Lawrence Pierson, Landslide Technology, Inc., & Peter Hardcastle, R&M Consultants, Inc.
Funding: $4,000,000 (STP)
Project Manager: Dave Stanley, C.P.G.
Estimated Completion Date: December 2017

Benefits to the State

The USMP is part of the overall Geotechnical Asset Management Program and focuses on one class of geotechnical assets: soil and rock slopes. This project is still in its initial stages for two areas: (1) inventory and condition survey to identify, assess, and rate our unstable slopes for hazard and risk; and (2) developing a knowledge base about our slopes, their condition over time, and how to manage the slopes on a lifecycle cost basis to optimize performance in support of our transportation system.

Drilling of the soil and rock slope on Glenn Highway in preparation for the Tecco Mesh used to reinforce the soil slopes. Reinforced rock slopes are examples of geotechnical assets that will be included in research that will help the AKDOT&PF to assess conditions, predict service life, manage risk, and reduce life-cyle costs. Photo: Terry Barber, AKDOT&PF.

T2-11-10 Geotechnical Asset Management

Principal Investigator: Dr. Andrew Metzger (UAF & AUTC)
Funding: $80,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2012

Geotechnical assets—things like rock and soil slopes, shore protection, embankments, retaining walls, material sites, bridge foundations, tieback anchors, and more—literally touch or affect every other physical asset owned by the AKDOT&PF. Because of this interconnection, effective management of geotechnical assets is necessary to maintain the level of transportation safety and service required by people who use the transportation system in Alaska. AKDOT&PF Commissioner Marc Luiken recently identified asset management as the second of six key initiatives the department will target in its new strategic plan.

This project seeks to develop a framework for addressing challenges related to geotechnical asset management (GAM) that can be implemented with other asset management systems. Overcoming the several salient challenges GAM brings is integral to any comprehensive management approach. For instance, unpredictable service life, financial accounting complexities, and difficulties with maintenance performance are among the proven obstacles to managing geotechnical assets within most infrastructure organizations, including those in Alaska.

The researchers expect the GAM project to produce a "road map" for transportation-related GAM in the state of Alaska. This draft program framework will include specific planning recommendations that address the most significant challenges for implementation of GAM across the broad range of geotechnical assets owned by AKDOT&PF.

Benefits to the State

Implementing a geotechnical asset management plan will give AKDOT&PF a better idea of repairs and maintenance that need to be done to its geotechnical assets.

T2-12-01 FY 11 CTIP Unstable Slope Management Program (USMP), WFL

Principal Investigators: Dave Stanley, C.P.G (AKDOT&PF) with Landslide Technology, Inc. (Portland, OR)
Funding: $80,000 Western Federal Lands Coordinated Technology Implementation Program
Project Manager: Dave Stanley, C.P.G.
Estimated Completion Date: December 2013

Provide support to FHWA Federal Lands Highway Division by adapting and demonstrating AKDOT&PF's Unstable Slope Management Program (USMP) for several federal lands agencies (Bureau of Indian Affairs, National Park Service, Federal Lands Highways, U.S. Forest Service, and U.S. Fish and Wildlife Service) associated with the Coordinated Technology Implementation Program. Demonstrations are planned for the West (probably near Denver) and the East (probably Great Smokies National Park).

Benefits to the State

Further development of the USMP by (1) adapting and deploying USMP to federal agencies for implementation of asset management for slopes, the work for which will (2) also result in continued advancement of the USMP program and further refinement of the hazard and risk management aspects of the USMP along with more advanced aspects of geotechnical asset management, including estimates of service life and development of condition indices, service levels, and performance measures.

T2-12-15 Use of LIDAR to Evaluate Slope Safety

Principal Investigators: Dr. Andrew Metzger (UAF & AUTC)
Funding: $115,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: November 2013

Evaluate the potential for light detection and ranging (LiDAR) technology for mapping and managing unstable slopes. Mobile vehicle-mounted laser-scanning equipment will be used to collect data on two unstable slopes along Alaska's highway system. The researchers will analyze the data and prepare analytical geospatial based tools and/or models useful for developing an unstable slope management program.

Benefits to the State

This project will produce improved tools for managing unstable highway slopes. When implemented, this will create cost-effective and proactive slope remediation, which will increase traveler safety and reliability on Alaska's highway corridors.

Rockfall on the Glenn Highway at the Glenn Highway Long Lake unstable slope research site at milepost 73–83. Photo: Andrew Pavey, AKDOT&PF.

Truck-mounted mobile LiDAR scanning system including inertial GPS proposed for use on highway slope scanning in Alaska. Photo from the research project team's September 2012 presentation to AKDOT&PF.

The project team brings multi-organizational and discipline research expertise to the study of slope asset management. Photo: research project team's September 2012 presentation to AKDOT&PF.

One of the slopes being studied on the Parks Highway near milepost 240. The research team is using the GigaPan website to display and study high-resolution panoramic images.

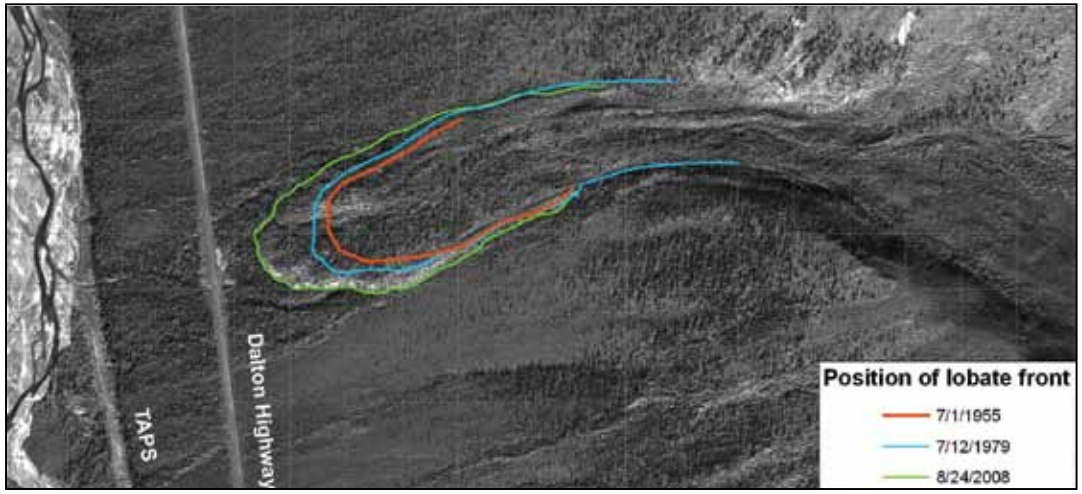
T2-12-17 Monitoring and Analysis of Frozen Debris Lobes, Phase I

Principal Investigator: Dr. Margaret Darrow (UAF & AUTC)
Funding: $60,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

A large mass of frozen material is slowly approaching the Dalton Highway at milepost 219. This research will analyze the movement of the frozen debris to learn the soil properties and rate of movement. The research will instrument boreholes drilled as part of the Dalton milepost 209-235 materials investigation.

Benefits to the State

Results of the research will enable selection of the best mitigation technique to prevent damage to the Dalton Highway.



Position over time of debris lobe at Dalton milepost 219 from 1955 to 2008.

T2-12-21 Geotechnical Asset Management Program

Principal Investigators: Dave Stanley, C.P.G.
Funding: $1,350,000 (STP)
Project Manager: Dave Stanley, C.P.G.
Estimated Completion Date: September 2015

This effort will create geotechnical asset management (GAM) program architecture and research and develop performance measures, methods for predicting future performance of assets, and analysis methods. It will create an inventory and condition survey for assets and monitor the performance of assets over time and compare them to performance measures. The project will provide decision-making support to agency management on maintenance, repair, and rehabilitation alternatives.

Benefits to the State

The GAM program is an important element of the overall implementation of best transportation asset management practices for AKDOT&PF. The GAM program defines the role that geotechnical assets take in both primary roles like rock slopes and in supporting roles such as embankments supporting pavement structure. The research for this project will take the department many steps forward in understanding the characteristics of geotechnical assets as to the length of service life, condition during service, appropriate service levels and performance measures, incorporation of risk management, determination of life cycle costs, identification of critical data elements required, and development of the means to store and use the data in support of a decision-support framework for managing our transportation system.

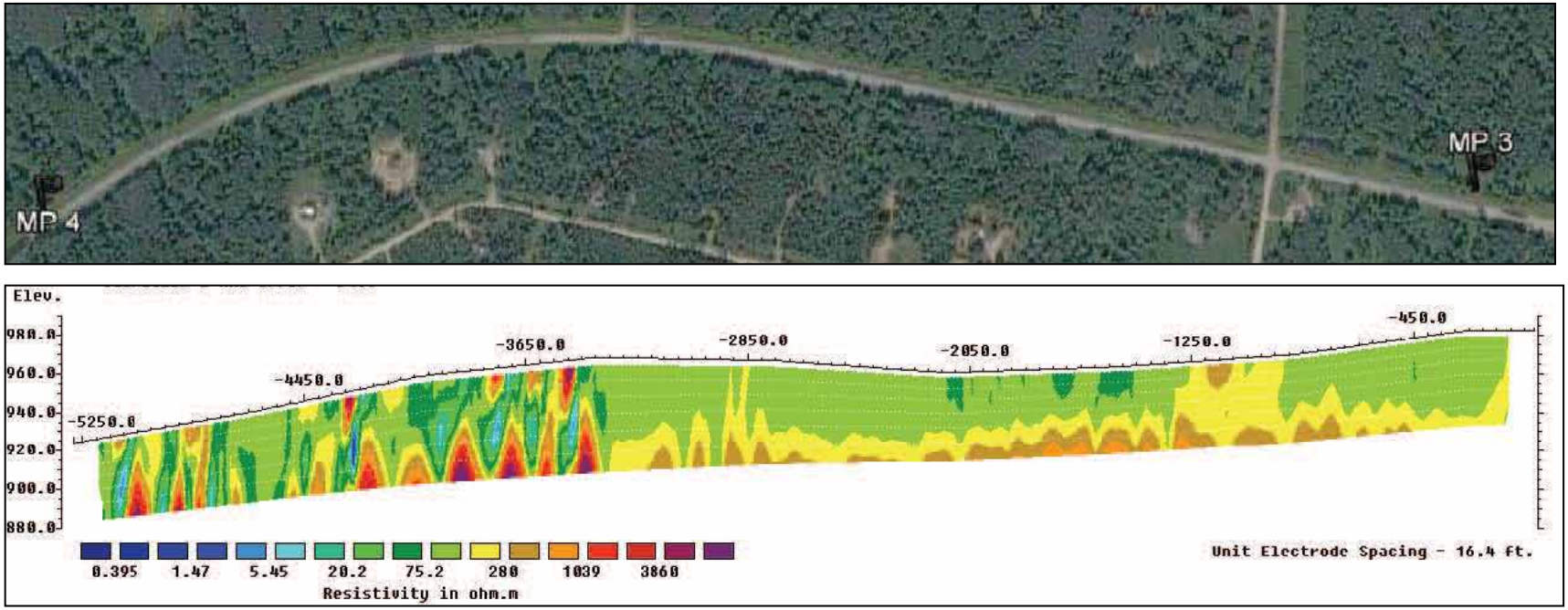
T2-12-24 Geophysical Investigation at Mile 9 Dalton Highway

Principal Investigator: Kevin Bjella, PhD., Cold Regions Research & Engineering Laboratory (CRREL)
Funding: $23,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) will conduct a geophysical survey on the Dalton milepost 9–11 construction project. The geophysical survey results will be made available to AKDOT&PF design and construction staff for consideration in design revisions. CRREL will produce a report relating the geophysical survey to the Dalton milepost 9–11 materials report.

Benefits to the State

The research will evaluate the OhmMapper geophysical survey instrument as a predictive tool for detection of permafrost extent and severity. The use of continuous geophysical surveys is expected to be an inexpensive preliminary evaluation tool for alignments in permafrost areas. The department will use geophysical surveys as a supplement to borehole drilling programs.



Earth resistivity survey of milepost 3–4 Goldstream Road, showing probable permafrost areas. Photo: Kevin Bjella, CRREL.

T2-07-12 Development of Design Criteria for Vegetated Riprap

Principal Investigators: Michael Knapp and regional hydrologists
Funding: T2-07-12: Terminated
T2-07-10: $80,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: Terminated

The intent of this research project was to identify, evaluate, and document the biological benefits of and engineering design, construction, and maintenance criteria for vegetated stream bank protection. The research project team chose to terminate this research project and address the biological and engineering concerns on a case-by-case basis.

T2-08-15 Updated Precipitation Frequency Estimation for the State of Alaska

Principal Investigators: Douglas L. Kane, Svetlana Stuefer, and Dr. Amy Tidwell (UAF & AUTC)
Funding: $232,549 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Designing and building river and stream crossings like bridges, culverts, buried utilities, and pipelines is costly. Designers of these structures need good hydrological and meteorological estimates of stream flow and precipitation. This type of data is very sparse in Alaska.

Rainfall intensity maps for Alaska were created in the early 1960s. These maps haven't been updated in about 50 years.

AKDOT&PF got into this project with faculty in the Water and Environmental Research Center at UAF/INE and researchers at NOAA/NWS Hydrometeorological Design Studies Center in Washington, DC, to refashion the intensity-duration-frequency (idf) analysis maps for the state of Alaska. They used the most recent data up to 2010.

So far, the team has compiled data from over 1,000 stations from federal and state agencies and several university institutions, formatted and examined the quality of precipitation data, merged neighboring stations, estimated preliminary idf values, and reviewed spatially distributed estimates over all of Alaska.

The results of this study will be available online in electronic format in November 2012 as volume 7 of the NOAA Atlas 14.

Benefits to the State

Updated precipitation data will enable AKDOT&PF hydrologists and hydraulic engineers to better predict critical flows at bridges and culverts. This will reduce the risk of failure of these structures due to rainfall events.

T2-09-07 Field Study to Compare the Performance of Two Designs to Prevent River Bend Erosion in Arctic Environments

Principal Investigator: Dr. Horacio Toniolo (UAF & AUTC)
Funding: $33,500 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: February 2011

Rivers change their paths over time. This is a serious threat to existing infrastructure. In Alaska, roadways and pipelines are vital for the movement of people, goods, and resources. When shifting rivers threaten them, engineers must take on the environmentally delicate task of redirecting water flow to save structures that cost millions, and sometimes billions, to build.

This study examines two erosion-control projects built in Alaska using different design criteria. One was built by Alyeska Pipeline Service Company at Hess Creek to protect the Trans-Alaska pipeline. The other was constructed by AKDOT&PF to protect the Dalton Highway from the Sagavanirktok River.

As rivers change course, one bank will be cut down and undermine the infrastructure in its path. Engineers have developed several types of strategies to prevent stream bank erosion. These include watercourse realignment, a technique that essentially imitates a natural process by diverting the water to change the river's path.

Structures at the two study sites were composed of a series of stabilizing barbs, partial walls that extend from one bank into the river to slow the velocity near the bank. Hess Creek's barbs were oriented downstream and Sagavanirktok River's barbs were oriented upstream.

Researchers, led by UAF's Dr. Horacio Toniolo, gathered hydraulic data, including continuous velocity measurements, at selected points on both waterways. With this data, researchers modeled different hydraulic scenarios to demonstrate a river's behavior under different flow conditions at different seasons.

These models revealed that the first barb in a series is the most critical; if the first barb fails, chances that the others will fail increases significantly. This new information is valuable to current erosion control projects. AKDOT&PF personnel can now implement the model in different settings where the agency is planning and designing river training structures.

Benefits to the State

The information this provides on river training structures will help AKDOT&PF construct for longevity of critical infrastructure.

T2-12-11 Estimating Future Flood Frequency and Magnitude in Basins Affected by Glacier Wastage

Principal Investigator: Anna Liljedahl (UAF & AUTC)
Funding: $80,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: June 2013

The research will collect field measurements of weather and temperature to develop hydraulic models that characterize contemporary changes and trends in hydraulic flows from glacial streams. The final report will recommend engineering criteria and parameters for use in the design of bridges and culverts located in drainage basins with a component of glacial runoff.

Benefits to the State

The research is expected to result in better predictions of peak flows from streams affected by melting glaciers. Analyzing this component of flow along with rainfall data will result in more reliable designs for hydraulic structures.

Sagavanirktok River showing stream barbs near Deadhorse, June 2009. Photo: Dr. Horacio Toniolo.

T2-07-06 Evaluation of Alternatives for Integrated Vegetation Management

Principal Investigator: Dr. David L. Barnes (UAF & AUTC)
Funding: $63,600 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: February 2010

For more than 20 years the AKDOT&PF has used only mechanical brush cutting to manage vegetation that interferes with line-of-sight and maintenance of Alaska roadways. Manually removing brush and vegetation is costly and relatively ineffective, and the department wants to know how herbicides might be best used in vegetation removal efforts. While researchers have investigated herbicide effectiveness and attenuation in more temperate climates, little study has focused on cold regions.

The purpose of this project was to measure the effectiveness and attenuation of two different selective auxin-type herbicides (which target broadleaf plant species such as willow and alder and are ineffective on grasses) in two subarctic climates: an extremely cold continental climate (Delta Junction, Alaska) and a maritime climate (Valdez, Alaska). Questions addressed in the research include: Once these herbicides are applied, how long does it take for them to enter the soil? Where do they go? How long does it take for them to dissipate?

Results from this study indicate that the selective herbicides tested attenuate at the same rate during the growing season as found in more temperate regions. The overall persistence is longer, however, due to the relatively long period the soil temperatures are below freezing. Although the research was limited by the one-year study period and an unscheduled mowing at the Valdez test site, an important conclusion is that the herbicides were found to be effective at slowing the reestablishment of woody vegetation, which suggests that less herbicide will be required to reduce the density of woody vegetation over time.

Benefits to the State

Finding herbicides with low environmental impact will help the AKDOT&PF in developing effective and lower cost ways to control vegetation along highways. Good right-of-way vegetation management will sustain good visibility, which allows for safe movement of people and goods along Alaska's roadways.

T2-09-02 Alaska Rural Airport Inspection Program

Principal Investigator: Dr. David L. Barnes (UAF & AUTC)
Funding: $80,000 (M&O)
Project Manager: Clark Milne, P.E.
Estimated Completion Date: December 2012

Alaska's severe weather and freezing temperatures affect runway conditions and equipment, requiring high levels of maintenance and added expense. To compound this issue, many runways in rural Alaska are unpaved, speeding up erosion and structural undermining that causes runway surface failure and serious safety risks. As with any unpaved surface, routine inspection and maintenance are essential; however, the remoteness of many Alaska villages increases the cost of travel and reduces the frequency of inspections.

A comprehensive airport inspection program will improve transportation safety and reduce maintenance costs for Alaska's transportation infrastructure, especially in rural areas where airports are the lifeline of the communities they serve. This project is developing and implementing an inspection program for Alaska's rural airports.

The project's researchers worked collaboratively with AKDOT&PF Maintenance and Operations staff to develop, pilot, and implement an airfield condition and support system inspection program, which includes inspection methodology and creation of a database and reporting formats. These summer inspections were conducted by undergraduate civil engineering students and included visual inspections of the surface and general airfield conditions, taking photographs, conducting dust

monitoring and field stiffness testing, and collecting samples for lab tests to determine soil properties. This effort leveraged an ongoing research project that developed an innovative dust monitoring system to quantitatively assess the effectiveness of dust-control palliatives.

Benefits to the State

This project is expected to result in an immediately implementable inspection program with the opportunity to enhance workforce development by providing a system suitable for undergraduate civil engineering students to conduct future inspections. Data from the project will help guide maintenance practices to increase effectiveness and decrease costs and will integrate with AKDOT&PF's asset management systems. The condition reports can also be directly integrated onto AKDOT&PF's aviation system website for regulatory and public access.

T2-09-10 Dust Palliative Performance Measurements on Nine Rural Airports

Principal Investigator: Dr. David L. Barnes (UAF & AUTC)
Funding: $75,617 (GF)
Project Manager: Clark Milne, P.E.
Estimated Completion Date: June 2013

Starting in the summer of 2009, AKDOT&PF applied dust-control palliatives to rural airport runways across Alaska. AUTC researchers are monitoring almost 20 of these applications to assess palliative quality and durability. Measurements are taken with the UAF's innovative dust-monitoring device (DUSTM). Palliative performance is assessed by comparing the measured fraction of lofted dust produced by the DUSTM's on the treated section of the runway to the fraction produced on the untreated control section. Although the original research plan was to take measurements within 30 days after the first treatment on each runway and then to follow up with a measurement one year later, the overall schedule has been delayed and impacted by rainy weather and related air travel logistics problems.

Benefits to the State

Improved understanding of the quality and durability of dust palliatives will help the AKDOT&PF to select the most cost-effective products and plan efficient application schedules for Alaska's many unpaved runways. A secondary benefit to the AKDOT&PF from this research project came from the workforce development aspect. The UAF graduate student Travis Eckhoff (the AUTC's 2012 Student of the Year and lead student with the DUSTM related projects) successfully defended his thesis on these projects and is now employed with AKDOT&PF's Southeast Region as an Engineer Assistant III.

T2-10-07 Testing and Screening Surface Materials for Alaska's Yukon River Bridge

Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $46,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

The Yukon River bridge is the supply line to workers in one of Alaska's most valuable natural resources. If this bridge becomes impassable then the camps at the oil fields on the North Slope don't get their food and equipment.

Formally known as the E. L. Patton Bridge, it is two lanes and nearly 2,300 feet long. The bridge deck, made of a 5-inch layer of timber, has been replaced four times since the bridge was completed in 1975.

The purpose of this project is to find a more durable material to replace the timber decking with. The timber used for the deck is not getting any cheaper. Quality is also in decline as old growth trees are not commonly logged anymore. These trends will continue.

Each time the deck is replaced it costs taxpayers millions of dollars. If the time between replacements could be extended, money and human power could be saved or directed toward other projects.

Benefits to the State

The expected long-term savings to the AKDOT&PF resulting from this research is large (millions of dollars).

Truck on wood decking, Yukon River bridge. Photo: James Sweeney, AKDOT&PF.

T2-10-12 Performance of Dust Palliatives on Unpaved Roads in Rural Alaska

Principal Investigator: Dr. David L. Barnes (UAF & AUTC)
Funding: $40,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Dust from unpaved roads and runways in rural Alaska villages is costly. It can ruin subsistence-caught fish drying outside and it can cause respiratory illness. The dust is also part of the road that is floating away and will need to be replaced.

This project assesses the longevity of different dust controlling agents. These palliatives will be applied to rural Alaska roads over two summer seasons. Researchers will collect data using the UAF's dust-monitoring system (DUSTM).

DUSTM monitors the amount of airborne dust that is spread on a village street or unpaved roadway. It also calculates reductions or increases in dust over time. DUSTM was created and assembled by project PI Barnes and fellow researchers at the UAF Civil and Environmental Engineering Department. It can be attached to the rear of an ATV and is compact enough to be transported in a small airplane.

The research team will apply and monitor dust-control agents in five sections of Alaska's roads: three in rural villages and two in North Pole and Point McKenzie. This project is co-funded by AUTC and the Alaska Department of Environmental Conservation. ADEC seeks to compare associated dust concentrations measurements from DUSTM with those collected by their own stationary monitors. Correlation between the two data sources will determine how much of the measured fugitive dust is from a controllable emission source and how much is from uncontrollable sources.

Both for public health and cost-effectiveness considerations, researchers want to know how much fugitive dust must be suppressed to meet regulatory standards. Researchers will use this information to help local communities plan the use of dust-control agents.

Benefits to the State

The research goal is to apply a measurement method to dust palliative specifications to more effectively manage dust control and address regulatory agency concerns.

T2-11-06 Field Evaluating Crack Sealing of Asphalt Concrete Pavements in Alaska

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $90,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2012

Routine sealing of cracks in asphalt concrete costs the State of Alaska millions of dollars annually. Without new technology to eliminate the cracking, sealing and minor patching will continue to be a major expense for AKDOT&PF.

This project aims to find possible cost-effective improvements to existing crack-sealing methods. Some research suggests it may be possible to ignore cracks entirely, under certain circumstances, with no negative effects. Liu is working with field researchers to determine where sealing is necessary and where it is not in order to devise more economically sound approaches to road repair. The team will also determine the effectiveness of several different repair treatments for major transverse cracks.

The team will provide recommendations for saving a significant portion of the maintenance and operations funds now spent on crack sealing and minor patching of major transverse cracks. The research will provide AKDOT&PF with research findings that the agency can easily integrate into its departmental guidelines for pavement preservation treatments in Alaska.

Benefits to the State

This project will help AKDOT&PF achieve its goal of managing its infrastructure efficiently and effectively. This project will provide insight on how to save on repair costs while maintaining quality roads.

AUTC researchers are studying a variety of types of cracking on older hot mix asphalt pavements in Alaska to evaluate the results of past crack-sealing practices and to determine if there are certain conditions (environmental and/or asphalt-related) under which crack sealing could be avoided without a reduction of pavement service life. This image shows the Richardson Highway near Fairbanks in March 2010. Photo: Bob McHattie.

T2-11-07 Develop Locally Sourced Salt Brine Additive for Anti-icing

Principal Investigators: Xianming Shi (MSU-WTI) and Dr. Juanyu"Jenny" Liu (UAF & AUTC)
Funding: $140,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

AKDOT&PF, Montana State University's Western Transportation Institute, and AUTC are investigating whether local agricultural or distillery byproducts can replace high-cost proprietary products for anti-icing operations on winter roads. The partnership hopes to bring considerable cost savings and safety improvements to Alaska's roads.

Researchers will develop and test locally sourced salt brine additives by a review of existing research, agency surveys, laboratory investigation, and follow-up field tests, to determine their suitability for anti-icing during winter maintenance. The results will help improve traveler and commercial safety and mobility while reducing corrosion and environmental impacts.

The project will give AKDOT&PF more options for snow and ice control while promoting sustainable, cost-effective winter road service. In a time of fiscal belt-tightening, this work allows state winter road maintenance budgets to cover more roads or more frequent anti-icing activities.

Benefits to the State

Beyond reducing Alaska's winter road maintenance costs, this research may also boost local economic growth by building a new market for glycerol—the principal byproduct of biodiesel production. The bio-based local materials may also be useful for dust suppression and soil stabilization.

T2-12-07 Whittier Tunnel Signal System Investigation

Principal Investigator: DOWL HKM, Thomas L. Moses, Jr., P.E.
Funding: $150,000 (SP&R)
Project Manager: Michael San Angelo, P.E.
Estimated Completion Date: December 2014

The project will investigate causes and recommend technical and operational solutions for the progressive deterioration of the train/vehicle operations and traffic control system on the unique multimodal (highway-rail) Whittier Access Tunnel Facility.

Benefits to the State

The results of this study will help AKDOT&PF and the Alaska Railroad improve operations and maintenance of the Whittier Tunnel multimodal facility.

T2-12-13 Maintenance Decision Support System (MDSS)

Principal Investigator: Billy Connor, P.E. (UAF & AUTC) in Partnership with the National Center for Atmospheric Research (NCAR)
Funding: $225,000 (M&O)
Project Manager: Ocie Adams, Maintenance & Operations Specialist
Estimated Completion Date: December 2015

The project will evaluate and refine a software system to help roadway maintenance personnel optimize their snow and ice control operations. The system will analyze historical weather conditions and forecast data to prescribe optimal strategies for plowing snow and applying anti-icing treatments to roadways based on weather and pavement condition observation and forecasts. The AKDOT&PF's Fairbanks maintenance district will pilot the technology along roadway corridors with various weather microclimates in an effort to fine tune the predictive capabilities of the software and data collection system.

Benefits to the State

By improving weather and roadway condition assessment during winter storms and then optimizing snow and ice control efforts, the Department of Transportation and local transportation agencies should be able to provide safer road conditions while minimizing costs. Additionally, minimizing the use of de-icing and anti-icing agents promises environmental benefits and reduced impacts to roadway users.

T2-04-01 Aggregate Abrasion Using Nordic Ball Mill Test

Principal Investigators: State of Alaska Regional Materials Engineers
Funding: $65,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: January 2011

Aggregate durability, hardness, and abrasion resistance can be measured using tests such as the degradation value test (Deg), the Los Angeles test (LA), and the Nordic ball mill test (NB). However, the repeatability and reproducibility of the Deg test have been questionable. In addition, when compared to the NB test, the Deg and LA tests do not seem to distinguish among varying levels of aggregate wear susceptibility. Therefore, there was a need to study the NB test results in comparison to the conventional Deg and LA results and to assess its repeatability and reproducibility. This project tested aggregates from different material sources from the three regions of the state using the Nordic ball mill test. Test results were compared with results from the conventional Deg (ATM 313) and LA (AASHTO T96) tests. Repeatability and reproducibility of the Nordic test was also assessed. This work required interlaboratory and intralaboratory testing (i.e., replicate testing within a lab and testing of an aggregate obtained from a given source/region by the three regional labs).

Maximum Nordic abrasion specification values will be established for the different aggregate materials depending on their location in a pavement structure—wearing, binder, or base course—and the traffic level based on annual average daily traffic (AADT). The aggregate testing is now complete and the final report is written.

Benefits to the State

Repeatability and reproducibility of the NB test was assessed. In addition, the work establishes maximum Nordic abrasion specification values for the different aggregate materials depending on their location in a pavement structure (wearing, binder, or base course), and the traffic level (AADT). Roads of greater durability and load-bearing capacity can be designed with this knowledge.

A new Nordic abrasion tester fitted with a safety hood is ready for delivery from a local vendor. Photo: Russ Mitchell.

T2-04-02 Use of Rubber in Hot Asphalt Concrete to Reduce Rutting

Principal Investigators: Steve Saboundjian, State Pavement Engineer; Newt Bingham, Central Region Materials Engineer; Bruce Brunette, Southeast Region Materials Engineer
Funding: $70,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: December 2010

The objective of this research is to reevaluate the use of crumb rubber in hot mix asphalt used in projects constructed in the 1980s. Hot mix asphalt made using the Plus Ride method, a dry process, has demonstrated excellent resistance to studded tires. Although the mix design used in this research is initially more costly, the superior qualities of this mix are expected to have a much lower lifecycle cost, based on the known performance of the similar Plus Ride mix that was placed on the A-C couplet road project in 1986. The mix design will use the Marshall method then the Prall test to simulate studded tire wear and the loaded wheel rut tester to evaluate resistance to plastic deformation. The mix design has dry crumb rubber added into the mixing chamber of a hot plant with the hot aggregate and asphalt cement.

Pavement performance data records from the pavement management system indicate that the life of asphalt pavements is less than eight years on highways having high traffic volumes in the central and southeastern regions of Alaska. These roads typically have traffic volumes over 5,000 ADT per lane. The observed failure modes are rutting from studded tires in winter and plastic deformation in summer. The researchers are now writing the final report based on the recently completed Elmore Road project in Anchorage and newer projects on the Glenn Highway and East Dowling Road. The final report will include a specification for the use of hot mix asphalt with crumb rubber additive and may possibly include rut depth measurements of completed construction using this technology.

Benefits to the State

This research is an effort to improve on the A-C couplet design and to reduce the risk of failure of rubberized asphalt mixes by using highly crushed aggregate, coarse crumb rubber, and polymer modified asphalt cement. The deliverable from this research is new construction specifications for hot mix asphalt with crumb rubber.

T2-06-04 Experimental Features: Sasobit and Foamed Warm Mix Asphalt Techniques

Principal Investigators: Alaska Highway Experimental Feature: Leo Woster, Northern Region Materials Engineer; Petersburg Mitkof Highway Experimental Feature: Bruce Brunette, Southeast Region Materials Engineer, Steve Saboundjian, State Pavement Engineer
Funding: Alaska Highway Experimental Feature: $64,000 (SP&R)
Petersburg Mitkof Highway Experimental Feature: $70,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Dates:
Petersburg Mitkof Highway Experimental Feature: December 2012
Alaska Highway Experimental Feature: October 2012

Two experimental feature projects were initiated to study long-term performance and constructability of warm mix asphalt (WMA) technologies in Alaska's cold weather environment. WMA reduces the high mixing temperatures of conventional hot-mix asphalt, which has the effect of reducing fuel consumption and emissions during asphalt concrete production and placement. The use of WMA can increase the time between production and final compaction, which allows increased haul distances and extension of the paving season. WMA decreases binder viscosity, which improves mix workability and helps compaction.

EPA will likely mandate the use of WMA in the future because emissions are greatly reduced by this technology. This research assessed two commonly used WMA methods:

- Sasobit, a synthetic wax additive, is mixed into the binder and does not require plant modifications. This method was studied as part of the Petersburg Mitkof Highway Upgrade Project, Phase II.

- Foamed warm mix asphalt using the Astec double-barrel green system, which injects steam into the binder to lower its viscosity. This method, favored by contractors, was studied as part of the Alaska Highway milepost 1267–1314 project. These projects studied the field placement and handling characteristics of WMA, included Superpave testing (see T2-10-01), and allow for three years of monitoring including visual inspection, measurement of rutting, and falling weight deflectometer testing if available.

Benefits to the State

These studies will ensure successful construction practices on projects that use WMA technology. Long-term monitoring should reveal potential problems and the necessary adjustment needed for success.

Sasobit® flakes (left) and prills (right). Photo: Graham Hurley, Brian Prowell.

T2-06-09 Characterization of Asphalt Treated Base Material

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $75,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: August 2010

This study systematically investigates three types of Alaska asphalt-treated base material: hot asphalt treated, emulsion treated, and foamed asphalt treated base course materials. The study will collect data on their properties, including stiffness, fatigue, and permanent deformation characteristics at different asphalt contents and temperatures. The thorough study of asphalt-treated base materials in this project will directly benefit current pavement design systems in Alaska. Improved design equations and moduli values will be incorporated in a new edition of the *Flexible Pavement Design Software and Manual*. Designers will then be able to use this tool to design improved pavement structures.

This study will also enhance the use of marginal or locally available materials by detailing the beneficial effects of asphalt-treated base materials on pavement life and their economic advantages. Asphalt treated bases are the most commonly used type of stabilized layers in Alaska because of material availability and relative cost. The "Alaska Flexible Pavement Design Manual" and the statewide policy on stabilized base courses stipulate the use of stabilized layers for the majority of roadway pavements. The inclusion of asphalt, either hot or in the form of emulsion, is one of the options mentioned to construct asphalt-treated bases. However, at present there is a lack of data on engineering material properties for typical Alaska base materials, which are necessary for use in pavement design.

AUTC researchers are continuing the fabrication of samples and the testing of material properties. These lab test results will be compared with core samples and falling weight deflectometer data from finished projects.

Benefits to the State

More accurate design equations and material parameters will directly impact lifecycle costs and performance of asphalt-treated bases. Pavement quality and longevity will improve with greater understanding of design parameters.

T2-07-02 Development of GPS Survey Data Management Protocols and Policy

Principal Investigators: James Sweeney, P.E., Research Engineer, and Location and Construction Staff
Funding: $80,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

The goal of this research is to develop policy and criteria for collecting, analyzing, and managing global positioning system (GPS) survey data. The research project will determine the needs of the department in adopting the GPS real-time kinetic (GPS RTK) stakeout and automated machine grading (AMG) construction techniques. The project will result in reformatting and editing of the *Alaska Survey Manual*, proposed revisions to the *Construction Manual*, the *Design Manu*al, and to *Standard Specification 642—Construction Surveying*. The technical advisory committee consists of experienced AKDOT&PF surveyors, designers and construction engineers who form and direct the research. The committee members are from all three regions of the AKDOT&PF.

Project activities so far are as follows:

- pilot projects on the Petersburg Runway Safety Area project, Van Horn Road project in Fairbanks, North Pole Overpass, and on the Eagle River Bypass project in Eagle River
- literature search
- a comprehensive questionnaire to construction engineers in the three regions
- training on GPS in the three regions
- monitoring of GPS use at Savoonga Airport project and Fairbanks International Airport in 2009
- revisions to the *Alaska Survey Manual* and to *Standard Specification 642—Construction Surveying*

A draft of the *Alaska Survey Manual* is in review, two construction survey specification versions have been written, and the final report with recommendations is pending.

Benefits to the State

The state will greatly benefit by proactively adopting the next generation of design and construction tools, which are all linked together through digital technologies and 3D design methods. These methods offer many opportunities to reduce construction costs and errors.

T2-07-05 Development of Construction Dust Control Protocols

Principal Investigator: Dr. Robert A. Perkins (UAF & AUTC)
Funding: $50,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: May 2012

Dust produced on seasonal road construction sites in Alaska is both a traffic safety hazard and a public health concern. Dust from unpaved roads during construction severely reduces visibility and impacts stopping sight distance for drivers. It also adds small particulates to the air that are hazardous to people.

This study examined a variety of factors dealing with the use of dust-control palliatives. Experts believed applying a dust-control palliative like calcium chloride, Enviroclean, Durasoil, or EK35 to unpaved surfaces during road construction would solve the dust problem. This research experimented with the type of palliative to use and when, how often, and in what concentration it should be applied.

The project looked specifically at several factors, including the amount and size of the dust particles, the time the surface is to remain unpaved, the makeup of the unpaved road surface, local environmental conditions, and the palliative's cost and availability. Measurement systems used in other states involve special equipment and/or certification of observers, neither of which may be practical in Alaska with its remote locations and short construction season.

Benefits to the State

Finding an effective way to control dust on unpaved roads will reduce fine particulate dangers, reduce dust control costs on construction sites, and provide safety and convenience to the commuting public. The study concluded that water was the most cost effective and practical solution for dust control.

T2-07-20 Guidelines for Risk Analysis in Construction Contract Changes

Principal Investigator: Dr. Robert Perkins, PhD.
Funding: $20,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: June 2009

This research produced a brief guide for analyzing the risk portion of changes. The guide will be suitable for use by AKDOT managers and engineers in negotiations for changes.

It is usually in an owner's best interest to forward price a contract change, that is, to negotiate a lump sum price for the changed work before the changed work starts. These negotiations are fundamentally asymmetric, since the costs being negotiated are those of the contractor and the contactor is the expert on his own costs. Although the goal of both parties is a fair and reasonable price, the owner also realizes that there are uncertainties that must be accounted for in the price. Since a firm lump sum price will pass all the reasonably foreseeable risks of the changed work to the contractor, the contractor must be compensated for assuming these risks. Risks include delays to the work and impacts to the contractor's operations. Alaska's extreme seasonality and remote project locations increase the risks of extending projects into the following year. This can have severe direct cost consequences for a second mobilization and other indirect costs of staffing and bonding capacity in the following year.

The guide examines the change process and standard estimating procedures, then examines risks that are often issues in Alaska transportation construction. A future section of the guide will provide analysis of these risks and demonstrate common software tools used and provide working examples. The methods of software analysis and how they are utilized are described in the guide. An appendix includes notes on two software packages often used to analyze claims. By referring to the guide, AKDOT&PF project managers and project engineers should be better prepared for negotiations regarding changes and better able to make fair and reasonable offers to contractors.

Benefits to the State

The research will facilitate sound negotiations and fairly priced changes which will benefit both the AKDOT&PF and its contractors.

T2-08-09 Feasibility Study of RFID Technology for Construction Load Tracking

Principal Investigators: Dr. Oliver Hedgepeth, Morgan Henri (UAA & AUTC)
Funding: $53,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Radio frequency identification (RFID) is a common technology today. You may not have heard of it, but if you've ever seen the security gate at a store being triggered, you've seen it in action. It works by sending data between transponders with radio waves.

This project uses RFID to try to improve the paving process. Tracking the loads of asphalt for paving in Alaska uses a paper system. Paper tickets are printed at the asphalt plant then handed off to the truck driver and then to a DOT inspector at the paving site. Information about load size, location, and how much area each load covers are recorded on the ticket.

These tickets, after being passed off several times and written on, must get back to the office and the data used for payment items. Tickets have to be stored for three years after the job.

RFID will change this paper system to a digital system. Each person that would normally have to handle the ticket would

have a transponder. When the transponders come into proximity with one another the data is transferred. The digital data is easy to transfer and easy to store. The real-time digital data also allows for text message alerts to managers, so the process can be managed smoothly.

Benefits to the State

The successful use of RFID technology will result in more efficient methods to weigh, track, and measure unit price items weighed on certified scales. Contractor payments can be processed faster and claims documentation will become easier.

PaveTag operation showing RFID tag—blue object on tailgate and reader antenna. Photo: Minds, Inc.

T2-08-16 Application of a Nontraditional Soil Stabilization Technology: Lab Testing of Geofibers and Synthetic Fluid

Principal Investigator: Billy Connor, P.E. (UAF & AUTC)
Funding: $200,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Gravel is practically nonexistent in western Alaska. The cost of importing gravel exceeds $200 per cubic yard in some areas of the west. Gravel is often needed to build infrastructure such as roads or runways. These costs can be dramatically reduced if local soils can be made usable in place of imported gravel.

This project is investigating a new technique for using geofibers and a synthetic fluid to stabilize the loose, sandy, and silty soils typical of western Alaska. Lab tests measured how well these new materials might improve poor foundation soils.

Results showed that fibers can double or triple the strength of the soil. Addition of synthetic fluids adds some strength as well. Their primary function is to reduce moisture sensitivity of the fine-grained material. A two-part chemical additive has proven to increase the strength of sands, silts, and clays at a lower cost than imported gravel. This project is the basis for a field application of these new materials.

Benefits to the State

Synthetic fluids and geofibers proved to strengthen weak soils. The research findings from this study will directly benefit a wide range of transportation construction projects by enabling the use of locally available materials, providing significant reduction in overall construction costs.

T2-08-21 Warm Mix Asphalt

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $75,000 (SP&R)
Project Manager: James Sweeney, P.E.
Completion Date: April 2010

Transportation researchers are trying to find more cost effective and environmentally friendly ways to build strong, durable road surfaces in cold regions. There are several warm mix asphalt techniques available (hot mix asphalt is what is generally used in paving). Which one will perform best over the long-term in cold regions is still under examination.

This project evaluated the performance of warm mix asphalts (WMA) that included an additive called Sasobit®. Researchers investigated how materials performed at low temperatures, looking at their potential for rutting and their sensitivity to moisture. They used both lab and field tests.

Compared with conventional hot mix asphalt (HMA), Sasobit modified WMAs show lowered mixing and compaction temperatures and improved workability and rutting resistance. The effect of moisture susceptibility on the WMA is insignificant. Tests conducted suggest that adding Sasobit to WMA reduced the mix's resistance to low-temperature cracking.

Researchers concluded that additional low-temperature tests and more complete thermal cracking analysis would help clarify the effects of Sasobit on low-temperature cracking. The results of this study were presented across the state in professional seminars and pavement design classes for both practicing engineers and traditional college students.

Benefits to the State

Warm mix asphalt saves energy in heating, saving money for installation. If the warm mix asphalt could be found to be comparable to hot mix asphalt, it could change the way paving is done in Alaska and save the state tremendous amounts of money.

T2-09-08 Alaska Hot Mix Asphalt Job Mix Formula Verification

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $130,250 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Some asphalt pavement does not last as long as it should, which means that every year, the state spends significant sums on repair and maintenance of Alaska's paved roads. Since hot mix asphalt (HMA) is the major paving material used in Alaska, assuring its quality is critical for contractors and AKDOT&PF. Ensuring that contractors out in the field are operating with the appropriate HMA is crucial. This project is assessing HMA quality assurance specifications and evaluating how well contractors meet the requirements of job mix formulas.

The research focused on testing HMA samples collected from two AKDOT&PF construction projects: a rehabilitation and resurfacing project on the Parks Highway south of Nenana, and an Anchorage International Airport paving project. The mixtures included specimens mixed and compacted using job mix formulas in the laboratory, loose mixtures collected from windrow, and either compacted in the field using a portable gyratory compactor or compacted in the laboratory; and samples retrieved from the field. Researchers obtained data from AKDOT&PF and contractors at each phase of lab/design, production, and new construction. Data included general project information, details of the materials and job mix formulas used in the construction, and all construction test data.

This project is conducting four tests for job mix formula properties in the university lab, including aggregate gradation, asphalt content, mix volumetric, and density. Researchers are investigating HMA performance to further verify the job mix formulas and evaluate any impact of the construction process.

Benefits to the State

This research project is expected to describe the causes of variability for field versus laboratory volumetric and mechanical properties of Alaska HMA mixtures and recommend how the AKDOT&PF can improve specifications and criteria for quality assurance and mix design verification or validation. Resulting better long-term performance of HMA pavements will reduce the state's pavement maintenance and repair budget.

T2-09-09 Inclusion of Life-Cycle Cost Analysis in Alaska Flexible Pavement Design Program

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $65,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

With budgets becoming tight, AKDOT&PF is looking for ways to reduce operating costs while maintaining quality transportation services. The cost, quality, and longevity are important factors to consider when deciding whether to repair or replace a piece of infrastructure.

This project's goal is to improve Alaska's Flexible Pavement Design Software. The software is currently used by engineers to make decisions about materials and thicknesses needed for paving for a desired product life. This project would add life-cycle cost analysis—a key consideration for selecting materials and techniques that optimize the service life of a pavement in terms of cost and performance.

The project team has developed a new layout for the program. They have also added new modules, including "equivalent single axle loads calculation" and "LCCA analysis," and designed more user-friendly interfaces for two other modules, "Mechanistic Pavement Design" and "Excess Fines Design."

Benefits to the State

The improvements to this program will give engineers a better idea of what building methods and materials would be most cost-effective without hurting the infrastructure performance.

AUTC researchers have updated AKDOT&PF's Flexible Pavement Design Software to include an integrated life-cycle cost analysis module and other enhancements to the core program to help engineers optimize road pavement designs. (Image is the software's opening screen as taken from the final draft of the software currently being tested and reviewed by AKDOT&PF engineers.)

T2-10-01 Foamed Warm Mix Asphalt Lab Testing: Experimental Features in Highway Construction

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $26,986 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

One way to reduce the cost of paving is to find ways to reduce the amount of energy it takes to apply asphalt to a surface. Hot mix asphalt (HMA), used predominantly on paving projects, is typically spread at temperatures between 280° and 320°F. When road crews use warm mix asphalt (WMA), applied at significantly lower temperatures (250° to around 270°F), they reduce the energy requirements and costs of highway paving.

Researchers wanted to see if WMA could be applied without adversely impacting pavement performance in Alaska. They worked with AKDOT&PF on a paving project near Tok, Alaska. The team experimented with one form of WMA that involves adding small amounts of water (as steam) to the asphalt mixer system. The investigators collected samples on site. They conducted laboratory tests to assess how this WMA technique works and to determine if there is any significant difference between how HMA and WMA pavements performed.

Tests included material characterization, rutting potential, resistance to fatigue, moisture susceptibility, and performance under low temperatures. Results show that the engineering properties of the asphalt mixture are not significantly affected by adding steam during production. Liu recommended that tests on field-collected, field-compacted specimens for foaming WMA could provide more representative and definitive results.

Benefits to the State

If found to be comparable in strength and durability, warm mix asphalt could dramatically reduce the cost of paving by saving energy that it takes to heat the asphalt to mixing and application temperatures.

T2-10-08 Using the Micro-Deval Test to Assess Alaska Aggregates

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $60,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Choosing the right material is half the battle in building Alaska's roads. The extreme conditions typical of cold regions require a durable aggregate that is both abrasion-resistant and freeze-thaw resistant. AKDOT&PF wanted to know if its engineers are using the most effective and accurate methods available to select the right aggregate to build the state's highways.

To evaluate surface abrasion and degradation values, Alaska currently uses a testing method known as "Method 313," or the Washington degradation test. This project is examining an alternate method that may prove safer and less costly, if its results are replicable and correlate with field performance. One method, the Micro-Deval test, involves putting aggregate materials in a tumbling steel drum with water and steel balls to measure how they degrade.

The test is relatively easy, safe, and less costly to perform than traditional testing methods. It is also suitable for smaller equipment, requires smaller sample quantities, and uses a simple procedure. Liu's team has completed and summarized their aggregate testing results and will soon focus on additional testing methods that use sand equivalents and a hydrometer.

Benefits to the State

Building a road with the right material can add years to the life of the road. Knowing the conditions that each material degrades in will give engineers a better idea which materials would make a road last the longest in its environment.

T2-10-10 Characterization of Alaska Hot Mix Asphalt Mixtures with the Simple Performance Tester

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $90,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: October 2012

With the current trend toward developing mechanistic flexible pavement design and the need for more reliable design procedures, accurate characterization of hot mix asphalt (HMA) properties is needed. NCHRP Project 1-37A considers the dynamic modulus master curve as a design parameter in AASHTO 2002 Mechanistic-Empirical Pavement Design Guide, and simple performance tests are recommended to complement the Superpave volumetric mixture design method, including dynamic modulus, flow number, and flow time tests. The current AKDOT&PF mechanistic design method uses resilient modulus to characterize hot mix asphalt. Research indicates that the dynamic modulus provides better characterization of HMA than the resilient modulus.

This research study is developing a catalog of dynamic modulus values for HMA mixtures typically used in Alaska and creating correlations between the simple performance test results and HMA lab. The suitability of the Witczak and Hirsch models in the dynamic modulus prediction of local mixtures will be evaluated as well.

Benefits to the State

The research findings will enhance understanding of Alaska HMA mixes. The results will provide practical information to AKDOT&PF regarding how Alaska HMA mixtures respond to new simple performance test procedures and how it will affect current flexible pavement design method.

T2-10-11 Stabilization of Erodible and Thawing Permafrost Slopes with Geofibers and Synthetic Fluid

Principal Investigator: Dr. J. Leroy Hulsey and Dr. Xiong Zhang (UAF & AUTC)
Funding: $132,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

Thawing, unstable, and eroding permafrost slopes pose serious challenges for road maintenance crews and transportation engineers in Alaska. Frozen soils can heave or sink with temperature change. This can cause safety risks such as dips and cracks in the roadways.

Recent research on synthetic fluids and geofibers has proven that these materials can reinforce the volatile frozen soils in pavement bases and mitigate these problems. Traditional stabilization techniques are costly and require specialized skills and equipment to ensure adequate performance. They also are only marginally effective in the cold climates of Alaska and other northern regions.

This project is conducting a large-scale field investigation to study the feasibility of stabilizing erodible and thawing permafrost slopes with geofibers and synthetic fluid. Geofibers and synthetic fluids can improve very loose, sandy soils—the material often left behind after permafrost thaws. These types of soils are very common in Alaska, especially in northern and western areas.

Benefits to the State

The outcomes of this research will help future engineering teams build safer, more reliable, cost-effective road embankments. The embankments should also hold up better over time, improving the life of the road.

T2-10-14 Guidelines for Pavement Preservation

Principal Investigator: Dr. Gary Hicks (California Pavement Preservation Center), Dr. Juanyu "Jenny" Liu (UAF & AUTC), Hannele Zubeck (UAA)
Funding: $91,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Alaska's extreme climate takes a toll on pavement. Harsh cold, repeated freezing and thawing, moisture buildup, and other environmental factors, along with commercial wear and tear, reduce roadway service life. The resulting maintenance costs continue to strain state and federal budgets. In the past, the practice has often been to repair the worst first, but this approach means that repairs are extensive and costly. Some decision-makers argue that more frequent and proactive maintenance can extend operational life and cost less over the long term.

The state of Alaska has committed to creating an active pavement preservation program, which requires development of program guidelines and solutions to road surface damage. The aim of this project, a joint venture between the California Department of Transportation, Alaska University Transportation Center, and AKDOT&PF, was to provide a basis for these guidelines.

Using field site visits and internationally distributed surveys, researchers identified road repair methods that are more cost-effective and environmentally sound. They helped AKDOT&PF and local agencies find pavement preservation techniques suitable to specific environmental regions in the state.

Researchers at the California Pavement Preservation Center are developing an online database of preservation methods based on results produced by UAA and UAF researchers, who have applied their specific expertise in Alaska's cold regions to field monitoring test sites and synthesizing the vast amount of information available internationally. The research team has developed a process for selecting the appropriate preservation strategy for any given area and traffic scenario in Alaska.

Benefits to the State

This project will help the AKDOT&PF to implement more proactive maintenance specifically tailored to Alaska's various climate regions. This will improve the condition of Alaska's roads and increase driver safety, as well as save on maintenance costs.

As part of the Guidelines for Pavement Preservation research project, researchers at the California Pavement Preservation Center created a web-based computer system to help AKDOT&PF pavement and M&O engineers select appropriate preservation treatments and evaluate various life-cycle cost scenarios.

T2-10-15 Experimental Feature: Evaluation of AASHTO Site Manager Software, 2010–2012

Principal Investigator: Frank Ganley, Construction Manager
Funding: $10,000 (SP&R) + $94,500 in Federal-aid Construction Funds
Project Manager: James Sweeney, P.E.
Estimated Completion Date: April 2013

In 2010, AKDOT&PF's Northern Region Construction Section began comparing the AASHTO Transport Site Manager software to current recordkeeping processes. The 2010 pilot project was an experimental feature under the Alaska Highway milepost 1412–1422 rehabilitation project. The Construction Section evaluated Site Manager's construction management systems for project management. This program had client-server type architecture under an initial no-cost six-month evaluation license.

Site Manager automates construction project recordkeeping through the following functions:

- Data can be electronically transferred to and from the field to minimize data entry and reduce errors.
- Allows extensive creation, review, and approval of contract changes.
- Estimates are automatically generated, reviewed, and routed for approval.
- Sophisticated adjustments and calculations are provided in the estimate, along with reported discrepancies.
- Data can be passed to an agency's financial management system.
- Reports can be generated to provide a variety of project information such as contract status, daily work report history, installed work report, and change order report.
- Site Manager has material management modules and a laboratory information management system.
- The system uses client/server architecture: data is stored on a server.

About twenty four other state DOT's are currently using this software with excellent results. Evaluation of the software through this pilot project is a cost-effective way to explore improvements to the construction documentation process.

- In 2010, one project tested Site Manager but also kept a duplicate set of paper records.
- In 2011, Site Manager was tested on remote construction projects with satellite uplinks and also included the Materials Management module. Four projects used Site Manager in 2011 and no paper duplicate files were kept.
- In 2012, about twenty new highway project starts incorporated Site Manager with the Materials Module and the Laboratory Information System (LIMS).

The interim report is available at the T2 website.

Benefits to the State

The use of Site Manager has resulted in greater transparency, more secure recordkeeping, better checks on materials testing requirements, less travel to construction sites, and a streamlined change order and payment process.

T2-11-02 Geosynthetic Design Guidelines and Construction Specifications Review and Update

Principal Investigator: Eli Cuelho (MSU-WTI)
Funding: $16,000 (SP&R) + $73,500 (State GF)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: March 2013

Engineers strive to provide safe and effective transportation corridors and facilities that are economic to construct and maintain. AKDOT&PF routinely uses geosynthetics (planar products manufactured from polymeric material) to create innovative design solutions for soil stabilization, soil reinforcement, separation, mechanically stabilized earthen structures, embankments, drainage, erosion control, pavement, and silt fences. The department's specifications and design practices are over five years old and do not account for the rapidly evolving world of geosynthetics technologies and design practices.

The objective of this project is to provide recommendations to update Alaska's geosynthetic design guidelines and construction specifications to provide for the most economical geosynthetic selection while minimizing conflicts and promoting competition. The research team includes nationally recognized experts in the field of geosynthetics for transportation engineering applications. The research team will review current geosynthetic design and construction practices in Alaska, historic and future uses of geosynthetics within the state, and design and construction practices from other state and federal sources; and will synthesize this information to update Alaska's geosynthetic design and construction practices. The researchers will also conduct a training course in Alaska to transfer the results of this project and help AKDOT&PF engineers to effectively and efficiently use geosynthetics in design and construction.

Benefits to the State

The products of this research include updated design and construction specifications that will be suitable for direct implementation by AKDOT&PF staff. The specifications will be reviewed and updated in consideration of specific local concerns identified through review of geosynthetic use throughout Alaska.

The results of this research project will help AKDOT&PF to update design and construction specifications, which will assist designers, construction, and M&O engineers to more effectively use modern geosynthetics for roads and airports. Photos show polypropylene geo fiber that was blended into sand with synthetic fluid binder at Cape Simpson in 2008.

Melting ice-rich slopes at Dalton milepost 37–49 project. Photo: James Sweeney, AKDOT&PF.

T2-11-05 Experimental Study of Various Techniques to Protect Ice-Rich Cut Slopes

Principal Investigator: Dr. Xiong Zhang (UAF & AUTC)
Funding: $85,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

For more than fifty years, Alaska state construction has wrestled with erosion, runoff, and slope failures from permafrost. These unforeseen problems can add significant development costs via environmental distress, project delays, change orders, and claims that often occur during building.

Researchers Dr. Xiong Zhang and Mingchu Zhang will study ways to prevent the permafrost from thawing and to mitigate the erosion if thawing occurs. Cutting into the permafrost cannot always be avoided during construction. Excavation causes exposure of the frozen ground to the air, causing melting until it thaws or insulation is added.

While research has been done to address the issue, environmentally acceptable, legal, and economically viable solutions remain rare. New environmental laws are making current AKDOT&PF methods for dealing with ice-rich permafrost either undesirable or completely unacceptable. Zhang and Zhang will study several potential thermal erosion mitigation techniques that address the regulatory concerns raised by current practices.

The researchers will construct several test sections in the study and monitor the sections to evaluate different techniques.

Benefits to the State

This research will result in recommendations and guidelines for design and construction. This will ensure proper application of successfully tested mitigation approaches on future construction projects that require cuts in ice-rich permafrost.

T2-11-11 Economic Impact of Fines in Unbound Pavement Layers

Principal Investigator: Dr. Juanyu "Jenny" Liu (UAF & AUTC)
Funding: $90,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2012

In Alaska's spring months, ice thawing underneath road pavement weakens roads and other transportation infrastructure. This causes great expense to the state and inconvenience and safety hazards for private and commercial motorists. This project examines how the fines in the base materials that a road is built on affect susceptibility to frost heaving and support for loads during the spring thaw.

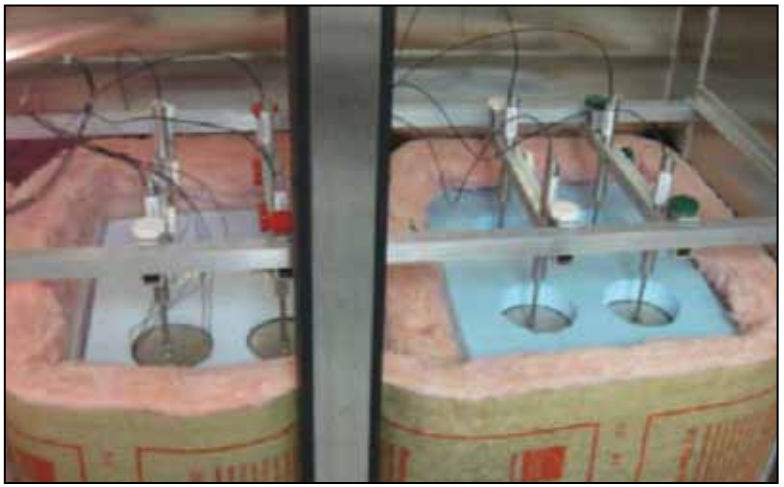
Too much fines in base material can cause serious road problems. In the winter, the freezing horizon moves down through a road into the base material. Fines act like a wick, drawing moisture up, which conglomerates in lenses of ice that expand. During the expansion, material gets pushed around to make room for the ice. This can lead to heaves in the road. In spring, when the ice melts, these spots will be weakened and become sunken.

The current policy on allowable fines in base material is a set percentage. While this is good for keeping fines at low levels, research shows this may not be necessary. A recent study done at UAF shows that the type of material and the setting it is in may have an effect on the susceptibility of the road to frost heaving.

Replacing material to build a road can add large costs to a project. This project will examine the way fines content affects frost heaving in materials with different moisture content and temperature gradients.

Benefits to the State

Knowing what acceptable fines content is for different materials in different settings will allow for less hauled material, saving the state money without affecting road performance.



Laboratory testing equipment used to test base course materials for the impact of fines content. Frost heave cell (top) and triaxial chamber (bottom) used for repeated testing of the resilient modulus of base course materials. Photos: AUTC.

T2-12-05 Video Documenting Best Practices for Mitigating Frost Damage to Transportation Infrastructure

Principal Investigator: Billy Connor, P.E. (UAF & AUTC)
Funding: 15,000 (SP&R)
Project Manager: Clint Adler, P.E.
Estimated Completion Date: December 2012

Northern tier states and provinces are influenced by frost action and have collaboratively developed ways to minimize its effect on our transportation infrastructure. This project will update an existing frost video from the early 1980's, produced by US Army Corps of Engineers, Cold Regions Research & Engineering Laboratory (CRREL), to show how to design for preventing frost heaves, show examples of frost heaves, demonstrate how frost actions take place, and explain what fixes are available.

Benefits to the State

The material from this project will educate transportation professionals on the impacts Alaska's climate has on roads. This improved understanding is essential to ensure cost effective, reliable, and resilient transportation infrastructure in Alaska.

Research for Material Site Inventory/ Management Program

Principal Investigators: R&M Consultants, Inc.
Funding: Material Site Inventory/Management Program
Project Manager: Dave Stanley, C.P.G.

Benefits to the State

Material sites are one of our most important resources. We cannot build infrastructure for our transportation system without the use of earth materials such as gravel and rock. AKDOT&PF has thousands of materials sites around the state, but most information about these sites has been contained in regional paper files for decades. The material site inventory program has been doing inventory and condition surveys for several years to provide readily available reports on the status and condition of our materials sites. Considerable data has been collected about our many current and former material sites. The data has been collated and is displayed on a department webpage with a map interface so staff and the public have ready access to the information. Additional work in the future will include improving the delivery method of the data to an interactive database and an improved map interface. The research components of this effort support exploration of additional asset management characteristics of materials sites and how to incorporate the information into the overall transportation asset management program to support department decision-making.

Experimental Feature: Tencate Mirafi® H2Ri Wicking Fabric

Principal Investigator: Jeff Currey (Northern Region Materials Engineer)
Funding: $25,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: August 2015

Moisture freezing in the ground can cause heaving. Under roads, this can cause damage that leads to safety risks and maintenance costs. In an effort to minimize these risks, AKDOT&PF partnered with AUTC and Tencate to research a possible solution.

The use of Mirafi nylon wicking fabric, could help prevent saturation of the ground that causes frost heave damage. The fabric is impermeable much like a rain jacket. When installed properly, it keeps much of the moisture out of the material that the road is built on. No moisture, no problem.

The fabric, provided by Tencate, was installed by AKDOT&PF on Alaska's Dalton Highway as a pay item on the Dalton Highway milepost 197-206 reconstruction project. This section of road will be monitored by AKDOT&PF maintenance forces and researchers from the AUTC for three years. The results will help Northern Region engineers design safer roads that require less maintenance.

Benefits to the State

The use of construction fabric in building roads in Alaska should extend road life, especially in areas particularly susceptible to frost heaving.

Soft spots resulting from saturated material at the Beaver Slide area on the Dalton Highway. Photo: Jeff Russell, AKDOT&PF.

T2-07-09 Demonstration of Non-intrusive Traffic Data Collection Devices in Alaska

Principal Investigator: Erik Minge (SRF Consulting, Inc.)
Funding: $76,100 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: June 2010

Installation of traditional traffic data collection methods, such as inductive loops and road tube counters, requires intrusion into the roadway. AKDOT&PF often tapes pneumatic tubes to the road surface to collect volume data where inductive loop counters do not exist or are impractical to install. This practice not only exposes staff to traffic hazards (especially on high-volume roads), but it collects only volume data and only over a very short timeframe. These tubes are also labor intensive to install and maintain.

AKDOT&PF's traffic data collection staff (planners, technicians, and engineers) initiated this research project to collaborate with nationally recognized traffic detection expert Erik Ming to evaluate the use of non-intrusive technologies for traffic detection in Alaska. Two different portable traffic detection systems were evaluated: a pole-mount radar system (Wavetronix SmartSensor HD) and a ground-mount axle-counting ranging laser system (PEEK Axle Light).

Data was collected from nine sites from July 2008 to February 2010, representing all three AKDOT&PF regions. Results indicate that the pole-mounted system performed accurately in detecting traffic. However, several deployment issues were noted, namely the size and weight of the system's batteries, which impact the system's portability, and the need for a minimum amount of traffic in order to successfully calibrate the system. These deployment issues limit the utility of the system as a replacement for current data collection practices.

The pole-mounted system was also briefly tested for its ability to detect pedestrians and bicyclists. The system demonstrated an ability to detect bicycles, but pedestrian detection was not satisfactory. Testing with the axle-based detection system did not produce valid traffic data. Alaska AKDOT&PF staff was not able to successfully set up and calibrate the system.

The researcher provided recommendations to the AKDOT&PF on further research that could be done to investigate other simpler sensors (lower power consumption, more quickly deployed) and to examine methods used by other agencies to collect bicycle and pedestrian data.

Benefits to the State

The value of this research was primarily in providing AKDOT&PF personnel with experience in setting up and collecting data with the non-intrusive systems, including insight into the limitations of these systems for meeting Alaska's needs for portable systems.

T2-08-10 LiDAR Testing Under Heavy Tree Canopy and in Steep Terrain

Principal Investigator: Tim Reed, Location Surveyor, Southeast Region
Funding: $40,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: December 2012

LiDAR (light direction and ranging) is a remote sensing measuring technique accomplished from an airplane using lasers and computers to map areas for road design decisions. LiDAR can be an extremely accurate and efficient mapping method when the surface being measured is unobstructed. However, LiDAR has not been thoroughly tested in the dense vegetation and extreme terrain of southeast Alaska. When foliage and trees obstruct direct light contact with the surface intended to be mapped, the vertical accuracy of the measurements degrades, despite techniques to filter out and correct for the obstructions. Vertical accuracy of LiDAR data is generally twice as good as the horizontal accuracy, so steep terrain also adversely affects the accuracy of the data.

We need to analyze the quality of LiDAR data collected in Alaska. The data at Alaska's northern location can be affected by poor geoid definitions, solar weather, and poor satellite geometry. The better the initial topographic data, the more defined and thorough the design of a preliminary route will be, allowing for alignment changes, bridge site location adjustments, computing cut and fill quantities and catch points, determination of soil types, and determination of areas of clearing and grubbing.

Better initial topographic data means fewer follow-up field surveys that require mobilization costs, travel time, per diem compensation, and other expenses. This research also has the potential to identify areas of good LIDAR coverage versus those of poor coverage. This will enhance confidence in the LIDAR mapping product, resulting in maximum usage of this economical and effective survey method. Results of this study will be incorporated into the Alaska Survey Manual in a chapter on LiDAR quality control and contract specifications. The report on the accuracy of LiDAR under tree canopy and in steep terrain will be distributed to location and design managers and consultants.

Benefits to the State

The primary benefit of this study will be to provide the department with a better understanding of what kind of accuracy can be expected from LiDAR in a variety of conditions.

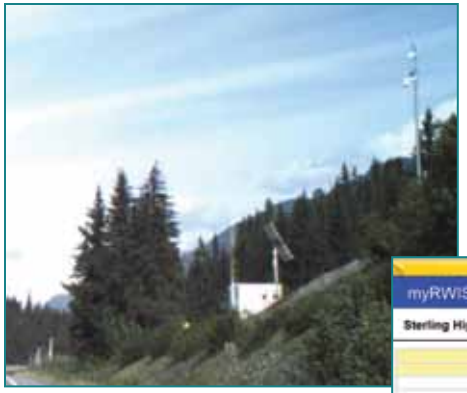
T2-12-18 Review of Power Sources for Road Weather Information Systems, Phase I

Principal Investigator: Dr. Richard Wies, Jr. (UAF & AUTC)
Funding: $40,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: December 2013

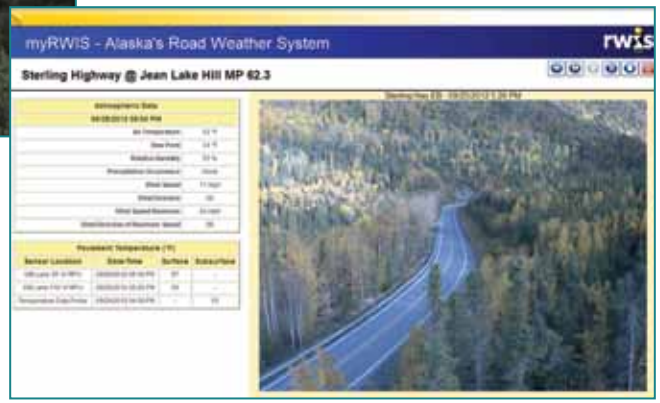
This research project involves studying the AKDOT&PF road weather information systems (RWIS) sites that are currently installed off the power grid. The first generation of RWIS power generation units have outlived their economic lives: they are failing and are not cost effective to repair. The researchers will evaluate the state-of-the art in alternative power sources such as wind, solar, and fuel cells along with the latest in weather monitoring systems and recommend improved equipment and power configurations and operating scenarios for each of the subject RWIS sites. In the next phase of the project, the researchers will work with AKDOT&PF to develop and test the most promising prototype system at one of these sites.

Benefits to the State

This project will help the AKDOT&PF provide for the safe and efficient movement of people and goods on Alaska highways by investigating and recommending innovative remote off-grid power systems to improve the efficiency and reliability of the road weather information system.



Off-grid RWIS site on the Seward Highway at milepost 11.5. Photo: AKDOT&PF.



Web display of information from one of the off-power grid RWIS sites proposed to be studied for alternative power generation. (http://www.dot.state.ak.us/iways/roadweather/forms/IndexForm.html)

T2-12-19 A Design for an Interface Board Between a MRC Thermistor Probe and a Personal Computer

Principal Investigator: Dejan Raskovic (UAF & AUTC)
Funding: $30,000 (SP&R)
Project Manager: James Sweeney, P.E.
Estimated Completion Date: June 2013

The project will develop a new handheld device for reading and testing in-pavement temperature sensors maintained by AKDOT&PF's Highway Data Section. Existing readers are no longer manufactured and only one remains functional. Technicians manually record pavement temperature data to assist with the commercial truck weight restriction compliance, usually in the spring while the roads are still going through the spring thaw. The Highway Data Section maintains about 100 temperature data probe sites statewide. Properly maintaining and collecting temperature data probes is critical to data-driven decisions for the pavement design group and to truck weight restriction enforcement.

Benefits to the State

The new interface device improves on the reliability and accuracy of pavement temperature data, thereby improving the effectiveness of Alaska's springtime pavement load restriction program.

T2-11-17 Rapid Research Response Program

Funding: $200,000 (SP&R)
Supplemental Research Programs

The Rapid Research Response program supports a portfolio of research projects, technology transfer, and workforce development activities to rapidly respond to opportunities to improve practices, procedures, and processes within the department as they arise and on an ad hoc basis. The account is funded through a revolving line item in the section's work program entitled "Rapid Research Response."

Benefits to the State

The research response project funds the following types of research activities:

- Generally short term, high-priority research projects to provide or address urgently needed information or problems.
- Augment existing research projects to take advantage of unforeseen opportunities where timing is of the essence. During the course of a research project, the researchers may identify a previously unforeseen opportunity or method worthy of exploration to enhance the research and provide more useful results. The Rapid Response funds allow timely response to such opportunities.
- Research coordination and advisory services with national, university, and other state research programs.
- Unique and timely research and technology demonstration efforts.
- Policy-related research to address the immediate needs of decision makers.

T2-11-17 Rapid Research Response Program

Project Title	Project No.	Project Amount	RD&T2 Contact
Strategic Communication Assessment	T2-12-09	$40,000	Clint Adler, P.E.
Cordova Sectional Barge Study	T2-12-16	$45,000	James Sweeney, P.E.
Monitoring and Analysis of Frozen Debris Lobes, Phase I	T2-12-17	$60,000	James Sweeney, P.E.
A Design for an Interface Board between a MRC Thermistor Probe and a Personal Computer	T2-12-19	$30,000	James Sweeney, P.E.
Geophysical Investigation at Nine Mile Dalton Highway	T2-12-24	$23,000	James Sweeney, P.E.

T2-11-18 Research and Technology Deployment Program

Funding: $200,000 (SP&R)
Supplemental Research Programs

The Research and Technology Deployment program augments the AKDOT&PF portfolio of research projects, technology transfer, and workforce development activities to respond rapidly to opportunities to implement practices, procedures, and processes within the department as staff become aware of such opportunities. Emphasis is on research and technology transfer products from other states or research programs. The account is funded through a revolving line item in the section's work program entitled "Research and Technology Deployment."

Benefits to the State

The benefits of this program are enhanced implementation and deployment of research and technologies as they become known to the AKDOT&PF. Examples of externally developed research and technologies include products of the Transportation Research Board's cooperative research programs, other state DOTs, international transportation programs, and professional organizations. The Research and Technology Deployment Program supports the following types of activities necessary for implementation and deployment of research and technology products developed external to the RD&T2 program of AKDOT&PF:

- Scans of international, national, and state research and technology products for potential deployment within the department.
- Communication, outreach, marketing, and education activities, products, and tools necessary to raise awareness and promote deployment of external research results within the department and other stakeholder agencies.
- Facilitation of workshops, technical and policy meetings, social networking, partnerships, and other necessary promotion of research and technology products and activities to maximize their deployment.
- Professional technical communications and publication services and activities.
- Professional services necessary for research and technology deployment.

T2-11-18 Research and Technology Deployment Program

Project Title	Project No.	Project Amount	RD&T2 Contact
Health Monitoring & Condition Assessment of Chilitna River Bridge, Phase II	T2-11-08	$80,000	Angela Parsons, P.E.
Mitigating Frost Damage to Transportation Infrastructure	T2-12-05	$15,000	Clint Adler, P.E.
Development of Transportation Asset Management Plan (TAMP)	T2-12-18	$80,000	Clint Adler, P.E.

T2-11-19 Experimental Features in Highway Construction

Funding: $125,600 (SP&R)
Supplemental Research Programs

The FHWA Experimental Features Program encourages innovation in state highway design and construction. Experimental features incorporated into highway projects under this program are eligible for federal funding participation, which is normally limited to more proven and conventional items. Another advantage of the program is that if an experimental feature fails for any reason, the FHWA will pay for its repair or replacement. Experimental features are often physical objects; however, they can also be a new technique for using conventional materials.

The RD&T2 program maintains an account to support evaluations of experimental features.

Pooled Fund Studies

Funding: $280,000 (SP&R)

When significant or widespread interest is shown in solving transportation-related problems, research, planning, and technology transfer activities may be jointly funded by several federal, state, regional, and local transportation agencies, academic institutions, foundations, or private firms as a pooled fund study. The FHWA Transportation Pooled Fund (TPF) Program allows federal, state, and local agencies and other organizations to combine resources to support transportation research studies.

AKDOT&PF participates in the following pooled fund studies. Details and status are available at http://www.pooled-fund.org/.

T2-11-19 Experimental Features in Highway Construction

Project Title	Project #	Project Amount	RD&T2 Contact
Foamed Warm Mix Asphalt		$64,000	James Sweeney, P.E.
Ongoing Evaluation of AASHTO Ware Site Manager, 2010 - 2012	T2-11-01 & T2-12-06	$40,000	James Sweeney, P.E.
Tencate Mirafi H2Ri Wicking Fabric		$25,000	James Sweeney, P.E.

Pooled Fund Studies

Title	Study ID	Lead Agency	Project URL
Aurora Program	SPR-3(042)	Iowa Dept. of Transportation	www.pooledfund.org/Details/Study/189
Strength and Deformation Analysis of MSE Walls at Working Loads	SPR-3(072)	Washington State Dept. of Transportation	www.pooledfund.org/Details/Study/225
Western Alliance for Quality Transportation Construction (WAQTC)	TPF-5(064)	Utah Dept. of Transportation	www.pooledfund.org/Details/Study/274
Long-Term Maintenance of Load and Resistance Factor Design Specifications	TPF-5(068)	Iowa Dept. of Transportation	www.pooledfund.org/Details/Study/286
Roadside Safety Research Program	TPF-5(114)	Washington State Dept. of Transportation	www.pooledfund.org/Details/Study/345
Structural Acoustic Analysis of Piles	TPF-5(140)	Federal Highway Administration	www.pooledfund.org/Details/Study/369
Fish Passage in Large Culverts with Low Flows	TPF-5(164)	Federal Highway Administration	www.pooledfund.org/Details/Study/388
An Analytical Review of Child Mobility Assessments for School Site Programs	TPF-5(172)	Washington State Dept. of Transportation	www.pooledfund.org/Details/Study/399
Northwest Transportation Consortium	TPF-5(191)	Washington State Dept. of Transportation	www.pooledfund.org/Details/Study/414
Loop and Length Based Classification Pooled Fund	TPF-5(192)	Minnesota Dept. of Transportation	www.pooledfund.org/Details/Study/416
2009 National Asset Management Conference	TPF-5(196)	Federal Highway Administration	www.pooledfund.org/Details/Study/421
Core Program Services for a Highway RD&T Program	TPF-5(223) TPF-5(240) TPF-5(261)	Federal Highway Administration	www.pooledfund.org/Details/Study/451 www.pooledfund.org/Details/Study/492
Shaking Table Testing to Evaluate Effectiveness of Vertical Drains for Liquefaction Mitigation	TPF-5(244)	Utah Department of Transportation	www.pooledfund.org/Details/Study/471
2012 Multi-State Asset Management Implementation Workshop	TPF-5(245)	Federal Highway Administration	www.pooledfund.org/Details/Study/473
2014 Asset Management Conference and Training on Implementation Strategies	TPF-5(275)	Iowa Department of Transportation	www.pooledfund.org/Details/Study/510

T2-08-05 Performance Analysis of the Dowling Multilane Roundabouts

Principal Investigator: Dr. Ming Lee (UAF & AUTC)
Funding: $32,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: December 2010

Multilane roundabouts are hardly new to the Lower-forty eight states but are relatively new to Alaska's urban areas. Alaska's first multilane roundabouts (a set of two working together) came to Anchorage's Dowling Road/Seward Highway interchange in 2004. Roundabouts are a useful tool in effective traffic operations. In Anchorage they serve as junctions for commuters accessing the Seward Highway, but as traffic grows, the Dowling roundabouts are becoming more congested. They are operating at or near capacity, with longer lines at their entrances during peak traffic hours.

This research project examined the performance of Anchorage's roundabouts and how drivers use them. Analysis showed that unbalanced flow patterns caused high circulating flow in front of one roundabout, leading to longer lines. This high volume of traffic circulating through one roundabout and into another one resulted in lower capacity and longer delays. Researchers also found accident rates and pedestrian dangers increased in the past two years. Modeled traffic flow patterns for several possible alternatives suggested that reducing the eastbound flow rate (think of it as "upstream" of the roundabout) by 70% could result in an acceptable level of delay and line length at the eastbound approach to the west roundabout.

Benefits to the State

A study like this not only helps planning engineering in Anchorage but also gives agencies statewide better ideas about how to design future multilane roundabouts in ways that will provide safe and efficient travel.

T2-08-06 Evaluation of the Overheight Detection System at the Eklutna Overcrossing Bridge

Principal Investigator: Dr. Ming Lee (UAF & AUTC)
Funding: $58,500 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: October 2012

Some of Alaska's most important transportation assets are its bridges. Unfortunately, overheight trucks have collided with bridge structures, causing damage and increased maintenance costs. Because the Eklutna Glenn Highway overcrossing bridge (approximately 25 miles north of Anchorage) has sustained repeated impacts from overheight trucks, in 2006 the AKDOT&PF installed an over-height vehicle warning system, which uses laser detectors, alarms, and message boards to warn truckers that their rigs are too tall. After completion of the system, the bridge continued to sustain impacts from vehicles, despite witness testimony that the system was triggered and did issue warning to the overheight vehicles.

The objective of this project is to assess and improve the effectiveness of this existing overheight detection and warning system. Surveillance equipment (cameras and a data logger) was added to the existing southbound detection and warning system. Data captured by the surveillance system is being analyzed to determine the frequency and characteristics of bridge impact accidents.

Benefits to the State

If the early warning systems for bridge height monitors can prevent costly damage from big rig collisions, then maintenance costs will be reduced. This need was recently underscored by overheight strikes that occurred in 2010 in the unmonitored northbound lane, which resulted in a repair project (valued at almost $950,000) to replace damaged girders.

Achieving effective and sustainable overheight detection systems would be an asset to AKDOT&PF by providing images of violating vehicles and revealing more information about why overheight vehicles do not follow the warning to take the bypass exit ramp.

T2-08-13 Frequency and Potential Severity of Red-Light Running in Anchorage

Principal Investigator: Not yet assigned
Funding: $200,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: To be determined

Red-light running is among the leading causes of urban automobile crashes. In many communities, the yellow light has come to symbolize "hurry up" instead of "slow down." The rate of crashes at traffic signals has been increasing in Alaska over the last decade. In Alaska and across the nation, more than half of the deaths in red-light running crashes are other motorists and pedestrians, so there is little debate that red-light runners are dangerous drivers who irresponsibly put others at risk. AKDOT&PF would like to better understand the most effective strategies for reducing severe crashes at signalized intersections. Policy and law-makers also need relevant information in order to establish the most effective counter measures.

The project's objectives include the use of a sophisticated video system to monitor several Anchorage intersections that have a high incidence of red light violations and injury crashes. This "intelligent" automated video monitoring system will be capable of documenting the number and nature of the violations by sensing when a violation occurs and then storing the low-resolution video that includes the entire red light running violation. Other data (such as weather conditions, traffic congestion, and turning motions) will be collected to analyze individual violations and trends relative to external conditions.

Although red-light running studies have been done before in Alaska, they have not included data on how far into the red light cycle the violations occur (severity), nor have they acquired video of the violations for in-depth post-violation analysis. Although a principal investigator has not yet been selected for this project, the project's Technical Advisory Committee worked in collaboration with the University of Alaska Anchorage Civil Engineering Department to do preliminary research and investigation into the use of the Municipality of Anchorage's existing traffic cameras to test the concepts for video-based monitoring and help develop the requirements for the broader research project. This work also involved updating a 2005 manual-based assessment of red light running for selected Anchorage intersections.

Benefits to the State

As part of the Strategic Traffic Safety Plan finalized in March 2012, the state adopted the Towards Zero Deaths campaign and is committed to the long-term goal of eliminating traffic-related deaths. The results from this research project will help the AKDOT&PF determine and implement effective and data-driven counter measures to reduce fatal and serious injury crashes due to red-light running.

Reduction of traffic crashes relies on the 3 E's: engineering, education, and enforcement. This research project is expected to produce data and recommendations that will help not only with implementing engineering improvements, but will likely produce information and illustrations that will aid in public education about potentially more effective means of enforcing compliance with red lights.

T2-08-14 Analysis of Electromat At-Grade Moose Crossings

Principal Investigator: David Bryson (ElectroBraid, Inc.)
Funding: $270,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Completion Date: Terminated August 2012

The objective of this project was to reduce moose-vehicle collisions on Alaska roads by designing, installing, and conducting an in-situ test of an innovative at-grade barrier to control moose movement. This project was to use the unique Electromat and ElectroBraid fencing system to close off openings in the existing moose fencing along the Glenn Highway in the area from Arctic Valley Road to the Joint Base Elmendorf Richardson exit. The research intended to include measuring the results of the at-grade installation by analyzing multiple years of crash statistics, determining the durability and operational requirements of the system under Alaska conditions, monitoring the reactions of moose to the system, and monitoring and analyzing the before-and-after movements of moose in the research area using monitoring camera systems.

However, the project team was unable to achieve the necessary sustained collaboration between governmental agencies and critical project stakeholders to get agreement on the required research scope, define the roles and responsibilities of each group relative to data collection, or secure permits and permissions within the timeframe of the funding requirements. These issues caused the project to stall out and resulted in a high risk of not being able to achieve successful and implementable research results.

Benefits to the State

Although the original objectives of the project were not met before project termination, the project did result in several important outcomes. This includes that the AKDOT&PF successfully established a partnership with the ElectroBraid company, which delivered preliminary design and permitting documents that can be leveraged for a revised research project or for future Highway Safety Improvement Program projects.

The project also fostered communication within AKDOT &PF and with other State of Alaska agencies about mitigation of animal-vehicle crashes. This communication resulted in the formation of a multiagency workgroup whose goal is to create a partnering structure to avoid and resolve issues for future construction or research projects.

T2-10-03 Pavement Marking Systems Demonstration

Principal Investigator: Paul Carlson (Texas Technology Institute)
Funding: $50,000 (FHWA)
Project Manager: Angela Parsons, P.E.
Completion Date: March 2011

It is a challenge for the AKDOT&PF to maintain roadway safety markings, especially in areas where winter maintenance activities such as snow plowing and removal are frequent. Pavement marking retroreflectivity is hard to maintain or repair until the warmer and dryer weather of summer when road striping crews can start refurbishing the markings. In these areas, it is difficult enough to maintain pavement marking presence through the winter months let alone retroreflectivity.

In Alaska's urban areas (such as Anchorage), many of the state-maintained roadways are provided with continuous roadway lighting. Recessed retro reflective pavement markers are used on some unlighted rural roadways. AKDOT&PF engineers worked with researchers from Texas Technology Institute to find out if the markings provide adequate nighttime visibility on continuously lit roadways.

The purpose of this research project was to assess the nighttime visibility of representative Alaska highway pavement markings and recessed road markers under lighted conditions relative to the proposed FHWA Manual on Uniform Traffic Control Device (MUTCD) pavement markings

retroreflectivity levels. The researchers used innovative luminance measuring technology and software to collect and analyze field measurements from sites in the Anchorage area and on Kodiak Island. The researchers determined the visibility of road markings along lighted highway sections and assessed the visibility of recessed road markers along unlighted highways.

The researchers found that continuous roadway lighting provided better visibility of pavement markings at longer distances than unlit highways. Along dark rural highways, the visibility of the raised retroreflective pavement markers and guardrail delineation tabs was greater than the pavement markings. The research successfully showed that all of the pavement markings tested in this study would be in compliance with the FHWA's proposed minimum retroreflectivity levels.

Benefits to the State

AKDOT&PF traffic safety engineers have embraced the results from this research effort, especially recognizing the potential economic benefits from not having to rely on painting beads (which don't last long under Alaska conditions) where there is good striping (especially inlaid Methyl Methacrylate (MMA)) and continuous lighting. As long as pavement marking presence can be maintained on these roadways, the department may be able to invest in durable urban striping and extend restriping practices to achieve retroreflectivity on more miles of rural unlit roadways. The research also shows that the department is on the right track by using highway delineation and signing and by continuing to test recessed pavement markers for safety results.

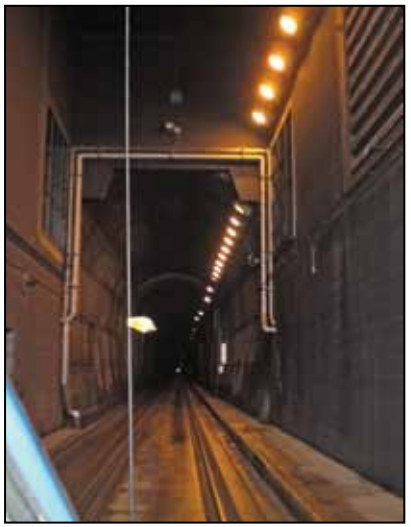
T2-12-10 Whittier Tunnel Operations Study

Principal Investigator: Thomas L. Moses, P.E. (Consulting Engineer and DOWL HKM Contractor)
Funding: $150,000 (SP&R)
ADOT&PF Project Manager: Robert Wright (ROW Chief)
Estimated Completion Date: December 2014

Conduct operational research on the Whittier Access Tunnel with the objective of improving vehicle and freight operations scheduling of this unique multimodal facility.

Benefits to the State

The Whittier Access Tunnel was opened to the public in 2000 and is maintained and operated by AKDOT&PF and the Alaska Railroad Corporation. This research project will investigate the existing scheduling matrix that blends vehicle traffic with railroad usage to understand if there are opportunities to improve peak traffic flows and increase efficiencies. The consultant and contractor will also review the initial assumptions that created the schedules and investigate how those assumptions have changed by identifying the current stakeholders that rely on this transportation asset.



The Whittier Access Tunnel supports both vehicle and railroad traffic. Photo: Russ Mitchell.

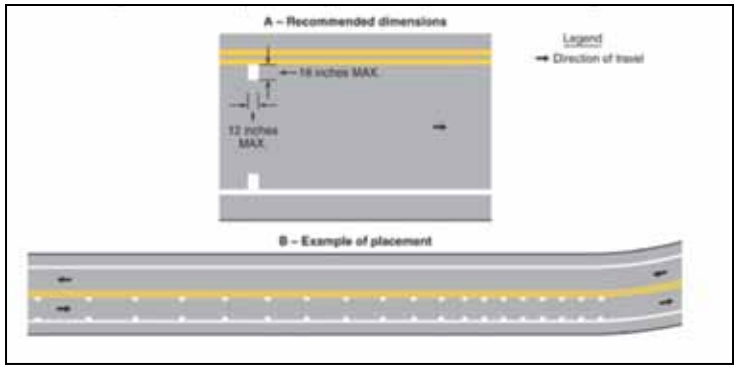
T2-12-14 Passing Lanes Study

Principal Investigator: Billy Connor, P.E. (UAF & AUTC); Ahmed Abdel-Rahim & Brian Dyre (University of Idaho)
Funding: $60,000 (SP&R)
Project Manager: Angela Parsons, P.E.
Estimated Completion Date: March 2013

This study will develop novel highway lane markings and signage based on a scientific understanding of human perception and decision making (i.e., human factors) and will assess the potential of these safety interventions for reducing speed and risky passing behavior by conducting a series of driving simulation experiments.

Benefits to the State

Reduce the number of crashes that occur relative to passing lanes on Alaska's nondivided rural highways.



An example of pavement markings used to influence speed judgment that may be investigated by researchers at the University of Idaho using their driving simulation facility.

An example of a transition from passing lane to undivided two-lane rural road on the Seward Highway, Turnagain Pass area. Intense traffic levels occur during the summer (especially with weekend and holiday fishing and recreation), which can lead to risky passing behaviors and crashes.

An Anchorage-bound traffic jam in a passing lane zone on the Seward Highway near Portage. Photo: Scott Thomas AKDOT&PF Central Region traffic safety engineer.

Housed within AKDOT&PF's Research Section, Technology Transfer (T2) provides support to federal, state, and local governments and other transportation personnel. We are comprised of three programs, integrated to provide a seamless training and technology transfer service.

Snow plow orientation video. This DVD provides critical safety and operational information to AKDOT&PF's operators. This was a collaborative effort with the regions and Statewide M&O.

Local Technical Assistance Program: $280,000

A national network of centers funded by FHWA. The LTAP mission is to foster a safe, efficient, and environmentally sound surface transportation system by improving skills and increasing knowledge of the transportation workforce and decision makers. Each LTAP center adapts its program to address the unique challenges faced by the customers it serves. LTAP's primary focus is on:

- training events and programs,
- quarterly newsletter, and
- library services.

National Highway Institute: $350,000

Provides transportation-related education programs to AK DOT&PF employees to help improve the quality of the state's highway system by enhancing economic growth, improving public safety and quality of life, and promoting environmental stewardship. This is accomplished by technology transfer to the planning, design, construction, and maintenance personnel working for Alaska's transportation infrastructure.

Rapid Technology Transfer: $100,000

State of Alaska program designed to respond to high-value, unprogrammed needs related to training and technology transfer. Funds are limited to courses, projects, programs, or equipment that will benefit the maximum number of stakeholders. Use of funds should result in cost savings, leveraging of external resources, or enhancement of partnerships. Priorities are:

- Special project seed funds.
- Training to meet crucial project needs, mandates, or consent decrees.

T2 Highlights

- In calendar year 2010, T2 offered 104 events to over 1,350 participants from state and local governments and other transportation agencies.
- In calendar year 2011, T2 offered 103 events to over 2,500 participants from state and local governments and other transportation agencies.
- T2 delivered specialized training on gravel road inspection and maintenance planning to Fairbanks North Star Borough road commissioners to help them inspect and manage their service areas.
- Expanding road service program to Kenai Peninsula Borough.
- Participated in Alaska Summer Research Academy by delivering the civil engineering module to high-school students.
- Developed and disseminated snow plow orientation video for statewide maintenece and operations. Video covers safe operations, walk-around inspections, and operator techniques.
- Continuation and expansion of Construction Management Program with UAF's Institute of Northern Engineering. First AKDOT&PF graduates in 2011.
- Hosted Region 9 LTAP meeting in Fairbanks with particiaption from six western states and FHWA.
- Partnered with FHWA to deliver six Every Day Counts webinars to all three regions.

High school students from the UAF Summer Research Academy (ASRA) designed, tested and built this ATV bridge now owned by Alaska State Parks. It's truss design will handle over 3,000 Lbs. over an 8-foot span, is modular and made only of 2x4's, and cost under $500 in materials. RD&T2 staff, Dave Waldo, was co-instructor of this year's civil engineering module.