Alaska Department of Transportation & Public Facilities

Research, Development & Technology Transfer

Annual Report 2013

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

The Research Development and Technology Transfer (RD&TT) Section within the Division of Design and Engineering Services of the Alaska Department of Transportation & Public Facilities (ADOT&PF) provides research management, library, technical assistance, training, and technology deployment services to ADOT&PF, local transportation agencies, and their partners.

RD&TT provides services largely through the collaborative relationships with and financial support from the Federal Highway Administration, the Alaska University Transportation Center and the ADOT&PF. By leveraging resources and developing partnerships with a variety of transportation organizations and professionals. RD&TT taps into a vast network of expertise and resources and eliminates duplication of effort. RD&TT also provides an avenue for multidisciplinary support from a network of engineering, management, leadership, law, planning, and the environment.

This is a report of the research, development, and technology transfer activities carried out by the ADOT&PF and its partners. This report covers federal fiscal year 2013, beginning October 1, 2012, and ending September 30, 2013.

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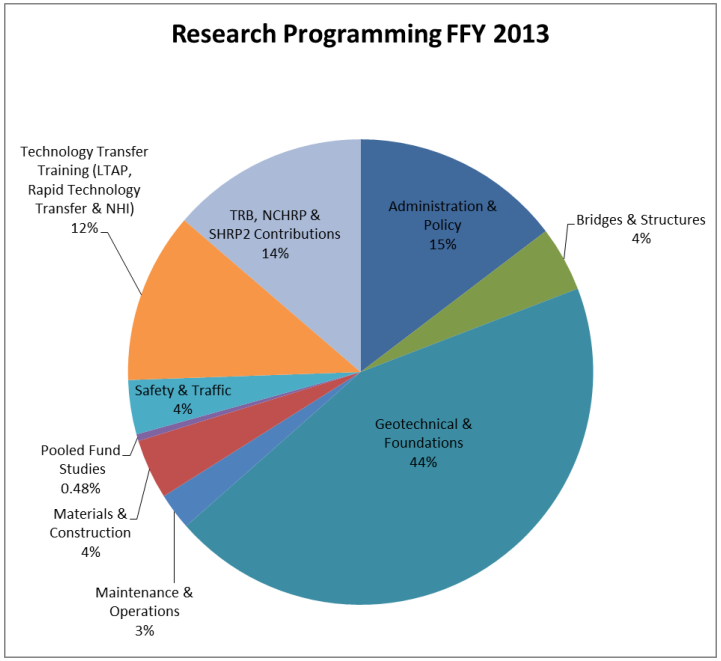
Fiscal Summary

RD&TT received funding from the Federal Highway Administration's (FHWA) State Planning and Research Program (SP&R), Local Technical Assistance Program (LTAP), Surface Transportation Program (STP), and state matching funds (SM). Additionally, RD&TT leverages funding with the Alaska University Transportation Center (AUTC), and the FWHA's Transportation Pooled Fund Program.

FFY 2013 RD&TT Fiscal Summary		2013
Revenues		
SP&R Program Funds (STIP ID#6451)	$	1,614,910
USDOT IRT Program Grant	$	80,000
State Project Funds	$	150,000
NHI Funds (STIP ID#6452)	$	350,000
Unstable Slope Management Program {STP-4000(126)}	$	1,700,000
Geotechnical Asset Management {Fed #SP000S (802)}	$	1,350,000
Transportation Asset Management Program	$	1,000,000
State Match Funds	$	403,728
Reinvested Project Closures	$	656,556
Total	**$**	**7,305,194**
Expenditures & Obligations		
NCHRP Dues	$	507,153
TRB Core Services	$	100,983
SHRP2 Contributions	$	391,954
Pooled Fund Studies	$	35,000
Technology Transfer / Training	$	866,104
Research Project Programming (Obligations)	$	1,274,000
Other Research Programming (Obligations)	$	4,130,000
Total	**$**	**7,305,194**

Research Funding Distribution

Research Funding Distribution Category	***Total***
Administration & Policy	$1,070,000
Alaska Marine Highway System	$0
Bridges & Structures	$330,000
Environmental	$0
Geotechnical & Foundations	$3,238,000
Hydraulics & Hydrology	$0
Maintenance & Operations	$187,000
Materials & Construction	$304,000
Planning & Design	$0
Pooled Fund Studies	$35,000
Safety & Traffic	$275,000
Technology Transfer Training (LTAP, Rapid Technology Transfer & NHI)	$866,104
TRB, NCHRP & SHRP2 Contributions	$1,000,090
Grand Total (21 Projects Programmed)	**$7,305,194**



Acronyms

ADOT&PF	Alaska State Department of Transportation & Public Facilities
AUTC	Alaska University Transportation Center
CRREL	Cold Regions Research & Engineering Laboratory
FHWA	Federal Highway Administration
GF	General Fund (State of Alaska)
LTAP	Local Technology Assistance Program
M&O	Maintenance & Operations
MSU	Montana State University
NCHRP	The National Cooperative Highway Research Program
NCSU	North Carolina State University
NHI	National Highway Institute
PacTrans	Pacific Northwest Transportation Consortium
RD&TT	Research, Development & Technology Transfer
SHRP	Strategic Highway Research Program 2
SP&R	(FHWA) State Planning & Research
STIP	Statewide Transportation Improvement Program
STP	(FHWA) Surface Transportation Program
TRB	Transportation Research Board
UAA	University of Alaska Anchorage
UAF	University of Alaska Fairbanks
UofI	University of Idaho
WTI	Western Transportation Institute

Research Projects Programmed in FFY2013

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Flashing Yellow Arrow Public Information Campaign	T2-13-01	61085	Safety and Traffic	$25,000 (SP&R)
Development of GPS Survey Data Management Protocols and Policy	T2-13-02	61085	Materials & Construction	$10,000 (SP&R)
Transportation Asset Management Program	T2-13-03	80880	Administration & Policy	$1,000,000 (STIP)
LTAP Technology Transfer Program (LTAP)	T2-13-04	62407	Alaska Technology Transfer	$396,104 (SP&R)
NHI National Highway Institute	T2-13-05	62404	Alaska Technology Transfer	$350,000 (STP)
Rapid Technology Transfer	T2-13-06	76550	Alaska Technology Transfer	$120,000 (GF)
Expedient Permafrost Resistivity Investigation	T2-13-07	60533	Geotechnical and Foundations	$68,000 (SP&R)
Unstable Slope Management - Phase II	T2-13-08	62467	Geotechnical and Foundations	$1,700,000 (STIP)
Testing & Screening Surfacing Materials for Alaska's Yukon River Bridge	T2-13-09	60533	Maintenance & Operations	$137,000 (SP&R) $ 50,000 (GF)
Tencati Wicking Fabric Design	T2-13-10	61105	Materials & Construction	$35,000 (SP&R)
Reinforced Concrete Filled Pipe Piles in Soils	T2-13-11	62725	Bridges & Structures	$330,000 (SP&R)
Long Term Monitoring of Ice-Rich Cut Slopes at Dalton Highway MP 9	T2-13-12	61105	Geotechnical and Foundations	$40,000 (SP&R)
Evaluate Presawn Transverse Thermal Cracks	T2-13-13	63031	Materials & Construction	$75,000 (SP&R)
Wicking Fabric Design Specification	T2-13-14	63041	Materials & Construction	$125,000 (SP&R)
Value of Depressed Medians on Divided Highways in Alaska	T2-13-15	63039	Safety and Traffic	$150,000 (SP&R)
Optimizing Highway Patrol Investment Levels	T2-13-16	63068	Safety and Traffic	$100,000(SP&R)

Research Projects Programmed in FFY2013 (cont.)

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Evaluation Low Temperature Pavement Cracking	T2-13-17	60533	Materials & Construction	$8,000 (SP&R)
Geotechnical Asset Management - Stage II	T2-13-18	63076	Geotechnical and Foundations	$80,000 (STIP)
Polyester Concrete For Approach Slabs	T2-13-19	61105	Materials & Construction	$51,000 (SP&R)
Enhancing Research & Technology Deployment through Program Recording	T2-13-20	61085	Administration & Policy	$30,000 (SP&R)
Improving Quality Workshop	T2-13-21	61085	Administration & Policy	$40,000 (SP&R)

Active Research Projects FFY2008 - FFY2012

Shading indicates projects expected to be completed and closed out during FFY2014

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Experimental Features: Sasobit And Foamed Warm Mix Asphalt Techniques	T2-06-04	61072	Materials & Construction	$134,000 (SP&R)
Optimizing Implementation of Civil Rights Requirements for Vessel Construction	T2-06-08	62905	Administration & Policy	$50,000 (SP&R)
Plastic Strain Limits for Reinforced Concrete	T2-08-02	60855	Bridges & Structures	$300,000 (SP&R)
The Response of Pile-Guided Floats Subjected to Dynamic Loading	T2-08-08	60946	Alaska Marine Highway System	$100,000 (SP&R)
Frequency and Potential Severity of Red Light Running in Anchorage	T2-08-13	60973	Safety and Traffic	$200,000 (SP&R)[1]
Application of a Nontraditional Soil Stabilization Technology: Lab Testing of Geofibers and Synthetic Fluid	T2-08-16	60932	Materials & Construction	$200,000 (SP&R)
Load Environment of Washington State Ferry and Alaska Marine Highway Landings	T2-09-03	63280	Alaska Marine Highway System	$107,000 (SP&R)
Foamed Warm Mix Asphalt Lab Testing: Experimental Features in Highway Construction	T2-10-01	61072	Materials & Construction	$26,986 (SP&R)
Phase II: Development of an Unstable Slope Management Program Research	T2-10-04	63440	Geotechnical and Foundations	$4,000,000 (STIP)
Ductility of Welded Steel Columns to Cap - Part II	T2-10-05	63695	Bridges & Structures	$180,000 (SP&R)

[1]*Project was canceled for lack of support from Stakeholders*

Active Research Projects FFY2008 - FFY2012 (cont.)

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Stabilization of Erodible and Thawing Permafrost Slopes with Geofibers and Synthetic Fluid	T2-10-11	63707	Materials & Construction	$132,000 (SP&R)
Performance of Dust Palliatives on Unpaved Roads in Rural Alaska	T2-10-12	63701	Materials & Construction	$40,000 (SP&R)
Selecting Preservatives for Marine Structural Timbers in Herring Spawning Areas	T2-10-13	63703	Bridges & Structures	$77,534 (SP&R)
Geosynthetic Design Guidelines and Construction Specifications	T2-11-02	76174	Materials & Construction	$73,500 (GF) + $16,000 (SP&R)
Field-Evaluating of Crack Sealing of Asphalt Concrete Pavements in Alaska	T2-11-06	60600	Materials & Construction	$90,000 (SP&R)
Develop Locally Sourced Salt Brine Additive for Anti-icing	T2-11-07	60595	Materials & Construction	$140,000 (SP&R)
Structural Health Monitoring and Condition Assessment of Chulitna River Bridge	T2-11-08	60742	Bridges & Structures	$483,000 (SP&R)
Economic Impact of Fines in the Unbound Pavement Layers	T2-11-11	60642	Materials & Construction	$90,000 (SP&R)
Alaska Bald Eagles and Highway Construction Projects	T2-11-13	60579	Environmental	$50,000 (SP&R)
Rapid Research Response FFY 2011-FFY2013	T2-11-17	60533	Various	$778,396 (SP&R)
Research & Technology Deployment FFY 2012- FFY 2014	T2-11-18	61085	Various	$778,396 (SP&R)
Experimental Features FFY2012-FFY2014	T2-11-19	61105	Various	$500,000 (SP&R)
FY 11 CTIP Unstable Slope Management Program (USMP), WFL	T2-12-01	54270	Geotechnical and Foundations	$80,000 (FHWA Western Federal Lands)

Active Research Projects FFY2008 - FFY2012 (cont.)

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Video Documenting Best Practices for Mitigating Frost Damage to Transportation Infrastructure	T2-12-05	61085	Geotechnical and Foundations	$20,958 (SP&R)
Whittier Tunnel Signal System Investigation	T2-12-07	61862	Safety and Traffic	$150,000 (SP&R)
Whittier Tunnel Operations Study	T2-12-10	61907	Safety and Traffic	$150,000 (SP&R)
Estimating Future Flood Frequency and Magnitude in Basins Affected by Glacier Wastage	T2-12-11	61923	Hydraulics & Hydrology	$80,000 (SP&R)
Investigation of High-Mast Light Pole Anchor Bolts	T2-12-12	61925	Bridges & Structures	$80,000 (SP&R)
Maintenance Decision Support System (MDSS)	T2-12-13	80839	Maintenance & Operations	$225,000 (SP&R)
Improving Passing Lane Safety and Efficiency for Alaska's Rural Non-Divided Highways	T2-12-14	61965	Planning & Design	$60,000 (SP&R)
Use of Lidar to Evaluate Slope Safety	T2-12-15	61972	Planning & Design	$115,000 (SP&R)
Cordova Sectional Barge Study	T2-12-16	60533	Alaska Marine Highway System	$45,000 (SP&R)
Review of Power Sources for Alaska DOT Road Weather Information Systems, Phase I	T2-12-18	62084	Hydraulics & Hydrology	$40,000 (SP&R)
A Design for an Interface Board between a MRC Thermistor Probe and a Personal Computer	T2-12-19	60533	Materials & Construction	$30,000 (SP&R)
Improving Engineering Education Delivery	T2-12-20	62133	Administration & Policy	$30,000 (SP&R)
Geotechnical Asset Management Program	T2-12-21	80900	Geotechnical and Foundations	$2,700,000 (STIP)

Active Research Projects FFY2008 - FFY2012 (cont.)

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
ADOT&PF Leadership Academy Development	T2-12-22	62131	Administration & Policy	$50,000 (SP&R)
Assessment of Implementation of SAFETEA-LU Section 6004	T2-12-23	62129	Environmental	$80,000 (SP&R)[2]
Geophysical Investigation at Mile 9 Dalton Highway	T2-12-24	60533	Geotechnical and Foundations	$23,000 (SP&R)

[2] *Project Cancelled*

Research Projects Completed During FFY 2013

Title	T2 Project #	AKSAS Project #	Category	Report Number
Development of GPS Survey Data Management Protocols and Policy	T2-07-02	76983	Materials & Construction	Report being finalized
Development of Construction Dust Control Protocols	T2-07-05	76989	Materials & Construction	FHWA-AK-RD-12-02
Analysis of ADOT&PF Pile Driving and Dynamic Pile Testing Results	T2-08-01	60616	Geotechnical and Foundations	FHWA-AK-RD-12-07
Evaluation of the Overheight Detection System at the Eklutna Overcrossing Bridge	T2-08-06	60832	Bridges & Structures	FHWA-AK-RD-13-01
Feasibility Study of RFID Technology for Construction Load Tracking	T2-08-09	61223	Materials & Construction	FHWA-AK-RD-12-27
LiDAR Testing under Heavy Tree Canopy and in Steep Terrain	T2-08-10	60934	Planning & Design	Report being finalized
Updated Precipitation Frequency Estimation for the State of Alaska	T2-08-15	60932	Hydraulics & Hydrology	FHWA-AK-RD-13-04
Life Cycle Cost Analysis for Alaska Bridge Components	T2-08-18	60932	Bridges & Structures	Report being finalized
Using Shallow Anchors and an Anchored Mesh System for Cut Slope Protection in Ice-Rich Soils	T2-08-20	60932	Geotechnical and Foundations	Report being finalized
Seismic Performance of Bridge Foundations in Liquefied Soils	T2-09-01	63267	Bridges & Structures	FHWA-AK-RD-12-19
Alaska Rural Airport Inspection Program	T2-09-02	63229	Maintenance & Operations	Report being finalized
Evaluation of In-place Inclinometer Strings in Cold Regions	T2-09-06	63273	Geotechnical and Foundations	FHWA-AK-RD-12-28
Alaska Hot Mix Asphalt Job Mix Formula Verification	T2-09-08	63271	Materials & Construction	Report being finalized
Inclusion of Life Cycle Cost Analysis in Alaska Flexible Pavement Design Program	T2-09-09	63265	Materials & Construction	FHWA-AK-RD-13-07

Research Projects Completed During FFY 2013 (cont.)

Title	T2 Project #	AKSAS Project #	Category	Total Current Project Funding
Effect of Load History on Performance Limit States of Bridge Columns	T2-10-06	63697	Bridges & Structures	FHWA-AK-RD-12-09
Dust Palliative Performance Measurements on Nine Rural Airports	T2-09-10	63265	Materials & Construction	Report being finalized
Testing & Screening Surfacing Materials for Alaska's Yukon River Bridge	T2-10-07	63709	Bridges & Structures	FHWA-AK-RD-12-21
Using the Micro-Deval Test to Assess Alaska Aggregates	T2-10-08	63711	Geotechnical and Foundations	FHWA-AK-RD-12-22
Shake Table Experiments of Bridge Foundations in Liquefied Soils	T2-10-09	63705	Bridges & Structures	FHWA-AK-RD-12-19
Characterization of Alaskan HMA Mixtures with the Simple Performance Tester	T2-10-10	63693	Materials & Construction	Report being finalized
Guidelines for Pavement Preservation	T2-10-14	63699	Materials & Construction	FHWA-AK-RD-12-14
Experimental Feature: Agreement for Evaluation of AASHTO Ware Products	T2-10-15	61777	Materials & Construction	Report being finalized
Strain Limits for Concrete-Filled Steel Tubes in AASHTO Seismic Provisions	T2-11-03	60717	Bridges & Structures	FHWA-AK-RD-13-05
Frozen Soil Lateral Resistance for the Seismic Design of Highway Bridge Foundations	T2-11-04	60644	Bridges & Structures	FHWA-AK-RD-12-23
Experimental Study of Various Techniques to Protect Ice-Rich Cut Slopes	T2-11-05	61105	Geotechnical and Foundations	Report being finalized
Knowledge Transfer Needs and Methods	T2-11-09	60660	Administration & Policy	FHWA-AK-RD-12-26
Geotechnical Asset Management	T2-11-10	60652	Geotechnical and Foundations	Project Terminated
Development of Transportation Asset Management Program (TAMP)	T2-12-08	61085	Administration & Policy	Project Cancelled
Strategic Communications Assessment	T2-12-09	60533	Administration & Policy	Project Cancelled
Monitoring and Analysis of Frozen Debris Lobes, Phase I	T2-12-17	60533	Geotechnical and Foundations	FHWA-AK-RD-12-17

Note: All research reports are available in full text electronically in our online RD&TT library at: http://dot.alaska.gov/stwddes/research/search_lib.shtml

T2-06-08 Optimizing Implementation of Civil Rights Requirements for Vessel Construction
Principal Investigator: E. W. Morris & Associates, Inc.
Funding: $50,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completed December 2013

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 ADOT&PF Civil Rights Office personnel explained the problems they have encountered in meeting federal civil rights contacting requirements in contracts for AMHS refurbishment and new vessel construction contracts. In instances where projects are funded by only one agency monitoring contractors' compliance with required contract provisions is relatively straightforward. However, when multiple agencies (in this case the FHWA and the Federal Transportation Administration) are involved, civil rights related 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 ADOT&PF's federally approved DBE program.

T2-11-09 Knowledge Transfer Needs and Methods
Principal Investigator: Dr. Robert A. Perkins, P.E., Dr. Lawrence Bennet, P.E.
Funding: $36,000 (SP&R)
ADOT&PF Project Manager: Clint Adler, P.E.
Completion Date: December 2012

Conduct a review of the knowledge transfer needs of the Alaska DOT&PF. Study best practices and related literature, conduct focus groups to get preliminary results, and create tools.

The study compares employees with over ten years with the department and those with fewer than ten years with the department.

Research topics include regulations, policies, procedures, project management process, coordination with agencies and elected officials, manuals and budgeting. Interviews with DOT&PF staff examine how knowledge is transferred and the degree of effectiveness.

Benefits to the State: Recommendations for procedural and organizational knowledge transfer for more efficient project development and coordination. Provide a roadmap for implementation.

T2-12-20 Improving Engineering Education Delivery – Phase I
Principal Investigator: Dr. Robert A Perkins, P.E.
Funding: $30,000 (SP&R)
ADOT&PF Project Manager: Clint Adler, P.E. & Carolyn Morehouse, P.E.
Completion Date: April 2014

Review academic literature on non-traditional teaching techniques and materials, evaluate these techniques in the classroom, and partner with universities and other state Departments of Transportation on academic curriculum development and delivery.

Benefits to the State: Study of alternative methods for learning including web based training, video conferencing, recorded training sessions and information packages for producing transportation engineering modules.

T2-12-22 DOT&PF Leadership Academy Development
Principal Investigator: Dr. Robert A. Perkins, P.E., Dr. Lawrence Bennett, P.E.
Funding: $50,000 (SP&R)
ADOT&PF Project Manager: Clint Adler, P.E. & Carolyn Morehouse, P.E.
Completion Date: June 2014

Investigate the feasibility of developing a cohesive series of training experiences for the Department of Transportation & Public Facilities 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: System for implementing a leadership development program for technical skills which includes mentoring, skills assessment, training and tracking progress.

T2-13-03 Transportation Asset Management
Principal Investigator: Cambridge Systematics, Inc.
Funding: $1,000,000
ADOT&PF Project Manager: Carolyn Morehouse
Completion Date: September 2014

This research project was established to have an outside entity make recommendations for planning and implementing a Transportation Asset Management System and Data Solution an Asset Management program in the Department.

The research project's scope consists of the following twelve tasks: 1) Create Work Plan; 2) Document and Assess all Federal Requirements and Associated Research; 3) Research Other State Best Practices; 4) Stakeholder Coordination; 5) Evaluate Current Systems and Extent of Integration (Existing Condition); 6) Develop ADOT&PF TAMIS Framework (Desired Condition); 7) TAMIS Gap Analysis; 8) Research TAMIS System Model Alternatives; 9) Research Recommendations for TAMIS; 10) Develop and Conduct a Project Communication Plan; 11) Data Business Plan for TAMIS; and 12) Develop a Proof of Concept for TAMIS Application.

Benefits to the State: This project will result in improved data management for the department. The recommendations will lead the department toward creating a system that all employees can easily use and for the department to maintain. It will strengthen the ability of data programs to support core business functions of the department. It will improve the data quality throughout the organization and protect data by treating it as an asset of the agency and limit the risks associate with the loss of data and information or making decisions using poor quality data. Short

term benefits include the drafting of a data and information technology policy and procedure. Cambridge will also do an asset management maturity assessment that will help in drafting our TAM Plan for FHWA.

T2-13-20 Enhancing Research & Technology Deployment through Program Recording
Principal Investigator: Patrick Casey (CTC & Associates, LLC)
Funding: $30,000 SP&R (spent $5,000)
ADOT&PF Project Manager: Clint Adler, P.E. & Carolyn Morehouse, P.E.
Completion Date: January 2014

The Research, Development, & Technology Transfer (RD&TT) section of the Alaska Department of Transportation & Public Facilities (DOT&PF) exists to facilitate the identification, development, and deployment of research results and beneficial technologies in order to improve the delivery of transportation systems and services in Alaska. Federal and state regulations require annual reporting of the activities of the RD&TT section.

Benefits to the State: The ADOT&PF Research Advisory Board asked RD&TT to identify improved reporting efforts to, if possible, increase effectiveness in promoting deployment and awareness of the section's activities within the ADOT&PF.

T2-13-21 Improving Excellence Workshop
Principal Investigator: Billy Connor (UAF – AUTC)
Funding: $40,000 SP&R
ADOT&PF Project Manager: Clint Adler, P.E. & Carolyn Morehouse, P.E.
Completion Date: June 2014

Conduct research deployment, technology transfer and marketing activities necessary for deployment of research products and/or technologies.

Benefits to the State: This collaborative project supports and promotes a partnership with the Alaska University Transportation Center (AUTC) to identify and promote additional opportunities for the partnership to support ADOT&PF's core value of Excellence as defined in its "Strategic Plan". Both agencies intend to use this project to enhance communication and coordination amongst stakeholders of the DOT&PF Research, Development & Technology Transfer Section and the Alaska University Transportation Center.

T2-08-08 The Response of Pile-Guided Floats Subjected to Dynamic Loading
Principal Investigator: Dr. Andrew Metzger (UAA & AUTC)
Funding: $100,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Janelle White
Completion Date: June 2014

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.

ADOT&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 ADOT&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 which avoid under and overdesigning. The resulting designs will be more economical with increased longevity.

T2-09-03 Load Environment of Washington State Ferry and Alaska Marine Highway Landings
Principal Investigator: Dr. Andrew Metzger (UAA & AUTC)
Funding: $107,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completion Date: May 2013

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.

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 cost-sharing project in which ADOT&PF and Washington State DOT are able to have a cooperative research project and 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 acquired a robust statistical sample of the metrics needed to define the design criteria. The data was gathered by monitoring two in-service facilities, the AMHS terminal at Auke Bay near Juneau, Alaska, and the WSF Seattle terminal in Washington. The data collected resulted in updated design criteria for AMHS engineers.

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: $77,534 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
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 tested the toxicity of marine structural preservatives to herring eggs under a variety of conditions common in Alaska marine waters, focusing on Southeast Alaska. It also compared the durability of creosote-versus ACZA-treated marine timbers under comparable climatic and service conditions. Information from this project will help ADOT&PF make selections of wood structural materials for the marine environment, concentrating on the selection of wood-preserving methods. Results indicated that there is no significant difference between ACZA and creosote with regard to herring egg toxicity. ACZA should not be used for submerged glulam however.

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 Rapid Research Response: Cordova Sectional Barge Study
Principal Investigator: Dr. Andrew Metzger, (UAA & AUTC)
ADOT&PF Funding: $45,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Janelle White
Completion Date: June 2014

This project will assist ADOT&PF's engineers evaluate the effectiveness & 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.

T2-08-02 Plastic Strain Limits for Reinforced Concrete
Principal Investigator: Dr. Mervyn J. Kowalsky (NCSU)
Funding: $300,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: August 2014

ADOT&PF's bridge design engineers are challenged by many unknowns when designing reinforced concrete transportation structures to withstand Alaska's seismic loads. They must utilize concrete and steel strain limit states that have minimal experimental or theoretical basis. And while the strain limits that are typically utilized 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 non-linear range are well established, the strain limits which define maximum structural capacity are less well defined.

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 ADOT&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 ADOT&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. Consideration of these criteria will be made in order to recommend strain limits and how the limits can be utilized 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. It is anticipated that a workshop will also be conducted at the conclusion of this project that will transfer knowledge and assist the ADOT&PF to improve the safety and reliability of Alaskan bridges.

T2-08-18 Life Cycle Cost Analysis for Alaska Bridge Components
Principal Investigator: Dr. Leroy Hulsey (UAF &AUTC)
Funding: $150,000 (SP&R) State Funds Match 2008
ADOT&PF Project Manager: Lauren Little, P.E. & Janelle White
Completion Date: In progress

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 Shake Table Experiments of Bridge Foundations in Liquefied Soils

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

Two major earthquakes in Alaska, the 1964 Great Alaskan earthquake and 2002 Denali earthquake, occurred during winter when the ground crust was frozen. At the time of those seismic events, none of the existing bridge foundation types were able to withstand the force from the frozen crust overlying liquefied soils. This project studied how the frozen ground crust affects the performance of bridge pile foundations which will help bridge designers to estimate the loads imposed by the frozen ground crust.

The researchers constructed a physical model and conducted a shake table experiment to gain in-depth understanding of the mechanism of frozen ground crust-pile foundation interaction. The experimental component of the project provided data which the researchers used to validate a solid-fluid coupled finite element (FE) computer simulation model and a simplified method, i.e. the beam-on-nonlinear-Winkler-foundation (BNWF) or p-y approach.

Loads imposed on pile foundations by the frozen crust were studied through solid-fluid coupled FE analyses of a typical Alaskan bridge foundation under two soil conditions–one with an unfrozen crust and the other with a frozen crust–and by comparison of results obtained from these two cases. The effectiveness of the p-y approach in predicting the response of piles subject to frozen ground lateral spreading in liquefiable soils was evaluated by comparing the analyses of results with those obtained from the FE modeling.

The researchers proposed guidelines for design practitioners to analyze the performance of pile foundations embedded in liquefiable soils subject to frozen ground crust lateral spreading with the p-y approach.

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.

Photos: From Final Research Report, FHWA- AK-RD-12-19

Figure 1.4. Lateral spreading observed in a bridge site after the 2002 Denali earthquake

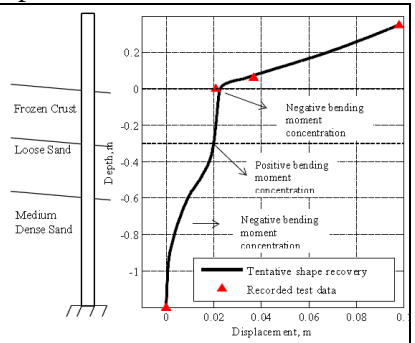


Figure 2.34. Deformed shape estimated by observation and measurement

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)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: January 2013

This research was a continuation of a project that investigated bridge and marine structure design practices, aiming to identify improved connection design approaches to produce the necessary ductility and energy absorbing capacities required for satisfactory designs in Alaska.

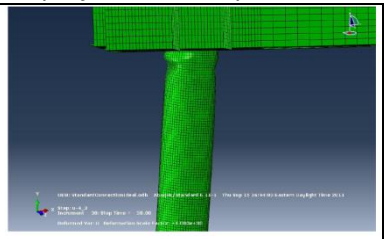
Through earlier testing, the researchers not only proved what methods were inadequate (such as the current practice of fillet-welding the cap beam to the pile as well as alternative welding methods) but also confirmed that a new method of using a plastic hinge-relocating concept was more successful. This method utilized a round steel column capital in which the top portion welded to the cap beam is thicker than the bottom thinner portion welded to the pile. The approach successfully reduced the inelastic demands of the cap beam weld, and forced the inelastic action to occur in the pile itself.

This second phase of the research involved optimizing the new design to improve displacement capacity and ductility, and investigated additional connection designs proposed by ADOT&PF engineers. To do so, the concept of modified weld protected connections was developed based on capacity design principles. The concept was aimed at developing connection configurations that would improve the seismic capacity of steel pier systems by relocating damage in the pile elements away from critical welded regions in addition to strengthening critical welded regions to remain in the elastic range of response. Three such connection configurations were developed with two being shown to fulfill both key criteria.

Benefits to the State: The research result in design recommendations in regards to standard welded connections, modified weld protected connections, and the ductility capacity of systems utilizing a composite connection configuration. The results of this research are anticipated to lead to design methods for piles that will make them more durable and resistant to damage from shaking. These design improvements are targeted at improving the performance of steel bridges and marine structures containing these connections while achieving improved lifespan and less maintenance.

Photos: In order to recommend improvements to ADOT&PF's design of standard welded connections for bridge and marine structures, NCSU researchers used a variety of experimental methods including large-scale quasi – static experimental testing, scaled dynamic shake table experimental testing, and analytical (computer simulation) investigations.
Illustrations extracted from the research project's final report.

Figure 6.216 Scaled Steel Pier with Mass Block System on Shake Table



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)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: August 2012

This project investigates the impact of seismic loading history on the design of reinforced concrete bridge piles typically used in Alaska; basically evaluating the amount of strain that can be put upon a structure before it breaks.

The goal of performance based seismic engineering is to design structures to achieve a specific level of performance under a specific earthquake hazard within definable levels of reliability. To satisfy the aims of performance based design, levels of damage which interrupt the serviceability of the structure or require more invasive repair techniques must be related to engineering criteria. For reinforced concrete structures, concrete compressive and steel tensile strain limits are the best indicators of damage.

A related experimental study (ADOT&PF Project T2-08-02, Plastic Strain Limits for Reinforced Concrete) is currently underway to assess the performance of thirty large-scale circular, well-confined, bridge columns subjected to various unidirectional displacement histories including monotonic, reversed cyclic, and earthquake timehistory response. The test variables include load history, transverse reinforcement detailing, axial load ratio, and aspect ratio.

This project's researchers explored the importance of displacement history and its effects on performance limit states, the relationship between strain and displacement, and the spread of plasticity in reinforced concrete structures. This report focused on test specimens 8-18 which included load history and transverse steel detailing as primary variables. Longitudinal reinforcing bars were instrumented to obtain strain hysteresis, vertical strain profiles, cross section curvatures, curvature distributions, and fixed-end rotations attributable to strain penetration.

Benefits to the State: The research team will provide ADOT&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. The goal of these advancements is to improve the reliability of bridges, decrease maintenance costs, and improve safety.

Photos: This research project involved analysis with a fiber-based model which considered a number of load histories and important structural variables (axial load ratio, transverse steel detailing, aspect ratio and longitudinal steel content), and found that the relationship between strain and displacement was not influenced by load history. Analysis with other load histories will be conducted to confirm this statement.
Illustrations below were taken from the research project's final report.

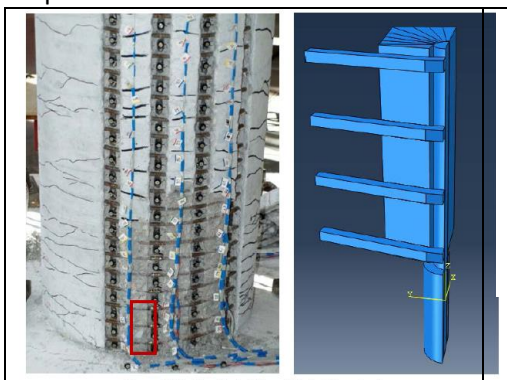


Figure 3-22. Local Modeling at Plastic Hinge Region

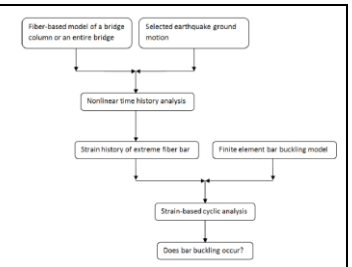


Figure 3-23. Flowchart on Predicting Bar Buckling with Finite Element Model

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)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2012

Soil liquefaction occurs when stress, usually caused by an earthquake, causes soil to act more like a liquid, losing stiffness and strength. 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 non-liquefiable crust rides on top of liquefied soil during an earthquake. This research effort examined how earthquake-associated liquefaction threatens bridge foundations.

This research involved collaboration between University of Alaska research engineers and Professor Yulin Yang, an engineer at China's University of Science and Technology in Beijing, who is also interested in the effect of liquefaction on structures in cold regions. The Chinese researcher shared the cost of two large-scale shake table tests, which integrated physical testing with the ongoing computer simulation project (ADOT&PF project T2-09-01).

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 results will reduce the costs and safety risks created by potential large-scale destruction of key infrastructure during an earthquake. The international collaboration developed during this research project could also lead to further collaboration and technology sharing between countries with similar transportation 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)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: August 2013

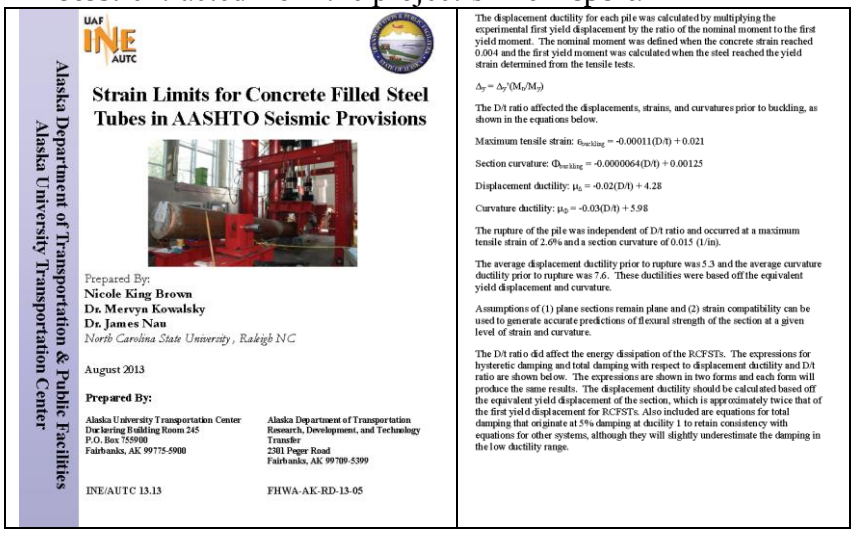
Steel piles are a key infrastructure component. The state's transportation infrastructure uses concrete-filled steel piles because of their strength and simple construction. Research on concrete-filled tubes has only dealt with piles without internal reinforcement and only on a small scale. Important 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.

Experimental tests were performed on twelve large scale reinforced concrete filled steel tubes (RCFSTs). The large scale pipe-piles specimens were subjected to reversed cyclic four-point bending with a constant moment region centered in the pile. The tests focused on two variables: (1) diameter-to-thickness ratio and (2) internal reinforcement ratio. The effect of D/t ratio and internal reinforcement ratio on the initiation of buckling and rupture, ductility, damping, and strain compatibility were determined. Analyses were performed to compare the curvature distribution and plastic hinge length of RCFSTs and convention reinforced concrete columns and a finite element model was created to capture the monotonic response of the specimens.

As a result of this project, the researchers recommend that the ADOT&PF consider sponsoring similar studies to determine the effect of variable loading histories on the behavior of reinforced concrete filled steel tubes and to test pipe pile specimens in soil to determine the effect of soil stiffness on the plastic hinge length.

Benefits to the State: Knowing the structural limitations of the reinforced piles will help engineers design structures that are efficient and safe. The design recommendations resulting from this project are appropriate for consideration by ADOT&PF for contribution to a concise design manual.

Photos: extracted from the project's final report.



Alaska Department of Transportation & Public Facilities
Alaska University Transportation Center

UAF INE AUTC

Strain Limits for Concrete Filled Steel Tubes in AASHTO Seismic Provisions

Prepared By:
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FHWA-AK-RD-13-05

The displacement ductility for each pile was calculated by multiplying the experimental first yield displacement by the ratio of the nominal moment to the first yield moment. The nominal moment was defined when the concrete strain reached 0.004 and the first yield moment was calculated when the steel reached the yield strain determined from the tensile tests.

$\Delta_P = \Delta_Y(M_n/M_y)$

The D/t ratio affected the displacements, strains, and curvatures prior to buckling, as shown in the equations below.

Maximum tensile strain: $\varepsilon_{buckling} = -0.00011(D/t) + 0.021$

Section curvature: $\Phi_{buckling} = -0.0000064(D/t) + 0.00125$

Displacement ductility: $\mu_\Delta = -0.02(D/t) + 4.28$

Curvature ductility: $\mu_\Phi = -0.03(D/t) + 5.98$

The rupture of the pile was independent of D/t ratio and occurred at a maximum tensile strain of 2.6% and a section curvature of 0.015 (1/in).

The average displacement ductility prior to rupture was 5.3 and the average curvature ductility prior to rupture was 7.6. These ductilities were based off the equivalent yield displacement and curvature.

Assumptions of (1) plane sections remain plane and (2) strain compatibility can be used to generate accurate predictions of flexural strength of the section at a given level of strain and curvature.

The D/t ratio did affect the energy dissipation of the RCFSTs. The expressions for hysteretic damping and total damping with respect to displacement ductility and D/t ratio are shown below. The expressions are shown in two forms and each form will produce the same results. The displacement ductility should be calculated based off the equivalent yield displacement of the section, which is approximately twice that of the first yield displacement for RCFSTs. Also included are equations for total damping that originate at 5% damping at ducility 1 to retain consistency with equations for other systems, although they will slightly underestimate the damping in the low ductility range.

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)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2012

ADOT&PF partnered with researchers at the University of Alaska to improve the seismic design of highway bridges in Alaska. 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). Frozen soils, especially seasonally frozen soils, have a significant effect on the seismic performance of bridge pile foundations. To account for this effect, it is necessary to evaluate frozen soils' mechanical properties.

This research obtained the mechanical properties of naturally frozen silty soils in Alaska. High-quality specimens of both permafrost and seasonally frozen soil were prepared by block sampling and machining following a procedure designed to minimize mechanical and thermal disturbances. Both horizontal and vertically specimens were prepared to investigate the effect of specimen orientation. Unconfined compression tests were performed at below freezing temperatures and at a constant deformation rate that corresponds to strain rates that are equivalent to that expected in the frozen soil during a design earthquake in Interior Alaska.

Test results including soil characteristics and mechanical properties (stress-strain curves, compressive strength, yield strength, and modulus of elasticity) were presented and compared with data in the literature. The researchers also reviewed the impact of temperature, dry density, water content, and specimen orientation on mechanical properties. These mechanical properties

can be directly used to evaluate frozen soil lateral resistance in the analyses of laterally loaded pile foundations during seismic or other events in cold regions.

Benefits to the State: 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. Knowledge about lateral resistance of frozen soils, particularly seasonally frozen soils at shallow depths, will help improve pile foundation design in Alaska. Better understanding of the effect of routine seismic activity on bridge foundations will help the State of Alaska's bridge designers increase the longevity of the state's bridges.

Photos: University of Alaska researchers collected naturally frozen soil samples and maintained the frozen state while machining specimens for conditioning and laboratory testing. Taken from AUTC's final project presentation to ADOT&PF, December 2012.

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

Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $483,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: August 2014

Bridge safety and performance are national transportation priorities, and remain important challenges for ADOT&PF as well. The purpose of this research project is to select and test an innovative structural health monitoring (SHM) technology and protocol for bridges in cold, remote locations. The project is intended to help the ADOT&PF improve the maintenance and repair of bridge structures, and to extend their service lives.

The research team is studying the Chulitna River Bridge which is located 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 found that although the bridge inspected well, it rated more poorly than expected and recommended it for further analysis using a SHM system.

The first phase of this research involved selecting, configuring, installing, and testing an optimal SHM instrumentation and protocol for use on this bridge, with an eye toward extending this approach to bridges throughout Alaska. The system of fiber optic connected sensors (strain, accelerometer, displacement, tilt, temperature) is monitoring the behavior of defects or irregularities, and is collecting and in real-time is relaying data on the bridge's structural integrity and safety. The data provides reliable information to improve decision-making about timely maintenance, repair, and closure needs.

The second phase of the project includes collaboration between structural engineering faculty at the University of Alaska (AUTC) and Washington State University (PacTrans) with the aim to

use the SHM system to better understand the bridge's response to known loads, and predict future performance.

The research tasks in this phase include continuing monitoring of the sensors to determine if the girders are over stressed under standard highway loads and permit vehicles, monitoring critical members and providing real-time alerts when sensing systems approach or exceed established limits, and creation of Finite Element models for estimating and evaluating the current condition and condition changes of the bridge structure response to static and dynamic loading.

Benefits to the State: More effective bridge structural health monitoring (SHM) systems can provide structural response data, enable development of improved decision-making tools, conform and augment visual assessment, improve inspection credibility and subsequent load rating, assist transportation asset management efforts in assessing long-term bridge performance, optimize inspection schedules, maintenance schedules and dollars, and increase structure reliability.

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

Photos: *Load testing of the Chulitna River Bridge's newly installed SHM system. Photo credit AUTC.*

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

Principal Investigator: Dr. Scott Hamel
Funding: $80,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2014

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 ADOT&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.

Two high-mast light poles on the Glenn Highway near Anchorage are being studied. The researchers modified standard anchor rods by drilling out and bonding strain gages into the center, and then connected them to a computer controlled data acquisition system to monitor during standard tightening procedure and for longer term ambient conditions. Preliminary findings show that several of the anchor rods yielded during the FHWA tightening procedure including establishing a snug-tight condition followed by 60 degrees of turn-of-the-nut method. The researchers note that the snug tightened fasteners for large diameter fasteners with short grip lengths are likely to exceed the recommended snug tight pretension range. However, if the degree of rotation in the turn-of-nut method was varied with the grip length/bolt diameter ratio, in addition to the existing recommendations about bolt diameter and grade, then final bolt pretensions may be more likely to fall within the desired range.

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.

T2-13-11 Reinforced Concrete Filled Pipes in Soils
Principal Investigator: Billy Connor, P.E. & Dr. Mervyn J. Kowalsky (NCSU, UAF & AUTC)
ADOT&PF Funding: $330,000 (SP&R)
ADOT&PF Project Manager: Janelle White
Completion Date: December 2015

The use of reinforced concrete filled steel pipe piles is common in Alaska and is gaining acceptance across the nation. It is often a preferred support system for bridges as these piles provide good seismic performance and can be driven rather than drilled in resulting in reduced construction cost and environmental impacts. This project will supplement the research conducted under T2-08-02 Plastic Strain Limits by conducting large scale testing of reinforced concrete filled pipe piles in soil media and structural analysis. The project will evaluate the impact of relative soil-pile stiffness on pipe pile strain limits, plastic hinge length and deformation characteristics, proposed analysis methods, and damping.

Benefits to the State: This research will provide experimental validation of proposed models for concrete filled steel tubes forming pipe-soil systems, allowing Bridge engineers in Alaska and nationwide improved confidence in the structural analysis and use of these cost effective bridge support systems.

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

Principal Investigator: Taylor Horne, Statewide Environmental Manager
Funding: $50,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Janelle White
Completion Date: December 2014

In May 2007 the USFWS established new National Bald Eagle Management Guidelines as a result of the Bald Eagle being de-listed from the Threatened and Endangered Species list. On September 11, 2009 the USFWS published new regulations which 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 60-90 days to obtain. The Southeast (SE) Region has been working closely with the USFWS on developing a monitoring effort to establish impacts associated with chip-seal maintenance of roads in SE. This research project would use the SE 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 report on 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 DOT&PF to start construction projects sooner and at a better time of the year to further reduce impacts to Bald Eagles.

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

Principal Investigator: Taylor Horne, Statewide Environmental Manager
Funding: $80,000 (SP&R)
ADOT&PF Project Manager: Clint Adler, P.E. & Carolyn Morehouse
Completion Date: Project Canceled June 2014

This project will assess the effectiveness of the ADOT&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.

T2-08-20 Using Shallow Anchors and an Anchored Mesh System for Cut Slope Protection in Ice-Rich Soils
Principal Investigator: Chuang Lin, Liangbiao, Xiong Zhang, Robert Mchattie
Funding: $150,000 (SP&R)
ADOT&PF Project Manager: Lauren Little, P.E.
Completion Date: December 2012

Anchors are one of the simplest and most commonly used methods used to support structures in permafrost areas. The challenge is that the anchors tend to creep over time. More needs to be known about the relationship between the displacement rate for anchors in ice rich soils and the shear stress at the interface of the soil and pile.

The objective is to study grouted anchors in ice rich soil. The major tasks for the project included a literature review, laboratory tests conducted on anchors in frozen soils, field tests with three load levels at different durations in Fox, Alaska, test results, data analysis and recommendations.

The outcome of the project provides detailed design information for placing grouted anchors in ice-rich soils. An increase in the soil's ice content will decrease the load capacity of the anchor.

Benefits to the State: Detailed understanding of anchors in ice rich silt resulting in loading schedules and temperature recommendations for installation. Resulting designs will reduce maintenance costs.

Fully Grouted Anchor

T2-09-06 Evaluating In-Place Inclinometer Strings in Cold Regions
Principal Investigator: Dr. Margaret Darrow (UAF & AUTC)
Funding: $222,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2012

This research focused on 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 newer type of geotechnical instrumentation will allow for remote electronic sensors together with the inclinometer. These MEMS-based inclinometers (M-IPIs) consist of MEMS accelerometer segments separated variously by flexible joints or field-connection systems, and encased in watertight housing. 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 and they have promise to be reusable.

This study evaluated two M-IPIs from different manufacturers for three different vertical and horizontal applications in Interior Alaska. Each M-IPI was evaluated for ease of

installation and subsequent retrieval, durability, and functionality in frozen ground.

Measurements from both devices compared well to those from the inclinometer probe, indicating that these devices are suitable for use in cold regions. Field experience indicates that the installation procedure for each instrument is better undertaken at above freezing temperatures, due to required manual dexterity and the temperature requirements of casing adhesive. If used to measure both ground movement and temperature in frozen ground, the M-IPI temperature sensors should be calibrated. The researchers recommended replacing cold-affected plastic components between installations to avoid unwanted breakage during reinstallation.

Benefits to the State: Technology like this will help ADOT&PF monitor and manage its transportation infrastructure with more accuracy and less man-power. Ground movement data will also allow give engineers a better idea of how to design infrastructure to better overcome environmental challenges.

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

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

Collect and assess necessary data to develop and deploy a new DOT&PF Unstable Slope Management Program.

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 Photo: Terry Barber

T2-11-10 Geotechnical Asset Management

Principal Investigator: Dr. Andrew Metzger (UAF & AUTC)
Funding: $80,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: Terminated September 2013

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 Alaska Department of Transportation and Public Facilities (ADOT&PF). Effective management of geotechnical assets is necessary to maintain the level of transportation safety and service required by people who utilize the transportation system in Alaska.

The purpose of this project was to develop a framework for addressing challenges related to geotechnical asset management (GAM) that could be implemented with other asset management systems. The researchers expected that the GAM project would produce a "road map" for transportation-related GAM in the state of Alaska. This draft program framework needed to include specific planning recommendations that address the most significant challenges for implementation of GAM across the broad range of geotechnical assets owned by ADOT&PF.

However, the need for concluding this research as programed in this project was superseded with the establishment of a separate program within the Department to develop a Geotechnical Asset Management Program, so this research project was terminated.

Benefits to the State: Implementing a Geotechnical Asset Management plan will give ADOT&PF a better idea of repairs and maintenance that need to be done to cost-effectively extend the life of its geotechnical assets. The research produced in this project gave preliminary recommendations and an assessment that has benefited and enhanced the new program's development efforts.

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

Principal Investigator: Dave Stanley, C.P.G (ADOT&PF) with Landslide Technology, Inc. (Portland, OR)
Funding: $80,000 (Western Federal Lands Coordinated Technology Implementation Program)
ADOT&PF Project Manager: Barry Benko, C.P.G.
Completion Date: December 2014

Provide support to FHWA - Federal Lands Highway Division by adapting and demonstrating ADOT&PF's Unstable Slope Management Program (USMP) for use by several federal lands agencies (Bureau of Indian Affairs, National Park Service, Federal Lands Highways, U.S. Forest Service and U.S. Fish & Wildlife Service) associated with the Coordinated Technology Implementation Program.

In 2013, Landslide Technology began development of the database structure and produced a demonstration video for database use training. The principle investigators also collaborated with the partner federal agencies to create customized unstable slope rating criteria and a field rating form. The systems will be field tested in demonstrations planned for Summer 2014.

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, all of which will benefit ADOT&PF.

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

Principal Investigators: Dr. Andrew Metzger & Keith Cunningham (UAF & AUTC)
Funding: $115,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: November 2014

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 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 of Alaska's highway corridors.

T2-12-17 Rapid Research Response: Monitoring and Analysis of Frozen Debris Lobes, Phase I

Principal Investigator: Dr. Margaret Darrow, (UAF & AUTC)
Funding: $60,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completion Date: December 2012

A large mass of frozen material is slowly approaching the Dalton Highway at MP 219. This research analyzed the movement of the frozen debris to obtain knowledge of the soil properties and rate of movement. A drilling program was conducted in September 2012 to assist in determining the soil properties, direction and rate of movement, and the nature of the shear zone for the frozen debris lobe (FDL). The investigation found that the FDL was generally homogeneous silty sand with gravel overlying white mica schist bedrock. The FDL was measured to moving at an average rate of 1.0-inch per day. Further investigation is recommended to better characterize the movement mechanism and determine potential options to stop or slow this FDL and other FDL's along this important commercial route.

Benefits to the State: Results of the research provided initial clues as to the makeup and movement of this FDL and resulted in a decision to evaluate relocating the Dalton Highway in this area.

T2-12-21 Geotechnical Asset Management

Principal Investigator: Dave Stanley, C.P.G.
Funding: $2,700,000 (STIP)
ADOT&PF Project Manager: Dave Stanley, C.P.G. & Barry Benko
Completion Date: September 2015

This effort will create Geotechnical Asset Management (GAM) program architecture, research and develop: performance measures, methods for predicting future performance of assets, and analysis methods. Create inventory and condition survey for assets. Monitor performance of assets over time and compare to performance measures. Provide decision-making support to agency management on maintenance, repair and rehabilitation alternatives.

Significant progress was made in 2013, including continuing development of a formal development plan, inventory data compilation for material site, retaining wall, and unstable slope assets, risk evaluations, and pilot GAM implementation in high-risk transportation corridors.

Benefits to the State: The GAM program is an important element of the overall implementation of best transportation asset management (TAM) 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 Rapid Research Response: Geophysical Investigation at Mile 9 Dalton Highway
Principal Investigator: Kevin Bjella, PhD., Cold Regions Research & Engineering Laboratory (CRREL)
ADOT&PF Funding: $23,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse, P.E.
Completion Date: June 2014

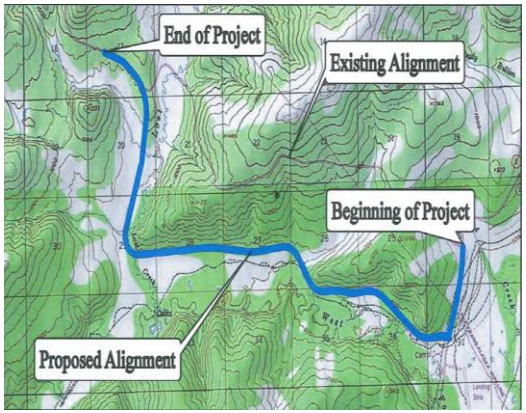
The US Army Cold Regions Research & Engineering Laboratory (CRREL) will conduct a geophysical survey on the Dalton MP 9-11 Construction Project. The geophysical survey results will immediately be made available to ADOT&PF design and construction staff for consideration in design revisions. CRREL will produce a report relating the geophysical survey to the Dalton MP 9-11 Materials Report.

Benefits to the State: The research will evaluate the Ohm Mapper 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.

T2-13-07 Rapid Research Response: Expedient Resistivity Investigation (Ohm Mapper)
Principal Investigator: Kevin Bjella, PhD., Cold Regions Research & Engineering Laboratory (CRREL)
ADOT&PF Funding: $68,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: July 2014

The US Army Cold Regions Research & Engineering Laboratory (CRREL) will conduct a geophysical survey using the OhmMapper instrument for the Dalton Highway MP 0-9 Reconstruction project in conjunction with the centerline drilling program. The OhmMapper results will be correlated with the drilling to determine the optimum alignment for the realignment project.

Benefits to the State: The research will evaluate the Ohm Mapper results in conjunction with the drilling program to determine the extent and locations of ice-rich vs. ice-poor permafrost. This method will result in greater coverage of the project subsurface condition, resulting in an optimized centerline alignment with reduced construction and maintenance costs over the life of the highway.

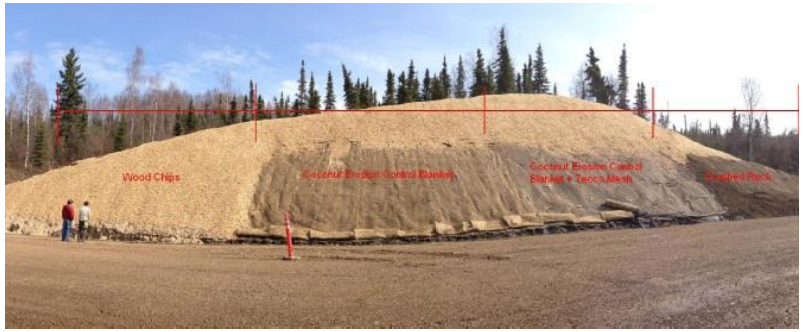


Proposed realignment Dalton Highway MP 0-9 Reconstruction.

T2-13-12 Experimental Feature: Long Term Monitoring of Ice-Rich Cut Slopes at Dalton Highway MP 9
Principal Investigator: Dr. Xiong Zhang (UAF & AUTC)
Funding: $40,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse, P.E.
Completion Date: December 2014

This project is a follow on to project T2-11-05 Experimental Study of Various Techniques to Protect Ice-Rich Cut Slopes. Researchers will monitor the performance of the test section and techniques used on the Dalton Highway 9 Mile Hill construction project for a year.

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 which require cuts in ice-rich permafrost.



Test sections constructed on the Dalton Highway 9 Mile Hill North project. Photo credit AUTC.

T2-13-08 Unstable Slope Management – Phase II
Principal Investigator: Darren Beckstrand Landslide Technology
Funding: $1,700,000 (STIP)
ADOT&PF Project Manager: Barry Benko, C.P.G.
Completion Date: December 2015

This effort continues the development of the Unstable Slope Management Program (USMP), initiated in 2009. In Stage I of program development, the investigators compiled a database of the "Top 200" unstable slopes, refined the slope rating system, and created a web page portal to the data.

Under the scope for this research project, the investigators will finish the architecture of the database system and continue populating the inventory by adding the remaining unstable slopes in the road network, with key transportation corridors receiving priority in the work sequencing. Asset management elements will be incorporated into the USMP in the areas of service life prediction, establishing services levels and performance measures and initiating development of analysis tools to determine life cycle cost of slopes in support of decision-making for transportation corridors. Ultimately the database and webpage will be migrated to Department servers, and the website will be made available to the public.

It is expected that progress in the next fiscal year will include database architecture improvements, service life and performance measure analysis, as well as slope inventory, assessment, and process testing in key highway segments along the Tongass Highway and Haines Highway

Benefits to the State: Unstable slopes along the State's routes present critical risks to safety and mobility in the transportation system. This research effort will enable the realization of sound asset management, resulting in the most economic allocation of resources to unstable slopes.

T2-13-18 Geotechnical Asset Management - Stage II
Principal Investigator: Various
Funding: $80,000, Non SP&R (other STIP project)
ADOT&PF Project Manager: David A. Stanley, C.P.G. & Barry Benko, C.P.G
Completion Date: December 2014

The project supports four research contracts for developing Geotechnical Asset Management (GAM) concepts for state Departments of Transportation:

- GAM plan development,
- A risk management framework for GAM,
- Service life, service level, performance measures and condition indices, and
- Life Cycle Cost Analysis for geotechnical assets.

The Federal Highway Administration (FHWA) is participating in funding these GAM-related research projects through an Infrastructure Research & Technology (IRT) program allocation to research and develop Geotechnical Asset Management principles and practices for eventual deployment in Alaska and other state or local government transportation agencies. An important aspect of these deliverables is that they are created specifically for a broader audience than Alaska transportation agencies.

Benefits to the State: Deliverables will include:

- An executive level summary,
- Individual graphics suitable for use in FHWA publications and pamphlets,
- PowerPoint presentation slides,
- Other deliverables that may be developed during the course of the work and the execution of the project's Communication Plan.

The final content of the additional deliverables will vary from project to project. Each project will include a communication plan based on NCHRP Report 610, "Communicating the Value of Transportation Research" and will address these deliverables tailored to the subject or the individual contracts.

T2-08-15 Updated Precipitation Frequency Estimation for the State of Alaska
Principal Investigator: Douglas L. Kane, Ph.D, Svetlana Stuefer, Ph.D
Funding: $232,549 (SP&R)
ADOT&PF Project Manager: Lauren Little, P.E.
Completion Date: June 2013

Designing and building river and stream crossings like bridges, culverts, buried utilities, and pipelines are 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.

ADOT&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-durationfrequency (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 ADOT&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. Precipitation frequency atlas for Alaska which is available at http://dipper.nws.noaa.gov/hdsc/pfds/

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)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: June 2014

The research will collect field measurements of weather and temperature to develop hydraulic models which 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.

T2-09-02 Alaska Rural Airport Inspection Program
Principal Investigator: Dr. David L. Barnes (UAF & AUTC)
Funding: $80,000 (M&O)
ADOT&PF Project Manager: Jason Sakalaskas, P.E.
Completion Date: December 2014 (but with initial condition reports finalized in 2013)

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 ADOT&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 on-going 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 ADOT&PF's asset management systems. The condition reports can also be directly integrated onto ADOT&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 Barnes (UAF & AUTC)
Funding: $75,617 (GF)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2013

Starting in the summer of 2009, ADOT&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 ADOT&PF to select the

most cost effective. Products and plan efficient application schedules for Alaska's many unpaved runways. A secondary benefit to the ADOT&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 ADOT&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: $51,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little
Completion Date: December 2012

The Yukon River Bridge is a critical link in the supply line to oil & gas industry workers. 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 2300 feet long. The bridge deck, made of a 5 inch layer of timber has been replaced 4 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. The timber used for the deck is going up in cost due to reduced logging in quality old growth forests. Each time the deck is replaced it costs tax-payers 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: Finding a more durable and cost effective bridge decking solution for this critical route will save the State millions of dollars over the long term through reduced road closures and maintenance costs.

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)
Principal Investigator: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: July 2014

Over 50% of Alaska's state-owned roads are unpaved—as are nearly all private and local roads outside the major metropolitan areas. Annually, traffic can remove up to 750 tons of gravel per mile, amounting in roughly $15,000 in annual maintenance costs. The use of dust palliatives such as calcium chloride can save around $7,000 per mile per year over untreated roads.

More than 80% of Alaska's communities can only be accessed by air or off-road vehicles, and rely on 255 state-owned airports—many unpaved—and local unpaved roads for access and supplies. These unpaved roads and runways generate fugitive dust, leading to impaired quality of life, and costly maintenance.

The research team will apply and monitor dust control agents in three sections of Alaska's roads: two in rural villages and one in North Pole. 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 will assess the longevity and success of different palliatives to determine life cycle costs, assisting engineers with decision making and potentially providing significant life cycle cost savings. The results from this research along with other dust related research is being combined into a recommended ADOT&PF Dust Manual with associated training materials.

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

Principal Investigator: Dr. Juanyu "Jenny" Liu
Funding: $90,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2013

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 ADOT&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 ADOT&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 ADOT&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.

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)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: June 2014

ADOT&PF, MSU's Western Transportation Institute (WTI) and AUTC are investigating whether local agricultural or distillery by-products 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 developed and lab tested locally sourced salt brine additives. The preliminary results show some promising combinations including distillery by-products. The results will help improve traveler and commercial safety and mobility while reducing corrosion and environmental impacts.

The project will give ADOT&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 providing a market for salt brine production using local materials.

T2-12-07 Whittier Tunnel Signal System Investigation
Principal Investigator: DOWL HKM, Thomas L. Moses, Jr., P.E.
Funding: $150,000 (SP&R)
ADOT&PF Project Manager: Mike San Angelo, P.E.
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 multi-modal facility.

Determine current and future needs of highway and rail traffic users of the Whittier Tunnel. Evaluate current schedule and develop the most efficient schedule to accommodate future needs. Review tunnel operations and develop a visual model to illustrate problems and possible solutions.

Benefits to the State: The results of this study will help ADOT&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)
ADOT&PF Project Manager: Ocie Adams
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 ADOT&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 deicing and anti-icing agents promises environmental benefits and reduced impacts to roadway users.

T2-13-09 Rapid Research Response: Testing and Screening Surface Materials for the Yukon River Bridge – Phase II
Principal Investigator: Dr. J. Leroy Hulsey (UAF & AUTC)
Funding: $137,000 (SP&R) & $50,000 (M&O)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse
Completion Date: June 2014

This research project is the second stage of T2-10-07 Testing and Screening Surface Materials for Alaska's Yukon River Bridge. The purpose is to find a more durable material to replace the timber decking. The timber used for the deck is going up in cost due to reduced logging in quality old growth forests. Each time the deck is replaced it costs tax-payers millions of dollars. If the time between replacements could be extended, money and human power could be saved or directed toward other projects. Several products were installed in the summer of 2013 and will be evaluated through the winter to determine if they have potential to be future deck replacement materials.

Benefits to the State: Finding a more durable and cost effective bridge decking solution for this critical route will save the State millions of dollars over the long term through reduced road closures and maintenance costs.

Yukon River Bridge

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

Principal Investigator: 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)

ADOT&PF Project Manager: Lauren Little, P.E. & Angela Parsons, P.E.

Completion Date: In process

Two experimental feature projects were initiated to study longterm 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.

T2-07-02 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)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: June 2014

The goal of this research was to develop policy and criteria for collecting, analyzing, and managing global positioning system (GPS) survey data. The research project determined the needs of the Department in adopting the GPS real time kinetic (GPS RTK) stakeout and automated machine grading (AMG) construction techniques. The project resulted in reformatting and editing of the "Alaska Survey Manual," proposed revisions to the "Construction Manual," the "Design Manual," and to Standard Specification 642—Construction Surveying.

Project activities included pilot projects for highways and airports, a comprehensive questionnaire for construction engineers in the three regions, and GPS training for the regions.

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)
ADOT&PF Project Manager: Lauren M Little, P.E.
Completion Date: Completed 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 can impact community quality of life.

This study examined a variety of factors dealing with the use of dust-control palliatives. There are several commercially available dust palliatives on the market for dust control but there has been little comparison on cost effectiveness of dust palliatives versus watering. This research evaluated several proprietary products as dust palliatives for unpaved surfaces during road construction to determine the type of palliative to use and when, how often, and in what concentration it should be applied.

The project looked 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.

The project concluded that watering was generally more cost effective for construction dust control compared to commercially available palliatives. The researchers also found that reducing the posted speed through the construction site had a significant impact on dust generation.

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.

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

Principal Investigators: Dr. Oliver Hedgepeth, Morgan Henri (UAA & AUTC)
Funding: $53,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completed December 2012

Radio Frequency Identification (RFID) is a common technology today. You may not have heard of, 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 and 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 data get used for payment items. Tickets have to be stored for 3 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.

Results of this research showed it to be promising in areas where cellular communications were available. It remains to be seen if it can be used on remote sites.

Benefits to the State: The successful implementation 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.

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

Principal Investigator: Billy Connor, P.E. (AUTC)
Funding: $200,000 (SP&R)
ADOT&PF Project Manager: Lauren Little, P.E. & Steve Saboundjian, P.E.
Completion Date: ~August 2014

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. Testing of soil to determine the indirect tensile and resilient modulus tests on Tanana silt, Horse Shoe Lake Sand, and Fairbanks silt. Update the Alaska DOT&PF Soil Stabilization Manual. Describe the use of fibers, synthetic fluids and two-part soil stabilizers for base stabilization.

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.

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

Principal Investigator: Dr. Juanyu "Jenny" Liu
Funding: $130,250 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2014

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 ADOT&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 (JMFs).

The research focused on testing HMA samples collected from two ADOT&PF construction projects; a rehabilitation and resurfacing project on the Parks Highway south of Nenana, and an Anchorage International Airport (AIA) paving project. The mixtures included specimens mixed and compacted using JMF 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 ADOT&PF and contractors at each phase of lab/design, production, and new construction. Data included general project information, details of the materials and JMF used in the construction, and all construction test data.

The researchers conducted tests for JMF properties in the university lab, including aggregate gradation, asphalt content, mix volumetric, and density. Researchers investigated HMA performance to further verify the JMF 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 Alaskan HMA mixtures and recommend how the ADOT&PF can improve specifications and criteria for quality assurance and mix design verification or validation. Resulting enhancement to the 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
Funding: $65,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: October 2012

This project's goal is to improve Alaska's Flexible Pavement Design software. This is the software Alaska's engineers use to make decisions about materials and thicknesses needed for paving for a desired service life. This research project added the ability to do a life cycle cost analysis in a single software package – 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 developed a new layout for the program. They 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."

The project was complicated by upgrades in Window's PC operating system that prevented the core pavement design code from executing and allowing seamless operation of the design software plus the new lifecycle cost components. However, a phase II research effort will be undertaken to upgrade the core pavement design code and finalize the software.

Benefits to the State: Upon completion, the project will provide the updated software, a modified AKFPD manual and case studies with complete analysis processes to help the new user navigate the software. The phase II portion will also include in-person training workshops for DOT&PF and their consulting engineering firm pavement designers.

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.

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

Principal Investigator: Dr. Juanyu Lui and ADOT&PF NR Construction/Materials
Funding: $29,986 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E., Angela Parsons, P.E.
Estimated Completion Date: August 2014

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 ADOT&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
Funding: $60,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2012

Aggregate used in the construction of roads must be durable, abrasion resistant, and freeze-thaw resistant in order to perform well in a pavement or as base course. Tests for properly characterizing aggregate durability are critical. Currently, ADOT&PF Standard Specifications for Highway Construction (2004) specifies

percentage of Los Angeles (LA) wear by the LA abrasion test and degradation value by Alaska Testing Method (ATM) 313 (or Washington degradation test) along with other parameters for evaluating durability of aggregates for asphalt concrete pavements and base courses.

This project evaluated the feasibility of using the Micro-Deval test (which involves putting aggregate materials in a tumbling steel drum with water and steel balls to measure how they degrade) to assess the durability of Alaskan base course aggregates in pavement construction, and to explore the potential of utilizing it as a better alternative to the current Washington degradation test. 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.

The researchers found the Micro-Deval test to be comparable to existing tests and recommended that the ADOT&PF use it as an additional test for a period of time to allow both ADOT&PF personnel and contractors to become familiar with how the new testing relates to traditional testing and actual performance of the roads. They also recommended testing more Alaskan aggregates to facilitate the implementation of specification requirement of Micro-Deval loss values for quality aggregates.

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 under will help engineers select materials that maximize the performance of the road.

T2-10-10 Alaska Hot Mix Asphalt Job Mix Formula Verification

Principal Investigator: Dr. Juanyu "Jenny" Liu
Funding: $90,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2013

Asphalt degrades with use and weathering. Every year the state spends significant sums for repair and maintenance of Alaska's paved roads. Hot mix asphalt (HMA) is the most common paving material used in Alaska, assuring its quality is critical for contractors and ADOT&PF. Ensuring that contractors are operating with the appropriate HMA is crucial.

This project assessed HMA quality assurance specifications and evaluated how well contractors meet the requirements of job mix formulas (JMFs). Researchers field-tested a samples taken from representative construction projects. These HMA mixtures were applied under four different scenarios. Researchers obtained data about the material and construction tests from ADOT&PF and contractors at each phase of lab/design, production, and new construction. The researchers conducted lab tests to investigate HMA performance to verify the mix formulas and evaluate any impact of the construction process.

With the current national trend toward developing mechanistic flexible pavement design along with and the need for more reliable design procedures, accurate characterization of HMA properties is are needed. This project was a systematic study to start a catalog of Simple Performance Test (SPTs) data and investigated the correlations between SPTs and HMA performance for typical Alaska HMA mixtures.

Benefits to the State: The project's results will help improve current mix design protocols, will benefit the asphalt-paving process, and ensure the quality of HMA. Verification will enhance the long-term performance of HMA pavements and significantly reduce the state's pavement maintenance and repair budget.

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)
ADOT&PF Project Manager: Lauren M. Little, P.E., Angela Parsons, P.E.
Completion Date: August 2014

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. For slopes, this can result in significant erosion and stability issues with the roadway embankment.

Recent research on synthetic fluids and geofibers has shown that these materials can reinforce the volatile frozen soils in pavement bases and mitigate these problems. Traditional interim slope 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 in stabilizing the slope until vegetation can establish.

This project constructed a test slope 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. Results of the research indicated promise for some synthetic fluid and geofiber combinations for interim slope stabilization; however one product tested inhibited grass growth, making it impractical for slope stabilization in terms of erosion control.

Benefits to the State: The outcomes of this research will provide engineers and contractors with additional options for short term (1-3 years) stabilization of erodible slopes. Use of some of the products tested could result in shorter time periods for CGP and project closeout, providing significant savings to the Department.

T2-10-14 Guidelines for Pavement Preservation
Principal Investigator: Dr. Gary Hicks, Dr. Juanyu "Jenny" Liu, Dr. Hannele Zubeck
Funding: $91,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 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. In the past, the practice has often been "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 purpose of this project was to provide a basis for pavement preservation guidelines to assist the ADOT&PF to use "the right treatment, at the right time, on the right pavement" to extend the service live of the state's roadways in a cost effective way.

Using field site visits and internationally-distributed surveys, researchers identified road repair methods specific to the typical geographic and environmental areas of Alaska, and that may prove to be more cost-effective than previous practices.

The Researchers at the California Pavement Preservation Center developed an online database of preservation methods based on results produced by the UAA and UAF researchers, who used their specific expertise in Alaska's cold regions to field check test sites and synthesize the information available internationally. The research team worked with ADOT&PF experts to determine which techniques were most likely to perform best in Alaska, and

developed a process and tools for selecting the appropriate preservation strategy for any given area and traffic scenario in Alaska.

Benefits to the State: This project will help the ADOT&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.

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

Principal Investigator: Frank Ganley, Construction Manager
Funding: $10,000 (SP&R) + $94,500 in Federal-aid Construction Funds
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse, P.E.
Completion Date: April 2013

In 2010, ADOT&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 record keeping 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 24 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. Projects were tested from 2010 through 2012.

Benefits to the State: The use of Site Manager has resulted in greater transparency, more secure record keeping, better checks on materials testing requirements, less travel to construction sites and a streamlined change order and payment process. It has also streamlined response to records requests.

T2-11-02 Geosynthetic Design Guidelines & Construction Specifications Review & Update
Principal Investigator: Eli Cuelho (MSU-WTI)
Funding: $16,000 (SP&R) + $73,500 (State GF)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: October 2014

Engineers strive to provide safe and effective transportation corridors and facilities that are economic to construct and maintain. The Alaska Department of Transportation and Public Facilities (ADOT&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 main objective of this project is to provide recommendations that will assist the ADOT&PF 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, will conduct a reviews of current geosynthetic design and construction practices in Alaska, historic and future uses of geosynthetics within the state, design and construction practices from other state and federal sources, and will synthesize this information to adequately 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 assist ADOT&PF engineers to effectively and efficiently utilize geosynthetics in design and construction.

Benefits to the State: The products of this research include updated design and construction specifications materials that will be suitable for direct implementation by ADOT&PF staff. The specifications will be reviewed and updated in consideration of specific local concerns identified through the review of current and anticipated geosynthetic use throughout Alaska.

T2-11-05 Experimental Study of Various Techniques to Protect Ice-Rich Cut Slopes
Principal Investigator: Dr. Xiong Zhang (UAF & AUTC)
Funding: $135,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse, P.E.
Completion Date: June 2014

For more than 50 years, Alaska state construction has wrestled with erosion, runoff, and slope failures from permafrost. These unforeseen problems potentially 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 ways 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 ADOT&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 evaluate a test section constructed on the Dalton Highway in the study. Long term monitoring will be conducted under the follow on project T2-13-12 funded through the Experimental Features program.

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 which require cuts in ice-rich permafrost.

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

Principal Investigator: Dr. Juanyu "Jenny" Liu
Funding: $90,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2014

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 affects 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 at 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's in may have an effect on the susceptibility of the road to frost heaving.
This is important. Replacing material to build a road can add large costs to a project. This project will examine the way content of fines 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.

T2-12-05 Video Documenting Best Practices for Mitigating Frost Damage to Transportation Infrastructure
Principal Investigator: Billy Conner, P.E. (UAF& AUTC)
Funding: $15,000 (SP&R)
ADOT&PF Project Manager: Clint Adler, P.E.
Completion Date: December 2013

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.

Completed video:
Full Length: http://www.youtube.com/watch?v=qnI7T5wbNjc
Executive Summary: http://www.youtube.com/watch?v=fkrrSys03qQ

T2-13-02 Research & Technology Deployment: GPS Protocols Survey
Principal Investigator: ADOT&PF staff
Funding: $10,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.
Completion Date: December 2014

This project is a follow up to T2-07-02 Development of GPS Survey Data Management Protocols and Policy. The Alaska Survey Manual was updated in 2010 under that project and a 642 construction Specification drafted. This project will evaluate how the manual has been received by internal and external stakeholders and if any updates are needed as well as work towards full implementation of the 642 construction Specification.

Benefits to the State: Modern GPS survey methods are typically more cost effective for construction surveyors; however quality control must be assured to protect the Department's infrastructure investments. Evaluating current best practices versus our internal requirements will allow for development of effective Statewide policy to allow this cost effective method on our construction projects.

Photo: Former Northern Region Survey Chief Scott Sexton works with GPS survey equipment.

T2-13-10 Experimental Feature: Tencate Mirafi® H2Ri Wicking Fabric

Principal Investigator: Jeff Currey, Northern Region Materials Engineer

Funding: $30,000 (SP&R)

ADOT&PF Project Manager: Lauren M. Little, P.E. & Angela Parsons, P.E.

Completion Date: December 2016

The freezing of moisture 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 ADOT&PF partnered with AUTC and Tencate to research a possible solution. The use of the building fabric, Mirafi Nylon Wicking Fabric, could help prevent saturation of the ground that causes frost heave damage. The fabric is an 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 the Department's Contractor on the Dalton Highway MP 197-206 Reconstruction project. This section of road will be monitored by ADOT&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. Preliminary field results show this fabric is promising for removing water from the embankment.

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.

Wicking fabric installation location on the Dalton Highway MP 197-209 Rehabilitation project.

T2-13-13 Evaluate Presawn Transverse Thermal Cracks
Principal Investigator: Juanyu "Jenny" Liu (UAF – AUTC)
Funding: $75,000 SP&R
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: December 2015

Road-width thermal cracks (major transverse cracks) are perhaps the most noticeable form of distress on asphalt concrete pavements throughout the colder regions of Alaska. In these cold areas it has as not yet been possible to prevent this crack type from forming. To date, this appears to remain true regardless of paving material, embankment material, or construction method. A review of research and testing conducted in the Fairbanks area about 30 years ago shows that the technique of precutting thermal cracks in the pavement during construction has real potential for minimizing pavement distress associated with transverse cracking.

This research project will monitor and evaluate the recently reconstructed Richardson Highway project (Mile 340-346, near North Pole) which included sections with presawn cracks and a control section without presawn cracks. The researchers will use visual inspections, laboratory evaluations of asphalt core samples, and numerical simulation studies to make recommendations for future effective design and construction practices to control thermal cracking in asphalt concrete pavements.

Benefits to the State: The ADOT&PF spends a significant amount of money each year crack-sealing pavements. If a successful pre-cutting method can be determined it could provide significant savings in pavement preservation dollars each year and contribute to better performance of Alaska's valuable pavement assets.

Photo: Pre-cut pavement section on the Richardson Highway near Moose Creek. Photo credit Bob McHattie and Dr. Jenny Liu.

T2-13-14 Wicking Fabric Design Specification
Principal Investigator: Dr. Xiong Zhang (UAF & AUTC)
Funding: $125,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse,P.E.
Completion Date: June 2015

H2Ri wicking fabric is a new geotextile manufactured by TenCate Geosynthetics. It contains both a high modulus polypropylene yarn for reinforcement and a nylon wicking yarn which can absorb and transport water for drainage under unsaturated conditions. Therefore, H2Ri is a dual functional geosynthetic product, which can serve as reinforcement and provide drainage. When properly designed, it has the potential to dehydrate the subgrade and base course and consequently improve the performance of pavements. This potential has been qualitatively

confirmed by a laboratory research performed at the University of Alaska Fairbanks and a small test section constructed on the Dalton Highway at mile 110, AKA "Beaver Slide" in Alaska.

This research will build on the ongoing monitoring of the Dalton 9 Mile test section (project T2-13-10). It will develop design guidance, determine product limitations, and cost benefit values for engineers to use in deciding when and how to use the fabric.

Benefits to the State: Use of this fabric may allow use of low quality, locally available materials to build roads and airport. It has the potential to bring significant savings in construction, maintenance and repair cost for roads in wet, swampy areas and areas of thawing permafrost. When properly used, it has proven to have the ability to wicking the water out of the pavement structure and eliminate the frost have and subsequent thaw weakening.

Photo: Wicking fabric installation at Dalton Highway MP 110.5 Beaver Slide. Photo credit AUTC.

T2-13-17 Evaluation Low Temperature Pavement Cracking

Principal Investigator: Tonya Burrit (AK DOT&PF - Central Region Materials)
Funding: $8,000 SP&R
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: August 2014

The purpose of this research is to assess the actual performance of recently constructed highway projects that used asphalt pavements that were specially modified to reduce low temperature cracking. Modified asphalts add to the cost of paving projects, so it is important to determine if their use has actually resulted in reduced cracking.

This research involves conducting field measurements to evaluate and characterize pavement cracking on representative roadway segments. This analysis will also involve consideration of existing lab tests and mix designs. Deliverables from this project will include an interim compilation of the work done to date under previously funded research, and a final report and presentation to ADOT&PF materials, M&O, and construction staff.

Benefits to the State: The knowledge gained through this research effort is expected to be used by ADOT&PF materials engineers when designing future projects to achieve better performing asphalt pavements with reduced maintenance costs for crack sealing and patching which will help lower the life-cycle costs of Alaska's valuable highway pavement assets.

T2-13-19 Experimental Feature: Polyester Concrete Approach Slabs

Principal Investigator: Leslie Daugherty, P.E., Bridge Engineer, Statewide
Funding: $51,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E. & Carolyn Morehouse, P.E.
Completion Date: December 2017

This experimental feature will evaluate polyester concrete for approach slabs on the Parks Highway MP 239-252 Rehabilitation construction project. The experimental feature will compare structural performance of various types of slabs to include polyester concrete, Class-A concrete, and paved asphalt approaches without a slab. The polyester concrete is high-strength, rapid-setting, and water impermeable. The concrete provides protection from chlorides and other contaminants to help protect the steel reinforcement giving longer life. Superior abrasion and skid resistance allow for a safe and durable driving surface. With a rapid curing time, traffic would be allowed to drive on the slab in about 4 hours which would be beneficial on the Parks Highway during the middle of summer. Polyester concrete does not crack or delaminate even through extreme freeze/thaw cycles and has a higher compressive strength than conventional Portland cement concrete.

Polyester concrete use in Alaska has been limited to a bridge deck overlay on the Susitna River Bridge. However, numerous states, such California, Washington, and Nevada, have used this system for bridge deck repairs and overlay projects on major highways. In states like Washington and California where traffic volume is high and this product has been used for over a decade, results show the concrete is performing as expected with no major signs of wear.

Benefits to the State: This research will determine if polyester concrete may be a practical, cost saving alternative to traditional concrete methods for approach slab and deck construction. If the polyester concrete performs as planned, it could save millions in traffic control costs and impacts to the traveling public on future bridge retrofit and deck projects.

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)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completion Date: March 2014

LiDAR (Light Detection and Ranging) is a remote sensing technique accomplished from an airplane or mobile unit 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 degrade 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.

Additionally, data acquired in 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 requirements for follow-up field surveys that would equate to repeated mobilization costs, travel time, per diem compensation, and other expenses. In addition, this research has the potential to identify areas of good LIDAR coverage versus those of poor coverage. This in turn will enhance the confidence level in the LIDAR mapping product, resulting in maximum usage of this economical and effective survey method. The report on the accuracy of LiDAR under tree canopy and in steep terrain will be distributed to location and design managers and consultants for informational purposes.

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. This will allow for cost effective use of LiDAR for acquiring topographic information for large areas.

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

Principal Investigator: Richard Wies, Jr., (UAF & AUTC)
ADOT&PF Funding: $40,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2014

This research project involves studying the ADOT&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 DOT&PF to develop and test the most promising prototype system to install and test at one of these sites.

Benefits to the State: The results from this project will help the ADOT&PF provide for the safe and efficient movement of people and goods on Alaskan highways by investigating and recommending innovative remote off-grid power systems to improve the efficiency and reliability of the Road Weather Information System.

T2-12-19 Rapid Research Response: A Design for an Interface Board between a MRC Thermistor Probe and a Personal Computer

Principal Investigator: Dejan Raskovic, (UAF & AUTC)
ADOT&PF Funding: $30,000 (SP&R)
ADOT&PF Project Manager: Lauren M. Little, P.E.
Completed December 2013

The project developed a prototype for a new handheld device for reading and testing in-pavement temperature sensors maintained by ADOT&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 months while the roads a still going through the spring thaw. The Highway Data Section maintains about 100 Temperature Data Probe (TDP) sites statewide. Properly maintaining and collecting TDP is critical to data driven decisions for the pavement design group and 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.

T2-08-06 Evaluating the Overheight Detection System at the Eklutna Overcrossing Bridge
Principal Investigator: Dr. Ming Lee
Funding: $58,500 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: March 2013

Some of Alaska's most important transportation assets are its bridges. Unfortunately, over-height trucks have collided with bridge structures, causing damage and increased maintenance costs. The Eklutna Glenn Highway Overcrossing Bridge (approximately 25 miles north of Anchorage) has sustained repeated impacts from overheight trucks. In 2006 the ADOT&PF installed an overheight vehicle warning system, which uses laser detectors, alarms, and message boards to warn drivers when their vehicles or loads 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 over height vehicles.

The objective of this project was 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 direction detection and warning system. Data captured by the surveillance system was analyzed to determine the frequency and characteristics of bridge impact accidents.

The system was found generally to be working as intended, but several recommendations were made to improve performance such as relocating the blankout sign, installing a cellular modem to establish real-time connection for data download and configuration changes, and restoring controller cabinet grounding to prevent drop outs.

Analysis of the recorded data showed that the majority of the false alarms occurred in extreme winter weather events when the air temperature were below minus 10 degrees and a freezing fog came from the trucks' exhaust pipes, and during heavy snow events.

Benefits to the State: The researchers provided recommendations for design specifications and site consideration for future overheight detection systems installation and documents to help maintenance staff operate, troubleshoot, and maintain the system components of this specific installation.

If the early warning systems for bridge height monitors can prevent costly damage from overheight vehicles and load 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 prove to be an asset to ADOT&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.

Photo: Semi-truck with freezing exhaust causing false overheight alarm. Photo from research final report FHWA-AK-RD-13-01.

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

Principal Investigator: Not yet assigned
Funding: $200,000 (SP&R)
ADOT&PF 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 no debate that red light runners are dangerous drivers who irresponsibly put others at risk. ADOT&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 are known to have 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 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 (UAA) 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 DOT&PF determine and implement effective and data-driven counter measures that when implemented will 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, it will likely produce information and illustrations that will aid in public education, and may even be used to convince policy makers to approve more effective means of enforcing compliance with red lights.

T2-12-10 Whittier Tunnel Operations Study
Principal Investigator: DOWL HKM, Thomas L. Moses, Jr., P.E.
Funding: $150,000 (SP&R)
ADOT&PF Project Manager: Robert Wright & Mike San Angelo, P.E.
Completion Date: April 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 ADOT&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, (UofI)
Funding: $60,000 (SP&R)
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2014

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 non-divided rural highways.

T2-13-01 Flashing Yellow Arrow Public Information Campaign
Principal Investigator: Meadow Bailey
Funding: $25,000 (SP&R)
ADOT&PF Project Manager: Meadow Bailey & Hannah Blankenship
Completion Date: Pending Project Closure

The public education campaign will encompass several communication media elements - including print, radio, television, and social media. Assess effectiveness of media campaign through surveys, monitoring coverage, interviews, and data and information analysis.

Benefit to the State: Information will be provided to the public regarding flashing yellow arrows at intersections.

T2-13-15 Value of Depressed Medians on Divided Highways in Alaska

Principal Investigator: Dr. Ghulam Bahm & Dr. Osama Abaza (UAA – AUTC)
Funding: $150,000 SP&R
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2015

The population of Alaska is steadily increasing, especially in the city of Anchorage. As a result, traffic volume is higher, and the demand to add lanes to existing highways in order to relieve congestion is increasing. In Alaska, an expressway or freeway is a high-speed (≥ 50 mph), multilane, divided highway with partial access control. These divided highways typically utilize wide medians.

During the Alaskan winter, where snow accumulates in medians from October to April, drivers can lose control of their vehicles in slippery road conditions. Wide medians with heavy snow serve as a refuge to absorb the impact of a crash. However, in order to provide additional through lanes, cater to the needs of higher traffic, and keep traffic congestion to a minimum, these wide medians could be replaced with narrow ones which may reduce the median's ability to function as a safety cushion. These depressed wide medians also act as snow storage areas, allowing snow to be plowed on both sides of the road. Eliminating these medians will reduce the available snow storage space and require plowing all of the snow to the right, increasing the snow load to one side of the road.

The main objective of this project is to compare the benefits of depressed wide medians (vee ditch) with other types of medians (narrow medians and no snow storage) in terms of safety, operations and maintenance. This will include analysis of historical crash data along with snow storage observations and vehicle tracking observations after snowfall to evaluate non-crash reported run off the road type incidents. The researchers will compare known high speed urban arterials with narrow medians (no vee-ditches) and no snow storage and additional lanes to improve traffic flow.

Benefits to the State: The results of this research will be valuable in helping Alaska's highway designers to determining appropriate engineering alternatives to deal with increasing traffic volumes in Anchorage and the surround areas.

Photo: The research team is compiling photos from car mounted GPS equipped video cameras to analyze runoff the road events. Photo taken on the Glenn Highway near Eklutna in December 2013 by Scott Thomas, ADOT&PF Traffic and Safety Engineer.

T2-13-16 Optimizing Highway Patrol Investment Levels
Principal Investigator: Billy Connor (UAF – AUTC)
Funding: $100,000 SP&R
ADOT&PF Project Manager: Angela Parsons, P.E.
Completion Date: June 2015

State crash data shows fatal crashes occur more often on rural high speed highways, and higher volume highways. The highest density of severe crashes occurs within the State's four designated Safety Corridors. There is a need to optimize highway enforcement performance levels (and in turn optimize the State's funding) so that highway travel is no longer a leading risk. Road projects (Engineering) with specific termini are easily linked directly to a road segment's safety performance.

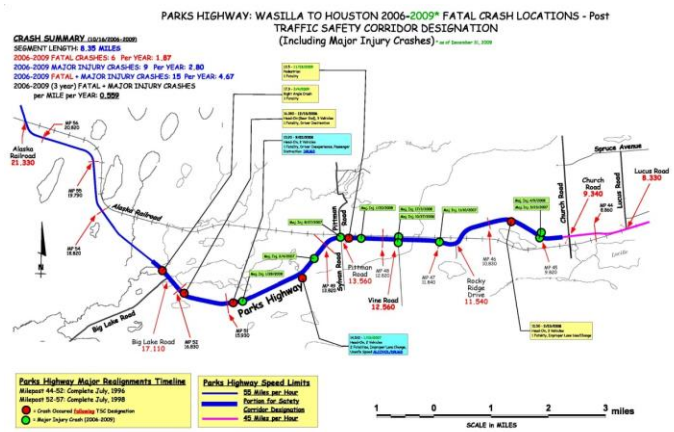
But how can enforcement be directly linked to road safety when officers provide multiple duties away from roads? Reductions in citations or arrests could falsely indicate staffing reductions are possible when they may actually be needed to hold down illegal human factor driving. A new performance measurement will be needed to help find the balance of enforcement time within and around target areas.

This research project will focus on documenting the benefits of enforcement presence and the costs associated with enforcement presence on some of the higher risk road segments in Alaska. The study is expected to include the use of GPS based automated tracking technologies to quantify the presence of enforcement patrol vehicles in the Matanuska-Susitna area safety corridors. The study will develop a benefit/cost relationship for fatal and major injury crashes compared to the cost of the enforcement hours and produce a sensitivity analysis to optimize the cost vs benefit of reduced crashes.

Benefits to the State: Annual audits of the Traffic Safety Corridors emphasize the importance of increased enforcement to combat aggressive driving, DUIs and speeding, but do not quantify how much additional enforcement is needed. This project's approach of tracking officer presence will provide a full picture of enforcement impacts on our highways.

Data collected could be presented graphically, comparing "hours" of police presence by year against crash experience by severity, citation, or aggressive/impairs violations. Having this information organized could reveal unrecognized correlations and permit a new level of decision-making to be applied to safety and enforcement efforts on State Highways, helping to optimize the State's investment in law enforcement

Photo: This map shows an analysis of fatal crash locations on a Parks Highway Safety Corridor, an area expected to be studied in the proposed research project "Optimizing Highway Patrol Investment Levels." Graphic from the Alaska Highway Safety Office website (http://www.dot.alaska.gov/stwdplng/hwysafety/safety_corridors.shtml).



T2-11-17 Rapid Research Response FFY 2013
Principal Investigator: Various
Funding: $170,000
ADOT&PF Project Manager: Carolyn Morehouse, P.E.
Completion Date: various

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".

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 and 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.

Benefits to the State: DOT&PF can conduct research in a short period of time with quick results for immediate implementation.

Project Title	Project #	Amount	Contact
Flashing Yellow Arrow Public Information Campaign	T2-13-01	$25,000	Meadow Bailey
Evaluation Low Temperature Pavement Cracking	T2-13-17	$8,000	Angela Parsons, P.E.
Testing Screening Surfacing Materials for the Yukon River Bridge – Stage II	T2-13-09	$137,000	Lauren Little, P.E.

T2-11-18 Research & Technology Deployment FFY 2014
Principal Investigator: Various
Funding: $148,000
ADOT&PF Project Manager: Carolyn Morehouse, P.E.
Completion Date: various

The Research & Technology Deployment program augments the ADOT&PF portfolio of research projects, technology transfer, and workforce development activities to rapidly respond 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 & 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 ADOT&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 & Technology Deployment Program" supports the following types of activities necessary for implementation and deployment of research and technology products developed external to the RD&TT program of ADOT&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.

Project Title	Project #	Project Amount	RD&TT Contact
Development of GPS Survey Data Management Protocols/Policy	T2-13-02	$10,000	Lauren Little, P.E..
Expedient Permafrost Resistivity Investigation (Ohm Mapper)	T2-13-07	$68,000	Lauren Little, P.E.
Enhancing Research & Technology Deployment Through Program Recording	T2-13-20	$30,000	Clint Adler, P.E.
Improving Excellence Workshop	T2-13-21	$40,000	Clint Adler, P.E.

T2-11-19 Experimental Features FFY 2013
Principal Investigator: Varies
Funding: $126,000 (Federal)
ADOT&PF Project Manager: Carolyn Morehouse, P.E.
Completion Date: various

The Federal Highway Administration (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, can also be a new technique for using conventional materials.

The RD&TT Program maintains an account to support evaluations of Experimental Features.

Benefits to the State: DOT&PF can conduct research and evaluate experimental features during construction and monitor results.

Project Title	Project #	Amount	Contact
Tencati Wicking Fabric Design	T2-13-10	$35,000	Lauren Little, P.E.
Long term Monitoring of ice rich cut slopes at Dalton Highway MP 9	T2-13-12	$40,000	Lauren Little, P.E.
Polyester Concrete for Approach Slabs	T2-13-19	$51,000	Lauren Little, P.E.

Pooled Fund Studies FFY 2013
Principal Investigator: Varies
Funding: $35,000 (SP&R)
Completion Date: various

Benefits to the State: 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. ADOT&PF participates in the following pooled fund studies. Details and status are available at http://www.pooledfund.org/ .

Title	Study ID	Lead Agency	ADOT&PF FFY 2013 Funding	Project Website
FFY 2013 Funding				
Aurora Program	SPR-3(042)	Iowa Department of Transportation	$25,000	www.pooledfund.org/Details/Study/189
2014 Asset Management Conference and Training on Implementation Strategies	TPF-5(275)	Iowa Department of Transportation	$10,000	www.pooledfund.org/Details/Study/510
Validation of Tsunami Design Guidelines for Coastal Bridges	Solicitation # 1332	Oregon Department of Transportation	Pending	www.pooledfund.org/Details/Solicitation/1332
Projects Active in FFY2013 but Funded prior to FFY2013				
Western Alliance for Quality Transportation Construction (WAQTC)	TPF-5(064)	Utah Department of Transportation		www.pooledfund.org/Details/Study/274
Strength and Deformation Analysis of MSE Walls at Working Loads	SPR-3(072)	Washington State Department of Transportation		www.pooledfund.org/Details/Study/225
Roadside Safety Research Program	TPF-5(114)	Washington State Department 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
Western Maintenance Partnership	TPF-5(145)	Utah Department of Transportation		www.pooledfund.org/Details/Study/401
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 Department of Transportation		www.pooledfund.org/Details/Study/399

Title	Study ID	Lead Agency	ADOT&PF FFY 2013 Funding	Project Website
Transportation Research Program Management Database	TPF-5(181)	Washington State Department of Transportation		www.pooledfund.org/Details/Study/407
Northwest Transportation Consortium	TPF-5(191)	Washington State Department of Transportation		www.pooledfund.org/Details/Study/414
Loop and Length Based Classification Pooled Fund	TPF-5(192)	Minnesota Department 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
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
Core Program Services for a Highway RD&T Program	TPF-5(277) TPF-5(223) TPF-5(240) TPF-5(261)	Federal Highway Administration		www.pooledfund.org/Details/Study/513 www.pooledfund.org/Details/Study/472 www.pooledfund.org/Details/Study/451 www.pooledfund.org/Details/Study/492

Alaska Technology Transfer

Housed within ADOT&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.

Local Technical Assistance Program: $396,104

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
- newsletters and tech briefs
- 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.

T2-13-06 Rapid Technology Transfer: $120,000

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.

CY 2012 Program Dashboard

Total number of training sessions: **89**
Total number of participants: **1,342**
Total number of participant hours: **13,022**

CY 2013 Program Dashboard

Total number of training sessions: **80**
Total number of participants: **1601**
Total number of participant hours: **17,839**

T2 Highlights

- Specialized training on gravel road inspection and maintenance planning to Fairbanks North Star Borough and Mat-Su area road commissioners to help them inspect and manage their service areas.
- Continuing participation in Alaska Summer Research Academy by delivering the civil engineering module to high-school students.
- Continuation and expansion of Construction Management Program with UAF's Institute of Northern Engineering.
- Developed and deployed an on-line version of the OSHA Hazard Communication (HazCom) workshop that has allowed 1700 employees to complete this required training on demand.
- Developed and deployed a rural airport maintenance video for airport contractors in cooperation with M&O.
- On-going management/delivery of the ATSSA and Alaska CESCL training programs.