Alaska Department of Transportation and Public Facilities

Alaska DOT&PF Research Annual Work Program

FFY 2025

FFY 2026

Summer 2024

Table of Contents

Research Development and Technology Transfer Certification

Alaska Department of Transportation & Public Facilities

The Research Development and Technology Transfer (RD&T2) Section within the Data Modernization and Innovation Division of the Alaska Department of Transportation & Public Facilities (DOT&PF) provides research management, library, technical assistance, training, and technology deployment services to DOT&PF, local transportation agencies, and their partners.

RD&T2 provides services largely through the collaborative relationships with and financial support from the Federal Highway Administration, the University of Alaska, University Transportation Centers, and the DOT&PF. By leveraging resources and developing partnerships with a variety of transportation organizations and professionals. RD&T2 taps into a vast network of expertise and resources and eliminates duplication of effort. RD&T2 also provides an avenue for multidisciplinary support from a network of engineering, management, leadership, law, planning, and the environment.

This document is the proposed work plan for the DOT&PF Research program for federal fiscal year 2025 based on project selection process outlined in our Standard Operating Procedures Manual available online at our website: http://dot.alaska.gov/stwddes/research/index.shtml

---

I, Cristina DeMattio, Acting Research Program Manager, DOT&PF of the State of Alaska, do hereby certify that the State of Alaska is in compliance with all requirements of 23 U.S.C. 505 and its implementing regulations with respect to the research, development, and technology transfer.

For additional information, contact:

Cristina DeMattio, P.E.
Acting Research, Development, & Technology Transfer Manager
Division of Data Modernization & Innovation
Alaska Department of Transportation & Public Facilities
2301 Peger Road
Fairbanks, AK 99701
907.451.5382
cristina.demattio@alaska.gov

Fiscal Summary

Research Funding Distribution

	FFY25	FFY26	TOTAL FFY25-26
TOTAL Research Plan	**$ 6,196,000**	**$ 5,187,000**	**$ 11,383,000**
Research Projects	$ 4,400,000	$ 3,385,000	$ 7,785,000
Pooled Fund Studies	$ 1,349,000	$ 1,205,000	$ 2,554,000
AASHTO Technical Service Programs	$ 237,000	$ 237,000	$ 474,000
Research Funds for LTAP	$ 210,000	$ 210,000	$ 420,000
AK DOT Research Peer Exchange	$ -	$ 150,000	$ 150,000

Research Funding Sources

	STIP 6451 FFY24*	STIP 6451 FFY25	STIP 6451 FFY26	STIP 25836 FFY25	STIP 25836 FFY26	TOTAL FFY25-26
TOTAL Research Funding	**$ 4,082,033**	**$ 3,386,212**	**$ 3,440,755**	**$ 237,000**	**$ 237,000**	**$ 11,383,000**
Research Projects FFY25	$ 4,082,033	$ 317,967	$ -	$ -	$ -	$ 4,400,000
Research Projects FFY26	$ -	$ 1,509,245	$ 1,875,755	$ -	$ -	$ 3,385,000
Pooled Fund Studies	$ -	$ 1,349,000	$ 1,205,000	$ -	$ -	$ 2,554,000
AASHTO Technical Services Programs	$ -	$ -	$ -	$ 237,000	$ 237,000	$ 474,000
Research Funds for LTAP	$ -	$ 210,000	$ 210,000	$ -	$ -	$ 420,000
AK DOT Research Peer Exchange	$ -	$ -	$ 150,000	$ -	$ -	$ 150,000

*FFY24 includes any remaining STIP 6451 funds from previous years.

STIP 6451 – Research and Technology Transfer Program
STIP 25836 – AASHTO Technical Programs Support

Research Projects Selected for FFY25

All the projects are funded by 80% Federal (SPR-B) and 20% State match for the combined totals shown. All projects are total project costs. Completion dates and durations are estimates.

#	Title	Champion(s)	Researcher(s)	FFY25 ($) *FY24 Start	Comp. Months	Comp. Date
1	Research Administration FFY25/26	Cristina DeMattio	N/A		24	Dec - 2026
2	Rapid Research, Deployment, Implementation & Tech Transfer FFY25/26	Cristina DeMattio	Varies		24	Dec - 2026
3	Geophysical and Geohydrological Investigation of Groundwater Aufeis and Its Effect on Transportation Structures	Jeff Stutzke, Roy Sayman	Pr. Kidanu, Pr. Misra, UAF		12	Dec - 2025
4	Assessment of Alaska Road Weather Information System (RWIS)	Isvan Gomez, Dan Schacher, Tim Glassett, Travis Eckhoff	In-house		12	Dec - 2025
5	Roadway Foundation Cooling using Micro-Thermosyphons	Jeff Curry, Matt Billings	Pr. Goering, Pr. Peterson, UAF		18	Jun - 2026
6	Remote Site Monitoring with Drone Docks	Ryan Marlow, Patrick Dryer, DNR, DEC, UAF	In-house		18	Jun - 2026
7	Implementation of Snowpack Modeling for Avalanche Hazard Forecasting along Alaska's Remote Transportation Networks	Patrick Dryer; Timothy Glassett; Ryan Marlow, AK L&P, DNR, UASE,USGS	In-house		18	Jun - 2026
8	Bridge Condition Anomaly Detection using Remote Sensing-Based Non-Destructive Techniques	Jesse Escamilla	Pr. Congress, MSU		24	Dec - 2026
9	Assessment of Mobility Potential and Safety Implications of E-Bike Use in Alaska	Anna Bosin	Pr. Vasudevan, UAA		24	Dec - 2026
10	Risk Management Strategies for Landslide Susceptible Transportation Corridors	Travis Eckhoff, Mitch McDonald, Patrick Dryer	In-house		24	Dec - 2026
11	Soil Stabilization Using Locally Sourced Materials	Steve Saboundjian, Andrew Pavey	Pr. Farzadnia, UAF		24	Dec - 2026
12	Innovative Approaches for Bike, Pedestrian, and ATV Counting in Alaska	Scott Vockeroth, Ben Glenn	In-house		30	Jun - 2027

13	New Spectral Displacement-based Ground Motion Model for Alaska	Nick Murray, Dave Hemstreet	Ashly Cabas, NCSU		30	Jun - 2027
14	Detection and Tracking of Non-Motorized Road Users	Anna Bosin	UAA		30	Jun - 2027
15	Rapid Post-Earthquake Displacement-Based Assessment of Bridges – Phase II	Nick Murray, Leslie Daugherty	Pr. Kowalski, NCSU		30	Jun - 2027
			Total FFY25	**$ 4,400,000**		

TBD – To be determined. No identified person/institution at this time.

Research Projects Selected for FFY26

All the projects are funded by 80% Federal (SPR-B) and 20% State match for the combined totals shown. All projects are total project costs. Completion dates and duration are estimates.

#	Title	Champion	Researcher(s)	FFY26 ($) Start	Comp. Months	Comp. Date
16	Rapid Imagery Based Monitoring for Geohazard Response	Travis Eckhoff, Mitch McDonald, Patrick Dryer, Andrew Dyke, Travis Watkins	In-house		18	Jun - 2027
17	Understanding Winter Weather Impact Challenges for Connected Vehicles	Pam Golden, Val Rader	In-house		18	Jun - 2027
18	Advancing Anchorage's Freight Transportation Network: A Comprehensive Analysis for Cost-Effective, Safe, and Resilient Operations	Anna Bosin, Steve Ribuffo (Dir), Michael Rhodes (Port Eng) Port of AK	Pr. Srinivas, UnivMissouri		18	Jun - 2027
19	Improving Thermal and Structural Stability of Culvert Crossings in Permafrost Zones	Jeff Russell	UAF		24	Dec - 2027
20	Stability Analysis of Susitna Bridge Abutment using Remote Sensing Techniques	Jesse Escamilla	Pr. Congress, MSU		24	Dec - 2027
21	Balanced Mix Design of Asphalt Mixtures to Complement the Marshall Method in Alaska	Steve Saboundjian, Andrew Pavey	Pr. Farzadnia, UAF		24	Dec - 2027
22	Optimized Bridge Girder Design Phase 2	Nick Murray	Pr. Kowalski, NCSU		24	Dec - 2027
23	Seismic Pile-Soil-Structure Interaction Including Frozen Soil Effects	Ben Still	Pr. Pekcan, Pr. Elfass, Univ Nevada		24	Dec - 2027
24	Shrinkage Mitigation Systems for Enhanced Durability of Alaska DOT&PF Concrete Mixtures	Rich Giessel, Jake Allen, Patrick Walter AS&G	Pr. Farzadnia, UAF		24	Dec - 2027
25	Analytical Bar Buckling and Fracture - Phase I	Nick Murray, Leslie Daugherty	Pr. Kowalski, NCSU		30	Jun - 2028
26	Condition Dependent Design Phase 2: Quantifying in-situ performance of bridges through 3D scanning of corroded steel	Nick Murray, Leslie Daugherty	Pr. Kowalski, NCSU		30	Jun - 2028

27	Effects of Climate Change on Ground Motion Characteristics in Alaska	Nick Murray, Dave Hemstreet	Ashly Cabas, NCSU		30	Jun - 2028
			Total FFY26	**$ 3,385,000**		
		TOTAL RESEARCH	**FFY25 - FFY26**	**$ 7,785,000**		

TBD – To be determined. No identified person/institution at this time.

Pooled Fund Studies FFY25/26

The Pooled Fund program is a joint effort between State DOTs and FHWA to share resources towards common research goals. FHWA or a DOT can be a lead agency for a pooled fund project. Alaska DOT&PF participates in pooled fund studies by transferring 100% SP&R federal funds to the lead agency and assigning a DOT&PF staff person as the technical advisor to participate in the national effort. Pooled funds generally take 3-5 years of commitment participation from each member agency as projects are developed, conducted, and disseminated.

TPF #	Title	FFY25	FFY26	Commitment	Lead Org.
1610	Phase II: Continuous Asphalt Mixture Compaction Assessment using Density Profiling System (DPS)	$25,000	$25,000	25K/year	MN
1615	Vehicle to Everything (V2X) Pooled Fund Study	$50,000	$50,000	50K/year – Replaces Connected Vehicle TPF	GA
1617	Aurora Program FY25 – FY29	$25,000	$25,000	25K/year	IA
1618	Smart Work Zone Deployment Initiative (FY25-FY29)	$25,000	$25,000	25K/year for 5 years	IA
1620	Uncrewed Aircraft Systems (UAS) Standardization	$50,000	$25,000	Committed $50K/2024, $25K/yr after.	AK
1621	Traffic Safety Culture Phase 3	$25,000	$25,000	25K/year for 5 years	MT
TPF-5(384)	Exploring Non-Traditional Methods to Obtain Vehicle Volume and Class Data	$0	$0	Previously committed. Commitment met. Ends 2025	FHWA
TPF-5(459)	Developing and Calibrating Fragmental Rockfall Models using Physics Engines	$0	$0	Previously Committed. Commitment met.	WA
TPF-5(462)	Assessment and Repair of Prestressed Bridge Girders Subjected to Over-Height Truck Impacts (OHTI)	$0	$0	Previously committed. Ends in 2024	MO
TPF-5(476)	Western Alliance for Quality Transportation Construction (WAQTC) 2021-2025	$12,000	$0	$12K/year. Ends 2025	UT
TPF-5(479)	Clear Roads Winter Highway Operations Phase III Pooled Fund	$25,000	$25,000	25K/year	MN
TPF-5(484)	Develop Countermeasure Strategies for Protecting Bridge Girders Against Overheight Vehicles Impact	$0	$0	Previously committed. Commitment met.	FHWA
TPF-5(485)	Consequences-Based Analysis of Undrained Shear Behavior of Soils and Liquefaction Hazards, Phase 1: Filling the Data Gaps	$0	$0	Previously committed. Ends in 2025	UT

TPF-5(486)	Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE	$35,000	$35,000	Previously committed. 3-year commitment required. 35K/yr	IN
TPF-5(491)	Super-Elastic Copper-Based and Iron-Based Shape Memory Alloys and Engineered Cementitious Composites for Extreme Events Resiliency	$30,000	$0	Ends 2025	WA
TPF-5(492)	2023 through 2025 Biennial Asset Management Conference and Training on Implementation Strategies	$12,000	$0	For 2025 Biennial Conference. Ends 2026	IA
TPF-5(497)	Transportation Avalanche Research Pool (TARP) 2.0	$0	$0	Previously committed. Commitment met.	CO
TPF-5(501)	Roadside Safety Pooled Fund - Phase 3	$65,000	$0	Previously committed. Commitment met in FY25.	WA
TPF-5(521)	New Performance Approach to Evaluate ASR in Concrete	$5,000	$5,000	5K/year	FHWA
TPF-5(522)	National Partnership to Improve the Quality of Pavement Preservation Treatment Construction & Data Collection Practices (PG Phase III)	$50,000	$50,000	Previously committed. 50K/yr	MN
TPF-5(524)	Stormwater Management to Address Highway Runoff Toxicity Due to 6PPD-Quinone from Tire Rubber	$30,000	$30,000	Previously committed. 30K/yr	OR
TPF-5(526)	Western Transportation Research Consortium	$15,000	$15,000	15K/yr 2024-2026	UT
TPF-5(530)	TRB Core Program Services for a Highway RD&T Program	$150,000	$150,000	Estimated from FY24	FHWA
TPF-5(536)	Ahead of the Curve - Migration from NCHRP to AASHTO Technical Training Solutions (TTS)	$0	$0	Committed $20k for 2024. Obligation has been met.	LA
	NCHRP Dues	$720,000	$720,000	Estimated from FY24	
		$1,349,000	**$1,205,000**	**$2,554,000**	
		FFY25	**FFY26**	**TOTAL POOLED FUNDS**	

FHWA Approved Pooled Fund Studies can be found at: https://www.pooledfund.org/Home

AASHTO Technical Service Programs (TSP)

AASHTO Technical Service Programs are made available to State DOTs, who can use these programs instead of spending the money, time, and resources to create their own programs, or as a complement to existing programs and processes. Alaska DOT&PF participates in TSPs by transferring 100% SP&R federal funds (all of the programs listed qualify for a waiver to use 100% SPR-B funds) to AASHTO and assigning DOT&PF staff members to serve on the associated committees for each TSP. Technical Service Programs (transportation.org)

Technical Service Program (TSP)	FFY25	FFY26	Total FFY25 - 26
AASHTO Design Guidelines	$15,000	$15,000	$ 30,000.00
AASHTO Environmental Management	$10,000	$10,000	$ 20,000.00
AASHTO Equipment Management	$5,000	$5,000	$ 10,000.00
AASHTO Innovation Management	$6,000	$6,000	$ 12,000.00
AASHTO Materials Guidelines	$10,000	$10,000	$ 20,000.00
AASHTO Operations Technical Service Program (Ops TSP)	$15,000	$15,000	$ 30,000.00
AASHTO Performance Management	$15,000	$15,000	$ 30,000.00
AASHTO Preservation Management	$20,000	$20,000	$ 40,000.00
AASHTO Product Evaluation and Audit Solutions	$25,000	$25,000	$ 50,000.00
AASHTO Rail Management	$5,000	$5,000	$ 10,000.00
AASHTO re:source	$22,000	$22,000	$ 44,000.00
AASHTO Resilience and Sustainability Management	$10,000	$10,000	$ 20,000.00
AASHTO Safety Hardware Management	$10,000	$10,000	$ 20,000.00
AASHTO Safety Management	$10,000	$10,000	$ 20,000.00
AASHTO Structures Guidelines	$15,000	$15,000	$ 30,000.00
AASHTO Technical Training Solutions	$20,000	$20,000	$ 40,000.00
AASHTO Transit Management	$5,000	$5,000	$ 10,000.00
AASHTO Winter Weather Management	$4,000	$4,000	$ 8,000.00
National Operations Center of Excellence (NOCoE)	$15,000	$15,000	$ 30,000.00
Total TSP Costs	**$237,000**	**$237,000**	**$ 474,000.00**

Peer Exchange FFY26

The Statewide Research Program Manager conducts peer reviews every five years of the program as required by 23 CFR 420.207(b). The intent of Peer Exchanges is to engage with other State DOTs and technical experts to discuss ideas, examine methods, and share best practices. Federal requirements (23 CFR 420.203) specify that Peer Exchange "means a periodic review of a State DOT's RD&T program or portion thereof, by representatives of other State DOTs, for the purpose of exchange of information or best practices." A State DOT may invite others to participate in Peer Exchanges including "FHWA, and other federal, state, regional or local transportation agencies; the Transportation Research Board (TRB); and academic institutions, foundations, or private firms that support transportation research development or technology transfer activities." The most recent peer review hosted by DOT&PF was conducted in May of 2021.

Peer Exchange	FFY26
Alaska DOT&PF Research Peer Exchange	$150,000

Local Training & Assistance Program (LTAP) FFY25/26

The annual Local Training & Assistance Program's work plan includes activities anticipated during and funded on a Federal Fiscal Year (FFY). The LTAP Director develops the work plan and budget as guided by the National LTAP/TTAP strategic plan. Additional focus areas are determined with substantial input from Alaska's advisory boards. This program follows the LTAP focus areas of Safety, Infrastructure Management and Workforce Development. The Chief Engineer and FHWA must both approve the work plan before it is enacted.

LTAP funding comes from FHWA's national LTAP funding at a 50% Federal funding and 50% SPR-B state match. The LTAP Director is responsible for the financial management of the Alaska LTAP and DOT&PF technical training program. The LTAP Director determines funding availability and prepares an annual proposed work plan and budget for the RD & Training Program Manager and FHWA's approval. Upon approval, the LTAP Director implements the work plan with the Training Specialist.

Implementation includes assessing the need for changes to the work plan, tracking expenditures, and ensuring that project funds are spent appropriately.

LTAP Annual Plan	FFY25	FFY26	Total FFY25 - 26
FHWA LTAP Allotment	$210,000.00	$210,000.00	$420,000.00
SPR-B Match	$210,000.00	$210,000.00	$420,000.00
Total Training using SPR-B Research Funds	**$210,000.00**	**$210,000.00**	**$420,000.00**

FFY25 Project Summaries

1 - RESEARCH ADMINISTRATION

Category: Administration of Research Program
Funding: $
Manager: Cristina DeMattio
Champion: N/A

This is money specifically for research staff to administer the federal research program as outlined in the Alaska RD&T2 Standard Operating Procedures. Activities include reporting to FHWA, AASHTO RAC participation, UTC advisory, Master Agreements with universities, regional outreach, peer-exchange participation, TRB participation, STIC and other innovation program activities; travel, conference fees, and other such activities in support of and to maintain the research program. Additional activities included in this funding cycle are establishing best practices for tracking project status, performance measures, implementation, and other metrics. This funding is still required to comply with federal regulations for research projects as stated in Alaska's RD&T2 Standard Operating Procedures.

Benefits to the State: Compliance with FHWA regulations for SP&R-B funding.

2 - RAPID RESEARCH, DEPLOYMENT & TECH TRANSFER

Category: Varies
Funding: $
Manager: Cristina DeMattio
Champion: Varies

This is money specifically for quick turnaround of small research projects that are needed to answer specific questions for department consideration before proceeding to larger research projects or products. Rapid Research could include laboratory testing, literature reviews, or national surveys for best practices. Deployment is used to facilitate implementation of successful research products, training, outreach, innovative practices, etc. for wider department use. Example deployment deliverables could be: 1) development of specifications or drawings based on research outcomes, 2) new content creation for trainings, 3) training video content for implementation, or 4) targeted workshops. This funding is still required to comply with federal regulations for research projects as stated in Alaska's RD&T2 Standard Operating Procedures.

Benefits to the State: Ready funding available for time sensitive research needs as well as assistance for implementation.

3 - GEOPHYSICAL AND GEOHYDROLOGICAL INVESTIGATION OF GROUNDWATER AUFEIS AND ITS EFFECT ON TRANSPORTATION STRUCTURES

Category: Hydraulics & Hydrology
Funding: $
Manager: Cristina DeMattio
Champions: Jeff Stutzke, Roy Sayman

The purpose of this project is to conduct a geohydrological and geophysical investigation to characterize groundwater aufeis and its effect on transportation structures near the intersection of the Old Steese Highway and Blackberry Road in Fairbanks, Alaska. The key theme of this study is to enhance the understanding of aufeis initiation, formation and behavior in permafrost environments, and to plan targeted mitigation strategies to protect transportation infrastructure from the detrimental effects of aufeis.
The intersection of the Old Steese Highway and Blackberry Road is a critical transportation node in Fairbanks, serving as a key route for commuters, freight transport, and emergency services. However, this area is prone to challenges caused by the presence of groundwater aufeis over the winter months. Aufeis formation occurs when groundwater discharges onto the ground surface and freezes, creating ice lenses that can lead to uneven ground conditions, subsidence, and heaving, ultimately affecting the safety and durability of transportation structures. The urgency of addressing the aufeis issue is evident in ADOT&PF's Strategic Investment Areas, particularly in the areas of safety, asset management, and economic vitality. The safety of transportation infrastructure is paramount, and failure to address the effects of aufeis could result in increased maintenance costs, traffic disruptions, and safety hazards for the community. Furthermore, effective asset management requires a thorough understanding of the factors contributing to infrastructure deterioration, including the impact of aufeis. Addressing these challenges aligns with ADOT&PF's goal of ensuring safe, efficient, and resilient transportation systems that support economic activities and enhance the quality of life for Alaskans.

Benefits to the State: The expected benefits of this project include cost savings through targeted infrastructure maintenance and mitigation strategies, enhanced safety of transportation structures, and improved environmental compliance. Failure to address the effects of aufeis on transportation structures could lead to increased maintenance costs, traffic disruptions, and safety hazards. Without targeted mitigation strategies, the infrastructure at the intersection of the Old Steese Highway and Blackberry Road would be at risk of deterioration and failure, potentially resulting in costly repairs and compromising the safety of commuters and emergency services.

4 - ASSESSMENT OF ALASKA ROAD WEATHER INFORMATION SYSTEM (RWIS)

Category: Maintenance & Operations
Funding: $
Manager: Cristina DeMattio/TBD
Champion and Technical Advisors: Isvan Gomez, Dan Schacher, Tim Glassett, Travis Eckhoff

The Alaska Department of Transportation and Public Facilities (ADOT&PF) relies on the Road Weather Information System (RWIS) to monitor road conditions, geohazards, enhance safety, and optimize transportation operations. However, the existing RWIS infrastructure is aging and system coverage is incomplete. This hinders its ability to effectively serve the public and ADOT&PF in mitigating risks associated with winter weather, avalanches, and geo-hazards.

- Outdated Sensors: Many RWIS sites utilize aging sensors that may not provide accurate and timely data. These outdated components hinder effective decision-making during extreme weather events.
- Limited Coverage: The current RWIS network does not cover all critical transportation corridors, leaving gaps in real-time weather monitoring. These gaps impact emergency response, maintenance planning, and traveler safety.
- Technological Advancements: Advances in sensor technology, data analytics, and communication systems have outpaced the capabilities of the existing RWIS infrastructure.

- Lack of avalanche and geo-hazard monitoring: RWIS sites either lack sensors to monitor avalanche and geo-hazard risks or do not exist proximate to know hazard locations, leaving vulnerable areas inadequately covered.
- Unquantified economic impact: The cost-effectiveness of a robust RWIS system, considering both public and ADOT&PF benefits, remains unquantified.

Benefits to the State: This assessment will provide ADOT&PF with a data-driven roadmap for optimizing Alaska's RWIS, enhancing public safety, improving asset management, and facilitating data-driven decision-making during winter operations. The economic analysis will demonstrate the project's potential return on investment, justifying strategic investments in a more robust and effective RWIS system.

5 - ROADWAY FOUNDATION COOLING USING MICRO-THERMOSYPHONS

Category: Materials & Construction
Funding: $
Manager: Cristina DeMattio
Champion: Matt Billings, Jeff Currey

Roadway design in Alaska's permafrost zones remains challenging due to the large amount of thaw unstable foundation soil that must be traversed. Maintenance in the impacted roadway areas is often very high due to thawing permafrost and subsequent thaw settlement in the underlying foundation soils.
Roadway designs often rely on insulation layers to help protect underlying permafrost foundation soils. However, while insulation can slow the rate of thaw, it is usually not sufficient to eliminate thawing and embankment failure, and some form of passive cooling system is often needed. Thermosyphons can provide the needed cooling effect and have been used in a number of test sections in interior Alaska.
The research work proposed here would examine the possibility of integrating micro thermosyphons with an insulation layer to produce a system that would both insulate the embankment foundation during warm summer months and provide an enhanced cooling effect during winter conditions.

Benefits to the State: This project has the potential to significantly improve safety and reduce maintenance requirements on Alaska's roadway systems that are located in permafrost-effected areas. The potential economic benefits vary substantially depending on permafrost characteristics, roadway type, and traffic loading. Cost reductions will be greater for paved highways where maintenance costs for resurfacing tend to be large.

6 - REMOTE SITE MONITORING WITH DRONE DOCKS

Category: Materials & Construction
Funding: $
Manager: Cristina DeMattio/Ryan Marlow
Champion: Ryan Marlow

This research initiative seeks to address the pivotal challenge of effectively monitoring highway construction projects in Alaska's remote and challenging environments. Through a strategic partnership between the Alaska Department of Transportation & Public Facilities (DOT&PF), the Department of Natural Resources (DNR), The Department of Environmental Conservation (DEC), the University of Alaska Fairbanks' Alaska Center for Unmanned Aircraft Systems Integration (UAF ACUASI), and now with the crucial inclusion of the Federal Aviation Administration (FAA), the project is set to pioneer an innovative solution that integrates drone docking stations with Starlink satellite connectivity. With the FAA's collaboration, a significant focus will be on

obtaining Beyond Visual Line of Sight (BVLOS) authorization, a critical component for expanding drone operational capabilities and enhancing safety and efficiency in remote monitoring tasks. This approach is aimed not only at improving real-time monitoring and data collection but also at ensuring quick and scalable deployment models for emergency management situations such as erosion, landslides, avalanches, and earthquakes. The project aligns with DOT&PF's Strategic Investment Areas, emphasizing the use of technology to boost operational efficiency, ensure infrastructure resilience, and promote environmental stewardship, thereby addressing urgent needs in disaster preparedness and response.

Background: Alaska's vast landscapes and extreme weather conditions present unique obstacles to highway construction and maintenance. Traditional methods of site monitoring are often rendered inadequate by the state's remote expanses, leading to increased costs, safety risks, and potential environmental damage. Recognizing these challenges, DOT&PF has identified the urgent need for innovative monitoring solutions capable of providing accurate, real-time data on construction progress and environmental compliance.
The proposed research leverages small unmanned aerial systems (sUAS) or drones, outfitted with advanced sensors and cameras, supported by strategically located drone docking stations and Starlink's satellite internet service. This setup facilitates continuous, autonomous UAV operations and rapid data transmission to cloud-based platforms for immediate analysis. The addition of scalable models for rapid deployment in response to emergencies signifies a proactive approach to disaster management, enabling swift action in the face of erosion, landslides, avalanches, and earthquakes.
The collaboration with the FAA for BVLOS authorization is a game-changer, offering the potential to significantly extend the operational range of drones beyond the pilot's visual line of sight. This capability is crucial for expansive and inaccessible areas, ensuring comprehensive coverage and timely data collection during critical and emergency situations.
This initiative, grounded in DOT&PF's Strategic Investment Areas, represents a holistic approach to leveraging cutting-edge technology for infrastructure monitoring and emergency management. By incorporating the expertise of the FAA, the project not only aims to enhance the efficiency and effectiveness of construction monitoring but also sets a precedent for innovative, sustainable infrastructure development and disaster preparedness in challenging environments.

Benefits to the State: Integrating drone docking stations and Starlink connectivity presents significant advantages, including reduced operational costs, enhanced project efficiency, improved safety, better environmental compliance, and strengthened infrastructure resilience. A hypothetical cost-benefit scenario suggests a 1:4 ratio over four years, highlighting the project's potential for substantial returns in cost savings, safety improvements, and environmental compliance.

7 - IMPLEMENTATION OF SNOWPACK MODELING FOR AVALANCHE HAZARD FORECASTING ALONG ALASKA'S REMOTE TRANSPORTATION NETWORKS

Category: Maintenance & Operations
Funding: $
Manager: Cristina DeMattio/Pat Dryer
Champion: Patrick Dryer; Timothy Glassett; Ryan Marlow; Michael Janes, AK Electric Light & Power; Eran Hood, UA-SE; Gabrel Wolken, DNR; Katreen Wikstrom Jones, DNR; Jamie Pearce, USGS

This proposal seeks to implement a statewide initiative under the Alaska Department of Transportation & Public Facilities (DOT&PF) Avalanche Program to employ advanced snowpack modeling techniques for improved avalanche hazard forecasting across Alaska. Recognizing the diverse and often remote terrain of our state, this project aims to enhance public safety, infrastructure resilience, and emergency response efficiencies through

innovative technology and collaborative statewide data integration.

The purpose of this research initiative is to innovate avalanche hazard monitoring and forecasting in Alaska's remote areas through the development and implementation of advanced snowpack modeling techniques. By leveraging state-of-the-art remote sensing technologies, geographical information systems and meteorological data, this project aims to utilize a dynamic model that can predict potential avalanche occurrences with greater accuracy and lead times.
Recent advancements in snowpack modeling and meteorological forecasting offer new opportunities to enhance our understanding and prediction capabilities. By integrating high-resolution weather station data, orthomosaic imagery, and historical avalanche occurrences into a comprehensive snowpack model, Alaska DOT&PF could significantly improve its avalanche hazard forecasting. However, the quality and reliability of the input data are crucial for the success of such models, necessitating rigorous quality assurance and quality control (QA/QC) processes for all meteorological data used.
This research project aligns with Alaska DOT&PF's strategic focus on safety and infrastructure resilience, addressing a critical need for innovative solutions to natural hazard management. Through this initiative, ADOT&PF seeks to establish a more proactive and effective approach to avalanche hazard management, ultimately protecting the lives and livelihoods of Alaskans dependent on the state's transportation network.

Benefits to the State:
The expected benefits of this statewide snowpack modeling project include significant improvements in safety, operational efficiency, and cost savings for the Alaska DOT&PF. This will also promote data driven decision making by avalanche specialists while conducting avalanche hazard assessments. By implementing an innovative approach to monitor and forecast avalanche hazards in remote areas, Alaska DOT&PF can proactively manage and potentially mitigate risks associated with snow avalanches, which pose a serious threat to transportation infrastructure, commercial activities, and communities. The integration of weather station data and quality assurance/quality control (QA/QC) processes ensures the reliability of the modeling data, enhancing the efficiency of winter maintenance and avalanche hazard reduction operations.
Without this innovative snowpack modeling approach for recognition of potential avalanche hazards it could result in continued vulnerability to avalanche hazards, leading to potential loss of life, property damage, and prolonged disruptions to transportation networks. Without the predictive capabilities proposed by this project, Alaska DOT&PF may incur higher costs due to reactive, rather than proactive, management of snow and avalanche risks.

8 - BRIDGE CONDITION ANOMALY DETECTION USING REMOTE SENSING-BASED NON-DESTRUCTIVE TECHNIQUES

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champions: Jesse Escamilla

Bridges in Alaska connect the road network, ensure connectivity of the communities, and foster economic development. When these bridges are subjected to heavier than designed loads, the current traditional monitoring techniques are laborious and costly to substantiate the deterioration of the bridge infrastructure due to these heavy loads in near real-time. There is a need to develop a workflow to proactively and efficiently understand the bridge responses to these loads by utilizing new technologies, which will further help improve the structure's durability. Having new technologies like drones, IoT sensors, and machine learning tools at our disposal, a workflow can be developed by combining these technologies to develop a better baseline model that

feeds on real-time data to evaluate the anomalies and detect damage. The study helps improve connectivity, promoting safety and economic vitality, resiliency, & data-driven decision-making toward bridge infrastructure asset management

Benefits to the State: The study output will result in the following benefits
1) Track and quantify changes in the bridge performance over time;
2) The information can be used to proactively predict the conditions of the bridge subjected to different loadings and optimize maintenance strategies;
3) It will reduce the subjectivity and provide an objective assessment of the bridge condition for making informed decisions;
4) Can be used as a quick and efficient tool at the time of a disaster/accident event which might make the traditional approaches for bridge condition evaluation unsafe, time taking, and costly;
5) Extract full potential of the data collection tools possessed by the DOT.

9 - ASSESSMENT OF MOBILITY POTENTIAL AND SAFETY IMPLICATIONS OF E-BIKE USE IN ALASKA

Category: Safety & Traffic
Funding: $
Manager: Cristina DeMattio
Champion: Anna Bosin

Electric-assist bicycles (e-bikes) have been on the market for over a decade. Its popularity has been increasing each year across the country, including Alaska. E-bikes have several benefits including the promise of bridging the first-mile and last-mile problem for increasing public transit ridership and mode-shifting benefits and offer the potential to maintain alternative mobility options for commuters in adverse weather and topographic conditions. The anticipated surge in e-bikes will test the capacities of non-motorized infrastructure. Such a scenario could adversely impact the safety and mobility of non-motorized road users, including pedestrians, invariably acting as a destructive force in non-motorized activities. Notably, the speed differential between e-bikes, vehicles, and pedestrians presents a considerable safety problem. This proposal covers safety and sustainability in the strategic investment areas of Alaska DOT&PF.

Benefits to the State: A better understanding of the risks and opportunities that e-bikes bring to the current infrastructure. An understanding of the risks will help develop a more inclusive and safer infrastructure for the public accommodating the needs of various road user demographics. Since Alaska offers log bike tracks and trails, the results from this study are expected to be beneficial to various towns and other regions across the state.

10 - RISK MANAGEMENT STRATEGIES FOR LANDSLIDE SUSCEPTIBLE TRANSPORTATION CORRIDORS

Category: Maintenance & Operations
Funding: $
Manager: Cristina DeMattio/Pat Dryer
Champions: Travis Eckhoff, Mitch McDonald, Patrick Dryer

DOT&PF does not have a formal approach for managing landslide risks along Alaska's surface transportation corridors. Alaska's surface transportation infrastructure is susceptible to landslides ranging from small rockfall

events that fill roadside ditches to mountain-sized catastrophic events that result in loss of life and property. Since 2004 over 6,000 documented landslides have impacted DOT&PF roadways throughout the state. Landslide activity and severity has increased as severe weather events have become more frequent. Recent catastrophic landslides in Sitka, Haines, and Wrangell have resulted in 11 deaths and millions of dollars of damage, including economic disruptions and delays in essential services. Multiple landslides may occur during long duration storm events like the 2020 Southeast Alaska storm. This complicates emergency response efforts and increase the risk to the traveling public and Maintenance and Operations (M&O) crews responding to the event.

Rockfall and debris flows are the most common types of landslides to impact DOT&PF infrastructure. Rockfall includes individual cobbles and boulders that are released from a rock slope and large rock masses that fail suddenly. Debris flows are a mixture of saturated soil, rock, and woody debris that flow down slope and can travel great distance. Rockfall and debris flows are fast-moving landslides that provide little warning before they occur and often have devastating results. These landslides are typically caused by long durations of precipitation, short duration storms with high precipitation intensities, and periods of freeze/thaw activity.

It is impossible to forecast exactly when and where a landslide will occur. It is possible to forecast periods of increased landslide hazard based on forecasted weather. Understanding the relationship between weather and landslide initiation along landslide susceptible transportation corridors will help DOT&PF develop landslide specific risk management strategies.

Benefits to the State: This research will directly benefit DOT&PF's Strategic Investment Areas of Safety, Economic Vitality, and Resiliency. Developing corridor specific landslide danger scales will help M&O prepare for potential landslides. This will help reduce landslide related road closure durations and disruptions to essential services. Recognizing periods of high landslide danger allows for targeted public messaging to help reduce the risk to the travelling public. Risk management strategies are critical to support resilient infrastructure.

11 - SOIL STABILIZATION USING LOCALLY SOURCED MATERIALS

Category: Materials & Construction
Funding: $
Manager: Cristina DeMattio
Champions: Steve Saboundjian, Andrew Pavey

This project will develop an alternative binder using locally sourced fly ash—to completely replace Portland cement in soil stabilization processes while maintaining comparable stabilizing properties. Fly ash, a by-product of coal combustion in power plants, is abundantly produced in interior Alaska, with the University of Alaska power plant alone generating 8,500 tons of fly ash annually. This industrial waste can serve as an alternative to cement when processed using a recent technology known as Alkali Activation. Previous studies have demonstrated that alkali-activated fly ash (AAF), has superior properties as a soil stabilizer [2]. Apart from its typical applications in soil stabilization, employing AAF in soils containing high sulfate levels has proven effective in mitigating the adverse effects of sulfates, owing to the significant sulfate resistance exhibited by AAF. Using locally sourced fly ash as a soil stabilizer not only lowers costs but also contributes to sustainability through the utilization of industrial waste.

Benefits to the State: This project will facilitate the utilization of locally available fly ash, offering comparable mechanical properties and superior durability to Portland cement, as a cementitious soil stabilizer. Additionally, it can pave the way for the exploration of other locally available materials, decreasing construction costs, promoting sustainable practices, and reducing reliance on imported materials in Alaska. The development of a

performance-based specification will provide valuable guidance for engineers, thereby facilitating the adoption of this innovative and cost-effective approach.

12 - INNOVATIVE APPROACHES FOR BIKE, PEDESTRIAN, AND ATV COUNTING IN ALASKA *

Category: Safety & Traffic
Funding: $
Manager: Cristina DeMattio/TBD
Champion and Technical Advisors: Scott Vockeroth, Ben Glenn

This project aims to explore and test innovative methods for collecting bike, pedestrian, and, if permissible, ATV traffic data through crowdsourced and community-collected efforts. The goal is to enhance the accuracy, coverage, and cost-effectiveness of traffic counting, particularly in underserved and rural areas of Alaska.

Traditional traffic counting methods often overlook non-motorized traffic, leading to a gap in data that is essential for the planning and development of transportation infrastructure. This project seeks to fill this gap by leveraging new technologies and community participation to obtain reliable data on bike, pedestrian, and potentially ATV traffic.

Benefits to the State: Improved planning and resource allocation for bike and pedestrian infrastructure; enhanced understanding of non-motorized traffic patterns, leading to safer and more accessible transportation networks; and increased community involvement in transportation planning.

* This project will likely be combined with “Detection and Tracking of Non-motorized Road Users”

13 - NEW SPECTRAL DISPLACEMENT-BASED GROUND MOTION MODEL FOR ALASKA

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champion: Nick Murray, Dave Hemstreet

This research project will focus on the estimation of the seismic demand for critical components of the transportation network in Alaska, namely bridges via GMMs (ground motion models). GMMs are most commonly developed in areas of high recorded seismicity (i.e. western US, Japan, New Zealand, Chile) and must be continually updated/revised over time as more empirical data become available. While recent advances have enabled the development of modern GMMs applicable to subduction, and shallow crustal zones, such as the ones present in Alaska, important shortcomings must be addressed.
Estimates of the seismic demand for bridges in Alaska are needed for new designs, but also for inspection prioritization after a large seismic event. The framework of a rapid post-earthquake displacement-based assessment has been developed in collaboration with Dr. Mervyn Kowalsky at NC State through a Phase I project sponsored by AKDOT&PF. The proposed project herein aims to support those efforts by developing a new spectral displacement-based GMM to be used in such rapid post-earthquake assessments, or more broadly for planning purposes, and more routinary engineering applications that require estimations of ground motion.

Benefits to the State: This project will allow engineers to use GMMs with a more comprehensive understanding of their applicability and limitations in Alaska. The expected deliverables include a report summarizing pertinent literature in the selection and use of existing GMMs applicable to Alaska’s seismicity,

tools to implement existing GMMs will be compiled and included in this report. Additionally, example applications for earthquake scenarios selected from the USGS deaggregation tool for different locations in Alaska will be provided. A separate technical report will also provide detailed descriptions of recommended adjustments to existing GMMs and the new SD-based GMM developed as part of this project, its applicability and limitations. A spreadsheet and/or scripts will accompany the technical report to facilitate the implementation of the new SD-based GMM by AKDOT&PF engineers.

14 - DETECTION AND TRACKING OF NON-MOTORIZED ROAD USERS *

Category: Safety & Traffic
Funding: $
Manager: Cristina DeMattio/TBD
Champion and Technical Advisors: Anna Bosin

UAA proposes to test various off-shelf tools to capture non-motorized road users. Some of the off-shelf tools (e.g. Numina) offers promises. However, they have not been tested in extreme environments. Some other video detection techniques such as YOLO 7 has made significant progresses in processing video data. However, it is uncertain if they can capture pedestrians and bicyclists in various background such as snow, This project will help identify the right tools that work in extreme weather in Alaska. We propose to test some of the off-shelf tools and explore customizing some of them for Alaskan environment.
The major outcome is identification of the right sensors and tools to capture non-motorized road user behavior so that the DOT&PF and other agencies across Alaska can adopt them in their jurisdiction.

Benefits to the State: Capturing pedestrian and bicyclist data has been a challenge in Alaska. This project is expected to address this concern. With e-bikes gaining popularity, there has been a significant increase in biking activities statewide. Therefore, capturing non-motorist behavior is extremely important for planning and design purposes.

*This project will likely be combined with “Innovative Approaches for Bike, Pedestrian, and ATV Counting in Alaska”

15 - RAPID POST-EARTHQUAKE DISPLACEMENT-BASED ASSESSMENT OF BRIDGES – PHASE II

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champions: Leslie Daugherty, Nick Murray

Following a potentially damaging earthquake, rapid identification of the performance of impacted structures accelerates decision-making processes, hence mitigating indirect losses. Lifeline structures, such as bridges, have profound secondary impacts, thus necessitating a rapid evaluation, especially in states with sparse population distribution and limited route redundancy. In addition to post-earthquake assessment, the possibility of running a pre-earthquake scenario is beneficial for disaster response planning and vulnerability identification. In recent years, various rapid assessment tools, such as ShakeCast, developed by USGS, and HAZUS, developed by FEMA, have been employed to prioritize inspections. However, two main limitations are identified in these tools. First, they rely on ground motion intensity measure (IM) parameters based on acceleration, such as PGA and PSA values. However, it is widely acknowledged that the correlation between

acceleration and structural damage is inadequate, with spectral displacement being recognized as a more robust and reliable IM. Secondly, the outcomes from current tools frequently prove inadequate for achieving an accurate performance assessment, primarily due to the restricted structural data employed in obtaining the system's capacity curve.

To address the limitations of the assessment tools previously mentioned, a Direct Displacement-Based Assessment (DDBA) approach was developed as an alternative technique for rapid post-earthquake assessment of bridges during Phase I of this research program, which started in 2022 and will conclude in early 2025. DDBA relies on spectral displacement as an IM, which correlates well with structural damage. Moreover, DDBA is grounded in the analysis of an equivalent SDOF system, facilitating the performance evaluation of the structures. Consequently, DDBA enables a rapid and efficient evaluation process. **During Phase II, the accuracy of the DDBA approach will be verified by non-linear time history analysis, and a software application capable of deploying DDBA will be developed**. The tool would be connected to a bridge database (offering enough structural information) as well as a site database (offering subsurface characterization information) to run a deterministic assessment. The rapid assessment is initiated by the occurrence of a seismic event (or by the exploration of a hypothetical earthquake scenario) of engineering significance, providing results on structural performance.

Benefits to the State: This research will allow engineers to quickly estimate likely bridge performance. In the case of post-earthquake assessment, the approach could help prioritize bridge inspection following an event. Additionally, the work could be applied for planning purposes, allowing for the simulation of seismic scenarios. This modeling approach can inform decision-makers about the potential impacts of specific events on the bridge system so that vulnerabilities may be identified. Additionally, it facilitates the evaluation of the impact of future design choices.

FFY26 Project Summaries

16 - RAPID IMAGERY BASED MONITORING FOR GEOHAZARD RESPONSE

Category: Maintenance & Operations
Funding: $
Manager: Cristina DeMattio/Pat Dryer
Champions: Travis Eckhoff, Mitch McDonald, Patrick Dryer, Andrew Dyke, Travis Watkins

Alaska's surface transportation infrastructure is susceptible to landslides ranging from small rockfall events that fill roadside ditches to mountain-sized catastrophic events that result in loss of life and property. Since 2004 over 6,000 documented landslides have impacted DOT&PF roadways throughout the state. Rockfall and debris flows are the most common types of landslides to impact DOT&PF infrastructure. These are fast-moving landslides that provide little warning before they occur and often have devastating results. These events can create unstable slope conditions after the initial event. Loose or disturbed materials remaining on the slope after the initial failure are a significant hazard to M&O crews and Contractors removing debris from the roadway. After the debris is cleared and the road is opened any remaining loose or disturbed materials may present a hazard to the travelling public.

Continuous slope stability monitoring can improve worker and public safety. Assessing post landslide slope stability is often challenging due to remaining hazards, poor weather conditions, difficulty accessing the slope, costs, and the sheer scale of DOT&PF's transportation networks. Several temporal change detection analysis techniques have been developed to monitor unstable slopes. These techniques are generally low cost, do not require permanent instrumentation, and are well suited for multiple applications. Change detection can be performed using terrestrial and aerial based imagery. Using terrestrial and aerial imagery has different advantages and disadvantages. For example, most modern smart phones can take high-quality images suitable for change detection, but user capabilities vary drastically, and it is difficult to collect consistent images. Drones can collect very high quality imagery in hard-to-reach areas but require skilled pilots to operate and image processing can be time consuming.

Benefits to the State: This project will reduce geohazard response time while increasing personnel safety using cost effective, commonly available equipment. This could significantly reduce operating costs. For example, if an operator in a remote location can collect imagery suitable for change detection analysis specialized staff may not need to travel to the site. Using simple, inexpensive equipment for monitoring will allow more unstable slopes to be monitored continuously. This will improve the safety of the traveling public.

17 - UNDERSTANDING WINTER WEATHER IMPACT CHALLENGES FOR CONNECTED VEHICLES

Category: Safety & Traffic
Funding: $
Manager: Cristina DeMattio
Champions: Pam Golden, Val Rader

Connected intersections broadcast signal phase and timing (SPaT) messages, mapping information (MAP) messages and optional position correction data. These messages have the potential to drive down intersection crashes. National guidance for MAP messaging was updated by the Connected Vehicle Pooled Fund Study in June 2023, but relies on prescriptive nodes that are visible when pavement markings are 100% visible. States that are currently leading in CV2I have plow to pavement policies. After a snow event, vehicle paths at

Alaska's intersections often vary significantly from the pavement markings and can float to different locations after each winter weather event. The purpose of this project is to evaluate the shifting of vehicle paths at a selection of signalized intersections across the state to determine the accuracy of MAP messages against winter conditions and make recommendations on how to maintain reliability in broadcasted MAP messages over winter conditions.
Objective: Determine horizonal variations in lane approaches as compared to pavement markings. Information will be used to determine how to address MAP messaging for connected intersections across Alaska. Research is applicable to all states/provinces without plow to pavement policies and will be shared with the Connected Vehicle Poole Fund Study for consideration in future MAP guidance.

Benefits to the State: The results of this research are key to implementing life saving CV2I at Alaska's signalized intersections. The research will provide information on managing MAP messages throughout the winter when pavement markings are obscured by snow and ice.

18 - ADVANCING ANCHORAGE'S FREIGHT TRANSPORTATION NETWORK: A COMPREHENSIVE ANALYSIS FOR COST-EFFECTIVE, SAFE, AND RESILIENT OPERATIONS

Category: Safety & Traffic
Funding: $
Manager: Cristina DeMattio
Champions: Anna Bosin, Steve Ribuffo (Dir), Michael Rhodes (Port Eng) Port of AK

The city of Anchorage relies on a multi-modal transportation network (air, rail, truck) to move freight. The Port of Alaska (POA) serves as a critical hub of this freight network and receives over 90% of the freight entering the region. Subsequently, these goods are primarily distributed by trucks, while rail operated by ARCC is used to transport some freight. However, the current state of freight movement faces many challenges, such as limited redundancies/accessibility within the network, lack of planning capabilities for efficient, resilient, and cost-effective transport, and adverse residential neighborhood impact (e.g., traffic levels, noise, safety risk). Furthermore, these challenges are expected to intensify as freight activity is projected to grow in the forthcoming years, leading to a corresponding increase in regional truck traffic. This project seeks to undertake research into optimizing Anchorage’s freight transport network and develop data-driven methods to improve overall freight movement operations.
Purpose Statement: The purpose of the proposed project is to understand the current freight and fuel transportation across the Anchorage area and evaluate alternatives for improving freight mobility, cost-effectiveness, resiliency, safety, sustainability, and community cohesion. The intent is to i) enable multi-modal freight flows while ensuring that residents in the Anchorage area are not adversely affected by the truck traffic, (ii) identify feasible freight mobility alternatives and evaluate their impact on relevant criteria (e.g., cost, resiliency, community impact), (iii) improve state’s freight transportation planning and network connectivity capability, and (iv) provide value to decision-makers/stakeholders in terms of cost, time and resources.
Prior Work/History: As part of the 2023 STIC Project, the University of Missouri team has conducted an extensive scenario analysis of freight truck movement within the Port of Alaska. The team has developed a data-driven scenario analysis toolbox for improving the operational effectiveness and resiliency of freight truck movement. The tool uses multiple data sources, including near real-time data from the AKDOT weigh-in-motion database and Alaska 511, to enable accurate management of disruptions/incidents, alert notifications, truck routes, and long-term transportation planning. While this project focused on truck movement within the POA, the proposed project aims to extend it to the entire Anchorage area while considering additional issues that arise during freight transportation.

Benefits to the State: The anticipated benefits include better access and connectivity of freight vehicles to distribution centers, enhanced community cohesion, reduced road transportation expenses, increased supply chain efficiency, faster distribution (which increases customer satisfaction), and improved resiliency and redundancy (which addresses safety concerns). The potential consequences of not solving the problem are as follows: increased safety risks and inconvenience for neighborhood communities, ineffective freight transportation planning and infrastructure investments, lack of insights for handling growing freight demand, imbalanced utilization of freight modes, higher fleet management cost, higher emissions, and lower economic competitiveness.

19 - IMPROVING THERMAL AND STRUCTURAL STABILITY OF CULVERT CROSSINGS IN PERMAFROST ZONES

Category: Materials & Construction
Funding: $
Manager: Cristina DeMattio/TBD
Champion and Technical Advisors: Jeff Russell

Control of surface water movement across highway corridors in permafrost zones can be challenging due to the potential for permafrost thaw and resulting thaw settlement. Thaw settlement near culvert crossings has become an increasingly common problem along the Dalton Highway corridor. This is likely due to construction disturbance and warming climatic temperatures. Adequate control and routing of warm surface water moving across highway alignments is critical if the thermal state of frozen foundation soils is to be maintained.

This work proposes to utilize field measurements to identify key mechanisms leading to permafrost thaw and settlement near culvert crossings. Our hypothesis is that knowledge of the thermal and hydraulic conditions at culvert crossing sites will allow us to develop potential remedial solutions that are effective at reducing thaw settlement and related maintenance requirements.

Benefits to the State: If the proposed research is successful, it has the potential to provide effective solutions that stabilize culvert crossings along highways in Alaska that are impacted by ice-rich permafrost. This could significantly improve safety and reduce maintenance requirements on systems that are located in effected areas. An exact cost/benefit ratio would be hard to specify for this work, but the cost of this research represents a very small fraction of Alaska's annual maintenance budget related to releveling of roadways that are impacted by thaw subsidence, so, if this research is successful and implemented, the cost/benefit ratio could be very high.

20 - STABILITY ANALYSIS OF SUSITNA BRIDGE ABUTMENT USING REMOTE SENSING TECHNIQUES

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champion: Jesse Escamilla

Frozen ground near Susitna 687 bridge abutment on the Cantwell side has been thawing and slipping towards the bridge and causing unwarranted movements on the bridge structure. Several knowledge gaps that pose challenges to the Alaska DOT&PF have been identified: (1)Terrestrial data is being collected near the soil abutment areas that are actively moving; however, collecting similar terrestrial data over a larger vicinity of the area/region to identify the real extent of the active movement zone can be laborious, time taking, and costly

(2)Extent of the active zone in the movement region also provides a better understanding of the rate of movement and future prediction to assist in planning the repair/rehabilitation of the pier extension (3)Influence of these movements on the other bridge elements and the overall bridge structure is unknown (4)The influence of the permafrost action on these soil movements is unknown (5)Future route for a new bridge avoiding similar problems is unknown

1. **Benefits to the State:** The research study will provide the following benefits:
   Maintain the safety and optimal performance of the bridge structure;
2. The guidance document and application of remote sensing tools for mapping problematic areas efficiently, safely, and cost-effectively;
3. Track and quantify slope movement rates and provide a map for quick visual identification of problematic areas; and
4. Understanding these soil conditions will help the Alaska DOT&PF make informed decisions on future bridge replacement location along this route.

21 - BALANCED MIX DESIGN OF ASPHALT MIXTURES TO COMPLEMENT THE MARSHALL METHOD IN ALASKA

Category: Materials & Construction
Funding: $
Manager: Cristina DeMattio
Champions: Steve Saboundjian, Andrew Pavey

This study aims to initiate the efforts of developing and implementing a BMD approach in the state of Alaska. Members of the research team have past experience with developing and evaluating performance thresholds for different distresses (Kassem et al. 20193). This project aims to conduct a comprehensive laboratory testing program to examine the performance characteristics of typical asphalt mixtures produced and used in Alaska. The outcomes of this study will assist Alaska DOT&PF to implement a balanced mix design approach that complements the Marshall method to improve the performance of asphalt mixtures. Alaska DOT&PF can use these performance tests and associated thresholds to optimize the mix design for improved performance. This also enables Alaska DOT&PF to use more recycled materials in the mix without compromising the performance or longevity of pavements. The objectives of this research project and expected outcomes align well with Alaska DOT&PF's Strategic Investment Areas of Safety, Economic Vitality, and Sustainability by extending the service life of flexible pavements and lowering the cost of pavement construction saving Alaskans money, reducing the need for frequent and costly rehabilitation treatments, and the need for traffic closure and thus improving safety. Furthermore, Alaska DOT&PF can utilize more recycled materials and improve the sustainability of roads, preserve natural resources, and reduce greenhouse emissions.

Benefits to the State: This study shall assist Alaska DOT&PF to develop and implement the BMD approach to improve the longevity and durability of asphalt mixtures in the state. The BMD complements the volumetric design method in order to construct asphalt pavements with improved performance. In addition, the BMD performance criteria can be used as a quality control for mix production acceptance which enables Alaska DOT&PF to avoid issues with the quality and variability of the approved mix design during production. The BMD has several approaches by which respective DOT can select the one that suits the local conditions. These approaches provide more flexibility and enable innovation in developing asphalt mix design by modifying the mix proportions to achieve the target performance. Furthermore, the BMD allows the use of recycled materials without compromising the performance which reduces the cost of pavement construction and the need for frequent and expensive rehabilitation treatments required for pavements failing prematurely.

22 - OPTIMIZED BRIDGE GIRDER DESIGN PHASE 2: USING A HOLISTIC APPROACH TO RECOMMEND THE NEXT GENERATION OF CONCRETE BRIDGE GIRDERS FOR ALASKA

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champions: Nick Murray

Bridge designs with longer girder spans can readily reduce the number of substructure components (e.g., piers), consequently reducing the ecological impacts such as disruptions to stream flow and habitat. Use of longer girders also minimizes the number of girders needed, which increases the throughput of the girder fabrication process so that more bridge retrofitting or construction projects can be completed within the short construction period available each year. Use of longer girder spans creates the opportunity to identify girder configurations with more efficient use of concrete and steel to reduce not only the cost, but also the carbon footprint of prestressed concrete bridges that are common in Alaska. Creating such win-win-win solutions is the primary goal of this proposal.
Alaska DOT&PF can reach this goal by identifying the next-generation of prestressed concrete bridge decked girder designs that simultaneously meets all the current safety requirements, practical limitations and considerations, and the preferences of their subcontractors. An incremental design approach is not sufficient to achieve the multitude of design objectives stated above. Instead, the computational framework developed in Phase 1, the Girder Optimization Framework for Alaska (GOFA), to systematically analyze and optimize prestressed decked girder designs will be adopted to efficiently search and identify optimal girder designs to meet the many different objectives. Ultimately, this holistic approach is expected to result in the next-generation girder design that will perform well with respect to cost, safety, carbon footprint, ecological wellbeing, field conditions and practical factors.

Benefits to the State: Potential direct benefits to Alaska DOT&PF include the ability to span longer distances, reduce construction time, use limited resources more efficiently, and reduce cost; indirectly, the new design intends to reduce carbon footprint through efficient use of concrete and steel, reduce impacts of ecological services through reduction in bridge substructure components such as piers.

23 - SEISMIC PILE-SOIL-STRUCTURE INTERACTION INCLUDING FROZEN SOIL EFFECTS

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champion: Ben Still

Over the last five (5) decades, several highway bridges have experienced severe damage under strong ground shaking. Most of this damage was attributed to excessive seismic displacement demands that have been substantially underestimated during design. The underestimation of the seismic displacement capacity was partly due to a poor understanding of the kinematic characteristics of the ground motions and an often overestimation of stiffness and energy dissipation mechanisms.
The aim of the proposed investigation is to develop efficient time-domain computational tools guided by relevant experimental data generated by previous studies that investigated frozen soil properties and pile-soil-structure interaction. In essence, the proposed study is viewed as the second phase of a comprehensive three-phase project. In this regards, previous experimental and analytical studies that involved in-situ and laboratory

testing of frozen soils and small-scale shake-table experiments culminate into Phase 2 to develop experimentally validated advanced simulation tools. The future Phase 3 is envisioned as a comprehensive experimental investigation that will involve shake-table testing of large-scale pile-soil interaction using the laminar soil-box at the Earthquake Engineering Laboratories of the University of Nevada, Reno. Therefore, Phase 3 will allow further refinement of the simulation tools and development of recommended guidelines for the analysis and design of highway bridges.

Benefits to the State: Proper consideration of soil-structure interaction (SSI) in the design of highway bridges, with attention to varying soil properties due to seasonal temperature changes, particularly frozen soil conditions, will certainly lead to more economical designs, and to designs that improve life-safety with significantly lower levels of uncertainty. Bridge design engineers can make more informed decisions based on realistic representation of highly nonlinear SSI.

24 - SHRINKAGE MITIGATION SYSTEMS FOR ENHANCED DURABILITY OF ALASKA DOT&PF CONCRETE MIXTURES

Category: Materials
Funding: $
Manager: Cristina DeMattio
Champion: Rich Giessel, Jake Allen, Patrick Walter AS&G

Shrinkage cracks, resulting from both self-desiccation (autogenous chemical shrinkage) and moisture evaporation during early and late ages of concrete (drying shrinkage), poses a significant threat to the long-term performance and service life of concrete structures [1]. This is due to the ingress of deleterious materials into the concrete or the activation of harmful materials, such as active silica in aggregates, when exposed to infiltrated water over time. In cold climates like Alaska, these cracks can exacerbate damage through freeze-thaw mechanisms, significantly impairing structural components such as bridge decks and girders, leading to reduced service life and increased maintenance costs. Therefore, effectively controlling shrinkage cracking is crucial for extending the service life of concrete structures [2]. Moreover, the use of shrinkage-free concrete in Alaskan infrastructure allows for a broader range of locally sourced materials, including aggregates with moderate active silica content.
This project will investigate and compare two shrinkage mitigating strategies, with the aim of reducing shrinkage cracking in Alaska DOT&PF concrete mixtures used for bridge girders. The objective is to improve the durability of girders and expand the range of locally sourced concrete constituents, particularly aggregates, by minimizing shrinkage cracks during both the early and late ages of their service life. The absence of shrinkage cracks over an extended period, such as 50 years, ensures that there are no direct pathways into the concrete matrix or to the steel reinforcement.

Benefits to the State: Upon achieving the project's objectives, the development of shrinkage-free concrete will improve durability of concrete girders in Alaska and expand the versatility of using locally sourced materials, including aggregates. Shrinkage-free, low-permeability concrete will allow elimination of expensive bridge membranes currently used to protect decked-bulb-tee girders. The refined mixture design can be used in other bridge components such as bridge decks. The resulting concrete components will demonstrate improved durability, enhanced structural integrity, and increased safety. Extending the lifespan of bridge concrete girders and other structural components will lead to significant cost savings by reducing maintenance requirements. Additionally, this approach aligns with sustainable construction practices, as fewer replacements and decreased material consumption contribute to a greener infrastructure.

25 - ANALYTICAL BAR BUCKLING AND FRACTURE

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champion: Nick Murray, Leslie Daugherty

The objective of the research is to develop an analytical model for bar buckling and bar fracture that can be applied to all reinforced concrete column configurations that will lead to safer designs where the structural engineer can confidently design the bridge to the intended damage levels for prescribed levels of earthquake intensity. Modern well designed bridge columns typically fail by buckling and fracture of reinforcement. The onset of both conditions is dictated by achieving specific levels of tensile strain in the longitudinal reinforcement. Accurate estimates of those strain levels are essential for Performance-Based Seismic Design (PBSD) whereby structures are designed to achieve prescribed damage levels under a defined earthquake intensity. Inaccuracy in the prediction of the occurrence of those limit states leads to designs that will perform differently than the engineer intended, potentially resulting in more damage than expected, interruption of bridge service, and in extreme cases, collapse. While bar buckling and fracture has been studied for several years, with the basic mechanism conceptually understood, missing from the literature is a reliable model that can be broadly applied to bridge structures that is founded on the mechanics of the problem. This in turn leads to uncertainty in performance assessment which permeates throughout the entire design, assessment, and analysis process.

Benefits to the State: The existence of robust models to predict performance of bridge structures under extreme events is essential to accomplish performance-based design. This research aims to develop such a model via fundamental mechanics that will be applicable, without limits or restrictions, for the design of bridge columns. The specific focus is on reinforcing bar buckling and fracture. Existing empirical models are accurate (in the case of bar buckling), but have limitations on their applicability. There are no known strain-based models to predict reinforcing bar fracture.

26 - CONDITION DEPENDENT DESIGN PHASE 2: QUANTIFYING IN-SITU PERFORMANCE OF BRIDGES THROUGH 3D SCANNING OF CORRODED STEEL

Category: Bridges & Structures
Funding: $
Manager: Cristina DeMattio
Champions: Nick Murray, Leslie Daugherty

Corrosion of reinforcement is a widespread issue that has traditionally been a serviceability issue. However, recent tests at NC State have exposed the effects that corrosion can have on the strength and deformability of reinforcing steel. Although extreme, recent structure collapses have been tied to corrosion, such as the Fern Hollow bridge in Pennsylvania.
Scans of the reinforcing bars provide an opportunity to connect the geometry of the pits formed by corrosion and their behavior, as evidenced by the critical bending strain measurements. By adopting the scanning technique described in the Research Needs Statement to in-situ corroded reinforcing steel, it may be possible to predict the performance of bridge components under both normal (traffic) and extreme events (earthquakes, vessel impact). Mathematical modelling of the scanned surfaces, coupled with BBT and large-scale tests from prior research, could provide AKDOT&PF engineers with the ability to predict bridge structural performance via simple hand held scanning techniques. The current scanner being utilized is an infrared light binocular dual camera scanner, capable of precision up to 0.1mm. The resulting scanned images can be assessed from both the

perspective of mechanics, as well as from machine learning techniques. The mathematical surface from the scans can be used to measure different variables such as mass loss, local stress concentrations, and curvature.

Benefits to the State: The research will provide another tool that bridge inspectors can use to quantify bridge performance and help direct decisions on corrective actions, based upon likely present-day performance and expected future hazards.

27 - EFFECTS OF CLIMATE CHANGE ON GROUND MOTION CHARACTERISTICS IN ALASKA

Category: Bridge & Structures
Funding: $
Manager: Cristina DeMattio
Champions: Nick Murray, Dave Hemstreet

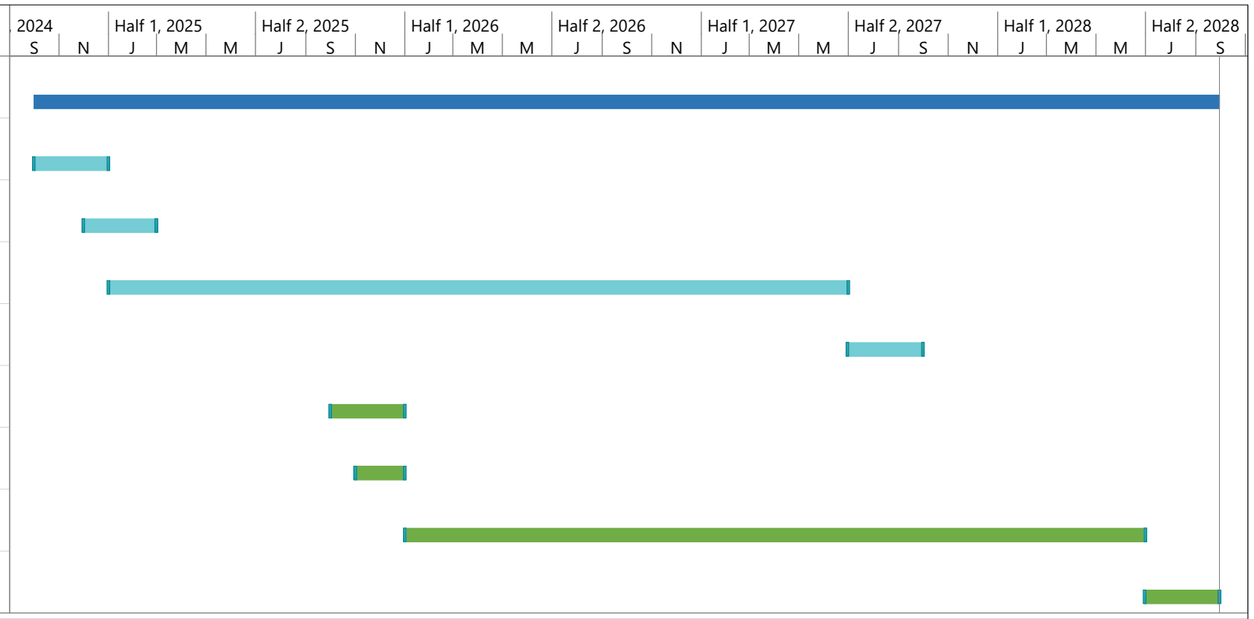
The intensity of earthquake ground motions is greatly influenced by near-surface geologic materials as seismic waves propagate from depth to the ground surface. Site response analyses (SRA) are used to estimate site-specific ground motions as a function of the properties of the soil profile, dynamic soil behavior, and the input motion at the base of the soil column of interest. To date, little research has focused on the effects of climate change on the geologic conditions that influence ground motion characteristics the most, including the shear wave velocity (Vs) profile at the site of interest, the ground water table, and the presence of permafrost and/or seasonal frost. These issues have a direct impact on Alaska's seismic hazard and the performance of critical civil infrastructure systems, such as bridges under cyclic loading. Considering the presence of permafrost, and significant seasonal changes (e.g., seasonal frost) in Alaska's near-surface geologic materials, this project addresses three main gaps in the state of the art and practice: 1) expanding the scarce dataset of subsurface data at selected bridge sites, 2) understanding the effects of local geology on the seismic demand of bridges in densely populated centers in Alaska, and 3) investigating temporal changes in soil properties and ground water table potentially associated with climate change, and their impact on seismic demands.

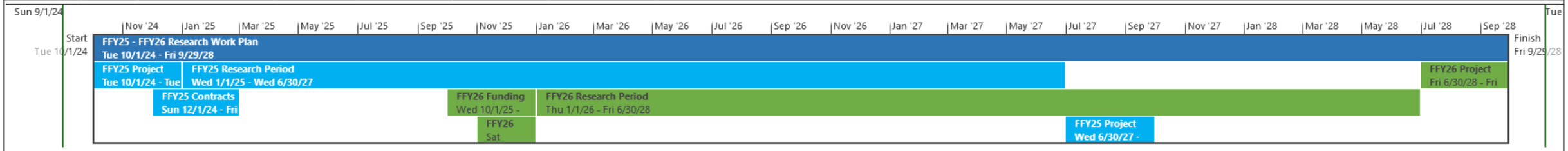
This project has three objectives: (1) To collect new subsurface data in Anchorage and Fairbanks, (2) to investigate site effects on the seismic demand of selected bridges, and (3) to provide recommendations to address spatial and temporal variations of local geologic conditions, with particular focus on those driven by climate change, seasonal frost, and permafrost.

Benefits to the State: This research will allow engineers to conduct site-specific analyses of bridges by providing them with additional subsurface characterization data at selected sites in Anchorage and Fairbanks and an analytical procedure that account for climate change impacts on ground motions that could be used for planning purposes or the design of new bridges. The expected deliverables include a detailed report with recommendations to conduct site-specific analysis, with a focus on permafrost (which is found beneath nearly 85 % of Alaska) and seasonal frost, which can inform decision-makers about the potential impacts of specific seismic events on the transportation network (particularly at bridge sites) and guide the evaluation of future design choices.

Appendix A - Research Work Plan: Project Starts FFY25 - FFY26

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		FFY25 - FFY26 Research Work Plan	1044 days	Tue 10/1/24	Fri 9/29/28		
2		FFY25 Project Funding	66 days	Tue 10/1/24	Tue 12/31/24		
3		FFY25 Contracts	66 days	Sun 12/1/24	Fri 2/28/25		
4		FFY25 Research Period	651 days	Wed 1/1/25	Wed 6/30/27		
5		FFY25 Project Closeout	67 days	Wed 6/30/27	Thu 9/30/27		
6		FFY26 Funding	66 days	Wed 10/1/25	Wed 12/31/25		
7		FFY26 Contracts	44 days	Sat 11/1/25	Wed 12/31/25		
8		FFY26 Research Period	652 days	Thu 1/1/26	Fri 6/30/28		
9		FFY26 Project Closeout	66 days	Fri 6/30/28	Fri 9/29/28		





* Research Periods are scheduled for 2.5 years to allow for varying project starts due to University/staff scheduling around the school year. Since funding isn't available until October, projects are anticipated to start during Spring Semester.

Project: FFY25 - FFY26 Research
Date: Wed 6/19/24

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone