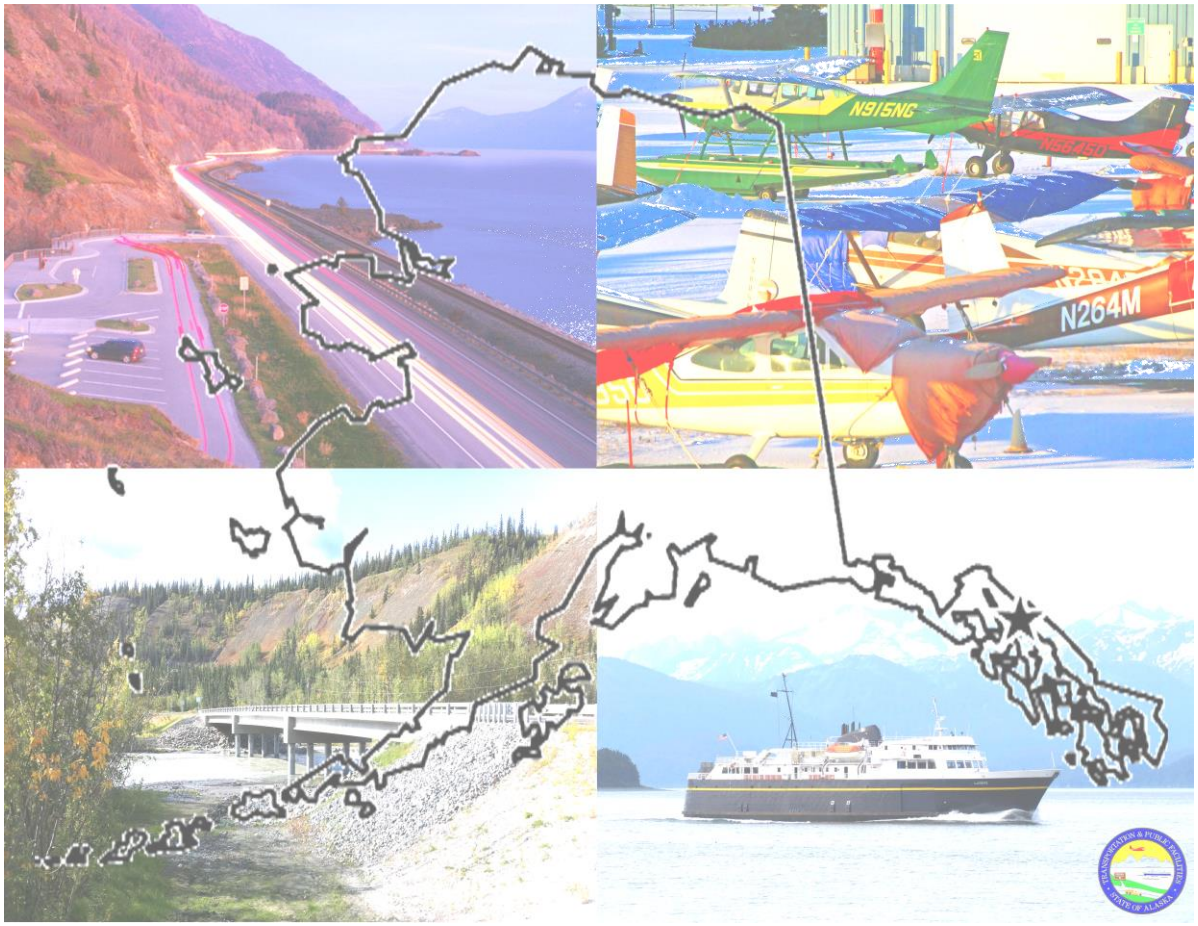
ALASKA DOT&PF RESEARCH
ANNUAL WORK PLAN

Federal Fiscal Year 2021-2022



August 2020

Research Development and Technology Transfer

Alaska Department of Transportation & Public Facilities

The Research Development and Technology Transfer (RD&T2) Section within the Division of Design and Engineering Services 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 2021 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

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I, Anna Bosin, 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.

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Fiscal Summary

Research Funding Distribution

Research Projects Selected for FFY21:

Title	Champion	Researcher(s)	FFY21
Influence of Reclaimed Asphalt Pavement Material on Cracking of Alaskan Asphalt Mixes	Drew Pavey, Steve Saboundjian	UAF	**
Landslide Collides with Highways: Measuring its Impact to Inform Future Mitigation	Jeff Currey	UAF	**
Seismic Behavior of High Strength Reinforcing Steel at Low Temps	Elmer Marx	NCSU	**
UAV Based Inspections for Highway Bridge and Structural Condition Monitoring and Inspection Works	Jesse Escamilla III, Mark Davis, & Ryan Marlow	University of Texas, Arlington	**
Efficient, Lightweight Snow Melting System for Snow River Pedestrian Bridges	Jim Amundsen, Rich Pratt	In-House/Consultant	**
Equipment Visibility in Sub-Arctic Winter Conditions	John Clendenin	In-House	**
Evaluating the Use of Structural Down Drains in Highway Embankments	Jeff Stutzke	In-House	**
Rapid Research/Deployment	various	TBD	**
Research Administration	Staff	In-House	**
Grand Total			$1,270,000

**-Engineer Estimates omitted for contract negotiations

Research Projects Selected for FFY22:

Title	Champion	Researcher(s)	FFY21
Rapid Post-Earthquake Displacement-Based Assessment Methodology for Bridges	Elmer Marx	NCSU	**
Condition Dependent Performance Based Seismic Design	Elmer Marx, Nick Murray	NCSU	**
Impact of Response Spectra Definitions and Direct Displacement-Based Design Simplification for Multi-Span Bridges	Elmer Marx, Nick Murray	NCSU	**
Urban Work Zone Safety Impacts	Pam Golden	TBD	**
Rapid Research/Deployment	various	TBD	**
Research Administration	Staff	In-House	**
Grand Total			$865,000

**-Engineer Estimates omitted for contract negotiations

Pooled Fund Studies FFY21/22

The Pooled Fund program is a joint effort between DOTs and FHWA to share resources towards common research goals. FHWA or DOT can be a lead agency for a pooled fund project. Alaska DOT&PF participates in pooled fund studies by transferring 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.

Title	FFY21	FFY22	Commitment
Aurora	25,000	25,000	Previously committed
New Universal Consequences-Based Liquefaction Hazard Analysis Framework for All CPT-Compliant Soils	20,000	20,000	3 year (60K) minimum commitment. RNS submitted
Connected Vehicle Pooled Fund Study	25,000	25,000	25K/year
Clear Roads Phase II	25,000	25,000	25K/year
Avalanche Research Pool	25,000	25,000	25K/year
Roadside Safety Research for MASH Implementation	25,000	25,000	25k/year
Unpaved Road: A Research Collaboration to Determine Crash Causation and Countermeasures	15,000	15,000	Previously committed
Developing and Calibrating Fragmental Rockfall Models using Physics Engines	30,000	30,000	30k/year
Assessment and Repair of Pre-stressed Bridge Girders Subjected to Over-Height Truck Impacts	45,000	45,000	45k/year
Road Usage Charge West	25,000	25,000	25K/year

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

FFY21 Selected Project Summaries

Influence of Reclaimed Asphalt Pavement Material on Cracking of Alaskan Asphalt Mixes
Category: Materials
Funding:
Manager: Drew Pavey
Champion and Technical Advisors: Drew Pavey, Bob Trousil, Steve Saboundjian

The objective of the proposed research is to investigate the influence of RAP on the cracking performance of HMA and if the use of rejuvenators allows higher percentages of RAP to be used in Alaskan mixtures while maintaining the required level of low temperature performance. This will be accomplished through the following steps:

1) Prepare a review on the state of the practice on the use of rejuvenators in asphalt materials and their previous applications worldwide and in Alaska;
2) Identify for the experimental campaign one or two rejuvenators among the most commonly used products available on the market.
3) Investigate the performance of mixes at varying RAP percentages (for example 0%, 15% to 25%) with and without the use of rejuvenators through specific performance-based laboratory tests. The tested material will consist of a Type II, Class B reference mix with binders commonly used in Alaska having a low Performance Grade (PG) ranging between -28 and -40ºC (two PG).
4) Perform cost and benefit-cost analyses on the use of rejuvenators and RAP.
5) Recommend modifications to current HMA specifications, if required, based on results and the maximum allowed percentage of RAP to be included in mixes.

Benefits to the State: Enhance the performance of Alaskan pavements, reduce construction and maintenance costs, and support the environmental and economic sustainability of the pavement design and construction process in Alaska.

Landslide Collides with Highways: Measuring its Impact to Inform Future Mitigation
Category: Geotechnical and Materials
Funding:
Manager: Erin Anderson
Champion and Technical Advisors: Jeff Currey, Garrett Speeter, Steve McGroarty, Matt Billings, Jocelyn Simpson

Frozen debris lobes (FDLs) are landslides in permafrost located along the Dalton Highway corridor. The closest to the highway, FDL-A has demonstrated a steadily increasing rate of movement which resulted in the realignment of the Dalton Highway in 2016. Based on movement trends, it is anticipated that FDL-A will impact the old embankment by 2021 and the current highway alignment in approximately 13 years. The collision of FDL-A with the old embankment represents a unique opportunity to observe a landslide impacting infrastructure in a safe and controlled way and on a predictable schedule. This project will work with UAF to install subsurface instrumentation along the old Dalton Highway embankment at milepost 219 that will measure the collision of FDL-A and collect LiDAR and photography data. DOT&PF Northern Region Materials will provide drilling support

Benefits to the State: The results of this study will help DOT&PF to develop mitigation measures that may slow or stop the movement of landslides in permafrost that threaten critical infrastructure.

Seismic Behavior of High Strength Reinforcing Steel at Low Temps
Category: Bridges
Funding:
Manager: Ian Grant
Champion: Elmer Marx

Reinforcing steel strengths have increased over the last several decades. In the US, there are primarily two ASTM designations for reinforcing steel: A615 and A706. For the seismic design of structures, reinforcing steel must possess sufficient strain capacity such that it can sustain reversals of loading at high deformation demands. What has not been studied is how low temperatures may impact the 'critical compressive strain'. Existing research on high strength steel in seismic regions is limited, and when coupled with low temperature effects is unknown. This project will study the impact of low temperatures on the seismic behavior of columns reinforced with A706 Grade 80 and 100 steel. This will be accomplished through the use of the Buckled Bar Tension test and large scale column tests, conducted at low temperatures.

Task One: Literature Review
Task Two: Material Tests on HS Steel at low temperatures
Task Three: Large scale column tests
Task Four: Analysis and Recommendations

Benefits to the State:
Application of high strength steel may reduce the steel content required in columns which would reduce bridge material and labor costs.

UAV Based Inspections for Highway Bridge and Structural Condition Monitoring and Inspection Works
Category: Bridges/ M&O/Facilities
Funding:
Manager: Anna Bosin
Champion and Technical Advisors: Jesse Escamilla III, Mark Davis, and Ryan Marlow, Ben Fetterhoff, Travis Miller

Alaska has over 1,000 public bridges that require reoccurring inspections. The current practice requires bridge inspectors to physically inspect the bridges from the ground or bridge deck level. The addition of UAVs as a bridge inspection tool can increase accessibility to hard to reach bridge areas, increase data collection and accuracy, reduce time and costs, and improve safety for the inspection team and the traveling public. This project will conduct a literature review of UAV/UAS best practices for bridge inspections. The project will then develop preliminary operation protocols and verify FAA compliance for performing field UAV studies in Alaska. Bridge sites will be selected for initial UAV surveys and inspections. Finally, the project will analyze bridge surveys and inspections and provide interim report of findings.

Benefits to the State: The use of UAVs has the potential to streamline current bridge inspection practices, potentially creating a cost savings to the Department. Also, UAVs can be used to inspect bridges during emergency events allowing for better informed and efficient operations.

Efficient, Lightweight Snow Melting System for Snow River Pedestrian Bridges
Category: Experimental Features (Central Region)
Funding:
Manager: Dave Waldo
Champions and Technical Advisors: Jim Amundsen, Rich Pratt, Clint Adler

Preventing snow and ice buildup on bridge pedestrian walkways can be challenging. When pedestrian walkways are added to existing bridges, the accumulation of snow and ice can exceed the bearing capacity of bridges. Mechanical and chemical snow and ice removal methods are not always effective. Incorporating lightweight electrical de-icing technologies may be a solution to help with snow and ice removal. This project will investigate various non-load bearing electrical de-icing technologies including: panels, power, control, and monitoring systems for existing and new walkway applications.

Benefits to the State: This is a proposed experimental feature for inclusion in an existing federally funded project. The solution may be applicable to other existing and proposed pedestrian bridges across the state.

Equipment Visibility in Sub-Arctic Winter Conditions
Category: Safety/M&O
Funding:
Manager: Erin Anderson
Champion: John Clendenin

Sub-arctic winter conditions create a series of variables making snow removal equipment very difficult for motorists to see in the active roadway. The combination of long duration low-light levels, near white-on-white contrast of ground and sky, and routine inversion causing vehicle emissions to remain at ground level make it very difficult for motorists to see lighting and beacons on heavy equipment. This project will research lighting and marking solutions in other states and develop an Alaska specific approach. Then the project will evaluate various exterior lighting and marking configurations to determine preferred solution.

Benefits to the State: Increased visibility will provide motorists with better advanced warning of approaching heavy equipment and potentially reduce the number of rear-end collisions. Fewer vehicle accidents will decrease damage to State assets and provide a safer work environment for DOT&PF operators.

Evaluating the Use of Structural Downdrains in Highway Embankments
Category: Hydrology
Funding:
Manager: Erin Anderson

Champion: Jeff Stutzke

Controlling highway drainage in areas with two lane highways with steep sidehill cuts typically requires culverts that are embedded in deep fills, in order to ensure that the culvert outlet falls at the bottom of the fill slope. These culverts are difficult and expensive to repair or replace, as the excavation limits needed to replace the culverts can encompass the entire roadway requiring extended periods of road closures. This project will conduct literature search to develop best practice methods for the use of structural downdrains on steep embankments that would prevent erosion and provide highway slope protection from culverts or other point discharge locations.

Benefits to the State: Alternatives for in-kind culvert replacements in deep fills has potential to reduce repair and replacement costs as well as limit impacts to motorists.

Rapid Research/Deployment
Category: Varies
Funding:
Manager: Anna Bosin
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. Deployment is used to facilitate implementation of successful research products, training, outreach, etc for wider department use. 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.

Research Administration
Category: Administration of Research Program
Funding:
Manager: Anna Bosin
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, UAF/UAA agreements, regional outreach, peer-exchange participation, TRB participation, and other such activities to maintain the research program. 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.

FFY22 Selected Project Summaries

Rapid Post-Earthquake Displacement-Based Assessment Methodology for Bridges
Category: Bridge
Funding:
Manager: Ian Grant
Champions and Technical Advisors: Elmer Marx

In the event of an earthquake (or for the purposes of planning for possible seismic hazard events), it is essential to have a reliable, robust tool that allows engineers to quickly estimate likely bridge performance before deployment for visual inspections. To that end, a pilot study conducted at NC State has resulted in the development of a rapid post-earthquake assessment method that could be implemented in the event of an earthquake to allow engineers to quickly estimate likely damage levels. The procedure has three basic components: (1) Bridge Metadata; (2) Seismic Hazard; and (3) Performance Limit States. Using the proposed methodology, given any two of the components, the third may be estimated.

Benefits to the State: The tool described in this RNS has two main uses: (1) Post earthquake-damage assessment, and (2) Evaluation of scenarios that could be conducted by DOT engineers for the purpose of understanding implications of various potential events (i.e., the impact of an earthquake of prescribed magnitude and location on the surrounding bridge inventory). It is envisioned that cost savings to the department may be realized for both of these applications as a result of efficient use of inspection teams (or for prioritization of bridge retrofit).

Condition Dependent Performance Based Seismic Design
Category: Bridge
Funding:
Manager: Ian Grant
Champions: Elmer Marx and Nick Murray

While there are studies that have tried to incorporate both the effects of multiple earthquakes and aging, this has been made through the use of fragility curves with some limitations in its applications. A study that considers both the effect of aging in the materials and multiple earthquake through a deterministic analytical procedure has not been done.

The expected outcomes of this research will be immediately deployable in bridge design practice. While the recommendations could be used by other agencies to design resilient infrastructure, for AKDOT practice, a design methodology will be proposed that will allow engineers to design structures that considers the effects of aging and accumulated damage.

Benefits to the State: This research needs statement will emphasize the importance of understanding cumulative damage in structures. Furthermore, given that bridges are having a service life greater than 50 years (typically structures are design for a service life of 50 years), it is important to understand what their behavior is and what can be done in new designs to improve the behavior of structures as they age.

Impact of Response Spectra Definitions and Direct Displacement-Based Design Simplification for Multi-Span Bridges
Category: Bridge
Funding:
Manager: Ian Grant
Champions: Elmer Marx and Nick Murray

This problem statement addresses two related issues for multi-span bridge seismic design: (1) Hazard Characterization and its impact on design; and (2) Simplification of the Direct-Displacement Based Design methodology for multi-span bridges.

The objectives of this research are to (1) Determine the impact of response spectra definition on the design of bridge systems (i.e., differences in required strength as well as differences in bridge performance), (2) Propose a response spectra definition, that may be bridge specific, that could be deployed for bridge design to achieve the desired performance objective, and (3) Propose simplifications to the DDBD method for the seismic design of bridges. The most important benefit to the department will be that engineers will have greater confidence that their structures are designed to an appropriate hazard level for their intended performance.

Benefits to the State: By simplifying the DDBD approach, it will be possible to more readily apply the design method, which has been shown to be superior to other methods at prescribing structural performance (albeit at increased computational effort). Simplifications that remove the iterative nature of the approach inherent to bridge structures is a more efficient, customized approach and would allow more widespread implementation with minimal impact on accuracy of the method.

Urban Work Zone Safety Impacts
Category: Traffic Safety
Funding:
Manager: Erin Anderson
Champion: Pam Golden

Projects in urban settings need an easy to use, repeatable, and unbiased decision making tool to assist in the evaluation of road closures and lane restrictions to balance impacts to drivers (delay and safety) with local access, work zone safety and construction schedules.
"Work Zone Operations Best Practices Guidebook (Third Edition) Addendum #1" was released in 2017 and lists best practices utilized around the country and may be a good source to reference when creating DOT&PF's unique tool to fit our design-bid-build processes.
TASKS:

1. Literature Review;
2. Select a set of 5 typical urban projects recently put under contract as a benchmark for costs and schedule factors. Define a range of factors for each case.
3. Formulate an analysis methodology that would allow parametric analysis of each situation. This methodology should include cost-effectiveness and benefit-cost approaches. Estimate the traffic control costs for each project and possible application of

all traffic control options. Identify effective approaches and describe their relative importance.

4. Test tool in field season for 2 urban located construction projects. Prepare a final report that documents the efforts and findings of the research with recommended tool. Workshop and training on tool to staff may be considered depending on complexity of findings and recommendations.

There is a significant portion of the urban areas of DOT&PF's highway network that qualifies for maintenance every year in conjunction with local agencies, which could benefit from this research. There is growing public unrest related to delays and congestion. There are requirements under the FAST Act for impact analyses which implies DOT's must consider such delays, costs, and safety be addressed by DOT&PF in a consistent way.

Benefits to the State: The urgency for this research is high, as it can potentially be applied to make roadway construction and work zones more efficient to save construction costs and improve network efficiency for the traveling public.

Rapid Research/Deployment
Category: Varies
Funding:
Manager: Anna Bosin
Champion: Varies

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