TECHNOLOGY FOR

Alaskan Transportation

DOT Statewide Research, Development, & Technology Transfer
Local Technical Assistance Program

Keeping Alaska moving through service and infrastructure with applied research, training, and technology transfer

Spring 2020, No. 93

In this issue . . .

Working to Make Air Convection Embankments (ACE) More Efficient and Cost Effective

Compiled from the research proposals of Douglas J. Goering, PhD, PE; and Steve McGroarty, PE

Air Convection Embankments (ACE) have been part of a number of highway construction experimental features in the Interior over the past 20 years. The effectiveness of ACE has been well documented and they are recognized as an effective mitigation to prevent thaw settlement in permafrost-rich soils. The research project "Improved Permafrost Protection using Air Convection and Ventilated Shoulder Cooling Systems" will use data from past and current ACE features to develop a thermal model to help the DOT&PF design more efficient ACE structures.

Matt Billings, Alaska DOT&PF Geotechnical Engineer, installs data logger hardware in weather proof case as part of the Alaska Highway ACE experimental feature.

What are we hoping to learn?

The Thompson Drive data analysis will be augmented with data available from other projects, including the Alaska Highway MP 1354–1364 Experimental Feature, the Dalton Highway MP 209–222 Experimental Feature, and the Elliot Highway MP 0–12 Experimental Feature, as that additional data becomes available. The results will be summarized in visual and tabular formats so that the details of the thermal patterns generated within the roadway embankment and foundation soils can be easily understood and potentially applied to new construction projects that are considering application of this technology.

The analysis of that field data could then be used to help provide verification data for model development. It is anticipated that a verified modeling approach will become an important design tool and will help with the generation of a modeling

(continued on page 2)

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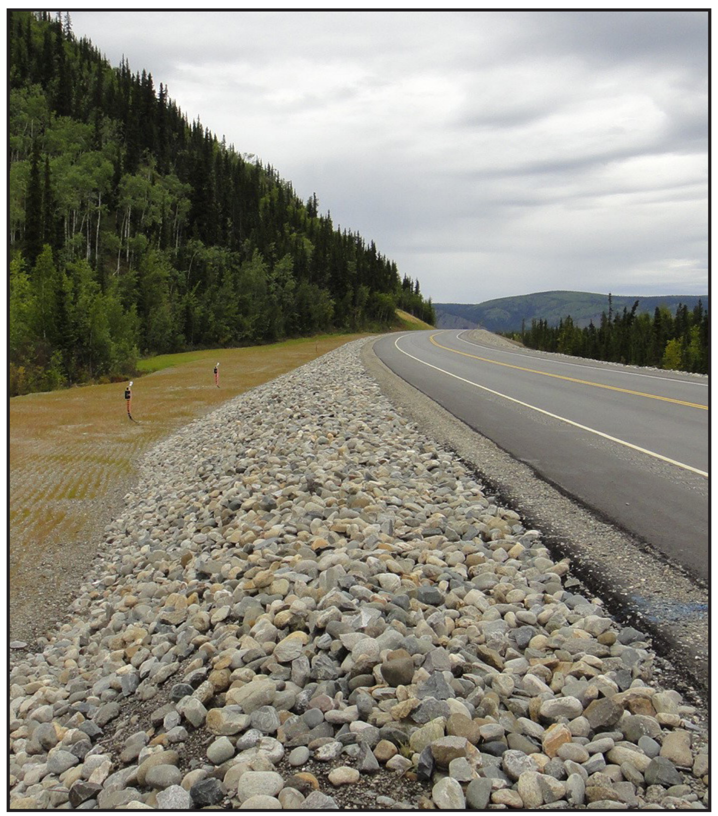
and design guide. This would give department geotechnical engineers the knowledge they need to ensure an adequate level of cooling effectiveness, while at the same time optimizing material requirements to reduce construction costs.

If money was no object, we'd see ACE embankments or ACE shoulders in numerous locations, maybe for long stretches of Interior highways. Unfortunately, the cost of hauling the amount of angular rock believed to be necessary is cost prohibitive.

Can we make ACE more cost effective by using different rock?

On the Alaska Highway MP 1354–1364 Experimental Feature, the research is investigating if round rock can be used rather than angular rock. Round alluvial rock is more readily available in the Interior so it would have the potential for shorter hauls and would not need to be crushed—both significant cost savings.



ACE experimental feature on the Alaska Highway at MP 1354–1364. On the left two data loggers gather temperature data year round, which is transmitted to a vendor via satellite.

This experimental feature proposed to examine the following:

- Could ACE be constructed out of round rock (alluvial cobbles)?
- Are there differences in the thermal performance of ACE constructed out of round rock vs. angular ACE fill material?
- Is the long-term pavement performance different between ACE constructed with round rock vs. constructed with angular ACE fill material?

Can ACE be more cost effective by using less rock? How low can we go?

On the Dalton Highway we are testing the effectiveness of an insulated conventional embankment with variable ACE ventilated shoulder top-widths. On this section of the Dalton, located at MP 219 over thaw-unstable ice-rich permafrost foundation soils, we will examine the question of "What is the minimum effective top-width of an ACE Shoulder?" This is functionally equivalent to examining the thickness of the ACE shoulder layer. Existing ACE shoulders in Alaska have been constructed with 10- to 15-foot wide shoulders. If this can be reduced to 5 feet, this would represent a 50% to 67% reduction in ACE fill requirements with corresponding cost savings.

This experimental feature proposes to examine the following:

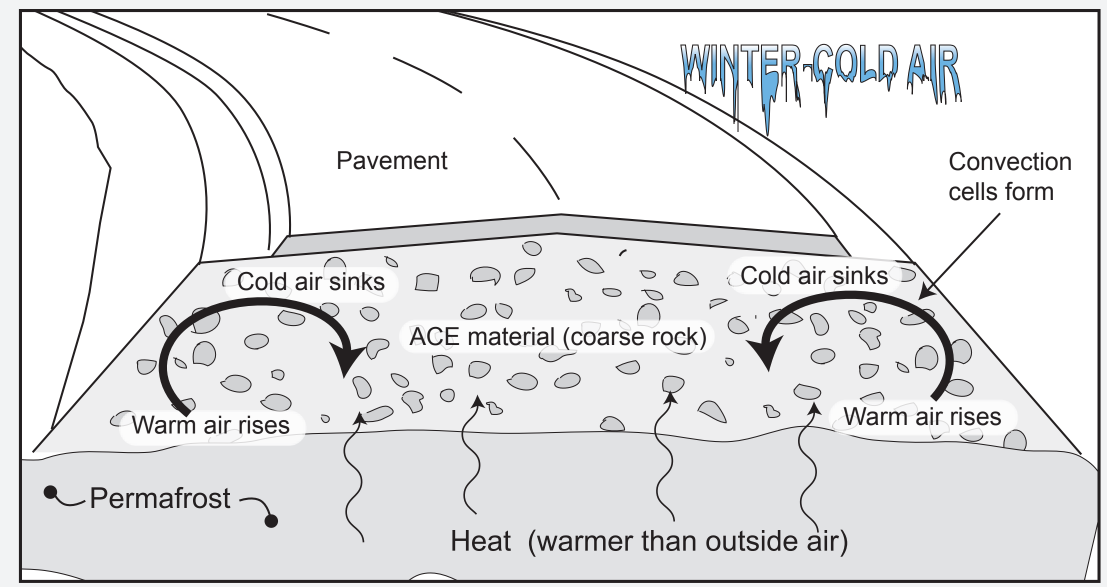
- Performance of ACE shoulders with reduced top-widths.
- Performance of ACE shoulders on road embankments with different heights above the surrounding original ground surface.
- Performance of 3"–5" angular vs. 5"–8" angular ACE shoulders of equal top-widths.
- Minimum thickness of ACE shoulders for 3"–5" and 5"–8" angular ACE Fill.

With over a decade of data from Thompson Drive, and new data from the Dalton and Alaska Highway experimental features, there's reason to believe that improved ACE design will lead to more efficient and cost-effective installations. In about a year, at the conclusion of this project, results will be made available on the Research & T2 website and in this newsletter.

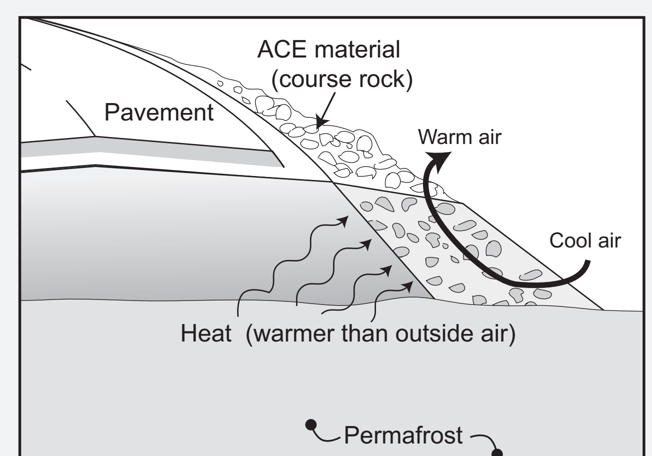
How does an ACE work? Air convection embankments (ACE) and ventilated shoulders have been used in several DOT construction projects over the past 15 years to combat permafrost thawing, and their use is expanding as their performance in the field is better understood. These systems are designed to counteract warming from construction disturbance and increasing climatic temperatures by providing a cooling influence to keep permafrost foundation soils from thawing and deforming the embankment geometries.

A properly designed ACE embankment fill promotes circulation of pore air within the embankment with heat being picked up at the bottom of ACE layer (top of foundation) and released at the embankment surface. The permeability of ACE fill material must be very high to allow the kind of air movement that makes the material a good convective heat transfer system.

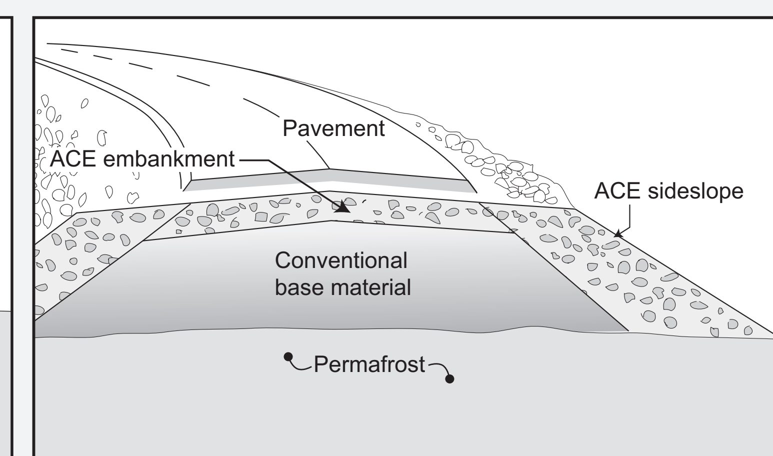
During the winter, low temperatures cool the ACE embankment at its upper surface. If the wintertime cooling effect is strong enough and the ACE material is permeable enough, natural convection cells begin to operate within the embankment mass. The figure below illustrates convective air movement within an ACE embankment. Convection occurs because the wintertime air temperature/density gradient is such that cold, dense surface air descends as warmer, less dense air moves upward. With the advent of summer warming, the top of the ACE embankment warms to the point where the pore air temperature/density gradient reverses and becomes stable. With warm air on the top and cold air at the bottom of the ACE fill, convection ceases.



The ACE chimney effect also acts as a one-way heat transfer device. When ACE material is placed on the sideslope, the movement of cold air passing through cools the embankment adjacent to the sideslope and transfers the heat to the air. The air is warmed slightly by the warm embankment and then escapes up through the rock.



ACE material on the sideslopes.



ACE material under pavement and on the sideslopes

Transportation Asset Management Update

The FAST Act and MAP21 require the use of performance-based planning and asset management systems. To meet these requirements, the department has developed a policy and procedure for the selection of highway and bridge maintenance, preservation, rehabilitation and reconstruction projects and has initiated two research projects.

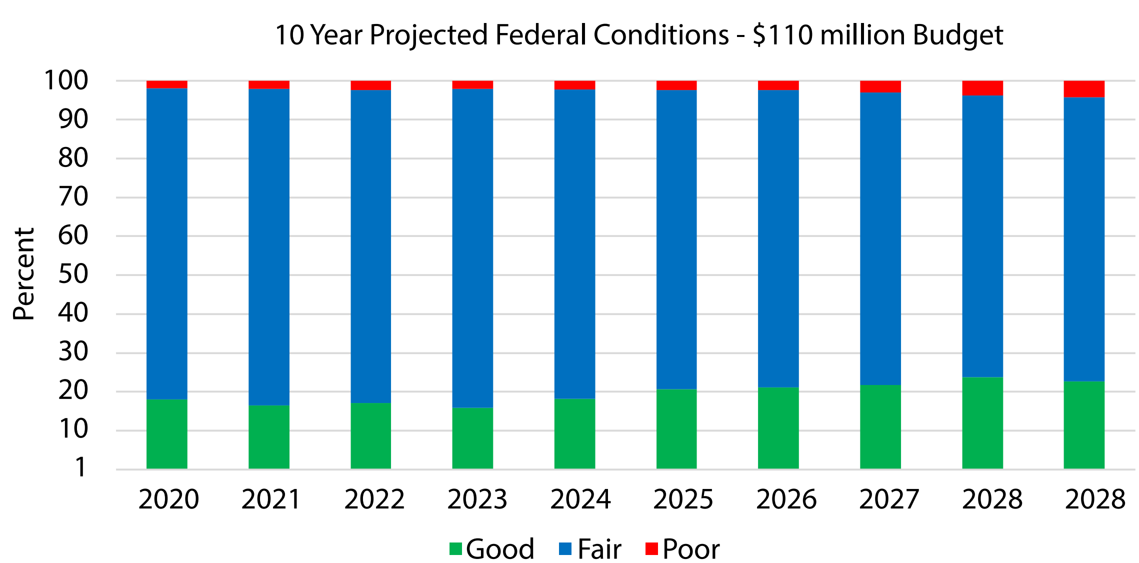
The first research project's goal is to recommend new criteria for the selection of Statewide Transportation Improvement Program (STIP) projects using data and performance-based planning. The second is a life-cycle planning project to determine the level of funding required to maintain the highway and bridge systems in a state of good repair. These efforts will lead to transparency in how decisions are made and maximize the use of available funds.

The new Pavement Management and Bridge Management Systems will be used to produce lists of recommended projects. The regions will then evaluate these lists to develop and initiate preservation and minor rehabilitation projects. Identified needs for major rehabilitation and reconstruction will be reviewed for inclusion in the STIP. Regional and statewide management teams met this February to assess the recommended projects and will create finalized project recommendations by September to begin initiating new projects.

The Performance-Based Planning and Programming research project will recommend criteria for strategic decision-making in the prioritization of STIP projects. As much data as possible will be used during this process, allowing for increased transparency and justification when projects are selected. This will provide the department with the ability to efficiently maintain pavement and bridge assets in a state of good repair, modernize our existing facilities, and expand capacity where required.

The Life Cycle Planning Project will be used to determine the funding required to maintain the National Highway System in a state of good repair. The Pavement Management and Bridge Management Systems will be used to predict conditions over a 20-year period given different funding scenarios. This will enable the department to select adequate funding to meet our federal targets and maintain the pavement and bridges at the desired level of service. Below is an example of a draft 10-year investment scenario from the Pavement Management System showing predicted federal conditions of good, fair, and poor pavements across the NHS.

These efforts are ongoing, and between them the department will be able to make transparent, data-driven decisions that meet the requirements of both MAP21 and the FAST Act for performance-based planning and asset management.



This is a draft scenario run for the Life Cycle Planning project and does not reflect the selected investment level in the TAMP.

AASHTO Releases New Edition of Pavement Design Guide

AASHTO Publications has released the third edition of its pavement design guide *Mechanistic-Empirical Pavement Design Guide: A Manual of Practice.*

Developed by the AASHTO Committee on Materials and Pavements, this guide describes the pavement design methodology termed mechanistic-empirical (M-E) pavement design. Based on engineering mechanics that have been validated through extensive road test performance data, the guide presents information necessary for pavement design engineers to use the M-E design and analysis method.

Updates Since 2015 Second Edition

This new 2020 third edition, which supersedes the 2015 second edition, includes a number of revisions and updates, including the following:

- new fracture mechanics-based model for reflective cracking in AC overlays over flexible, semi-rigid, and rigid pavements;
- new mechanistic-empirical model for short jointed plain concrete pavement overlays of flexible pavements;
- new flexible and semi-rigid pavement global calibration coefficients;
- the addition of non-structural preventative maintenance treatment consideration for flexible and rigid pavements;
- the addition of five level 3 default distributions for normalized axle load spectra;
- updated climate discussion for Modern Era Retrospective Reanalysis and North American Regional reanalysis data;
- the incorporation of crack load transfer efficiency for flexible pavements;
- expanded guidance for creep compliance and indirect tensile strength inputs for asphalt wearing surface layers; and
- updated standards references.

Available Formats

The guide is available in three formats: In a printed paperback; as a PDF download single-user, 5-user, or 10-user; and in a set that includes both the paperback version and the single-user PDF download version, at a discounted rate.

Order a Copy!

To order a copy of the new *Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, 3rd Edition,* visit the AASHTO Store online at https://store.transportation.org/
and search by the publication's item code, MEPDG-3, or click on this link directly to the publication's page on the AASHTO Store.
https://store.transportation.org/Item/CollectionDetail?ID=196&AspxAutoDetectCookieSupport=1

Related Software:

AASHTOWare Software:

The Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, 3rd Edition references the AASHTOWare Pavement ME Design™ M-E Pavement design software, commercially available through AASHTOWare, AASHTO's software development program. https://www.aashtoware.org/products/pavement/pavement-overview/

Related Publications

When you order your copy of the new *Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, 3rd Edition*, be sure to also order copies of these two related AASHTO publications, which provide additional information and guidance on mechanistic-empirical pavement design, and pavement engineering:

Guide for the Local Calibration of the Mechanistic-Empirical Pavement Design Guide, 1st Edition;
and
Pavement Design, Construction, and Management: A Digital Handbook, 1st Edition.

Two New Faces at Research

Erin Anderson recently joined the Development, and Technology Transfer division. Erin graduated from the University of Alaska Fairbanks with a degree in geological engineering in 2001. She spent the past six years working in the Northern Region Construction section. Before that, Erin spent time working in Utilities and Highway Design. Erin lives in Fairbanks with her family and enjoys shoveling snow.

Ian Grant is the research engineer based in Juneau at the AKDOT&PF 3-Mile Headquarters. Ian graduated in 2018 from the University of Alaska Fairbanks with a degree in mechanical engineering. Ian is currently working on eight projects for Research, Development, and Technology Transfer division. These projects include topics dealing with environmental preservation, bridge infrastructure, and hydraulic modelling. Ian is excited to help AKDOT&PF in its progress towards future development.

Telecommuting Resources on Microsoft Teams

For those of you who are teleworking, we know the transition to a new workspace without all of your usual comforts can be hard. Our IT team is ready to help you transition into your new space and help you troubleshoot all your tech problems. They have put together a statewide resource on Microsoft Teams to help you through some of the most common problems like forwarding your phone, using a VPN, and setting up WebEx. Please check out the Telecommuting Resources Public Team by clicking this link.

Take some time to explore what's available and you may learn something new. (Did you know you can turn your voicemails into emails?) If you can't find what you're looking for, use the chat page on the Question and Answer Channel to get answers to your questions. The team will be updated regularly with new resources, tips, and tricks to get you through your teleworking experience.

National Highway Institute Online Training

This could be a good time for online training offered by the National Highway Institute (NHI).

Many of the courses NHI offers online can be used toward obtaining Continuing Education Units (CEUs), Certification Maintenance (CM) credits, and Professional Development Hours (PDHs) for transportation professionals.

Start now by creating an account with your Alaska DOT&PF email account. We always encourage everyone to talk with your supervisor before enrolling in T2 or non-T2 sponsored courses.
https://www.nhi.fhwa.dot.gov/course-search?tab=0&sf=1

Online Training Available on the T2 Website

- Commercially Useful Function (CUF) Federal-aid Highway Program Video Training
- Wetlands
- Stormwater
- Hazard Communication
- Airports MSGP Training
- Introduction to Title VI Training
- Inspection Report Form 25D-100 Instructions

- Natural Occurring Asbestos: Asbestos Awareness Training
- Natural Occurring Asbestos: Competent Person Training
- Natural Occurring Asbestos: Project Designer Training

- RBA: Operate Alaska's Marine Transportation Services
- RBA: Modernize Alaska's Transportation Infrastructure
- RBA: Operate Alaska's Transportation Infrastructure

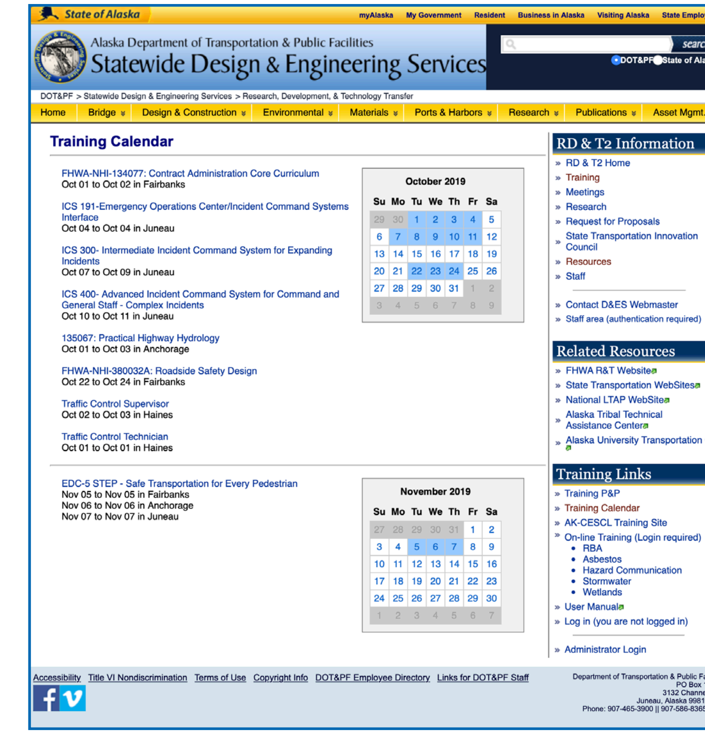
- NEPA Procedures Manual Training, Module 1: Environmental Procedures Overview
- NEPA Procedures Manual Training, Module 2: Class of Action Determination
- NEPA Procedures Manual Training, Module 3: Categorical Exclusions
- NEPA Procedures Manual Training, Module 4: Environmental Assessment and Finding of No Significant Impact
- NEPA Procedures Manual Training, Module 5: Environmental Impact Statement
- NEPA Procedures Manual Training, Module 6: Re-Evaluation
- NEPA Procedures Manual Training, Module 7: Public and Agency Involvement
- NEPA Procedures Manual Training, Module 8: Section 4(f) and 6(f)
- NEPA Procedures Manual Training, Module 9: Endangered Species Act and Marine Mammal Protection Act
- NEPA Procedures Manual Training, Module 10: Cultural Resources

How to enroll:

1. Go to our link: https://dot.alaska.ecatts.com/lmsTrainingCalendar
2. Log in to your account or create an account (sidebar, bottom right)
3. Find "on-line training" under the Training Links on the sidebar.
4. "Add on-line training" to your Scheduled Training and you're ready to go.

For information about T2-sponsored training, contact:
Dave Waldo at 907-451-5323,
david.waldo@alaska.gov
Simon Howell at 907-451-5482,
simon.howell@alaska.gov

Upcoming Training



June 2020

Alaska Flexible Pavement Design
June 25–26 in Fairbanks

September 2020

131139: Constructing and Inspecting Asphalt Paving Projects
Sep 1 to Sep 2 in Fairbanks

October 2020

A Guide to PEL and Accelerated Project Development
Oct 27 to Oct 27 in Anchorage

FHWA-NHI-134077: Contract Administration Core Curriculum
Oct 26 to Oct 27 in Anchorage
Oct 29 to Oct 30 in Juneau

November 2020

FHWA-NHI-380032A: Roadside Safety Design
Nov 3 to Nov 5 in Anchorage

The current training calendar can be found at:
https://dot.alaska.ecatts.com/lmsTrainingCalendar
For periodic emails about research, sign up for our list-serve:
http://list.state.ak.us/mailman/listinfo/dot-research-notification
For periodic emails about training, sign up for our list-serve:
http://list.state.ak.us/mailman/listinfo/dot-training-notification
For any other information about T2-sponsored training, contact:
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or
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simon.howell@alaska.gov
or go to: www.dot.state.ak.us

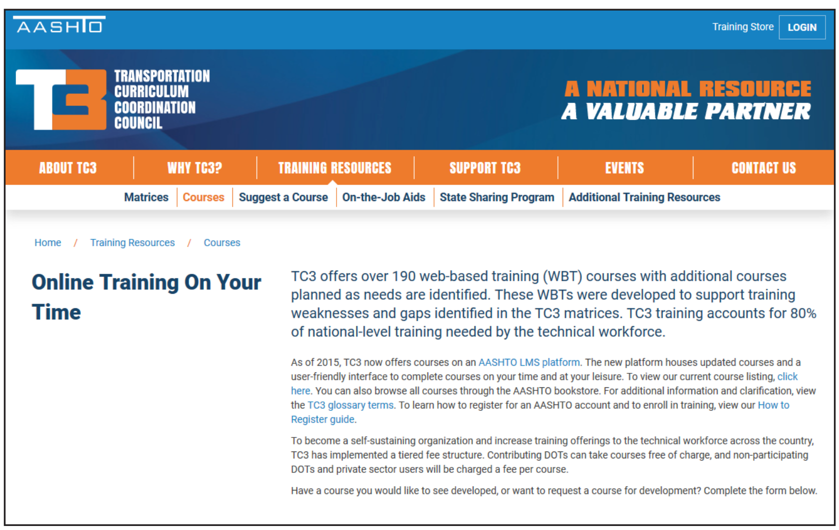
AASHTO T3 Training Available Free for Alaska DOT&PF Employees

Just create an account with your Alaska DOT&PF email account. Remember, we encourage everyone to talk with your supervisor before enrolling in T2 or non-T2 sponsored courses.

https://tc3.transportation.org/training-resources/courses/

Hundreds of courses in several topic areas:

- Construction
- Maintenance
- Materials
- Traffic and Safety
- Pavement Preservation
- Employee Development



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http://www.dot.state.ak.us/stwddes/research/

This newsletter is funded by the Federal Highway Administration and the Alaska Department of Transportation and Public Facilities. The material contained herein does not necessarily reflect the views of the Alaska Department of Transportation, Federal Highway Administration, or the T² staff. Any reference to a commercial product or organization in this newsletter is only for informational purposes and is not intended as an endorsement.

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