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Research Section Mission

To coordinate the Department's Research Federal Funded and In-House Research, with the primary objectives:

- 1) Reduce the costs of construction and maintenance;
- 2) Improve the quality of service to the highway users;
- 3) Increase the efficiency of highway planning, operations and administration;
- 4) Reduce crashes and crash severity;
- 5) Encompass the inter-relationship of socio-economic, environmental and technical factors into the transportation system; and
- 6) Implement favorable findings into departmental procedures and processes

Key Successes

By Mark Lindemann

The Purpose: To reduce operating costs and fees associated with the Nuclear Moisture-Density Gauge, the Department began evaluating the use of non-nuclear testing devices in 2012 and fully implemented the use of the Light Weight Deflectometer (LWD) on all NDOT projects, becoming “non-nuclear” in 2016.

The Results: LWD provides more reliable and direct information on the strength and stiffness of compacted soil materials and help ensure a more uniform product with the desired material strengths needed for the placement of the roadway pavement. In addition, there is no regulatory, storage, or transportation requirements to operate the LWD and training can be provided in-house by the Department.

Implementation: NDOT has collected LWD test results from the field and comparisons have been made for each individual Nebraska Group Index (NGI) soil classification system. Correlations have been developed for a majority of each Nebraska soil classification (totaling 38) which helps decrease the time needed in both the laboratory and the field to determine what the minimum requirements are needed during construction. NDOT will continue to develop and improve these correlations, which will aid in a quicker turn-around time from the lab to the field. On larger projects where substantial soil borings and lab testing is performed, the NGI and associated Deflection Target Values required for LWD field testing can be provided for the different soil types encountered.



Innovation: This information can be determined in potential cut and borrow sections on a project in the design stages and provided in the plans as well as on a Google Earth KMZ project alignment file. The Google Earth KMZ file can include boring location, soil descriptions, the NGI, and other engineering properties of the soils encountered. The intent is that the project inspector can use this information while onsite to help better identify and test the soils being used on the project without thumbing through plan sheets or reports. The first project set up to provide this type of soil information is the South Beltway project.

Federally Funded Contract Research and In-House

Federally Funded Contract Research

Throughout the year, The Nebraska Department of Transportation (NDOT) Research Section receives and solicits new ideas for research projects for the following year. These ideas can come from the general public, cities, counties, consultants, suppliers, contractors, Universities, FHWA and within Nebraska Department of Transportation. Need to solve a problem/concerns, submit a Statement of Need for consideration to the Research Section.

All Statement of Needs (SON) are compiled and separated into the following four Focus Groups:

- Materials, Pavements, Maintenance, and Construction
- Roadway, Hydraulics and Environmental
- Traffic, Safety, Planning, Transit and Intelligent Transportation Systems (ITS)
- Structures and Geotechnical

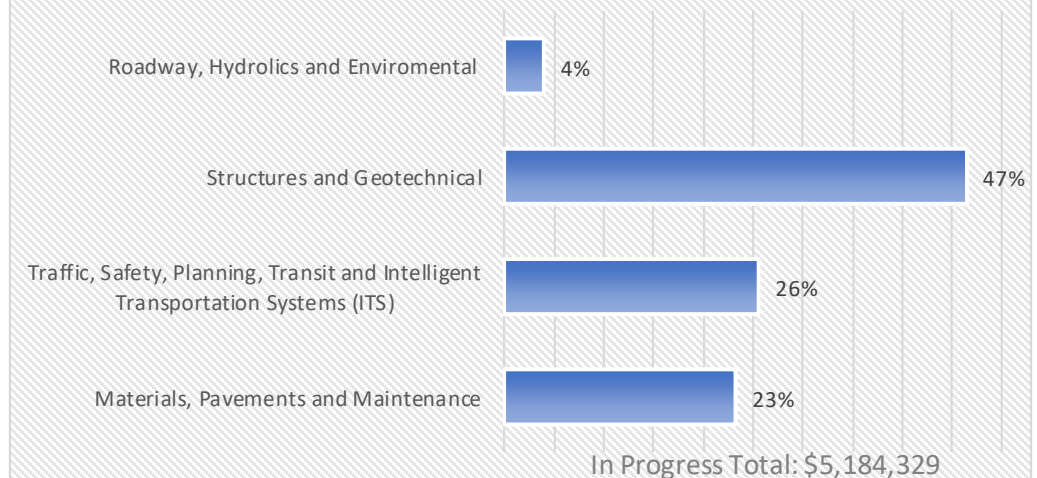
STATEMENT OF NEED
The form can be found under the information *For Researchers*
<https://dot.nebraska.gov/business-center/research/>

We welcome your feedback, research request and involvement on Technical Advisory Panels.

Contact The Research Section

ndot.research@nebraska.gov

NDOT Funded Research By Topic Area



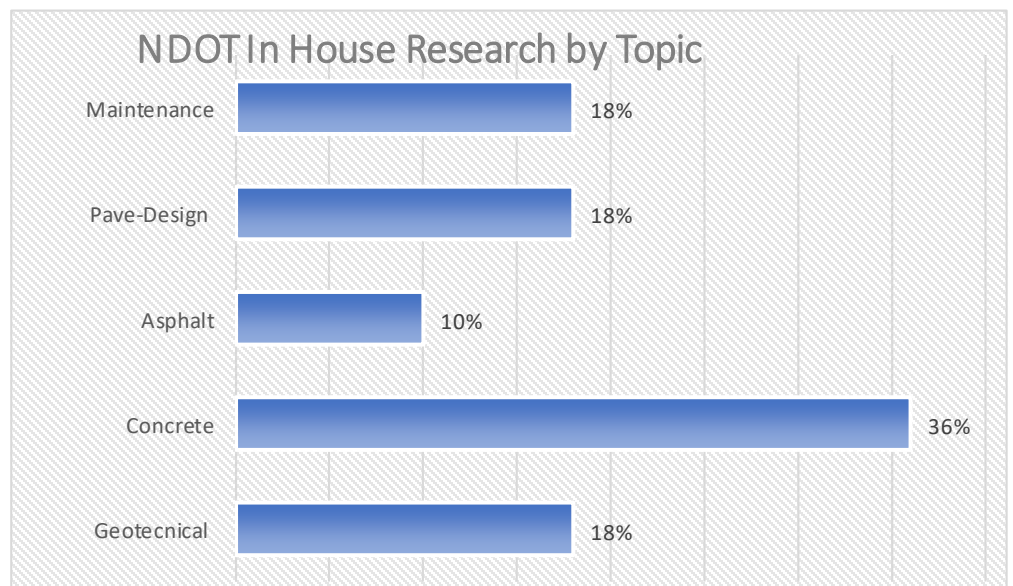
For more information visit
[Nebraska Department of Transportation Research Website](#)

In-House Research

In-house research differs from contracted research in that the researcher is an employee of NDOT. The in-house researcher often also serves as the Project Manager. In-house research enables NDOT to:

- Assess emerging research results and determine appropriate solutions to benefit Nebraska transportation.
- Provide a professional knowledge base to solicit, award, monitor, and evaluate the quality and cost-effectiveness of research.
- Evaluate field-implemented transportation innovations for cost saving implications.

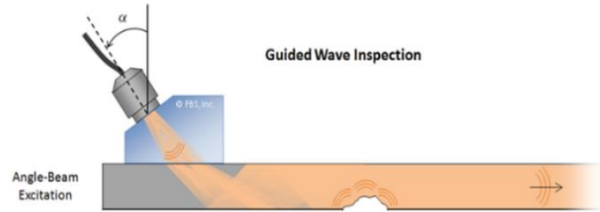
NDOT In House Research by Topic



NDOT Funded Research Highlights

Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field

Principal Investigator: Ece Erdogan

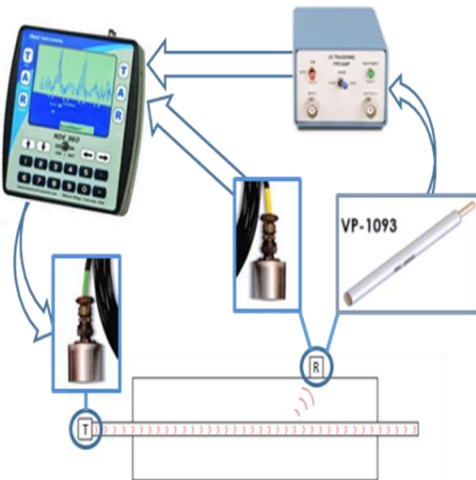


The Ultimate Goal of the project is to make the previously developed innovative testing method, namely the use of the leaked ultrasonic guided waves for the early detection of multiple flaws in reinforced concrete bridge decks, more practical and field-application ready.

The Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field methodology will potentially increase safety and health of reinforced concrete bridge decks and reduce maintenance cost on infrastructure over time by finding flaws sooner. This method has the potential to be a proactive tool that not only uses routine readings to assess the health of the bridge but also how long it takes for a new bridge deck to start experiencing rebar corrosion and time of delamination. If flaws as small as 0.008 inches can be detected sooner in a specific 10 ft. by 4.5 ft. location using a 2 inch diameter receiver, repairs can be made in just that location rather than drilling and coring the entire bridge to locate the flaw(s) thus resulting in less repair costs. Currently, the best method NDOT has for combating rebar corrosion and delamination is adding an asphalt overlay to a bridge deck at the 10 year mark. It could also potentially avoid the costly application of the asphalt overlay at the 10 year mark if it is found that the bridge is in good, sound condition.

Some of the experiments they conducted during the project to get the best results were determining a good seat angle for attachment to the rebar, couplant comparisons and improving the contact area. It was determined the best angle was 33 degree rebar end angle provides better results. Ultragel works better than White Lithium Grease for coupling. And Hydrocal gypsum cements shows improved contact area.

The Next Step is making this method more practical by developing ways to overcome issues that will occur on the field.



Detection of Flaws with Asphalt Overlaid Concrete Decks Using Ultrasonic Guided Waves

Principal Investigator: Ece Erdogan

This project will determine if the asphalt overlay effects the overall results of detecting flaws and if so, to what extent; and if the asphalt can be used as a waveguide in addition to or instead of the rebar. For the analysis/post-processing, they will utilize the energy or the amplitude, instead of the typically measured velocity. This allows smaller changes in delaminations, as small as 0.008" from 10 to 14 feet away from the transmitter, to be detected more clearly.

Currently, this method has only been tested on reinforced concrete lab specimens and a bridge deck without any membrane or asphalt overlay. The next step will be to study the feasibility of the UGWL method with the inclusion of an asphalt overlay, to ensure it remains feasible and applicable to Nebraska's infrastructure.

If successful, the method has the potential to offer NDOT a relatively low-cost and simple to interpret, non-destructive evaluation technique that could eliminate the need for multiple NDOT techniques and/or the need to hire consultants. *In the long term*, it may reduce maintenance costs on infrastructure by detecting flaws before the compromise the safety of the bridge causing the deck to be replaced.

What is the Goal?

To expand the capabilities of the recently developed novel UGWL testing method to detect flaws in asphalt overlaid reinforced concrete bridge decks through the unique placement of sensors to measure leaked energy caused by steel rebar delamination.

A Big Data Approach for Improving Nebraska Cycling Routes

Principal Investigator: Fadi Alsaleem

Co-Principal Investigator: Daniel Piatkowski

Goal - This project will provide a comprehensive knowledge of current cycling routes in Nebraska by utilizing the Strava Metro data. This knowledge can help the Nebraska Department of Transportation (NDOT) to make better-informed decisions to improve bicycle infrastructure while considering cyclists' safety. This new information includes, but not limited to, the preferred bicycle routes and traffic patterns in Nebraska.



What is Strava? It is an application that tracks running and cycling activities, where the user get information about distance, time, average speed, maximum speed and a map where the route from start to finish is mapped out. Compared to the traditional methods of collecting data using human counters or electronic gates, Strava data covers wider areas and has a lower cost.

What We Can Expect - The final product will be an analysis engine and algorithms that can extract useful information from the large (non-uniform) cycling data provided by Strava. This new information will be stored in the NDOT data warehouse and could be used in the future. Another possibility is to integrate this data with a GIS system.

Primary Project Objective- Provide a framework for performing a detailed analysis of bicycle counters data extracted from Strava Metro data. This analysis will inform the research team about cycling behavior and will help to promote a safer bicycle transportation system in Nebraska. Secondary project objective - Provide information that may be integrate into existing available databases, such as the NDOT geographic information system (GIS), to provide bikers with better routing information.

"Bike Walk Nebraska is very excited about the projects, A Big Data Approach for Improving Nebraska Cycling Routes and Investing in Bicycle Infrastructure to Spur Stateside Economic Growth through Bicycle Tourism.

We are so fortunate to have a top notch faculty and students at UNL that can provide the level of data collection and analysis we need to make smart decisions about how we can make biking and walking safer in Nebraska.

Beyond this, the data and analysis from these projects will be beneficial to us as we talk with elected officials and local leaders about policy considerations, too."

- Julie Harris, Executive Director, Bike Walk Nebraska

Investing in Bicycle Infrastructure to Spur Stateside Economic Growth through Bicycle Tourism

Principal Investigator: Daniel Piatkowski

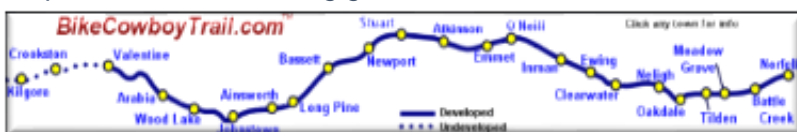
Co-Principal Investigator: Fadi Alsaleem

"Nebraska's Cowboy Trail offers an authentic Old West experience with friendly small towns and sweeping views of the High Plains and pristine prairie. At a whopping 219 miles, it's already the third longest rail-trail in the country and yet has 100 more miles awaiting future development. With the stunning bridge over the Niobrara River and a wildlife-rich backdrop—including roaming bison, wild turkeys, elk and prairie dogs—this is a bucket-list trail for true adventurers."

Bicycling, particularly bicycle tourism, is on the rise nationally and has proven highly beneficial to local economies, particularly in small towns and rural areas. Nebraska currently lacks designated routes in rural areas and on-street bicycle infrastructure outside of cities are limited. There are individual efforts to connect communities via rail-to-trail projects, but no organized effort to facilitate the creation of bike routes and build bike related features into highway projects.

Objective - Building off of data gathered from the project, A Big Data Approach for Improving Nebraska Cycling Routes, this project seeks to conduct a robust economic impact analysis based on current recreational bicyclist volumes in the state of Nebraska of the impact of bicycle tourism on the state. Based off of the data and analysis, the final report will include economic impacts at multiple applicable geographies. Results will be essential for planning for maximizing benefits of bicycle tourism for all types of Nebraska communities.

<https://www.railstotrails.org/greatamericanrailtrail/route/nebraska/>



Project Benefits – For NDOT, this work will provide an evidence based economic impact for planning a capital investments in bicycle facilities and includes identifying NDOT's role in fostering economic development through transportation infrastructure.

The Potential – Establishing NDOT as a national leader in using transportation investments to benefit and potentially revitalize rural communities. This project sets the stage for more comprehensive analysis of the current and future impacts of bicyclet ourism.

Effect of Antioxidant Additives and Recycling Agents on Performance of Asphalt Binders and Mixtures

Principal Investigator: Hamzeh F. Haghshenas

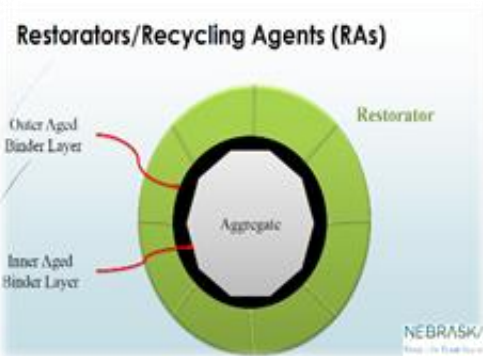
Co-Principal Investigator: Robert Rea

The Ultimate Goal - The use of recycling agent (RA) have gained popularity in recent years since they can effectively modify the engineering properties (e.g., stiffness) of the aged asphalt binder. Phase I of this project will focused on the effect of chemical properties of RAs on rheological and mechanical properties of asphaltic materials, especially, on long-term performance of asphalt binders and mixtures. In addition, the long-term performance of the restored binders modified by one type of antiaging will be examined. Finally, the combination effect of RAs and antioxidant additive will be evaluated on two different levels: mixture and binder.

Benefits - The findings of this research study could change Nebraska asphalt binders/mixtures specifications. Test results and findings can be used to provide useful implementation guidelines of Nebraska asphalt binders and mixtures containing laboratory/field aged materials. This research would also bring clear benefits in sustainability of pavements by expanding their service life.

What We Know – The Principal Investigator evaluated the long-term performance of three chemically different RAs (i.e., petroleum, tall oil and agriculture-based). It was reported that the tall oil and agriculture-based additive did not mitigate the effects of long-term aging and tall oil RA increased the moisture sensitivity of the mixtures, however, the immediate performance of these RAs was acceptable and was a lower cost alternative than petroleum-based.

- Phase II will begin in July 2020.



Category	Types of restorators/recycling agents Examples	Description
Paraffinic Oils	Waste Engine Oil (WEO) Waste Engine Oil Bottoms (WEOB) Valero VP 165® Storbit®	Refined used lubricating oils
Aromatic Extracts	Hydrolene® Reclamite® Cyclogen L® ValAro 130A®	Refined crude oil products with polar aromatic oil components
Naphthenic Oils	SonneWarmix RJ™ Ergon HyPrene®	Engineered hydrocarbons for asphalt modification
Triglycerides/Fatty Acids	Waste Vegetable Oil Waste Vegetable Grease Brown Grease Oleic Acid	Derived from vegetable oils, Has other key chemical elements in addition to triglycerides and fatty acids
Tall Oils	Sylvaroad™ RP1000 Hydrogreen®	Paper industry byproducts, Same chemical family as liquid anti-stripping agents and emulsifiers

High-Mast Tower Foundation

Principal Investigator: Chungwook Sim

Co-Principal Investigators: Chung Song, Brandon Kreling and Jay Puckett

High Mast Tower (HMT) foundations have been traditionally designed and constructed using a cast in-place with anchorbolts that are used to secure the tower to the ground. This type of design requires a large base plate that is welded to the tower shaft. NDOT has experienced issues with stresses that this type of design presents at the anchor bolt/foundation interface and base plate/tower shaft interface. The worst case scenario would be premature failures as shown in one of the towers at Milford.

The Main Objective - Previous studies have focused on 100-120 ft tall structures and not on the substructures related specifically to poles. The Research Team proposes to study and evaluate Possible alternative designs for the foundations, either directly buried or through drilled shafts, that may drastically reduce the stress that are present in the current design and could potentially eliminate fatigue-prone details associated with this connection.

How to Accomplish the Goal - By evaluating various types of foundations similar to NDOT towers, including evaluating drilled shafts and direct embedment foundations; evaluating corrosive environments with the steel pole structure being embedded either in concrete or soil and mitigate any corrosion issues found; and finally based off of those findings, provide a design and construction provision that will be integrated into NDOT specification for design and construction.

Expected Benefits – Providing an alternative base design that would eliminate the pole-to-baseplate connection that contains weldment details and bolts that are fatigue prone, reduce inspection and maintenance costs reviewing welds and bolt tightness, and provide a different approach to the pole-to-ground connection that could be used nationwide.

Next Steps – The Research Team will begin developing general guidelines for different soil type/foundation type combinations.



High Mast Tower Failure (Milford, NE, January, 2018)



High Mast Tower Base Plate, Anchor, Non-Shrink Grout and Cast-in-Place Foundation

NDOT In-House Research Highlights

Breaking the ICE – An Investigation into Winter Maintenance Chemicals

Principal Investigators: David Hansen, Lieska Halsey and Wally Heyen Advisers: Jasmine Dondlinger and Ty Barger

Winter road maintenance poses significant cost and logistical challenges to transportation departments around the world. Best management practices are largely developed through experience and word-of-mouth. Significant cost and material reductions might be achieved through optimizing a winter maintenance program through innovation and research. NDOT launched a multi-phase research project to optimize winter maintenance practices in Nebraska. Phase I validated a laboratory test to measure the performance potential of liquid deicing chemicals. Phase II explored the potential use of sucrose as an alternative to beet juice. Phase III developed a matrix of potential blends that could be made from bulk raw materials. Phase IV is a series of field trials that will measure the performance of deicers in real world applications. Each phase is discussed below.

Phase I – Validation of the Mechanical Rocker Test

The anti-icing and deicing industry has interest in the development of an objective, repeatable test procedure for the evaluation and comparison of anti-icing and deicing products. Pursuant to this goal, the Nebraska Department of Transportation (NDOT) funded research at the University of Nebraska-Lincoln (UNL) to develop the procedure for the Mechanical Rocker Test for Ice Melting Capacity (MRT-IMC) in 2014.

From 2017-2019, NDOT evaluated the MRT-IMC procedure for validity and suitability as a standard test procedure for assessing deicer performance at 15 minutes. NDOT first validated the MRT-IMC and determined an intra-laboratory, single operator precision. NDOT then initiated a round-robin test of two NDOT approved deicing products to establish a single-operator and multi-laboratory precision and bias in accordance with ASTM C802, *Standard Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods for Construction Materials*. A precision statement was developed in accordance with ASTM C670*, *Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials*. The MRT-IMC yielded a single-operator Coefficient of Variation (CV) of 2.66% and a multi-laboratory CV of 5.65%.



The Mechanical Rocker

“This Spring, NDOT will utilize the MRT-IMC (15 minute test) in the scoring of bids during a solicitation for Corrosion-inhibited Liquid Magnesium Chloride (Clear Roads Product Category 1).”

– Ty Barger

Hwy Operations Assistant Division
Manager

The results of this validation study indicate that the MRT-IMC is a valid and repeatable standard test method for assessing the IMC of a deicing product at 15-minutes. NDOT will use this test in the bidding process for liquid deicers, and will begin performing QA testing on approved products for 2020-2021 deicers. NDOT is continuing research into a 90-minute test, the MRT-IMC90. A curve is determined by measuring the IMC of a product at four time intervals; 15, 30, 60, and 90 minutes. The curve will indicate a product's performance over a time interval similar to the time to maintain a plow truck route.

Read the full report here: <https://dot.nebraska.gov/media/13477/mrt-imc.pdf>

Phase II – Sucrose Testing



Sucrose Blending in District 3 Norfolk Maintenance Facility

NDOT researchers investigated using sucrose as a potential replacement for beet juice in liquid deicing blends. Chemists in the NDOT chemistry lab determined the sucrose content of beet juice and prepared laboratory-grade sucrose solutions for mixing experiments. After successfully preliminary testing, researchers began investigating bulk-raw materials which would be more practical to use in the field.

An experiment to blend cane sugar (sucrose) utilizing a brine maker in District 3 Norfolk maintenance yard took place in January 2019. Researchers discovered that the brine maker loading was too fast to adequately blend sucrose to the desired concentration. This was overcome by cross-pumping two tanks to dissolve the sucrose into solution. Researchers were able to blend a sucrose solution close to the desired 20% concentration. However, logistical issues would cause difficulty in implementation. Following the sucrose experiment, researchers designed an experiment to create a “muffin mix” consisting of proportioning dry, bulk-raw ingredients then adding water to create a desired deicer.

Phase III – Matrix of Deicing Blends (Muffin Mixes)

In 2018 and 2019 NDOT researchers investigated the potential of developing in-house deicing blends. Researchers conducted experiments blending commercial products and raw materials, MgCl₂, NaCl, and sucrose to determine the feasibility of creating an NDOT blend. Results from the blending experiments in the lab indicate that commercial products cannot be blended due to precipitation issues. Researchers found success in blending lab-grade raw materials and testing progressed to blending with bulk raw materials.

Researchers designed a matrix to create a “muffin mix” consisting of proportioning dry, bulk raw materials then adding water to create a deicer blend of a desired concentration. Researchers learned that blending order matters and ultimately succeeded with blending eight mixes with different concentrations, and freezing point temperatures. After performing a cost analysis and testing the mixes in the mechanical rocker test as well as corrosion and freezing point tests, two mixes were eliminated as viable options. Six were chosen for field trial testing.



Muffin Mixes

Phase IV – Field Trials



Field Application Vehicle and Test Site

In February of 2020 M&R researchers began field trials with deicers to determine if a correlation between the Mechanical Rocker Test (MRT-IMC) and field application could be made. The chemicals were tested for both anti-icing and deicing capability. Researchers applied deicing chemicals to a test plot and then added water in freezing temperatures to test anti-icing. To apply water, researchers used a skid sprayer that the NDOT welding shop modified to extend spray nozzles over the lane to left of the driver. Researchers applied deicing chemicals to a layer of ice on a test plot to test deicing. The test plots were analyzed by collecting data from the Teconer Road Condition Monitor RCM-411, a device that measures the grip (coefficient of friction), water depth, road temperature, and ambient temperature. The RCM-411 is a mobile device that mounts on a vehicle, and transmits data that is presented on a world map. Operators can monitor

data in real time using Teconer’s smartphone app. Researchers will use the data to assess deicer performance in various weather scenarios related to the ice melting capacity measured in the lab. Preliminary results are promising and further more extensive testing is being planned for the 2020-2021 winter.

Colloidal Silica – Cement Enhancing Admixture – Materials Concrete

Principal Investigators: Lieska Halsey, David Hansen and Wally Heyen

Research Value

As Class F- fly ash becomes scarce and more expensive, PCC engineers will look to other supplemental cementitious materials (SCM) to replace F-ash and its ASR mitigating properties. Colloidal silica (CS) has been shown to mitigate ASR at certain replacement levels, however, CS cannot be a full replacement of F-ash.

What is Colloidal Silica?

“Colloidal silica are suspensions of fine amorphous, nonporous, and typically spherical silica particles in a liquid phase.”

Colloidal Silica is used as an admixture and supplement to F-Fly Ash.

Expected Benefits

This research is investigating the potential to use colloidal silica as a cement enhancing admixture in NDOT’s concrete mix designs. The objectives in this study are:

1. Determine if CS can enhance strength high early mixes for use in patching and repairs.
2. Determine if CS can maintain or improve ASR mitigation as F-ash content is decreased.

The Flexible Pavements Section is developing high performance hot-patching materials, at significantly lower costs, for our maintenance forces to use during winter and spring patching. Historically, the NDOT has used two types of materials, cold-patching mix and water activated patch materials. The cold patching product is reported to demonstrate good workability but is considered a temporary patch and costs approximately \$130/ton in bulk stockpiles or \$400/ton for bagged material. The water activated product comes in a 5 gallon bucket and must be kept sealed until used and is reported to have good workability and long-term durability, it currently costs approximately \$980/ ton.



NDOT engineers have been producing the new hot-patching materials using a portable KM International KM T-2 asphalt recycler. The hot-patching mix design utilizes 100% Recycled Asphalt Pavement (RAP) millings and NDOT Binder Pods with Green Technology rejuvenators and various recycling agents blended in. Engineers estimate that the hot-patch method will cost \$100-200/ ton, including equipment, labor and materials. A preliminary trial was conducted at the District 1 maintenance yard in late February. Four batches were made and placed in a heavy loading, high traffic driveway in the maintenance yard and are performing well.

Since the initial trial section, District 3 has produced well over 50 batches and has placed the hot-patch material in several patching scenarios. The District 3 maintenance force continues to produce the hot-patch material on a nearly daily basis, with the field reporting good results. Batch designs are based on testing the RAP material to determine the right amount of additives for the patching application. The batch designs can be easily adjusted for different applications, i.e. large patch areas, potholes, full depth patches, shoulder leveling, etc. Researchers will monitor the patch sections to measure performance and annual savings to the NDOT. Preliminary estimates on savings to NDOT are \$200,000 per year and additional savings are expected from a safety and labor aspect, as the patching is permanent and maintenance crews do not have to repeatedly return to re-patch areas throughout the winter in live traffic conditions.

[Innovation at NDOT - Hot Mix Patch Testing YouTube video](#)

Interaction Between Hot-Pour Joint Sealant and Penetrating Concrete Sealer – Material Concrete

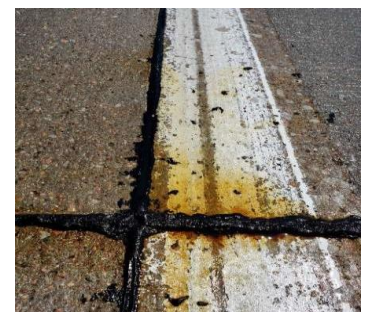
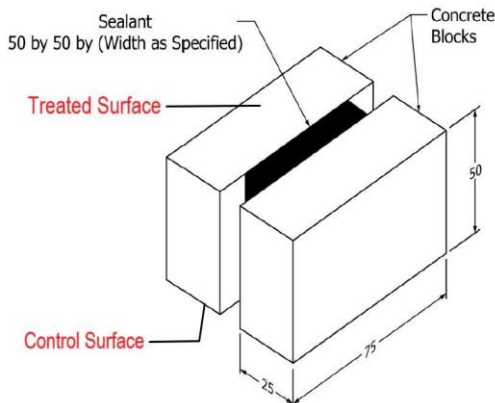
Principal Investigator: Bruce Barrett

Advisers: Dale Byre, Wally Heyen, Lieska Halsey and David Hansen

In May 2019, Nebraska Department of Transportation (NDOT) Project Managers and contractors observed discoloration and apparent dissolution of the hot-pour joint sealant during application of penetrating concrete sealer (PCS) to the exit ramps on NE-83 near North Platte, NE. Contractors sealed the joints with NDOT designation NE -3405 hot-pour sealant and applied NDOT approved PCS on the concrete surface.

Based on the field observations on NE-83, PCS potentially impacts the bond between the concrete and hot-pour sealant after application. If penetrating sealers break the interfacial bond after application, concrete pavements could become compromised and subject to freeze-thaw damage, chloride attack, and other deleterious effects.

Researchers developed a plan to test the five PCS products approved by the Department in accordance with ASTM D5329, *Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements*. Seven sets of three blocks were made; six sets following D5329 and one modified cupped block set to create a dike in the hot pour sealant for ponding PCS. Each standard block was treated with PCS in one of three ways; spraying, soaking face down for one minute, or soaking face down for 5 minutes. The blocks were frozen and pulled on the extension machine. All PCS products caused discoloration to the blocks, but none of the PCS products caused debonding issues between the hot-pour and the concrete surface. Maintenance crews and contractors should be advised that some discoloration is normal and should not cause concern. In addition, this testing will be performed on products applying to be included on the Department's Approved Product List.



Field observations on NE-83

Read the full report here:

<https://dot.nebraska.gov/media/113447/interaction-of-hot-pour-joint-sealant.pdf>

Using Falling Weight Deflectometer to Determine the Modulus of Underlying Layers in Concrete Pavements – Pavement Design

Principal Investigators: Bruce Barrett, Kellie Troxel and Brady Dresselhaus

A recent project had issues with foundation course and subgrade, the only way NDOT had to verify quality was with Falling Weight Deflectometry (FWD) testing on top of doweled concrete. NDOT needs to show the credibility of these results for future use.



Falling Weight Deflectometer equipment

The Pavement Design section is conducting a study to measure the strength characteristics of bare foundation course before and after doweled concrete placement using multiple test methods and equipment. Researchers will use three methods of determining modulus; FWD, Light Weight Deflectometer (LWD), and Dynamic Cone Penetrometer (DCP). All three methods will be used on the bare foundation course. Moisture content in the bare foundation course will also be measured. On top of doweled pavement, researchers will test using FWD and DCP. Cores will be taken to accommodate DCP testing. The results of the different methods will be compared to provide NDOT confidence in verifying quality in highway construction. Testing will occur during new construction on Hwy 30 from Rogers to Fremont, NE, and is scheduled to start in April 2020.

Erosion Characteristics Research of Nebraska's Group Index Soil – Geotechnical

Principal Investigator: Mark Lindemann

Research Value:

The Pin hole test simulates water run-off induced surface erosion phenomenon. This evaluation will provide measurements for all Nebraska's soils for its erodibility caused by water. In this study the use of the pin hole test, a commonly used device to evaluate the internal and surface erosion indices of soil, will be employed to evaluate the performance of each NGI soil classification.

Expected Benefits:

The determination of different Nebraska Soil types and their susceptibility to erosion and frost-heave potential, which is typical of erosive soils. The research also will show if there are benefits of using fly ash and lime to improve the soil erodibility characteristics. The results from this investigation will provide guidance to Pavement Design, erosion control for the Environmental Section and susceptible soils for Bridge and Roadway Hydraulics.



National Partnerships – Research Dollars



Midwest Roadside Safety Pooled Fund Program

Background In 1990, the University of Nebraska-Lincoln collaborated with the States of Nebraska, Kansas, and Missouri to form the Midwest States Regional Pooled Fund Program, a program dedicated for sponsoring roadside safety research. In the 30 years since it was established, the program has continued to grow to 19 participating states including California, Florida, Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Missouri, New Jersey, North Carolina, Ohio, South Carolina, South Dakota, Utah, Virginia, Wisconsin, and Wyoming.

Lead State *The State of Nebraska Department of Transportation is the lead agency for the program* and participates in 16 other projects. As Lead Agency, the State administers pooled fund contributions, both Federal and non-Federal, and review and pay expenses related to the project.

The Midwest Roadside Safety Pooled Fund Program is a collaborative program between state DOTs and the UNL Midwest Roadside Safety Facility (MwRSF) dedicated to sponsoring roadside safety research.

Largely due to the support from the Midwest Pooled Fund Program, MwRSF has come to be recognized as a global leader in the development of crashworthy safety structures. Numerous safety features have been developed through the Midwest Pooled Fund Program and have been adopted nationwide with several systems adopted internationally. These new safety features have saved the lives of countless motorists across the nation over the last decade.

For more information on the Transportation Pooled Fund Program and how to participate, please click on Pooledfund.org



MwRSF Goals

- Improve highway safety by making the roadside less hazardous for motorists
- Design, develop, and crash test roadside hardware
- Conduct safety performance evaluations of existing roadside features
- Perform computer simulation modeling of vehicle impacts with roadside hardware

The Transportation Pooled Fund (TPF) Programs allows federal, State and local agencies and others organizations to combine resources to support research into shared transportation Priorities, Currently Nebraska participates with 100% federal Funds into the following Pooled Funds;

Pooled Fund Participation Summary (100% Federally Funded)

Study Titles	Expenditures FY 2020	Required Commitments FY 2021	NDOT Technical Representatives
TPF-5(430) Midwest Roadside Safety Pooled Fund Program	\$65,000.00	\$65,000.00	Phil TenHulzen
TPF-5(316) Traffic Control Device Consortium	\$15,000.00	\$15,000.00	Dan Waddle
TPF-5(295) Smart Work Zone Deployment Initiative	\$25,000.00	\$25,000.00	Dan Waddle
TPF-5(353) Clear Roads Phase II	\$25,000.00	\$25,000.00	Mike Mattison
TPF-5(347) MDSS Maintenance Decision Support System	\$30,000.00	\$30,000.00	Mike Mattison
TPF-5(313) Technology Transfer Concrete Consortium	\$12,000.00	\$12,000.00	Wallace Heyen
TPF-5(432) Bridge Element Deterioration for Mid-west States	\$20,000.00	\$20,000.00	Fouad Jaber
TPF-5(317) Evaluation of Low Cost Safety Improvements	\$5,000.00	\$5,000.00	Dan Waddle
TPF-5(297) Improving Specifications to Resist Frost Damage in Modern Concrete Mixes	\$20,000	\$20,000	Wallace Heyen
TPF-5(326) Develop and Support Transportation Performance Management Capacity Development Needs for State DOT's	\$147,000.00	\$147,000.00	Tom Sands
TPF-5(288) Western Road Usage Charging Consortium	\$25,000.00	\$25,000.00	Vicki Kramer
TPF-5(384) Exploring Non-Traditional Methods to Obtain Vehicle Volume and Class Data	\$50,000.00	\$50,000.00	David Schoenmaker
TPF-5(372) BIM for Bridges and Structures	N/A	\$20,000.00	Fouad Jaber
Solicitation 1500 EconWorks - Improved Economic Insight	N/A	\$4,000.00	Ryan Huff

Expected Commitment for FY 2021: \$463,000.00

In Progress Federal Funded Research



In Progress Research Search Link <https://dot.nebraska.gov/media/113431/ndot-active-research-projects.pdf>

Materials, Pavements and Maintenance

Project Number	Research Proposal Title	Principal Investigator	Focus Area	Year Funded	Total Cost
M080	Feasibility and Implementation of Balanced Mix Design in Nebraska	Jiong Hu	Materials	2018	\$119,942.00
M084	Evaluation of Mixtures and Pavement Performance for Rehabilitation Methods	Jiong Hu	Materials	2018	\$103,517.00
M111	High-Mast Tower Foundation	Chungwook Sim	Materials	2019	\$47,196.00
M112	Data Analysis of Nebraska Pavements Containing RAP	Yong-Rak Kim	Materials	2019	\$97,523.00
M114	Best Practices to Address Issues of Excess Aggregate Dust in Nebraska	Jiong Hu	Materials	2019	\$130,158.00
M115	Research on High-RAP Mixtures with Rejuvenators - Field Implementation	Hamzeh Haghshenas	Materials	2019	\$99,950.00
M116	Effect of Antioxidant Additives and Restorations on Performance of Asphalt Binders and Mixtures – Phase I	Hamzeh Haghshenas	Materials	2019	\$270,000.00

Traffic, Safety, Planning, Transit and Intelligent Transportation Systems (ITS)

Project Number	Research Proposal Title	Principal Investigator	Focus Area	Year Funded	Total Cost
M050	Preparing for a Driverless Future	Daniel Piatkowski	Planning	2019	\$107,060.00
M091	Nebraska Rail Crossing Safety Research	Aemal Khattak	Traffic	2018	\$149,892.00
M092	Research on School Zone Safety	Aemal Khattak	Traffic	2018	\$177,888.00
M095	A Big Data Approach for Improving Nebraska Cycling Routes	Fadi Alsaleem	Planning	2019	\$65,179.00
M096	Evaluating ASCT operations for Dodge Street Corridor	Anuj Sharma	Planning	2019	\$103,025.00
M097	Investigation of Weather Conditions and their relationship to crashes	Mark Anderson	Traffic	2019	\$191,758.00
M098	Investing In Bicycle Infrastructure To Spur Statewide Economic Growth Through Bicycle Tourism	Daniel Piatkowski	Planning	2019	\$62,704.00
M100	A Statewide Geographic Information System (GIS) as a Predictive Tool for Locating Deeply Buried Archeological Deposits in Nebraska	Rob Bozell	GIS	2019	\$97,398.00
M117	Research and Education for Optimizing the Development and Implementation of an Unmanned Aircraft Program at the Nebraska Department of Transportation	Wayne Woldt	GIS	2019	\$93,472.00

In Progress Federal Funded Research



In Progress Research Search Link <https://dot.nebraska.gov/media/113431/ndot-active-research-projects.pdf>

Structures and Geotechnical

Project Number	Research Proposal Title	Principal Investigator	Focus Area	Year Funded	Total Cost
M030	Truck Platooning Effects on Girder Bridges	Joshua Steelman	Structures	2019	\$114,363.00
M068	Cost-Efficient, TL-2 Bridge Rail for Low Volume Roads	Scott Rosenbaugh	Structures	2016	\$59,763.00
M086	Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field	Ece Erdogan	Structures	2018	\$88,138.00
M087	Design Optimization and Monitoring of Joint-Less Integral and Semi-Integral Abutment Bridges in Nebraska	Chungwook Sim	Structures	2018	\$142,312.00
M088	Supporting Bridge Management with Advanced Analysis and Machine Learning	Joshua Steelman	Structures	2018	\$85,574.00
M102	Phase Construction Bridges: Monitoring and Analysis for Traffic-Induced Vibration	Christine Wittich	Structures	2019	\$117,482.00
M103	Simple for Dead Continuous for Live (SDCL) Steel Girder Bridges with UHPC and GFRP	Joshua Steelman	Structures	2019	\$132,358.00
M104	Data-Driven Prioritization and Empirical Predictions for Bridge Scour in Nebraska	Richard Wood	Structures	2019	\$115,662.00
M105	Low-Cost Modal Identification Sensors of Bridge Field Testing	Daniel Linzell	Structures	2019	\$142,519.00
M106	Feasibility Study: Alternatives to Prevent Settlements and Bumps at Bridge Approaches in Nebraska	Seunghye Kim	Structures	2019	\$99,469.00
M107	Outdoor Laboratory and Testbed for Bridge health	Richard Wood	Structures	2019	\$115,074.00
M108	Design and Detailing of Cast-in-Place and Precast Concrete Approach Slabs	George Morcous	Structures	2019	\$78,648.00
M109	To Automate, Detecting, Quantifying and Mapping of Delamination of Bridge Decks using Aerial Thermographic NDE	Zhigang Shen	Structures	2019	\$109,844.00
M110	Biopolymerized slope/subgrade stabilization and advanced field monitoring	Chung Song	Geotechnical	2019	\$103,828.00
M113	Detection of Flaws in Asphalt Overlaid Concrete Decks Using Ultrasonic Guided Waves	Ece Erdogan	Structures	2019	\$52,957.00

Newly Funded Research and In-House Research Projects

Project Number	<u>New Funded Project Title</u>	Focus Area
FY21(001)	An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways	Maintenance
FY21(002)	Development of Guideline for the Use of Geosynthetic in Different Roadway Layered Systems in Nebraska	Geotechnical
FY21(003)	Effect of Antioxidant Additives and Recycling Agents on Performance of Asphalt Binders and Mixtures - Phase II	Materials/Asphalt
FY21(004)	Midwest Guardrail System (MGS) Thrie Beam Approach Guardrail Transition (AGT) Retrofit to Existing Concrete Parapets and Bridges	Structures
FY21(005)	UHPC Decked I-Beam for Accelerated Bridge Construction	Structures
FY21(006)	Rapid Concrete Bridge Repair Survey and Patch Material Evaluation	Materials/Concrete
FY21(007)	Intelligent Work Zone Using Automatic Queue Detection (AQD) Systems	Traffic
FY21(008)	Estimating System and Traveler Costs Due to Lane Closures During Construction and Maintenance Operations	Traffic
FY21(009)	Energy Dissipation Optimization for Circular Culverts	Hydraulics
FY21(010)	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support	Structures
FY21(011)	Establishment of Wildflower Islands to Enhance Roadside Health, Ecological Value, and Aesthetics - Phase II	Environmental
FY21(012)	Field Demonstration of GPR and UAV technologies for Evaluation of Missouri River Bridge	Structures

<u>New In-House Project Title</u>	Focus Area
Air content Requirement for NDOT Concrete Pavement with Reduced Cement Content when using the tarantula curve.	Materials/Concrete
Evaluation of Reducing Cement Content for NDOT 47BD Concrete – Bridge Decks	Materials/Concrete
Evaluation for the implementation of the SAM for NDOT Concrete Pavement	Materials/Concrete
Colloidal Silica : Cement Enhancing Admixture	Materials/Concrete
Breaking the Ice- Deicers/Mechanical Rocker Field Implementation	Materials/Maintenance
Accelerated Corrosion Test	Materials/Maintenance
Expansion Joint Research	Pavement Design
Evaluating the consistency and reliability of testing for modulus under doweled concrete pavement	Pavement Design
Deflection Target Values - Follow up Implementation	Geotechnical
Erosion Characteristics of Nebraska's group index soils	Geotechnical
Pavement Patching Materials -KMT-2 Asphalt Recycler	Materials/Asphalt

2019-2020 Completed Funded and In-House Research Projects

Completed Research by Focus Area Link <https://dot.nebraska.gov/business-center/research/>

Project Number	<u>Completed</u> Funded Project Title	Focus Area
M026	Long-Term Performance Evaluation of NUDECK	Structures
M040	Improvement of Low Traffic Volume Gravel Roads in Nebraska	Geotechnical
M058	Establishment of Wildflower Islands to Enhance Roadsides for Pollinators Health and Aesthetics	Environmental
M060	Offset Right-Turn Lanes on State Highway Systems	Traffic
M061	Nebraska Specific Slope Design Manual	Geotechnical
M062	Performance Evaluation of Inverted Tee (IT) Bridge System	Structures
M064	Standard Design for Nebraska County Bridges	Structures
M065	Condition Assessment of Bridge Decks with Asphalt Overlay	Structures
M069	Evaluation of Reducing Cement Content in NDOR Class R combined Aggregate Gradations	Materials/Concrete
M070	High-RAP Mixtures with Rejuvenators and WMA Additives - Phase II	Materials/Asphalt
M071	Development of High Performance Rapid Patching Materials for Pavement Repair	Materials/Concrete
M072	Feasibility Study of Development of UHPC for Highway Bridge Applications in Nebraska	Materials/Concrete
M073	Development of a DSR Test Method to Determine Binder Low Temperature Properties	Materials/Asphalt
M074	Development of a Non-Destructive Testing (NDT) Tool for in-Situ Assessment of Prestressed Components	Structures
M075	Development and Implementation of a Moving Nondestructive Evaluation Platform for Bridge Deck Inspection	Structures
M076	CPT Based Pile Design	Geotechnical
M077	Restricted Crossings on Rural Highways	Traffic
M078	Assessing the Impact of Game Day Schedule and Opponents on Travel Patterns and Route	Traffic
M079	Remediating Soil for Successful Vegetation Establishment along Nebraska Highways	Environmental
M081	Correlation Analysis of MDSS and NEWINS	Maintenance
M082	Early Detection of Near-Surface Void Defects in Concrete Pavement Using Drone-Based Thermography and GPR Methods	Construction
M083	Application of Internal Curing to Improve Concrete Bridge Deck Performance	Materials/Concrete
M085	Precast Concrete Deck-to-Girder Connection Using UHPC	Structures
M090	Synthesis for Repair Practices for Damaged Precast/Prestressed Concrete Girders	Structures

<u>Completed</u> In-House Project Title	Focus Area
Evaluation of Nebraska's Aggregate Reactivity by the Miniature Concrete Prism Test Method – AASHTO T380	Materials/Concrete
Validation of the Mechanical Rocker Test Method for Ice Melting Capacity (MRT-IMC)	Materials/Maintenance
Compressive Strength of Concrete Cylinders by Sulphur, Neoprene Pads and Grinding Methods	Materials/Concrete
Evaluation of Tie-Bar Anchoring Methods: Non-Shrink Grout vs. Epoxy	Materials/Concrete
Investigating the Interaction of NDOT Hot-Pour PCC Joint Sealant and Penetrating Concrete Sealers	Materials/Concrete
Asphalt Binder Laboratory Short-Term Aging	Materials/Asphalt
Effect of Moisture Condition on Concrete Core Strengths	Materials/Concrete
Utilizing Kryton KIM Technology in Bridge Deck and Rail Construction to Protect Against Chloride Ion Penetration	Materials/Concrete

Technology Transfers

Technology Transfers Link

<https://dot.nebraska.gov/business-center/research/technology-transfers/>

University of Nebraska–Lincoln Local Technical Assistance Program (LTAP)

University of Nebraska–Lincoln (UNL) has a complete archive of all Nebraska Department of Transportation research reports. These reports are accessible to people all over the world. The research being done is helping infrastructure departments and workers in Nebraska and beyond. Please click to review all [NDOT Research Report](#) on UNL's website.



National Academies of Sciences, Engineering, and Medicine Transportation Research Board (TRB)

Their mission is to promote innovation and progress in transportation through research. Track National Trends, including Nebraska Department of Transportation research projects, through [TRB Publications Index](#).



The Midwest Roadside Safety Facility (MwRSF)



A research organization, which is part of the University of Nebraska-Lincoln, with a main focus of researching all aspects of highway design and safety. MwRSF conducts safety performance evaluations of various roadside appurtenances, developing new and innovative design concepts and technologies in the area of highway safety.

[MwRSF's Lasted Published Research](#)

Outdoor Laboratory and Testbed for Bridge Health

The facility site has one overarching objective to transform two bridge sites (for a total of three bridges) into a national research and educational facility for bridge health and testing. This allows access for nondestructive evaluation and destructive test verifications. Furthermore, this site is set up to permit future research projects and identify strategic directions for this first-of-its-kind facility on realistic aging infrastructure. This involves using decommissioned and under-used steel and concrete bridge structures in Nebraska. [Nebraska Outdoor Bridge Laboratory Webpage!](#)



U.S Department of Transportation and Federal Highway Administration



- Volpe Center
- Midwest Resource Center
- Federal Highway Administration Research Library
- FHWA Division Office Planning and Research Engineer
- Office of Corporate Research, Technology and Innovation Management



TRID
the TRIS and ITRD database

[TRID](#) is an integrated database that combines the records from TRB's Transportation Research Information Services ([TRIS](#)) Database and the OECD's Joint Transport Research Centre's International Transport Research Documentation ([ITRD](#)) Database. TRID provides access to more than 1.25 million records of transportation research worldwide.

In the Know Highlights

Council of University Transportation Centers (CUTC) Workforce Development and Technology Transfer Leadership Award

The CUTC Workforce Development and Technology Transfer Leadership Award is given to an institution that demonstrates outstanding leadership in designing and delivering workforce development and/or technology transfer programs. The award was presented to Director Dr. Laurence Rilett on behalf of the University of Nebraska-Lincoln's Mid-America Transportation Center (MATC) at the CUTC Annual Awards Banquet on Saturday January 11, 2020 at the Marriott Marquis in Washington, D.C.

MATC strives to engage student interest and involve underrepresented groups in the STEM field to create a more diverse future in transportation. The theme of MATC is improving safety and minimizing risk associated with increasing multi-modal freight movements on the U.S. surface transportation system.



Director Dr. Laurence Rilett & CUTC President Dr. Thomas O'Brian

MATC consortium partners include the University of Nebraska-Lincoln (UNL), University of Omaha, University of Nebraska Medical Center, University of Iowa, University of Kansas, University of Kansas Medical Center, Lincoln University, Nebraska Indian Community College, and Missouri University of Science and Technology. UNL serves as the lead institution and is where MATC headquarters are located.

2020 Kenneth A. Stonex Roadside Safety Award

The Kenneth A. Stonex Roadside Safety Award was established in 1991 to recognize lifetime contributions to roadside safety. The award was presented to MwRSF Director and UNL Research Professor Dr. Ronald Faller at the 99th Transportation Research Board meeting at the Walter E. Washington Convention Center, in Washington, D.C.

According to the award committee, "For over 30 years, Dr. Ron Faller has advanced the field of roadside hardware design through an unparalleled combination of engineering excellence, leadership, service, and overall dedication to the safety of the motoring public."



Ronald Faller & Roger Bligh

AFB20's 2020 Best Paper Award

The award-winning paper "Development of a Test level 4, Side-Mounted, Steel-Tube Bridge Rail" received the award at the 99th Transportation Research Board meeting at the Walter E. Washington Convention Center, in Washington, D.C. MwRSF has received this award for the fifth year in a row.

Authors are Jennifer Rasmussen, Scott Rosenbaugh, Ronald Faller, Bob Bielenberg, Joshua Steelman, Oscar Pena and Pascual Mauricio.

The Hub Corner for Information

Executive Summaries and Implementation

<https://dot.nebraska.gov/business-center/research/summaries/>



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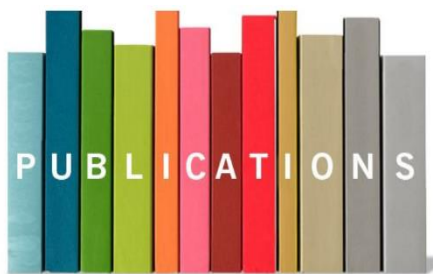
Research Projects



Find Active and Completed NDOT Research under "Research"

<https://dot.nebraska.gov/business-center/research/>

You can help shape research and innovation projects in your subject area by serving on a Technical Advisory Committee (TAC). Involvement may include meeting throughout the life of the research project assisting developing work plans and reviewing final deliverables impacting the Nebraska's transportation. Please contact the research section at ndot.research@nebraska.gov



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