NEBRASKA

Good Life. Great Journey.

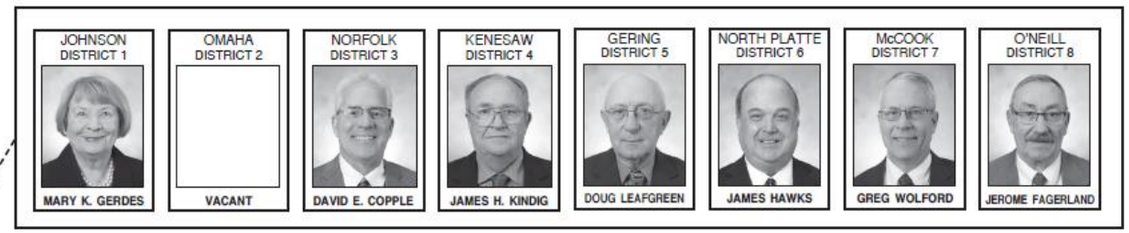
DEPARTMENT OF TRANSPORTATION

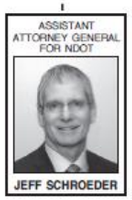
Nebraska Research Work Program

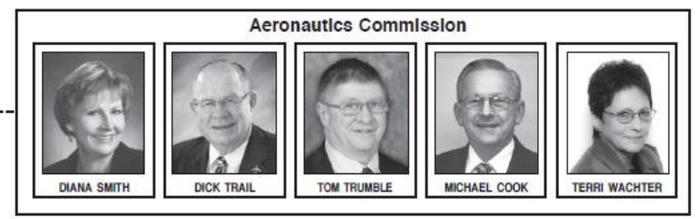
Fiscal Year 2021
July 1, 2020
to
June 30, 2021

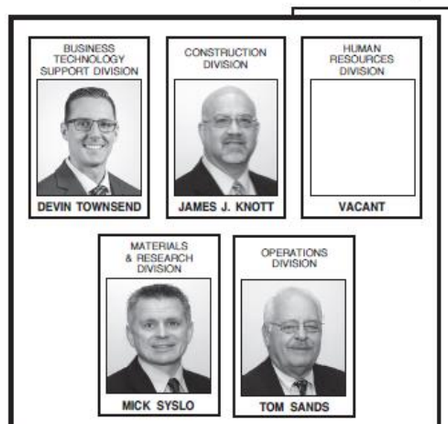
NEBRASKA
DEPARTMENT OF TRANSPORTATION
ORGANIZATION CHART

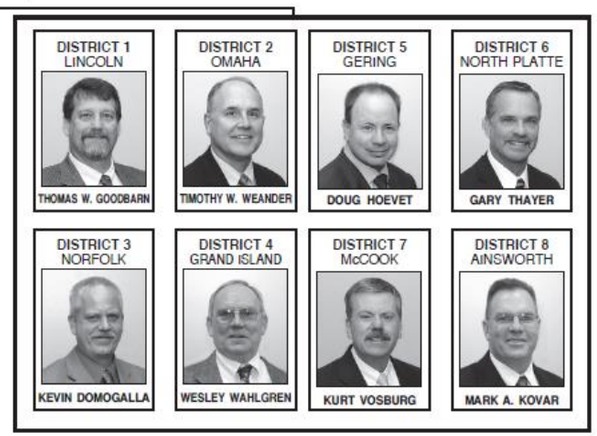
4-6-2020





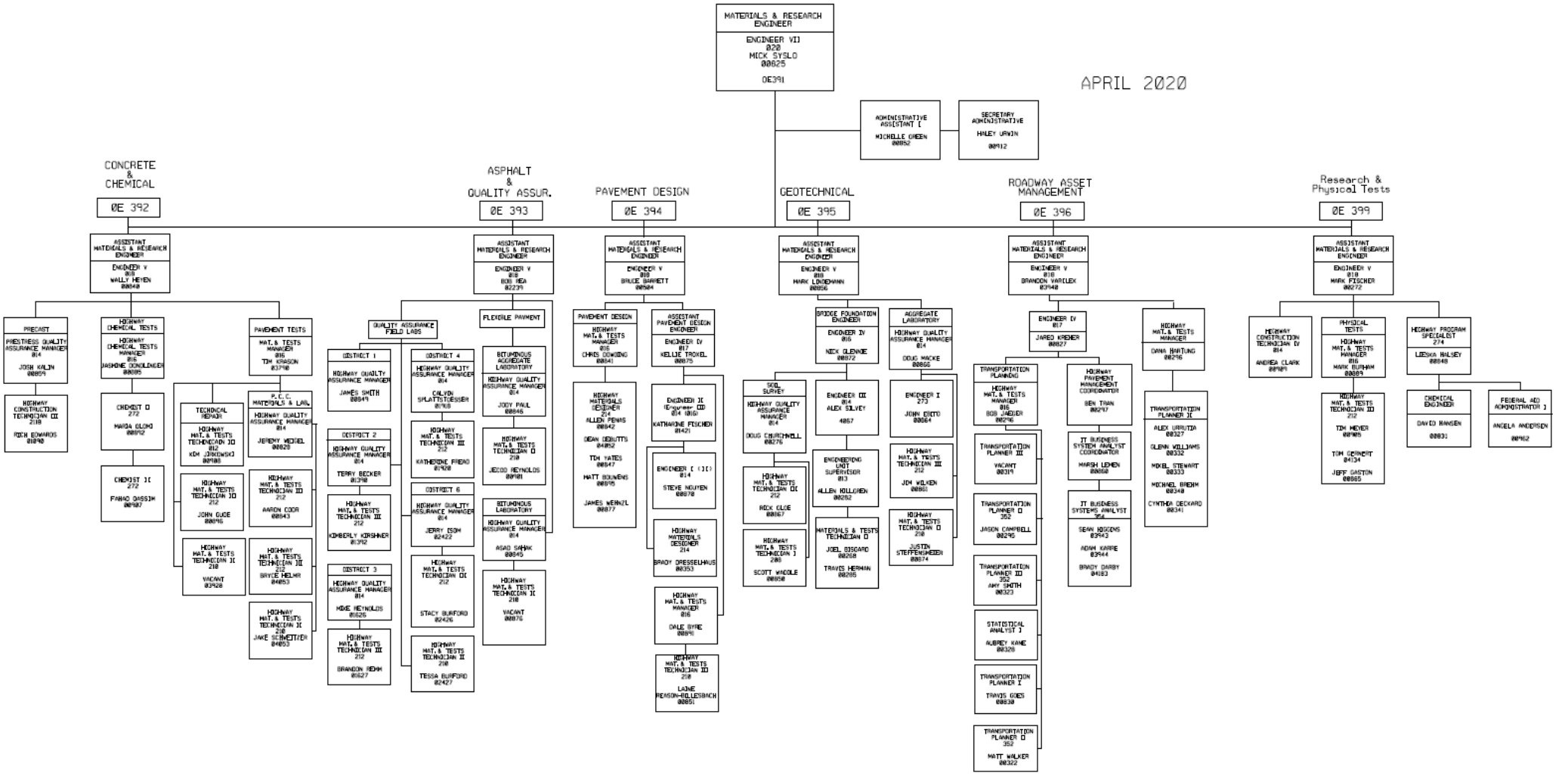






MATERIALS & RESEARCH DIVISION ORGANIZATIONAL CHART
OE 390

APRIL 2020



Research Coordination and Research Program Management

Mission/Objective

To coordinate the departments Research Program, with the following 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 interrelationship of socioeconomic, environmental and technical factors into the transportation system and
6) Implement favorable findings into departmental procedures and processes

Accomplishments FY-2020

1) In June of 2019, the solicitation was made to the entire State of Nebraska for Statements of Need for FY-2020 funding
2) October 7th and 8th, 2019, the Nebraska Transportation Research Council prioritized the Statements of Need in each focus group. NDOT Research Staff requested research proposals for the top twenty-two (22) Statements of Need.
3) November 1 through 15, 2019, NDOT organized and held 22 framework review meetings placing technical experts with the researchers to develop a proposal to help accomplish the department's mission.
4) On January 30, 2020, NDOT's Research Section conducted the RAC meeting and established the FY-2021 Research Program, adding twelve (12) new SPR projects. NDOT expended approximately $1,697,958.00 in FY-2020 for all on-going research projects and provided financial support to TRB and NCHRP.
5) Throughout the year, the Research Staff has held numerous Technical Advisory Committee meeting on in progress and completed research. To date NDOT hosted seventy-seven (77) update meetings in this fiscal year.
6) NDOT continues to be the lead state for the Midwest States Regional Pooled Fund Program - TPF-5(193) and transitioned this project to a new project number, TPF-5(430).
7) Started updating the researcher guidelines. Met with the university administration and researchers to discuss changes to the guide and request input.
8) Updated the agreement with the University of Nebraska-Lincoln.
9) Updated the NDOT Research Web page
10) Provided a new final report template for researchers
11) Complete and distribute a research newsletter.
12) Developed Executive Summaries and Implementation standard form for research projects completed this year.

Research Work Program Goals FY-2021

1) Establish the FY-2022 research program.
2) Monitor research projects and assist Technical Advisory Committees.
3) Assist with implementation of research results.
4) Work closely with our primary researchers on:
    A) Submission of progress and final reports
    B) Presentation to department personnel
    C) Development of one-page technical summaries
    D) Assistance in implementation of research results
    E) Researcher Guidelines
5) Administration of the Regional Pooled Fund Program activities, which are conducted at the University of Nebraska—Midwest Roadside Safety Facility.
6) Compile an Annual Work Program Report to be distributed to all States, Federal Highway Administration, Nebraska Transportation Research Council Members, Research Advisory Committee Members and NDOT Divisions and Districts.
7) Enhance Technology Transfer activities regarding NDOT Research Projects throughout Nebraska.
8) Distribute, collect and publish evaluations on each completed project
9) Update research program manual and researcher guidelines
10) Attend a peer exchange and begin planning to host a peer exchange.

Pooled Fund Participation Summary (100% Federally Funded) and Transfers			
STUDY TITLES	FUNDING TYPE	EXPENDITURES LAST YEAR	BUDGET PROGRAM YEAR
TPF-5(430) Midwest Roadside Safety Pooled Fund Program	Z560	$65,000	$65,000
TPF-5(447) Traffic Control Device (TCD) Consortium	Z560	$15,000	$15,000
TPF-5(438) Smart Work Zone Deployment Initiative	Z560	$25,000	$25,000
TPF-5(353) Clear Roads Phase II	Z560	$25,000	$25,000
TPF-5(347) Development of Maintenance Decision Support System	Z560	$30,000	$30,000
TPF-5(437) Technology Transfer Concrete Consortium	Z560	$12,000	$12,000
TPF-5(432) Bridge Element Deterioration for Mid-west States	Z560	$20,000	$20,000
TPF-5(317) Evaluation of Low Cost Safety Improvements	Z560	$5,000	$5,000
TPF-5(448) Improving Specifications to Reisist Frost Damage in Modern Concrete Mixes	Z560	$20,000	$20,000
TPF-3(326) Develop and Support Transportation Performance Management Capacity Development Needs for State DOT's	Z560	$147,000	$147,000
TPF-5(384) Exploring Non-Traditional Methods to Obtain Vehicle Volume and Class Data	Z560	$50,000	$50,000
TPF-5(451) Western Road Usage Charging Consortium	Z560	$25,000	$25,000
TPF-5(372) Building Information Modeling (BIM) for Bridges and Structures	Z560	-	$20,000
Solicitation 1500 EconWorks - Improved Economic Insight	Z550	-	$4,000
Transportation Research Board (TRB) Transfer	Z560	$90,743	$92,739
National Cooperative Highway Research Program (NCHRP) Transfer	Z560	$343,997	$360,165
			$915,904

1. Budget numbers as of 4/28/2020
2. Budget shows expenses that may not be entered into FMIS

MIDWEST ROADSIDE POOLED FUND BUDGET REPORT

TPF-5(193) CONTROL NO.: 00778

SUPPLEMENT NUMBER	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
	ACTIVE PROJECTS			
#74	Redesign of Low-Tension Cable Barrier Adjacent to Steep Slopes	$124,345	$91,797	$32,548
#86	Phase II Conceptual Development of an Impact Attenuation System	$256,184	$176,937	$79,247
#88	Evaluation of New Jersey TCB Performance under MASH TL-3	$702,369	$653,914	$48,455
#91	Design Guidance for MGS Placed on or neat Slopes	$54,309	$20,687	$33,622
#93	Development of Top Mounted Socket for Weak-Post Guardrail on Culverts	$130,538	$104,654	$25,884
#101	Iowa DOT Combination Bridge Separation Barrier with Bicycle Railing	$254,445	$193,398	$61,047
#106	Evaluation of the MGS with Curb	$161,926	$86,807	$75,119
#107	Continuation of Standardized Concrete Parapet for Attachments of Thrie Beam AGT's	$128,145	$77,830	$50,315
#111	Annual Fee to Finish TF-13 and FHWA Standard Plans	$3,998	$546	$3,452
#116	MASH TL-4 Steel-Tube Bridge Rail and Guardrail Transition	$926,851	$745,808	$181,043
#119	Portable Concrete Barrier - Steel Cover Plate for Large Open Joints	$172,816	$153,851	$18,965
#120	Steel Post Version of Downstream Anchorage System	$174,972	$72,852	$102,120
#122	MASH Testing of Single-Post, U-Channel Sign Support	$195,238	$80,441	$114,797
#123	MASH Testing of Thrie Beam Bullnose System - Phase II	$410,766	$187,775	$222,991
#128	Dynamic Testing and Evaluation of a New York State DOT Transition between Boxed Guardrail Under AASHTO MASH 2016 TL-3 Guidelines	$236,626	$131,404	$105,222
#130	Iowa - Development and Evaluation of a MASH TL-3 Compliance Parapet Mounted	$120,088	$119,088	$1,000
#131	Iowa - Sloped Ends 2: Crash Safety Evaluation of Concrete Barrier	$75,000	$70,418	$4,582
#132	Evaluation of Modified Thrie Beam Guardrail Under MASH TL-3	$157,217	$146,785	$10,432
#133	CALTRANS LS-DYNA Simulation Consulting Support	$31,391	$2,411	$28,980
#134	NYSDOT MASH 2016 Safety Hardware Evaluations - Phase 1	$955,951	$493,113	$462,838
#135	MASH 2016 Safety Hardware Evaluation	$1,033,463	$273,134	$760,329
#138	NDOT Redesign of the High-Tension Cable Median Barrier	$241,000	$176,340	$64,660

MIDWEST ROADSIDE POOLED FUND BUDGET REPORT				
TPF-5(193) CONTROL NO.: 00778				
SUPPLEMENT NUMBER	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
#139	NDOT Evaluation of Permanent Concrete Barrier	$163,621	$29,265	$134,356
#140	Evaluation of MGS with Curb and Omitted Post - Continuation	$111,133	$79,829	$31,304
#141	Guidelines for Flaring Thrie-Beam Approach Guardrail Transition	$72,411	$60,455	$11,956
#142	NDOT Generic End Terminal - Phase II	$325,393	$96,567	$228,826
#143	MASH 2016 Implementation Support	$401,000	$7,110	$393,890
#144	Midwest Pooled Fund MASH Hardware Clearinghouse	$51,206	$41	$51,165
#145	NDOT Q & A Improvements	$30,852	$4,633	$26,219
#146	Revision to Midwest Pooled Fund Q & A Website	$49,745	$7,272	$42,473
#147	Annual Consulting Services Support	$62,001	$32,993	$29,008
#148	Pooled Fund Center for Highway Safety	$13,340	$878	$12,462
#149	LS-DYNA Modeling Enhancement Support	$42,366	$0	$42,366
#151	Development of an Optimized MASH TL-4 Kansas Corral Rail	$401,400	$78,054	$323,346
#152	MASH 2016 Safety Hardware Evaluation - Phase 1	$1,239,301	$18,109	$1,221,192
#154	MASH Testing of Single Sign Support	$750,000	$444	$749,556
		$10,261,407	$4,475,638	$5,785,769

1. Budget numbers as of 4/28/2020
2. Budget shows expenses that may not be entered into FMIS

MIDWEST ROADSIDE SAFETY POOLED FUND BUDGET REPORT				
TPF-5(430) CONTROL NO.: 01010				
SUPPLEMENT NUMBER	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
ACTIVE PROJECTS				
#1	RPFP-20-MGS-2: MGS with Reduced Embedment and Post Spacing over Low-Fill Culverts (Indiana)	$185,912	$0	$185,912
#2	RPFP-20-AGT-1: Additional Retrofit Options for Post Conflicts within AGTs (New Jersey)	$251,429	$0	$251,429
#3	Guidelines for Flaring Thrie-Beam Approach Guardrail Transitions - Phase II	$302,783	$0	$302,783
#4	RPFP-2--TERM-1: Further Evaluation of the End Terminals Adjacent to Curb (New Jersey)	$257,208	$0	$257,208
#5	RPFP-20-SR-1: Development of a Short-Radius Guardrail for Intersecting Driveways or Roadways (New Jersey)	$251,032	$0	$251,032
#6	RPFP-20-CONSULT: Annual Consulting Services Support	$60,647	$0	$60,647
#7	RPFP-20-PFCHS: Pooled Fund Center for Highway Safety	$14,330	$0	$14,330
#8	RPFP-20-LS-DYNA: LS-DYNA Modeling Enhancement Support	$30,616	$0	$30,616
#11	Review of Median Barrier Warrants Based and ISPE of Cable Median Barriers (CMBs) In Kansas-Phase I (Kansas)	$32,907	$11,165	$21,742
#13	FY19-Iowa-Sloped Ends-2: Crash Safety Evaluation of Concrete Barrier Sloped End Treatments	$14,996	$0	$14,996
#14	Phase 2 Review of Median Barrier Warrants and ISPE of Cable Median Barriers (CMBs) In Kansas: Median Barrier Warrants	$108,065	$0	$108,065
		$1,509,925	$11,165	$1,498,760

1. Budget numbers as of 4/28/2020
2. Budget shows expenses that may not be entered into FMIS

FY2021 RESEARCH PROGRAM

CURRENT OBLIGATION

SPR-P1(20) CN # 00730L

PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	TOTAL EXPENDITURES	REMAINING BUDGET
SPR RESEARCH IN PROGRESS					
M030	Z560	Truck Platooning Effects on Girder Bridges	$114,363	$22,911	$91,452
M050	Z560	Preparing for a Driverless Future	$107,060	$36,197	$70,863
M068	Z560	Cost-Efficient, TL-2 Bridge Rail for Low Volume Roads	$309,141	$175,676	$133,465
M080	Z560	Feasibility and Implementation of Balanced Mix Design in Nebraska	$119,942	$55,825	$64,117
M084	Z560	Evaluation of Mixtures and Pavement Performance for Rehabilitation Methods	$103,517	$20,242	$83,275
M086	Z560	Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field	$88,138	$60,140	$27,998
M087	Z560	Design Optimization and Monitoring of Joint-less Integral and Semi-Integral Abutment Bridges in Nebraska	$167,687	$142,118	$25,569
M088	Z560	Supporting Bridge Management with Advanced Analysis and Machine Learning	$85,574	$59,835	$25,739
M091	Z560	Nebraska Rail Crossing Safety Research	$149,892	$56,523	$93,369
M092	Z560	Research on School Zone Safety	$177,888	$121,657	$56,231
M095	Z560	A Big Data Approach for Improving Nebraska Cycling Routes	$65,179	$38,344	$26,835
M096	Z560	Evaluating ASCT Operation for Dodge Street Corridor	$103,025	$29,334	$73,691
M097	Z560	Investigation of Weather Conditions and their Relationship to Crashes	$191,758	$47,030	$144,728
M098	Z560	Investing in Bicycle Infrustructure to Spur Statewide Economic Growth Through Bicycle Tourism	$62,704	$31,820	$30,884
M100	Z560	A Statewide Geographic Information System as a Predictive Tool for Locating Deeply Buried Archelogical Deposits	$97,398	$0	$97,398
M102	Z560	Phased Construction Bridges: Monitoring and Anlaysis for Traffic-Induced Vibration	$117,482	$33,069	$84,413
M103	Z560	Simple for Dead Continuous for Live (SDCL) Steel Girder Bridges with UHPC and GRFP	$132,358	$27,865	$104,493
M104	Z560	Data-Driven Prioritization and Empirical Prediction for Scour of Rural Bridges in Nebraska	$115,662	$16,661	$99,001
M105	Z560	Low-Cost Modal identification sensors of bridge field testing	$142,519	$57,238	$85,281
M106	Z560	Feasibility Study: Alternatives to Prevent Settlements and Bumps at Bridge Approaches in Nebraska	$99,469	$24,815	$74,654
M107	Z560	Outdoor Laboratory and Testbed for Bridge Health	$115,074	$10,897	$104,177
M108	Z560	Design and Detailing of Cast-in-Place and Precast Concrete Approach Slabss	$78,648	$0	$78,648
M109	Z560	To Automate Detecting, Quantifying and Mapping of Delamination of Bridge Decks using Aerial Thermographic NDE	$109,844	$82,050	$27,794

CURRENT OBLIGATION					
SPR-P1(20) CN # 00730L					
PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	TOTAL EXPENDITURES	REMAINING BUDGET
M110	Z560	Biopolymerized slop stablilization and advanced field monitoring	$124,386	$48,211	$76,175
M111	Z560	High-Mast Tower Foundations	$47,196	$12,450	$34,746
M112	Z560	Data Anlaysis of Nebraska Pavments Containing RAP	$97,523	$0	$97,523
M113	Z560	Detection of Flaws with Asphalt Overlaid Concrete Decks Using Ultrasonic Guided Waves	$52,957	$6,621	$46,336
M114	Z560	Best Practices to Address Issues of Excess Aggregate Dust in Nebraska	$130,158	$14,152	$116,006
M115	Z560	Research on High-RAP Mixtures with Rejuvenators - Field Implementation	$99,950	$1,004	$98,946
M116	Z560	Effect of Antioxidant Additives and Restorators on Performance of Asphalt Binders and Mixtures – Phase I	$170,662	$30,874	$139,788
M117	Z560	Implementation of an Unmanned Aircraft Program at the Nebraska Department of Transportation	$93,472	$44,193	$49,279
M118	Z560	USGS Water Resources Investigation	$35,000	$32,420	$2,580
BUDGET FOR IN PROGRESS SPR-P1(20) PROJECTS			$3,680,251	$1,340,169	$2,340,082
P100	Z560	Contingencies	$759,164	$40,406	$718,758 *
P089	Z560	Research Implementation	$50,000	$0	$50,000
P088	Z560	Administration	$6,000	$0	$6,000
SPR-P1(20) CONTROL #00730L TOTAL BUDGET			$4,503,851	$1,471,318	$3,032,533

* Remaining contingency will be used to fund the 2nd year of the currently obligated projects

1. Budget numbers as of 4/28/2020
2. Budget shows expenses that may not be entered into FMIS

FY2021 RESEARCH PROGRAM						
CONTROL NUMBER	PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
NEW PROJECTS						
01021	SPR-FY21(001)	Z560	An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways	$164,730	$0	$164,730
01021A	SPR-FY21(002)	Z560	Development of Guideline for the Use of Geosynthetics in Different Roadway Layered System in Nebraska	$106,536	$0	$106,536
01021B	SPR-FY21(003)	Z560	Effect of Antioxidant Additives and Recycling Agents on Performance of Asphalt Binders and Mixtures – Phase II	$145,238	$0	$145,238
01021C	SPR-FY21(004)	Z560	Approach Guardrail Transition Retrofit to Existing Concrete Parapets and Bridges	$87,978	$0	$87,978
01021D	SPR-FY21(005)	Z560	UHPC Decked I-Beam for Accelerated Bridge Construction	$98,251	$0	$98,251
01021E	SPR-FY21(006)	Z560	Rapid Concrete Bridge Repair Survey and Patch Material Evaluation	$93,572	$0	$93,572
01021F	SPR-FY21(007)	Z560	Intelligent Work Zone Using Automatic Queue Detection (AQD) Systems	$159,466	$0	$159,466
01021G	SPR-FY21(008)	Z560	Estimating System and Traveler Costs Due to Lane Closures During Construction and Maintenance Operations	$179,500	$0	$179,500
01021H	SPR-FY21(009)	Z560	Energy Dissipation Optimization for Circular Culverts	$107,088	$0	$107,088
01021J	SPR-FY21(010)	Z560	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support	$164,927	$0	$164,927
01021K	SPR-FY21(011)	Z560	Establishment of Wildflower Islands to Enhance Roadside Health, Ecological	$171,275	$0	$171,275
01021L	SPR-FY21(012)	Z560	Field Demonstration of GPR and UAV Technologies for Evaluation of Missouri River Bridge	$25,517	$0	$25,517
			TOTAL NEW PROJECTS	$1,504,078	$0	$1,504,078

Current Projects in Progress

PROJECT NUMBER	M030
PROJECT TITLE	Truck Platooning Effects on Girder Bridges
PRINCIPAL INVESTIGATOR	Joshua Steelman, Jay Puckett and Daniel Linzell – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Babrak Niazi, Emilie Hudon
PROJECT TOTAL COSTS	$114,363
PROJECT EXPENDITURES TO DATE	$22,911
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	30%
STATUS	On-Schedule
FY-2021 BUDGET	$91,452
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3, 4 & 5

Background: Truck platooning is anticipated to become increasingly prominent in the near future (Trimble et al., 2018e). Most research and development efforts have been focused on traffic operations and vehicle control. The structural safety of bridges carrying increased load from truck platoons has not yet been thoroughly studied, but DOTs will need to ensure that their structural assets will not be compromised before allowing platooning operations in their jurisdictions

Objective: This project will enable the Nebraska DOT to keep pace with advancements in autonomous vehicles while also maintaining structural safety for girder bridges in their transportation network. Revisiting the reliability implications with reduced truck loading uncertainty could possibly justify allowing heavier vehicles than routinely allowed when justified by data sharing from trucking companies combined with effective automated enforcement strategies.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$17,795	100%
Task 2: Parametric Reliability Analyses	$25,032	28%
Task 3: Parametric Demand Parameter Analyses	$27,072	0%
Task 4: Aggregation and Formulation of Guidelines	$24,192	0%
Task 5: Documentation and Presentation	$20,273	0%

Deliverables: The research team will produce actionable guidelines for safe truck platoon configurations corresponding to the data provided by the trucking company and the structures on the targeted route. As automated vehicle control systems continue to develop, the findings from this research could be integrated with software packages (e.g., AASHTOWare) to automatically configure optimal configurations at each structure for a specified platoon. The trucks in the platoon could then dynamically adjust configuration when transitioning between roadways on grade and particular bridge structures. This research will provide the baseline work for the highly automated systems that will be forthcoming in the next decade and will inform associated policy decisions.

Performance & Goals: The PI and the Research Team are currently about 30% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M050
PROJECT TITLE	Preparing for driverless future
PRINCIPAL INVESTIGATOR	Daniel Piatkowski and Santosh Pitla – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Craig Wacker, Dillon Dittmer, Ryan Huff, Curtis Nosal
PROJECT TOTAL COSTS	$107,060
PROJECT EXPENDITURES TO DATE	$36,197
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	50%
STATUS	On-Schedule
FY-2021 BUDGET	$70,863
FY-2021 TASKS TO BE COMPLETED	Tasks 3, 5, 6 & 7

Background: Autonomous vehicles (AVs) are widely considered to be the future of surface transportation in the US, but little is understood about how people will interact with these vehicles, what they will use them for, and how they will impact our roads. However, farmers have been interacting with some degree of AV technology, primarily auto-guidance, in Nebraska for at least the last 10 years. This research first aims to identify what transportation engineers and planners can learn from the agricultural sector when it comes to preparing for a driverless future. We then aim to understand the transportation implications of AVs for rural Nebraskans to help with NDOT planning efforts around this technology. The researchers will first interview farmers and autonomous farm equipment sellers to understand existing issues and their implications for our roads.

Objective: This research is necessary to address fundamental questions regarding AVs, including:

- What are the lessons learned from partially-autonomous farm equipment usage?
- What are rural Nebraskans perceptions of autonomous vehicles?
- How can engineers, planners, and policy-makers to be proactive in preparing for AVs?

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Search	$5,230	100%
Task 2: Identifying current AV Technology users	$12,101	100%
Task 3: Interviewing current AV users	$17,220	0%
Task 4: Developing a survey of rural Nebraskans perspectives of AVs	$28,535	100%
Task 5: Surveying rural Nebraskans	$14,504	0%
Task 6: Data Analysis	$18,954	0%
Task 7: Final Report and Documentation	$10,517	0%

Deliverables: The research will provide a set of conclusions, recommendations, and guidelines for how NDOT and the state of Nebraska can best prepare for, and benefit from, technological innovations in driverless technologies on our roads. Implementation and utilization of the research will be via NDOT and applicable stakeholders and practitioners.

Performance & Goals: The PI and the Research Team are currently about 50% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M068
PROJECT TITLE	Cost-Efficient, TL-2 Bridge Rail for Low Volume Roads
PRINCIPAL INVESTIGATOR	Scott Rosenbaugh, Ron Faller and Bob Bielenberg – UNL
PROJECT START DATE	2/9/2017
INITIAL COMPLETION DATE	8/31/2018
EXTENSION DATE	8/31/2020
TECHNICAL ADVISORY COMMITTEE	Mark Traynowicz, Phil TenHulzen, Fouad Jaber, Mark Ahlman, Joel Rossman, Mark Mainelli, Chris Lane
PROJECT TOTAL COSTS	$309,141
PROJECT EXPENDITURES TO DATE	$175,676
NUMBER OF EXTENSIONS GRANTED	Two
PERCENTAGE OF PROJECT COMPLETE	80%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$133,465
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: In 2016, the Nebraska State Legislature passed bill LB960 to adopt the Transportation Innovation Act. A portion of this act created a voluntary county bridge match assistance program intended to aid Nebraska counties in replacing deteriorated bridges. This program was targeted for the numerous bridges located on rural, low-volume roadways that need immediate attention. With the replacement of these bridges, new bridge rails and approach guardrail systems will also be necessary to provide safety to the motoring public.

Due to the large number of deficient bridges slated for replacement, these new bridges need to be constructed in a timely and cost- efficient manner. As such, the associated bridge railings should be optimized to minimize costs while satisfying current safety standards. The bridge rail should be mounted to the side of the bridge deck in order to maximize the traversable width of the bridge, and the railing should prevent damage to deck. For convenience, one bridge rail design is desired to treat all of the future installation sites for these rural bridges. Due to the low traffic volume associated with these bridges (50 – 500 ADT), a bridge railing that satisfies the Test Level 2 (TL-2) performance criteria of the Manual for Assessing Safety Hardware (MASH) is warrant rather than using more expensive TL-3 systems typically used on higher-speed, higher-volume roadways. Thus, a new TL-2 bridge rail is desired to provide an economical treatment for rural, low volume roads.

Objective: The research objectives for this project include the development and full-scale crash testing of a TL-2 bridge railing for use on rural, low-volume roadways. The bridge railing shall utilize side-mounted, weak steel posts in order to limit encroachment of the system over the bridge deck. Additionally, the bridge railing shall limit damage to the bridge deck during impact events. A detailed analysis of the required length of need will be performed to identify the minimum length of the guardrail adjacent to the bridge and limit the total installation costs. All crash testing will be conducted and reported according to the TL-2 safety requirements found in MASH.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Project Planning and Correspondence	$26,553	80%
Task 2: Design and Analysis	$57,285	65%
Task 3: Dynamic Component Testing and Full-Scale Crash Testing	$208,661	98%
Task 4: Reporting and Project Deliverables	$16,642	15%

Deliverables: MwRSF will work closely with NDOT engineers and TAC committee members throughout the design and evaluation of the optimized TL-2 bridge rail to ensure that the system evaluation meets the needs of NDOT. Once the W-beam bridge rail has been crash tested, evaluated, and declared eligible for federal reimbursement by FHWA, NDOT can implement the system into its Standard Plans. Finally, the publication and dissemination of the research results and demonstration program, in the form of research reports, presentations, and refereed journal papers, will aid the rapid transfer of this new technology to all interested organizations.

Performance & Goals: This research project was recently funded out of contingency funds and officially began on February 2, 2017. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. This project is on approved revised schedule, with 80% of the project completed and a completion date of August 31, 2020.

PROJECT NUMBER	M080
PROJECT TITLE	Feasibility and Implementation of Balanced Mix Design in Nebraska
PRINCIPAL INVESTIGATOR	Yong-Rak Kim – UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	9/15/2020
TECHNICAL ADVISORY COMMITTEE	Jody Paul, Mike Reynolds, Robert Rea, Hamzeh Haghshenas, Bruce Barret, Shin-Che Huang (FHWA)
PROJECT TOTAL COSTS	$119,942
PROJECT EXPENDITURES TO DATE	$55,825
NUMBER OF EXTENSIONS GRANTED	Two
PERCENTAGE OF PROJECT COMPLETE	75%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$64,117
FY-2021TASKS TO BE COMPLETED	Tasks 2, 3 & 4

Background: Balanced mix design (BMD) is an alternative mix design concept that is getting a lot of attention from the pavement community. It incorporates two or more mechanical performance tests, such as a rutting test and a cracking test, to assess how well the mixture resists common forms of distress. The BMD is considered as overcoming several issues in the current Superpave volumetric mix design, where proportioning of the aggregates and the asphalt binder relies primarily on empirical aggregate quality characteristics and mixture volumetric properties. Calculation of the volumetric properties is highly dependent on an accurate determination of the specific gravity of the mix components, which is not easy nor accurate with current test methods. Furthermore, the complexity and inaccuracy increase with the incorporation of reclaimed asphalt pavements (RAP) and foreign additives such as warm- mix additives, polymers, rejuvenators, and fibers. Therefore, performance tests need to be included as part of the mix design procedure to help ensure desirable pavement performance in the field.

Objective: The overall goal of this research effort is to examine the feasibility of the BMD approach for Nebraska pavements and to develop a potential implementation plan of the method if it appears feasible.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$14,381	100%
Task 2: Experimental Tests of Nebraska Mixtures for a NE-BMD Method	$54,156	63%
Task 3: Data Analysis of Test Results for Feasibility-Implementation	$28,956	25%
Task 4: Documentation and Presentation	$22,449	0%

Deliverables: Research findings will improve Nebraska's pavement engineering. The new mix design concept, if feasible and is being implemented in our state, will change our current volumetric mixture design method. It will also enable the more engineered use of local paving materials and better-performing pavements due to the addition of a performance based concept into the mixture design process. Ultimately, this research will contribute to a more engineered and better performing implementation of paving materials in Nebraska by providing core information and practical insights.

Performance & Goals: Yong-Rak and his Research Team are currently about 75% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings.

PROJECT NUMBER	M084
PROJECT TITLE	Evaluation of Mixtures and Pavement Performance for Rehabilitation Methods
PRINCIPAL INVESTIGATOR	Yong-Rak Kim - UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	9/15/2020
TECHNICAL ADVISORY COMMITTEE	Brandon Varilek, Bruce Barrett, Robert Rea, Shin-Che Huang (FHWA)
PROJECT TOTAL COSTS	$103,517
PROJECT EXPENDITURES TO DATE	$20,242
NUMBER OF EXTENSIONS GRANTED	Two
PERCENTAGE OF PROJECT COMPLETE	65%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$83,275
FY-2021TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: About 75% of 3R pavement rehabilitation practices in Nebraska is by milling old 4-in. asphalt surface and placing a new 4-in. layer. Another 10% is a deeper replacement such as 5-in. mill/fill or 6-in. mill/fill. Traditionally, NDOT has used one mix for the 4-in. strategy; previously 4-in. of the SP4 mix, now 4-in. of the SPR mix. For deeper rehabilitation, NDOT has been using a combination of SRM with SPR or SLX. SRM usually allows 35-65% RAP (reclaimed asphalt pavement) with a coarser mix gradation so that high stiffness can be achieved. The incorporation of high-RAP brings cost savings and the preservation of the environment and natural resources (due to more recycling). SLX is a thin-lift overlay that enables fast construction and provides various functional features, such as riding quality, smoothness, skid resistance, silence, and the drainage capability of the asphalt wearing course for about 8-10years of service.

NDOT is interested in investigating if a combination of 3-in. SRM and 1-in. SLX or 2.5-in. SRM and 1.5-in. SPR can be used for the 4- in. rehabilitation practice in addition to deeper rehabilitation strategies using SRM.

To improve pavement engineering practices in Nebraska, there is a clear need to look into the feasibility and potential applications of overlay configurations with more economical mixes such as SRM in our state, and this requires research efforts.

Objective: The research objective is to test several different mixtures and use mixture properties to investigate pavement performance and LCC analysis when they are used in different rehabilitation practices in Nebraska.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$13,438	15%
Task 2: Laboratory Tests of Nebraska Mixes	$33,789	39%
Task 3: Pavement Performance Analysis	$18,781	27%
Task 4: Life Cycle Cost Analysis of Different Strategies	$19,699	0%
Task 5: Documentation and Presentation	$17,811	0%

Deliverables: Research findings will advance Nebraska's pavement engineering. It will also enable the more engineered use of local paving materials including recycling materials and better-performing pavements. Successful accomplishment of this research would bring cost savings due to more optimized use of materials and less long-term performance maintenance.

Performance & Goals: Yong-Rak and the Research Team are currently about 65% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings.

PROJECT NUMBER	M086
PROJECT TITLE	Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field
PRINCIPAL INVESTIGATOR	Ece Erdogmus – UNO
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	6/30/2020
TECHNICAL ADVISORY COMMITTEE	Babrak Niazi, Fouad Jaber, Mark Traynowicz, Lieska Halsey, Wally Heyen, Kent Miller, Mike Vigil, David Mraz (FHWA)
PROJECT TOTAL COSTS	$88,138
PROJECT EXPENDITURES TO DATE	$60,140
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	68%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$27,998
FY-2021TASKS TO BE COMPLETED	Tasks 3 & 4

Background: Until recently, there were no methods for structural health monitoring of new reinforced concrete bridge decks, or diagnosis of existing ones, with the sensitivity to detect the early onset of various types of deterioration. Past and current NDOT- UNL collaboration on this topic by our team has developed a novel technique and succeeded in answering this gap. This method involves leakage of ultrasonic guided waves (UGW). In this method, the waves leaked from the wave guide (steel rebar) are detected by an array of receivers (R) placed on the surface of the concrete. Based on the location of the R, the increase or decrease in the amplitude of the detected waves, if read in the frequency domain, can be compared to theoretical expectations and a prediction can be made on the type, size, and location of one of the following flaws: corrosion, delamination, and cracking in concrete independent of rebars.

While these accomplishments are exciting, they have all taken place in the controlled environment of a laboratory. By leaving the end of the rebar exposed, the attachment of the transmitter to the rebar has not been an issue, it was accomplished by simple grease- coupling. Also, by avoiding interference from the environment, signals have been clear and repeatable; and no issues were observed with damage to the equipment over time. As such, the next step is to make this method more practical by developing ways to overcome issues that will occur on the field.

Objective: The ultimate goal of this 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.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Design of Experiments	$9,111	100%
Task 2: Laboratory Experiments	$4,837	100%
Task 3: Field Implementation	$65,473	60%
Task 4: Development of Deliverables	$8,718	75%

Deliverables: It is envisioned that once all of the research and development on the method is completed, NDOT can have their dedicated equipment and technical staff to take measurements on instrumented bridge decks and monitor their deterioration profile over time. One of the benefits of this method is that, if the right equipment is used, the interpretation of data is not as complicated as some of the other methods that only give graphical results.

Performance & Goals: Ece and the Research Team are currently about 68% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by June 30, 2020.

PROJECT NUMBER	M087
PROJECT TITLE	Design Optimization and Monitoring of Joint-less Integral and Semi-Integral Abutment Bridges in Nebraska
PRINCIPAL INVESTIGATOR	Chungwook Sim, Jongwon Eun, and Seunghee Kim – UNO, Chung Song – UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	8/15/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Joel Rossman, Mike Vigil, Jason Volz, Steve Sabra, Lynden Vanderveen, David Mraz (FHWA)
PROJECT TOTAL COSTS	$167,687
PROJECT EXPENDITURES TO DATE	$142,118
NUMBER OF EXTENSIONS GRANTED	Two
PERCENTAGE OF PROJECT COMPLETE	90%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$25,569
FY-2021TASKS TO BE COMPLETED	Tasks 2

Background: There are more than 9,000 integral abutment bridges and 4,000 semi-integral abutment bridges in the U.S., which increased dramatically in the past two decades (White 2nd, 2007). Nebraska is no exception – there are hundreds of integral and semi- integral abutment bridges in the state of Nebraska, and thus guidelines and specifications for these structures listed on the Bridge Office Policies and Procedures (BOPP, 2016). The obvious advantage of using integral abutment bridges is their reduced construction and maintenance costs by eliminating bearings and expansion joints that make the bridge "joint-less". This also fits well with Nebraska's "well-timed" bridge preservation practice of eliminating problems before they occur. Despite the wide acceptance in usage (more than 40 States are using integral abutment bridges) and the advantage listed above, integral and semi-integral abutment bridges are often built with specific limitations under each State's bridge design manuals; and the design primarily relies on limited empirical data. Noticeably, small numbers of problems were reported because these bridges were built within limitations of specific skew angles, pile types, span lengths, and construction practices to name a few.

Objective: The research objective of this project is to monitor the integral and semi-integral abutment bridges in Nebraska to: 1) obtain data for future design and construction practices for wider applications (longer spans, increased skew angles, improve design details in connections), 2) thoroughly understand the complex long-term behavior of soil-structure interactions (interaction between deck/abutment connection, soil/pile behavior both in integral and semi-integral bridges, backfill/abutment), and 3) better maintain existing structures (repair and strengthen if needed). Our multidisciplinary team of structural and geotechnical engineers will carefully investigate the loads produced in abutments over the Nebraska integral abutment bridges, measure the load displacement of piles with fiber optic sensing, examine ratcheting effects (passive pressure increase and inward residual displacement) and voids or settlement under approach span of these structures.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review/Field Investigation	$13,333	100%
Task 2: Field Instrumentation/Monitoring	$97,262	80%
Task 3: Numerical Simulation	$42,810	100%
Task 4: Design Recommendations	$14,282	50%

Deliverables: The end results of this research project will be the design and construction recommendations that can be integrated statewide or countywide for joint-less integral and semi integral abutment bridges. The recommendations will be incorporated into the NDOT BOPP manual as well as the NDOT Standard Specifications for Highway construction, which can be used for statewide and countywide implementation. The project staff intends to work with NDOT and Nebraska counties to ensure successful adoption and implementation. It is also anticipated that these recommendations will directly influence the maximum span lengths, skew angles, design considerations, and details outlined by the FHWA Technical Advisory.

Performance & Goals: The PIs and the Research Team are currently about 90% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by August 15, 2021.

PROJECT NUMBER	M088
PROJECT TITLE	Supporting Bridge Management with Advanced Analysis and Machine Learning
PRINCIPAL INVESTIGATOR	Joshua Steelman – UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	5/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Babrak Niazi, Kent Miller, Wayne Patras, David Mraz (FHWA)
PROJECT TOTAL COSTS	$85,574
PROJECT EXPENDITURES TO DATE	$59,835
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	75%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$25,739
FY-2021TASKS TO BE COMPLETED	Tasks 3, 4 & 5

Background: This project seeks to provide easy access to an approximation of advanced structural analysis, allowing practicing engineers to more accurately calculate bridge load ratings without needing to perform rigorous analyses themselves. Advanced analysis can provide insight into whether or not bridge management intervention is necessary. Rigorous modeling can sometimes reveal unacknowledged capacity overlooked in traditional simplified models. This existing but unacknowledged capacity can potentially be sufficient to justify removal of load posting and deferral of bridge maintenance or replacement. Effectively managing the bridge inventory serves several strategic goals identified by the Nebraska Department of Transportation, particularly by balancing safety and fiscal responsibility.

Objective: The primary objective of this research is to investigate and demonstrate the validity and usefulness of ANNs as a supplementary tool for bridge load rating and bridge management decision-making, substantiated through validation with diagnostic bridge tests. This research will calibrate and/or refine an existing, preliminary ANN model to better serve the needs of NDOT, by expanding the ANN training data with Nebraska bridges and integrating reliability into the ANN predictions consistently with AASHTO LRFD/R.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Bridge Selection	$2,918	100%
Task 2: Preliminary Analyses	$21,417	100%
Task 3: Field Tests	$20,392	75%
Task 4: Modeling Calibration and Neural Network Modeling	$31,448	34%
Task 5: Documentation	$9,398	30%

Deliverables: The primary functional deliverable (readily accessible to practitioners) for this project will be an Excel workbook, allowing load rating engineers to quickly estimate (and directly use, at their discretion) the potential benefits of refined analysis and/or load testing. Bridge owners will be able to rationally substantiate decisions to defer maintenance or replacement for bridges in the inventory. Alternatively, bridge owners can potentially raise or remove load restrictions for bridges. The primary benefits of the proposed research will be easy and rapid access to knowledge of the degree to which any individual bridge represented by the ANN training offers these benefits

Performance & Goals: The PI and the Research Team are currently about 75% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by May 31, 2020.

PROJECT NUMBER	M091
PROJECT TITLE	Nebraska Rail Crossing Safety Research
PRINCIPAL INVESTIGATOR	Aemal Khattak and Larry Rilett – UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Roger Figard, Dan Waddle, Don Butler, Jodi Gibson, Todd Palmer, Travis Haberman, Mark Lutjeharms, Larry Legg, Abe Anshasi (FHWA)
PROJECT TOTAL COSTS	$149,892
PROJECT EXPENDITURES TO DATE	$56,523
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	35.27%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$93,369
FY-2021TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background: Safety at the junction of highways and rails has been a concern for a long time. In the United States, more than 97% of these crossings are at-grade, meaning they are at the same level. While trains have the right-of-way, every year a number of crashes occur when highway users fail to yield the right-of-way to trains. Crashes at rail crossings are invariably more severe compared to crashes on the rest of the transportation network due to train involvement. In 2015, the number of crashes reported at rail crossings in the United States was 2,060, resulting in 237 fatalities; fatal crashes were 11.5% of the total reported incidents. Rail crossing safety models have been around since the 1940s. Some of the more prominent models include the Peabody Dimmick Formula, the NCHRP Hazard Index, and the USDOT Accident Prediction Formula. Based on crashes reported at rail crossings, these models predict future crashes at rail crossings; the results provide a ranking of competing rail crossings for the expenditure of limited safety funds.

The Nebraska Department of Transportation (NDOT) currently uses the Nebraska Accident Prediction Model for rail crossings to identify and rank crossings that may need scrutiny and perhaps subsequent safety improvements. Developed by the Midwest Research Institute (under contract to HNTB Corp.) in 1999, this crash prediction model was based on 5-year rail crossing accidents and inventory data from September 1993 through August 1998. It updated the previously used 1973 NDOR Hazard Index (a modified version of the NCHRP Report 50 Formula). The model over-predicts (about 10%), and results may not be optimal as many changes have occurred in terms of train and motor vehicle traffic, crash trends, and rail crossing inventory information. Other state DOTs (e.g., Iowa DOT) are in the process of updating their rail crossing crash prediction models. For acceptance and adoption by NDOT, the new model must outperform the existing NDOT Nebraska Accident Prediction Model for rail crossings.

Objective: The proposed research has two objectives: (1) update NDOT's Nebraska Accident Prediction Model for rail crossings using the latest crash and rail crossing inventory data, and (2) develop guidelines for improving safety (via uniformity of driver expectations) at urban rail crossings that are not Quiet Zones but are in vicinity of other Quiet Zone crossings.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Review	$21,317	95%
Task 2: Data Acquisition & AADT Update	$23,938	65%
Task 3: Accident Prediction Model Estimation & Validation	$19,110	55%
Task 4: Lancaster County Crossing Assessment	$32,702	20%
Task 5: Development of Guidelines	$28,575	0%
Task 6: Final Report and Documentation	$24,251	0%

Deliverables: The final deliverables from this research project will be a newly developed crash prediction model that will outperform the existing Nebraska Accident Prediction Model for rail crossings thereby allowing for more informed decisions regarding resource allocation for rail crossings. Guidelines for improving safety of urban crossings that are not Quiet Zone crossings will enable Nebraska public agencies to improve public safety and reduce possible liability from crashes at rail crossings.

Performance & Goals: The PIs and the Research Team are currently about 35.27% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by December 31, 2020.

PROJECT NUMBER	M092
PROJECT TITLE	Research on School Zone Safety
PRINCIPAL INVESTIGATOR	Aemal Khattak – UNL
PROJECT START DATE	7/1/2018
PROJECT COMPLETION DATE	6/15/2020
TECHNICAL ADVISORY COMMITTEE	Matt Neemann, Lonnie Burklund, Randy Hoskins, Alan Swanson, David Schoenmaker, Mark Lutjeharms, Abe Anshasi (FHWA)
PROJECT TOTAL COSTS	$177,888
PROJECT EXPENDITURES TO DATE	$121,657
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	70.36%
STATUS	On-Schedule
FY-2021 BUDGET	$56,231
FY-2021TASKS TO BE COMPLETED	Tasks 1, 4, 5 & 6

Background: The safety of children in the vicinity of schools is of paramount importance. School speed zones make areas around schools safer for children that may be walking or using bicycles. A common speed for motor vehicles in active school zones is 25 mph, although some school zones in Nebraska have lower or higher speeds limits in active school zones. Motorist speed compliance may vary in school zones with different speed differentials, i.e., motorists' speed reduction may be different when a speed limit changes from 45 mph to 25 mph in an active school zone versus a speed limit change from 35 mph to 25 mph. Additionally, there may be differences in motorist speed reduction depending on land use in the vicinity of schools and in urban versus rural settings. For example, motorist compliance with an active school zone speed limit may be higher when a school is visible from the street/roadway, crosswalks and signs are present, or when drop off/pick up lanes are adjacent to a school zone street/roadway. Similarly, motorist speed compliance may be different around schools in small rural communities (population less than 5,000) compared to schools in urban areas.

Objective: The proposed research has the following objectives: 1) Assess the effects of speed differential on motorist speed compliance in active school zones. 2) Investigate the effects of surrounding land use on motorists' speed in active school zones. 3) Quantify the safety benefits and costs associated with the creation of school zones. 4) Develop guidelines for school zone establishment in Nebraska.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Review	$16,079	95%
Task 2: Identify Data Collection Sites	$11,935	100%
Task 3: Collection of Motorist Speed Data at Different Sites	$64,858	100%
Task 4: Speed Data Analysis	$28,639	70%
Task 5: Development of Guidelines for Establishing School Zone	$17,766	30%
Task 6: Final Report and Documentation	$38,610	20%

Deliverables: The research will provide guidelines for NDOT and other public agencies in establishing school zones in a uniform manner to ensure the safety of children walking in proximity of schools. The research will provide a set of recommendations and guidelines for establishing school zones in various settings. Implementation and utilization of the research will be via NDOT and local public agencies.

Performance & Goals: The PI and the Research Team are currently about 70.36% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by June 15, 2020.

PROJECT NUMBER	M095
PROJECT TITLE	A Big Stata Approach for Improving Nebraska Cycling Routes
PRINCIPAL INVESTIGATOR	Fadi Alsaleem and Daniel Piatkowski - UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Julie Harris, Craig Wacker, Ryan Huff
PROJECT TOTAL COSTS	$65,179
PROJECT EXPENDITURES TO DATE	$38,344
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	60%
STATUS	On-Schedule
FY-2021 BUDGET	$26,835
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3, 4, 5 & 6

Background: Across the United States, cycling is becoming increasingly popular as users shift travel modes amid concerns of health, physical activity, air and environmental quality, and in an effort to escape roadway congestion. Unfortunately, the infrastructure in the U.S. (including Nebraska) traditionally caters to automobile traffic creating impediments for bikers and impacting their safety. To accommodate cycling, a major challenge is the lack of data to accurately assess the attributes of present assets and to inform additional investments to integrate bicycles into our transportation system. The goal of this project is to 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.

The Strava data, made available by the social fitness network company Strava, includes raw data for the hour-by-hour counts for bicycle trips (Fig.1 a) that have been mostly incorporated into existing maps for better visualization (Fig.1 b). In this project, we propose building a framework to extract more useful information from the large Strava data collected from Nebraska bikers over an extended period of time (Big data). This new information includes, but not limited to, the preferred bicycle routes and traffic patterns in Nebraska. While it is important to acknowledge that not all active transportation users utilize the Strava application, Strava users are the ones who typically ride in the road and would benefit from infrastructure improvements. Moreover, compared to the traditional methods of collecting data using human counters or electronic gates, Strava data covers wider areas and has a lower cost.

Objective: The primary project objective is to 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. A secondary objective is to provide information that may integrate into existing available databases, such as the NDOT geographic information system (GIS), to provide bikers with better routing information.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review and NDOT Meeting	$7,503	100%
Task 2: Nebraska Strava Datasets Review and Cleaning	$13,333	80%
Task 3: Strava Data Correlation with Stationary Counts	$8,475	80%
Task 4: Understand Bike Travel Patterns and Routes in Nebraska	$18,192	50%
Task 5: Advanced Analysis Report	$14,696	0%
Task 6: Final Report and Presentation	$2,980	0%

Deliverables: 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 might be stored in the NDOT data warehouse for future use and might be integrated with a GIS system.

Performance & Goals The PI and the Research Team are currently about 60% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M096
PROJECT TITLE	Evaluating ASCT operations for Dodge Street Corridor
PRINCIPAL INVESTIGATOR	Anuj Sharma - UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Vjad Zhuromski, Alan Swanson, Dan Waddle, Bryan Guy, Matt Neemann, Abe Anshasi (FHWA)
PROJECT TOTAL COSTS	$103,025
PROJECT EXPENDITURES TO DATE	$29,334
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	40%
STATUS	On-Schedule
FY-2021 BUDGET	$73,691
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 3, 4 & 5

Background: Maintaining arterial corridors that has a high volume of traffic and high density of intersections, is a matter of primary importance to the Traffic Division of any city. Traditionally Traffic Division maintained these traffic signals in three ways - entirely pre- programmed (pre-timed signals), partially based on actuations (partially actuated), or entirely based upon sensor actuations (fully actuated) (Koonce et al. 2010). However, all these type of signals need some retiming every three to five years which involves a lot of human effort in solving complicated optimization problems (Gordon 2010). In order to circumvent the effort of retiming, Adaptive Control Signal Technology (ASCT) was developed. ASCT tends to maximize the capacity of the existing system which reduces the cost to both the users and the system operating agencies. ASCT has been seen to reduce the number of stops by 28%-41 % (Hicks and Carter 1997), reduce crashes by 35% (Anzek, Kavran, and Badanjak 2005), and reduce the travel time on the corridors by 35%-39% (Sims and Dobinson 1980). However, the agencies implementing ASCT ends up spending $6,000 to $65,000 per intersection. Further, one-third of the agencies find ASCT to malfunction in over-saturated conditions (Stevanovic 2010). Also, the initial set-up has also been found to be labor intensive.
The City of Omaha has planned to set up the ASCT the Dodge Street corridor. This will involve setting up adaptive signals along 9 intersections of the corridor and 6 along other major roads. A detailed evaluation of the performance of the ASCT is to be studied in this project to determine its benefits to the City of Omaha.

Objective: The objectives of this study is to determine the efficiency of the ASCT on Dodge Street. The following benefits of the Dodge Street are to be studied in details: Operational efficiencies during normal conditions, Operational efficacies during anomalous situations, performance during over-saturation and safety concerns. The study will detail out the performance gains and any observed shortcomings of the ASCT with respect to the four categories listed.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Meeting with TAC members	$300	0%
Task 2: Literature Review	$5,700	100%
Task 3: Data Access and Field Data Collection	$40,000	80%
Task 4: Analysis	$49,025	50%
Task 5: Final Report	$8,000	0%

Deliverables: Nebraska has some of two of the top 15 biggest Midwest cities -Omaha and Lincoln located in close proximity which have very high and fluctuating traffic. ASCT seems to an option to handle such traffic. However, the ASCT has also been seen to malfunction under certain situations in the past. This project will highlight whether ASCT can handle the different variations of traffic on Dodge Street, Omaha. Owing to improvements in the traffic, the Traffic Division of Nebraska DOT can also aim to extent ASCT across other critical regions.

Performance & Goals The PI and the Research Team are currently about 40% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M097
PROJECT TITLE	Investigation of Weather Conditions and Their Relationship to Crashes
PRINCIPAL INVESTIGATOR	Mark R. Anderson and Aemal J. Khattak- UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Dan Waddle, Tom Sands, Mathew Baker, Don Butler
PROJECT TOTAL COSTS	$191,758
PROJECT EXPENDITURES TO DATE	$47,030
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	20%
STATUS	On-Schedule
FY-2021 BUDGET	$144,728
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6 & 7

Background: This project will investigate weather conditions and associated safety by analyzing start times of precipitation (e.g., snow, blowing snow with reduced visibilities, or even freezing rain} and the time of crashes on Nebraska Highways. The number of crashes and fatalities related to weather are relatively large when compared to other weather phenomena (e.g., tornadoes, hurricanes, etc.}. Questions such as how long had it be precipitating before a crash occurred are relevant to improving highway safety. Crash reports lack detailed weather information; this may be remedied by incorporating weather observations from National Weather Service (NWS} locations close to crash locations. It is also important to study whether there were NWS weather advisories, watches or warnings during or preceding a crash. There is literature regarding times of day and crashes with increases during the morning and evening commutes, however, there is not a lot of information dealing with weather conditions during those commute times. For Example, on Nebraska roads is it more likely to be involved in a crash in a winter weather condition during the morning or evening commute? Analysis of snow accumulation at selected observation locations indicates that there is a higher probability of accumulating snow for the morning rush hour than the evening rush period. Does the start time of precipitation help indicate when crashes will occur? Will crashes increase if precipitation starts several hours before the peak traffic hour? Preliminary analysis indicates that the number of crashes goes down with greater snowfall amount. More crashes occur with light snowfall amounts than with heavier amounts. However, severity of the crashes seems to increase with increasing snowfall amounts.

Objective: The main objective of this investigation is to correlate motor vehicle crash data to precise weather conditions associated with the time of the crash. We are limiting our investigation to when winter weather conditions could be a factor in the crash. This could include, snow fall resulting in snow covered roads, freezing rain causing icy conditions, low visibilities due to falling snow and/or high snowfall rates and strong wind speeds causing drifting snow onto the road surface. Statistical analyses can formulate what weather situation causes the greatest safety concerns, and what might be the appropriate maintenance response to those weather conditions. The crash data will be divided into fatalities/injuries and personal property damage. In addition, NWS forecasts will be analyzed before/during a crash to determine what weather information was available during the event.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC meeting and Literature review of crashes and weather conditions.	$26,203	90%
Task 2: Collection of Nebraska crash data.	$37,275	35%
Task 3: Collection of meteorological observations.	$37,124	35%
Task 4: Statistical analyses of the traffic crash data.	$23,986	0%
Task 5: Statistical analyses of the meteorological data.	$23,986	0%
Task 6 : Examination of the safety and meteorological information	$29,070	0%
Task 7: Final reports and presentations	$14,114	0%

Deliverables: The end result from this research project will be a better understanding of weather conditions and their relationship to crashes and we hope to answer questions such as can drivers be warned of weather conditions preceding a snowfall event to reduce crashes? As well, Pathfinder, is a collaboration between NDOT, NWS and a private weather enterprise will be initiated during the 2018 winter season to better prepare Nebraska citizens for dealing with winter driving conditions. The proposed project will help benefit all parties in better understanding what weather conditions precede crashes so that appropriate actions may be initiated to reduce crashes or crash severity in the future. Actions may be in the form of news releases to the general public, messages displayed on variable message signs before a weather event, and messages displayed during a weather event. The proposed project may also have implications for winter maintenance operations in Nebraska.

Performance & Goals The PI and the Research Team are currently about 20% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M098
PROJECT TITLE	Investing in bicycle infrastructure to spur stateside economic growth through bicycle tourism
PRINCIPAL INVESTIGATOR	Daniel Piatkowski and Fadi Alsaleem – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Julie Harris, Alex Duryea, Craig Wacker, Ryan Huff, Dan Waddle, Alan Swanson, Mike Owen, Curtis Nosal
PROJECT TOTAL COSTS	$62,704
PROJECT EXPENDITURES TO DATE	$31,820
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	50%
STATUS	On-Schedule
FY-2021 BUDGET	$30,884
FY-2021 TASKS TO BE COMPLETED	Tasks 3, 4 & 5

Background: Bicycle tourism is proving highly beneficial to local economies, particularly in small towns and rural areas. Bicycle tourism is a proven economic boost to states (the "Registered Annual Bicycle Ride across Greater Iowa" is estimated to generate upward of $350 million annually; bicycle tourism alone in Colorado has an estimated economic impact of over $700 million annually; and Wisconsin estimates $535 million in revenue from out-of-state bicycle tourism).

Bicycling, particularly bicycle tourism, is on the rise nationally. But currently Nebraska 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 (e.g., Cowboy Trail and MoPac Trail), but no organized effort to facilitate the creation of bike routes and build bike related features into highway projects. This stems from associated perception of risk and the additional costs. Intuitively or anecdotally, these routes would:

(i) direct bicycle traffic to safe routes and away from more hazardous ones (such as busy freight corridors),
(ii) capitalize on existing bicycle facilities in communities and regional ongoing rails-to-trails projects,
(iii) aid in long-term planning for prioritizing bicycle treatments where they are most likely to be used, and
(iv) foster economic development in communities across Nebraska.

NDOT will be developing a state bicycle route, and concurrently this research will assess the economic impact of such a route so as to better inform NDOT bicycle-related planning activities and return-on-investment of taxpayer dollars. We will a review of the impacts of bicycle tourism in neighboring (e.g., Iowa and Colorado) and other applicable (e.g., Oregon and Wisconsin) states to understand what Nebraska can do to maximize the economic benefits of bicycle tourism through bike infrastructure investments.

Objective: The objective of this work is to first conduct a robust economic impact analysis based on current recreational bicyclist volumes in the state of Nebraska (using data from the "Strava" app, already collected by the Co-PI) of the impact of bicycle tourism on the state. From there, future economic impacts of bicycling and bicycle tourism to the state of Nebraska will also be estimated based on growth- scenarios for increasing bicycle tourism (and associated economic impacts) for the state, while considering capital costs for NDOT in bicycle infrastructure. Then, using the results of the economic impact analysis, our final report will include economic impacts at multiple applicable geographies (from the state down to the zip-code level, depending on TAC priorities). Results will be essential for planning for maximizing benefits of bicycle tourism for all types of Nebraska communities (i.e., identifying key infrastructure needs, policies, and potential industries that should be put in place alongside investments in a bike route).

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Search	$7,212	100%
Task 2: Identify Regional Data Collection Sites	$7,212	100%
Task 3: Data Collection	$22,693	50%
Task 4: Conduct Economic Impact Analysis	$14,443	75%
Task 5: Final Report and Documentation	$10,933	0%

Deliverables: For NDOT, this work will provide an evidence base for the economic impacts of planning and capital investments in bicycle facilities. Benefits will also include identifying NDOT's role in fostering economic development through transportation infrastructure. Broader Impacts: The economic impacts of bicycling and bicycle tourism are well-studied, but determining what rural communities require to best benefit has not been studied. This work will establish NDOT as a national leader in using transportation investments to benefit (and potentially revitalize) rural communities.

Performance & Goals The PI and the Research Team are currently about 50% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M100
PROJECT TITLE	A statewide geographics information system as a predictive tool for locating deeply buried archeological deposits (Phase II)
PRINCIPAL INVESTIGATOR	Rob Bozell (History Nebraska, State Archeologist), Courtney Ziska (History Nebraska, Highway Archeology Program), Rolfe Mandel (University of Kansas, Kansas Geological Survey, Director and Distinguished Professor) and Anthony Layzell (University of Kansas, Kansas Geological Survey, Assistant Research Professor)
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Dillon Dittmer, Stacy Stupka
PROJECT TOTAL COSTS	$97,398
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	Behind Schedule
FY-2021 BUDGET	$97,398
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6, 7 & 8

Background: During 2016-2018, the Nebraska State Historical Society (now History Nebraska, HN) and the Kansas Geological Survey (KGS) collaborated on a research project funded through the NDOT Research Program. The effort created a GIS-based prediction tool to better estimate where deeply buried, and difficult to identify, archeological sites are likely to occur. The project serves to assist NDOT environmental planners and cultural resource consultants with an enhanced method to identify and avoid significant cultural properties during the transportation planning process (Layzell and Mandel 2018 and Layzell et al. 2018). Several large areas of Nebraska were not covered because available data were simply too limited. These areas include the following major drainage basins: Niobrara, White, central segments of the Platte, South Platte, and portions of the Loup (including the vast Sand Hills region drained by the North Loup, South Loup, Middle Loup, Dismal and Calamus rivers as well as numerous lakes). Improved data sets are now available for those drainages and we propose in this research project to extend the coverage to the entire state. To ensure state-wide coverage, the present proposal also includes field work to collect new data for select drainage basins.

Objective: The proposed project will be developed by HN as a collaborative effort with the KGS. The proposed project will add to the existing Phase I GIS-based data repository of all Nebraska geo-archeological information including: published and unpublished reports or portions of reports, bibliographies, stratigraphic profiles, radiocarbon ages, maps, notes, and photographs. These data will be linked to specific LSAs in specific stream valleys and drainage basins. The GIS will allow us to visualize the data in the form of maps and diagrams and reveal temporal and spatial patterns of landscape evolution in drainage basins. The complete statewide data set also will be organized in such a way that cultural resource specialists and transportation planners will be able to access a specific stream valley or portions of it and review the extant information for that area but a/so be able to use a GIS prediction tool to evaluate in general terms if the landscape has high, moderate or low potential to contain buried archeology and in specific settings such as floodplain, terrace, or fan. Depending on the past level of research effort and data quality, the predictive aspects of the GIS- layer will have the ability to extrapolate from one stream valley to others in the same basin of like rank-order. The results of the product are designed to be used in conjunction with more traditional archeological identification and assessment tools employed to understand shallower archeological materials.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Project Initiation and organization	$4,800	50%
Task 2: Collect and digitize reports and data for phase II regions	$1,950	0%
Task 3: Field Investigations in western Nebraska	$22,198	0%
Task 4: Refine GIS layer and add Phase II data	$58,450	0%
Task 5: Meet with TAC	$600	0%
Task 6: Update Final Report and GIS Users Guide for submission to TAC	$6,800	0%
Task 7: Revise Final Report and Users Guide based on TAC comments	$2,000	0%
Task 8: Final presentation to TAC	$600	0%

Deliverables: HN is poised to assemble the complete geomorphological data for Nebraska in such a way that it can be effectively used for NDOT and FHWA compliance with environmental regulations. The FHWA and NDOT are required under Section 106 of the National Historic Preservation Act and other laws/regulations to identify historic properties that might be impacted by highway construction. Historic properties can occur in the form of deeply buried prehistoric archeological sites dating between 1,000 and 12,000 years ago. Important deeply buried sites are preserved most often in stream valley terrace complexes, valley margins, and alluvial fans and rarely occur in uplands above or overlooking stream valleys.

Performance & Goals The PI and the Research Team are currently about 25% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. Discussion is in process to figure out the best path forward for this research.

PROJECT NUMBER	M102
PROJECT TITLE	Phased Construction Bridges Monitoring and Analysis for Traffic-Induced Vibration
PRINCIPAL INVESTIGATOR	Christine Wittich and Richard Wood – UNL, and George Morcous - UNO
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Joel Rossman, Jason Volz, David Mraz (FHWA)
PROJECT TOTAL COSTS	$117,482
PROJECT EXPENDITURES TO DATE	$33,069
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	27%
STATUS	On-Schedule
FY-2021 BUDGET	$84,413
FY-2021 TASKS TO BE COMPLETED	Task 1, 2, 3 & 4

Background: Due to the current state of deteriorating infrastructure in the region and country, the number of bridges in the state and in the country in need of replacement is expected to increase. However, the complete closure of a traffic route to allow for the construction of a new bridge is often not feasible -particularly in rural Nebraska, in which truck traffic is limited to few routes and is critical to the economic vitality of the state. To address this need and reduce detours, phased (staged) construction has become a very prevalent practice for bridge replacement, which allows the bridge to remain partially open to traffic throughout construction. While phased construction can be interpreted as a very broad term, herein it is defined as the situation where one segment of the bridge is constructed adjacent to an existing segment. Typically, the number of traffic lanes is reduced to allow for partial demolition of the bridge. Then, a new segment of the bridge is constructed -termed the first phase. Once traffic is re-routed to the new segment, the remaining bridge is demolished and replaced -the new construction termed he second phase. In most situations, rebar extends from the first phase deck and is spliced to the second phase deck reinforcement prior to pouring of the deck.

Objective: The primary objective of this research is to determine the amplitude, frequency, and duration of traffic-induced vibration that results in premature deterioration of concrete bridge decks in phased construction and identify methods for mitigating its effects.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review and Scope	$13,316	85%
Task 2: Field Monitoring of Bridges during Phased Construction	$29,649	75%
Task 3: Laboratory Evaluation of Traffic-Induced Vibration	$60,292	0%
Task 4: Recommendations and Reporting	$14,225	0%

Deliverables: As a result of this project, recommendations will be made to mitigate premature deterioration of concrete bridge decks poured during phased construction. If implemented, this will enhance the durability of Nebraska bridges reducing costs associated with deck maintenance, rehabilitation, and replacement. Furthermore, extensive cracking of phased construction bridge decks is a nationwide issue; and, recommendations developed in this project have the potential to impact construction practice around the United States and abroad.

Performance & Goals: The PI and the Research Team are currently about 27% complete with the project The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M103
PROJECT TITLE	Simple for Dead Continuous for Live (SDCL) Steel Girder Bridges with UHPC and GFRP
PRINCIPAL INVESTIGATOR	Joshua S. Steelman– UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Joel Rossman, Maher Tadros, Douglas Gremel, David Mraz (FHWA)
PROJECT TOTAL COSTS	$132,358
PROJECT EXPENDITURES TO DATE	$27,865
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	On-Schedule
FY-2021 BUDGET	$104,493
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3, 4, 5, 6, 7 & 8

Background: This research will investigate optimized construction methods for the diaphragm to provide comparable or superior constructability and structural performance, compared to existing SDCL for steel girder bridge details, when using ultra-high performance concrete (UHPC) at the girder continuity locations. Glass Fiber Reinforced Polymer {GFRP) in UHPC GFRP has been studied as a viable alternative to steel reinforcing to reduce life cycle costs for bridge structures, especially decks. The material behavior is well documented for uses in conventional concrete, but has not yet been thoroughly studied for uses in UHPC. The combination of UHPC and GFRP can offer an essentially maintenance-free structural system, with negligible cracking in the UHPC, and non-corrosive glass-reinforced polymer at crossing reinforcing bridging to conventional concrete in decks. The development length of steel reinforcing is known to be much shorter than in conventional concrete (Graybeal, 2014). Lap splices on the order of 5 to 6 inches have been implemented in practice for steel in UHPC. The required development and lap splice lengths for GFRP have received only limited attention at this time. Additionally, the susceptibility of steel crossing reinforcing to corrosion at the cold joint between conventional concrete and UHPC requires that concrete surfaces be roughened before placing UHPC. This additional labor cost can potentially be avoided by using GFRP. The availability of Owens Corning as a local resource in the state of Nebraska, and the willingness on the part of their company to collaborate and donate materials and expertise, present opportunities that will be leveraged in the proposed research for the benefit of NDOT.

Objective: The primary objectives of this research are to:

1. Develop details to optimize SDCL steel girder structural design and construction for material and construction efficiency with UHPC,
2. Identify available software tools for SDCL steel girder design and rating, and/or develop an action plan for modification to existing software, as applicable, and
3. Characterize development behavior and required embedment lengths for full development of GFRP bars in UHPC.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$3,977	100%
Task 2: SDCL Field Surveys	$2,253	20%
Task 3: Parametric SDCL Scoping Study	$12,164	50%
Task 4: GFRP in UHPC Direct Tension Tests	$12,775	25%
Task 5: GFRP Lap Splices in UHPC Deck Joint Tests	$10,778	25%
Task 6: Experimental SDCL Validation	$56,522	0%
Task 7: Software Integration Study	$18,751	0%
Task 8: Documentation and Presentation	$15,138	0%

Deliverables: The primary benefits of this project will be reduced cost for multi-span steel girder bridges and reduced life-cycle maintenance cost (potentially maintenance free) with more resilient joint construction. Additionally, this project will further extend the benefits of UHPC by documenting GFRP development behavior. The research will support the design option to use GFRP crossing reinforcing at cold joint interfaces between conventional concrete in the deck and UHPC in longitudinal deck closure joints. GFRP will be more tolerant of any de-icing chemical penetration that may occur through road surface paving and membranes. Therefore, using GFRP crossing reinforcing could justify waiving the surface roughening currently required to enhance interlock at conventional/UHPC cold joints. Lastly, the investigations into SDCL with UHPC at continuity joints and GFRP development in UHPC can potentially improve the longevity of the structure at continuity locations.

Performance & Goals: The PI and the Research Team are currently about 25% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M104
PROJECT TITLE	Data-Driven Prioritization and Empirical Predictions for Scour of Rural Bridges in Nebraska
PRINCIPAL INVESTIGATOR	Richard L. Wood, Christine E. Wittich, Junke Guo and Chung R. Song – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kirk Harvey, Jason Dayton
PROJECT TOTAL COSTS	$115,662
PROJECT EXPENDITURES TO DATE	$16,661
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	14%
STATUS	Behind Schedule
FY-2021 BUDGET	$99,001
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: Bridge scour is a leading cause of bridge closures and failures in the country and Nebraska [1]. Over the last few years, high-profile bridge closures in Nebraska have been widely publicized in the media-citing scour as the primary issue. Within the FHWA specified process, two critical steps rely on site-specific details. This includes step 2 -to develop hydraulic parameters and step 5 -to evaluate the results for reasonableness. Different materials will scour at various rates. Loose granular soils can rapidly erode by flowing water, whereas cohesive soils, which are common to specific areas of Nebraska, are more scour-resistant (61. However, HEC-18, in section 3.1, conservatively assumes that the ultimate scour in cohesive soils can be as deep as the scour in loose granular soils (or sands). While this assumption is expected to be conservative because of the increased critical shear stress in cohesive soils [9], this can lead to highly improbable scour estimates and the potential for over-designed and costly bridge foundations. However, significant challenges arise in order to verify the magnitude of scour for these varying soils. This is primarily due to the cyclic nature of the scour process where scour is deepest during the peak of a flood but may be hardly visible as floodwaters recede and scour holes fill with sediment. Therefore, there is a critical need to develop improved hydraulic parameters and to provide guidance on reasonableness for scour estimates that reflect Nebraska soils.

Objective: The first objective of this project is to reduce the uncertainty in the scour prediction equations specific to Nebraska soils and hydraulic conditions using empirical field data collected in this project. Particular attention will be paid to the scour predictions of clayey and cohesive soils, which are currently presumed to be overly conservative in the existing FHWA HEC-18 approach. The second objective of this project is to evaluate and provide guidance on reasonable scour estimates for Nebraska soil and hydraulic conditions. This objective is done to address engineering judgment on whether the numerical scour predictions are "unconservative" or "over- conservative". Guidance will be provided using real field measurements to benchmark and clarify the ranges of acceptable scour in this area from the highly detailed, high-fidelity site assessments.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review and Scope	$2,985	25%
Task 2: Geometric Data Collection and Temporal Scour Rates	$61,448	20%
Task 3: Site Characterization	$15,226	20%
Task 4: Data-Driven Scour Validation	$17,676	0%
Task 5: Reporting	$18,327	0%

Deliverables: This project will provide guidance on hydraulic parameters and reasonable scour estimates specific to Nebraska conditions. This will enable NDOT engineers to assess bridge sites for scour more confidently. In addition to these direct outcomes, this project is expected to result in the following: reduced bridge closures, structural savings for new bridge design, validation and/or limitations of existing scour predictions, enhanced knowledge of scour and model for other states/agencies.

Performance & Goals: The PI and the Research Team are currently about 14% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M105
PROJECT TITLE	Low-Cost Modal identification sensors of bridge field testing
PRINCIPAL INVESTIGATOR	Daniel G. Linzell and Saeed Eftekhar Azam – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Babrak Niazi
PROJECT TOTAL COSTS	$142,519
PROJECT EXPENDITURES TO DATE	$57,238
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	34%
STATUS	On-Schedule
FY-2021 BUDGET	$85,281
FY-2021 TASKS TO BE COMPLETED	Tasks 4, 5, 6 & 7

Background: This project seeks to provide a framework for experimental load rating of bridges via inclusion of low-cost vibration sensors and dynamic tests. Currently 25% of bridges in Nebraska are posted for live load. According to National Bridge Inventory in 2012, of all posted bridges in the US, 93% were posted using analytical load ratings, 7% were posted using field evaluation and engineering judgement, and only 1 % were posted using experimental load rating methods. Instrumentation costs and traffic interruptions can be problematic when load testing is necessary to accurately assess in-situ bridge live load capacity. Recent advances in (i) sensing technology and (ii) numerical methods used to process load test data permit more cost-effective data-enabled decision making. According to the AASHTO Manual for Bridge Evaluation (MBE), dynamic tests can be used for calibration of bridge numerical models that would enhance the value of a diagnostic test. This study aims to develop a procedure for selection and use of inexpensive, off the shelf vibration sensors for dynamic testing of typical bridges in Nebraska.

Objective: This project has one overarching objective: to provide a framework for experimental load rating of bridges via inclusion of low-cost vibration sensors and dynamic tests. More specifically, this project aims to:

- examine and select cost-effective dynamic sensors for use during field tests;
- develop cost effective procedures for modal identification of bridges in Nebraska that will make experimental load rating more viable for owners; and
- develop protocols for performing bridge load tests that will potentially require limited traffic disruption.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Search	$23,863	100%
Task 2: Modal Identification	$22,255	100%
Task 3: Select Bridges	$12,573	100%
Task 4: Bridge Testing	$17,083	0%
Task 5: Model Calibration	$22,145	0%
Task 6: Dynamic Load Rating	$21,822	0%
Task 7: Final Report	$22,777	0%

Deliverables: To improve traffic flow, bridge owners need to decide to remove a posted bridge via (i) rehabilitation, (ii) replacement, or (iii) other methods that can prove that sufficient additional capacity exists, with the most prevalent method being completion of a field test. Given that field tests can be costly the primary benefit of this project is reducing experimental load rating cost without sacrificing accuracy. This, in turn, facilitates data-enabled decision making for many bridge owners and improves bridge management and resource allocation. Development of the proposed framework also has the potential to be directly integrated into existing or new bridge health monitoring systems.

Performance & Goals: The PI and the Research Team are currently about 34% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M106
PROJECT TITLE	Feasibility Study Alternatives to Prevent Settlements and Bumps at Bridge Approaches in Nebraska
PRINCIPAL INVESTIGATOR	Seunghee Kim and Jongwan Eun – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Ahlman, Mark Traynowicz, Mark Lindemann, Jason Volz, Joel Rossman, Mike Vigil
PROJECT TOTAL COSTS	$99,469
PROJECT EXPENDITURES TO DATE	$24,815
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	40%
STATUS	On-Schedule
FY-2021 BUDGET	$74,654
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, & 5

Background: there is an important research need to provide more details and make necessary revisions to the current grade beam policy to minimize the settlement and bumps at the bridge approaches with less cost and same confidence level as before. Besides, there is a research need to investigate other potential alternatives to prevent such a differential settlement not only at the interface of the bridge abutment and the approach, but also at the interface of the approach and the roadway pavement. One of the feasible alternatives to mitigate such "bump at the end of the bridge" and the different settlement of an approach slab is the application of geosynthetic reinforcement (or geosynthetic reinforced soil, GRS) underneath the approach slab.

Objective: The proposed research will pursue two principal goals: (1) improve the current design practices of the approach slab foundation in Nebraska, and (2) examine the feasibility of applying geosynthetic reinforcement of soils for preventing the settlement issues at the bridge approaches with less cost.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Extensive Survey & Review of Current Bridge Approaches in Nebraska	$16,070	90%
Task 2: Review: Cases and Solutions in Other States	$14,970	50%
Task 3: Detailed Analysis: Improvement of Current Bridge Approach Design in Nebraska	$28,697	25%
Task 4: Detailed Analysis: Feasibility of Geosynthetic Reinforcement of Soils	$32,751	20%
Task 5: Cost-Effectiveness and Constructability Analysis	$6,980	0%

Deliverables: (1) it is anticipated that the in-depth review of current practices of bridge approaches in Nebraska will identify an opportunity of improvements in the design and construction with less cost and still superb performance.
(2) Extensive survey and review of cases and solutions in other states will provide relevance to Nebraska conditions and insights into possible other strategies to prevent the "bump at the end of the bridge approaches" problem.
(3) The proposed project will also provide the detailed analysis of feasibility on the geosynthetic reinforcement as a foundation soil of the approach slab for site-specific Nebraska geologic conditions.
(4) Therefore, the proposed project will contribute to effectively preventing the issue of bridge approach settlement with less cost tailored to the Nebraska soil conditions via the improvement of current design practices and the introduction of economically viable soil reinforcement strategies.
(5) Subsequently, the proposed project will greatly reduce the construction cost for a new bridge as well as the maintenance cost and time for existing bridges.

Performance & Goals: The PI and the Research Team are currently about 40% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M107
PROJECT TITLE	Outdoor Laboratory and Testbed for Bridge Health
PRINCIPAL INVESTIGATOR	Richard Wood, Christine Wittich, Joshua Steelman, Jay Puckett and Dan Linzell – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Babrak Niazi, Kent Miller, Fouad Jaber, Mark Traynowicz, Mark Ahlman, Joel Rossman, Kirk Harvey, Mike Vigil, David Mraz (FHWA)
PROJECT TOTAL COSTS	$115,074
PROJECT EXPENDITURES TO DATE	$10,897
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	11%
STATUS	Behind Schedule
FY-2021 BUDGET	$104,177
FY-2021 TASKS TO BE COMPLETED	Task 1, 2, 3 & 4

Background: Bridge health assessment invokes inspection, nondestructive evaluation, and destructive testing. Inspection and nondestructive evaluation are commonly implemented in practice; however, these techniques may involve subjective decision making, human interactions, and lack of verified or calibrated approaches. Furthermore, destructive tests such as deck coring and overstressing structural elements beyond their elastic limit are not commonly performed in practice due to their detrimental impacts to in-service structures. Therefore, realistic out-of2 service bridge site(s) are critically needed to fully understand how bridges behave throughout their service life.

Objective: The proposed research project has one overarching objective to transform two bridge sites (a total of three bridges) into a national research and educational facility for bridge health and testing. This will permit access for nondestructive evaluation and destructive test verifications. Furthermore, this facility can be leveraged for future research projects and identify strategic directions for this first-of-its-kind facility on realistic aging infrastructure.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Preliminary Site Staging	$45,303	14%
Task 2: Site Characterization	$32,613	0%
Task 3: Facility Demonstration	$19,356	0%
Task 4: Reporting	$17,802	0%

Deliverables: The project aims to establish a research and educational facility for studies related to bridge health and the training of students/future engineers, bridge engineers, and bridge inspectors. Due to the closed-traffic conditions of these bridges, this laboratory facility will enable testing of new methods for analytical modeling (with calibration), remote sensing, and diagnostic and health monitoring procedures. This project will provide a detailed characterization of realistically aged bridges (two steel bridges at Yutan and one concrete bridge at Omaha). In the long term, this project aims to study key questions on bridge health to address statewide and national needs. This facility will also increase national visibility of NDOT and UNL Engineering.

The project will create a shared-use facility to understand bridge health. Within the deliverables of this project, a detailed characterization and model will be created of each bridge that can be used in future and other projects of need. The detailed data from each bridge will be disseminated for interested parties and publicly hosted on the web to support bridge health studies.

Performance & Goals: The PI and the Research Team are currently about 11% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M108
PROJECT TITLE	Design and Detailing of Cast-in-Place and Precast Concrete Approach Slabs
PRINCIPAL INVESTIGATOR	George Morcous – UNO
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Joel Rossman, Jason Volz
PROJECT TOTAL COSTS	$78,648
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	Behind Schedule
FY-2021 BUDGET	$78,648
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, & 3

Background: The approach slab is a structural concrete slab designed to span from the back wall of the abutment (i.e. end of the bridge floor) to the grade beam or sleeper slab where the paving section begins. The purpose of the approach slab is to carry the dead and live loads over the backfill behind the abutments to avoid possible settlement of the backfill. Despite the simplicity of approach slab design as one-way reinforced concrete slab, it has been reported that most approach slabs experience cracking at early ages, as shown in Figure 1, which results in premature deterioration and shorter service life. The causes of this cracking are not clearly understood. On the other hand, NDOT recently considered the use of precast concrete approach slabs to achieve higher quality and faster construction than cast-in-place (CIP) concrete approach slabs. The first implementation of precast concrete approach slabs was completed in the summer of 2018 in the construction of Belden-Laurel Bridge. Several lessons were learned from this project, which could be considered to improve the design, fabrication, and construction of precast concrete approach slabs. Therefore, it is important and timely to re-visit the current design, detailing, and construction practice of standard CIP and precast concrete approach slabs in order to improve their durability and speed of construction.

Objective: The objective of this study is twofold: 1) investigate the causes of cracking of standard CIP concrete approach slabs and propose a refined design, detailing, and construction procedure; and 2) propose design alternatives using precast/prestressed concrete approach slabs based on the experience gained from the recent implementation. Special attention will be given to the longitudinal joints between the approach slabs, transverse joints with the paving section and end of floor. The new design alternatives could benefit from the recent development in the use of advanced materials, such as ultra-high performance concrete and glass fiber reinforced polymer (GFRP) reinforcement to enhance durability and speed of construction.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Review Current Practices	$13,837	40%
Task 2: Conduct Analytical Investigation	$16,747	60%
Task 3: Propose Design Alternatives	$16,747	80%
Task 4: Evaluate Detailing and Constructability	$17,374	100%
Task 5: Develop Specifications and Guidelines	$13,944	100%

Deliverables: This study could result in significant economic benefits to the State of Nebraska because improving the durability of approach slabs reduces user costs associated with their repair and replacement actions due to road closures and detours. Also, developing precast/prestressed concrete alternatives and using advanced materials will result in higher quality, more efficient use of materials, and accelerated construction. Time would then be spent assisting NDOT employees with implementing the lane closure tool as defined in the report. In this way, the expertise to modify/maintain the application going forward would remain in-house at NDOT.

Performance & Goals: The PI and the Research Team are currently about 25% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M109
PROJECT TITLE	To Automate Detecting, Quantifying and Mapping of Delamination of Bridge Decks using Aerial Thermographic NDE
PRINCIPAL INVESTIGATOR	Zhigang Shen and Ri Na – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Wally Heyen, Lieska Halsey, Jason Volz. Babrak Niazi, Jon Starr, Mark Lindemann, Kent Miller
PROJECT TOTAL COSTS	$109,844
PROJECT EXPENDITURES TO DATE	$82,050
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	30%
STATUS	On-Schedule
FY-2021 BUDGET	$27,794
FY-2021 TASKS TO BE COMPLETED	Tasks 3, 4, 5 & 6

Background: The recent technical advancements in image processing and UAV technology has the potential to transform the thermographic-based approach to detect delamination/debonding/deterioration in concrete decks. The three most relevant new technical advancements include: (1) new algorithms in computer vision to detect edges and recognize objects in high-noise situations; (2) new image processing techniques for distortion correction and image stitching for creating seamless and accurate full deck images; and (3) high-resolution thermal and optical cameras mounted on UAVs to take close-up aerial thermal and optical images of the bridge decks to capture the tiny temperature variations of the deck surfaces. As a result, the revitalization of research activities in thermographic detecting has been witnessed recently with improved outcomes. The PI proposes to investigate the performance of the new aerial high-resolution thermographic method in detecting, quantifying, and mapping delamination of bridge decks.

Objective: In this study, both experimental and numerical studies are to be employed to achieve the goals described in the last section. In the experimental studies, there are lab experiments and field experiments. Lab experiments will include casting concrete decks with artificial delamination of various depths and sizes in an outdoor environment, and thermographic monitoring of the detectability of the artificial delamination. The field experiments include three parts: (1) thermographic data collection of the actual bridge decks, (2) delamination prediction based on the post-processed thermographic images, and (3) field coring validation. The validation process will be iterative (expect 5 bridges in each iteration) so the performance (including accuracy, completeness, and robustness) of the detecting algorithms can be improved in each iteration.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature search	$3,236	100%
Task 2: Lab experiments	$7,352	100%
Task 3: Numerical simulations	$20,852	70%
Task 4: Field data collection	$46,970	80%
Task 5: Data analysis and model validation.	$23,485	30%
Task 6: Report and Presentations	$7,950	0%

Deliverables: 1-Safe, low-cost, and easy to deploy. Since the proposed NOE approach doesn't affect the normal traffic flow during the inspecting process, the potential accidents due to interrupting normal traffic flow and lane closures are minimized. 2. Highly efficient. The typical flying speed of the drone in this proposed project is roughly 20 mph in the air 120 feet or higher above the deck during operation, which can cover a 4-lane width (approx. 50 ft) with one single high-resolution thermal image. Therefore, it takes less than 20 minutes (including initial on-ground calibration time) to conduct a full-coverage thermographic survey of a 6-lane. 3. Accurate and precise. Since the images used in generating the delamination maps in the proposed method are orthophotos (aerial-view) of the bridge decks, image distortion and stitching errors are minimal compared to delamination maps created by stitching many perspective-view images from the ground vehicles. 4. Versatile. The drone-based thermography can be used to detect delamination of other bridge elements, such as the vertical or slanted concrete surfaces, which are difficult to access using other NOE methods. These vertical elements can be parapet walls, wing walls, girder and abutment walls, etc.

Performance & Goals: The PI and the Research Team are currently about 30% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M110
PROJECT TITLE	Biopolymerized slope stabilization and advanced field monitoring
PRINCIPAL INVESTIGATOR	Chung R. Song, Yong-Rak Kim, Richard L. Wood and Jongwan Eun – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Mark Lindeman, Nikolas Glennie, Alex Silvey, Bruce Barret, Mick Syslo
PROJECT TOTAL COSTS	$124,386
PROJECT EXPENDITURES TO DATE	$48,211
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	31.15%
STATUS	On-Schedule
FY-2021 BUDGET	$76,175
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3, 4 & 5

Background: The M-061 study (Nebraska Specific Slope Design Manual) found that the strength reduction of field soils and associated slope failures may be effectively prevented by applying biopolymers to field soils due to their high tolerance to sub-freezing temperature. In addition, biopolymers are environmentally friendly and sustainable because they are likely food additives. Application of biopolymers is rapidly increasing (De Jong et al. 2010, Chang et al. 2015, 2016). They have not, however, been widely used for stabilization of slopes up to date. In the M-061 study, six different biopolymers were preliminarily tested at UNL's Geotechnical Lab. The biopolymer treated soils demonstrated significant strength gain, with up to a 300% strength increase. Two promising biopolymers, Xanthan and Gellan were further tested under well-controlled, severe weathering conditions. Research outcomes will be the optimum mixing ratio of biopolymers and field soils, one for BoMag mixing and the other for auger mixing. The mixing ratio for the two different application techniques will be different because the auger mixing will require a higher water content than the BoMag technique to facilitate an easy mixing process. In addition, the optimum moisture content and degree of compaction will be studied for the BoMag and compactor based application.
Evaluation of the field performance of biopolymer-treated soils will also be accompanied by proper testing and monitoring plan with sophisticated equipment and novel evaluation techniques.

Objective: The first objective of this project is to apply laboratory-proven soil modification techniques with biopolymers to field condition and confirm their effectiveness and applicability to slopes and subgrade materials in Nebraska with climate conditions considered. Specifically, this objective is to reduce uncertainties in applying the biopolymer-based ground modification technique.
The second objective of this project is to provide guidance on determining optimum application parameters (such as mixing ratio, degree of compaction, water content, etc.) and rational field testing methods for evaluating field performance of these biopolymer-based soil modification techniques. This objective will be achieved by comparing performance resulting from multiple different testing methods. In the process, the following detailed documentation will be developed as supporting materials for retrofitting unstable slopes and subgrade materials in Nebraska.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature review	$16,639	100%
Task 2: Collection of field soils and tests of biopolymers in lab	$39,511	50.5%
Task 3: Application of biopolymers to target sites	$25,197	8.5%
Task 4: Field monitoring and performance evaluation	$23,767	0%
Task 5: Reporting	$19,272	0%

Deliverables: 1) Existing (problematic) slopes may be retrofitted quickly and economical. 2) New slopes may be treated by specific biopolymers at the point of construction, and the slope may be stabilized by incurring minimal extra costs. 3) The same technique may be used in stabilizing subgrade (and/or subbase) materials. With the proven long-term stability, the treated subgrade or subbase layers may provide superior performance and more extended load bearing capability compared to traditional techniques such as lime or fly-ash based stabilization. 4) Inclusively, the research results will bring in more resilient slopes and pavements. 5) Nebraska's geological history is similar to other Midwestern states. The research results, therefore, will contribute to design and construction of slopes in other states.

Performance & Goals: The PI and the Research Team are currently about 31.15% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M111
PROJECT TITLE	High-Mast Tower Foundations
PRINCIPAL INVESTIGATOR	Chungwook Sim, Chung R Song, Brandon Kreiling and Jay Puckett – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Mark Fischer, Mark Burham, Carl Humphrey
PROJECT TOTAL COSTS	$47,196
PROJECT EXPENDITURES TO DATE	$12,450
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	33%
STATUS	On-Schedule
FY-2021 BUDGET	$34,746
FY-2021 TASKS TO BE COMPLETED	Tasks 2 & 3

Background: High Mast Tower (HMT) foundations have been traditionally designed and constructed using a cast-in-place foundation with anchor bolts 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 as shown in Figure 1. The Nebraska DOT has experienced issues with stresses that this type of design presents at the anchor bolt/foundation interface and base plate/tower shaft interface. This issue in worst case may lead to a premature failure as shown in one of the towers at Milford, Nebraska that recently fell down during a winter snow storm event.

Objective: The research objective is to develop an alternative design for the High-Mast Tower Foundations, which can eliminate fatigue- prone details associated with the pole-to-base plate connection that is the primary failure location. To address critical issues, the follows will be investigate;

1. Evaluate the various types of foundations used in other structures that are similar in height and shape to the High-Mast Towers. This will include evaluating drilled shafts and direct embedment foundations for Power Transmission Line Structures.
2. Evaluate the corrosive environment with steel pole structure being embedded either in soil or concrete and propose mitigation measures for any corrosion issues found.
3. Based on these findings, provide design and construction provisions that will be integrated into NDOT specifications for design and construction.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$5,859	100%
Task 2: Corrosion Investigation	$9,911	0%
Task 3: Foundation Design and Construction Recommendations	$31,426	0%

Deliverables: 1) An alternative base design that would eliminate the pole-to-baseplate connection that contains weldment details and bolts that are fatigue prone.
2) Reduced inspection and maintenance costs reviewing welds and bolt tightness.
3) Provide a different approach to the pole-to-ground connection that could be used nationwide.

Performance & Goals: The PI and the Research Team are currently about 33% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M112
PROJECT TITLE	Data Analysis of Nebraska Pavements Containing RAP
PRINCIPAL INVESTIGATOR	Yong-Rak Kim – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Bruce Barret, Robert Rea, Mike Reynolds, Hamzeh Haghshenas, Brandon Varilek, Jody Paul, Mark Osborn, Rick Fischer
PROJECT TOTAL COSTS	$97,523
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	On-Schedule
FY-2021 BUDGET	$97,523
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3 & 4

Background: For the last about 10 years, Nebraska has used reclaimed asphalt pavement (RAP) materials in mixes at approximately 20-40% to produce asphalt concrete (AC) mixtures for flexible pavements. The expanded use of RAP materials in the production of AC mixtures brought significant economic benefits and environmental advantages through the reduction of material costs and environmental impacts associated with production, transportation, and processing of the conventional asphalt materials. It has been reported that about $30-50 million were saved annually due to the use of RAP materials. This infers that more use of RAP materials in the mixes is favorable to reducing costs and environmental impacts.

Despite the immediate cost saving and environmental benefits attributed to the use of RAP, it has also been reported that using a higher percentage of RAP may reduce the resistance of asphalt mixtures to cracking and durability. This in turn, can result in reduced pavement lifespan and/or earlier needs of maintenance (or rehabilitation). As a result, to avoid misleading practices in the use of RAP, a more rational approach that can evaluate the true economic benefits of using RAP materials in pavements should be pursued, and the approach needs to take into account not only the initial costs associated with materials and production, but also later-stage costs related to in-service performance of pavements.

Objective: This project aims to conduct a comprehensive data analysis of Nebraska pavements containing RAP materials. Toward that end, the research team and NDOT engineers will work together to select pavement sections in service for the last 5-10 years. A complete set of data will be collected and used to perform data analyses. If needed, further examination will be conducted through laboratory testing of samples cored from the field sections and numerical simulation of relevant mixtures and pavement structures. The data analysis will include typical statistical evaluation as well as the life cycle cost analysis, so that the practices for the last 10 years with RAP can be reviewed and improved for future projects.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$16,079	100%
Task 2: Selection and Data Collection of In-Service Pavement Sections	$11,935	0%
Task 3: Analysis of Collected Data	$64,858	0%
Task 4: Documentation and Presentation	$28,639	0%

Deliverables: Research findings will significantly help our pavement engineering. Data analysis results including the life cycle costs from various projects will provide useful information to examine the state's RAP practices in pavements for the last decade and to develop any working plans for future projects. This research would bring clear benefits in cost savings and sustainability by the use of recycling materials into our pavements in a more efficient and scientific manner.

Performance & Goals: The PI and the Research Team are currently about 25% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M113
PROJECT TITLE	Detection of Flaws with Asphalt Overlaid Concrete Decks Using Ultrasonic Guided Waves
PRINCIPAL INVESTIGATOR	Ece Erdogmus and Yong Rak Kim – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Babrak Niazi, Mike Vigil , Mark Traynowicz, Robert Rea, Kent Miller
PROJECT TOTAL COSTS	$52,957
PROJECT EXPENDITURES TO DATE	$6,621
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	35%
STATUS	On-Schedule
FY-2021 BUDGET	$46,336
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6 & 7

Background: The research proposed here builds on the achievements of a previous NOOT project. The novel, nondestructive ultrasonic guided wave leakage (UGWL) based testing method we developed recently promises to be able to detect the onset of corrosion and delamination in reinforced concrete bridge decks earlier than any other nondestructive testing (NOT) method (Garcia, Erdogmus, et al. 2017 and 2019); however, the effects of asphalt overlay on the method's effectiveness remains unclear. With this project, we aim to investigate the effect of asphalt overlays on the feasibility of the recently developed UGWL method.

Objective: The ultimate goal of the project is to expand the capabilities of the recently developed novel UGWL testing method to detect flaws in asphalt overlaid reinforced concrete bridge decks. Two objectives will help achieve this goal:

1) To determine the effects of the asphalt overlay on the testing method
2) To understand to what extent we can detect the flaws in reinforced concrete decks when there is an asphalt overlay
3) To determine if we can use the "asphalt" as a waveguide in addition to or instead of the rebar.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC- Kick off Meeting and Design of Experiments:	$13,006	80%
Task 2: Literature Review and TAC 50% meeting after Literature Review	$3,240	25%
Task 3: Experiment Set 1 (Asphalt only, Asphalt with steel rod)	$5,440	50%
Task 4: Experiment Set 2 (Asphalt+ plain concrete)	$3,530	50%
Task 5: Experiment Set 3 (Asphalt+ reinforced concrete)	$6,795	50%
Task 6: Field case studies	$17,600	10%
Task 7: Technology Transfer (Final Report, Presentation, Videos	$3,347	0%

Deliverables: •This project will render the previously developed innovative UGWL method more applicable to Nebraska's bridges, given the current philosophy of adding asphalt overlay to bridge decks after 10 years in service.
•This method may be implemented during the construction of new bridge decks as well as during the repair of older bridge decks.
•This method has the promise to also provide more insight regarding the deterioration times and patterns for Reinforced Concrete Bridge decks with asphalt overlays.
•This method presents a possibility for a relatively low-cost and simple to interpret non-destructive evaluation technique that can be utilized in-house by NOOT, eliminating the need for multiple NOT techniques to detect different types of flaws or hiring of consultants.
•In the long term, continuous monitoring and maintenance of bridge decks will provide increased safety and health of reinforced concrete bridge decks.
•In the long term, the methodology may help reduced maintenance costs on infrastructure.

Performance & Goals: The PI and the Research Team are currently about 35% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M114
PROJECT TITLE	Best Practices to Address Issues of Excess Aggregate Dust in Nebraska
PRINCIPAL INVESTIGATOR	Jiong Hu, UNO
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2020
TECHNICAL ADVISORY COMMITTEE	Mark Lindemann, Wally Heyen, Bruce Barret, Mick Syslo, Lieska Halsey, Kellie Troxel, Shin-Che Huang (FHWA)
PROJECT TOTAL COSTS	$130,158
PROJECT EXPENDITURES TO DATE	$14,152
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	30%
STATUS	On-Schedule
FY-2021 BUDGET	$116,006
FY-2021 TASKS TO BE COMPLETED	Tasks 2, 3, 4 & 5

Background: The extent and impact of dust in concrete depend not only on quantity, but also the nature of dust. Even though the negative impacts of an excessive amount of dust on concrete performance have been known and reported in different states, the impact of the types and amounts of clays on concrete performance is still not fully understood. In order to effectively prevent the clay dust issue, a more fundamental understanding of the nature of the impact of clay is necessary. Besides traditional tests for fresh, hardened and durability properties, advanced techniques such as scanning electron microscope and energy dispersive X-ray spectroscopy (SEM/EDX) can provide better options to understand the characteristics and mineralogy of aggregate dust as well as the extent of issues, such as ITZ debonding and deterioration inside concrete.

Objective: The overall goal of this research is to determine the best practice to address potential issues of excess aggregate dust in Nebraska concrete. To achieve the goal, three specific objectives of this study are to:

(1) Select and conduct various laboratory tests to characterize different types of aggregate dusts.
(2) Access the negative impact of excess dust on NDOT concrete properties and performance.
(3) Identify the best practice to further improve current NDOT methods to control the negative effects of for excess dust in concrete mixtures.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$8,207	100%
Task 2: Survey and Collection of Field Data and Materials	$24,744	60%
Task 3: Laboratory Study	$68,002	30%
Task 4: Data Analysis and Best Practice Development	$17,742	0%
Task 5: Documentation and Presentation	$11,462	0%

Deliverables: The extensive literature review, survey, data analysis, and laboratory tests will provide a better understanding of the impact of excess dust in Nebraska aggregates and effective measures to minimize the potential deleterious contribution to concrete performance. The outcome of this study will provide NDOT with the alternative options to be more proactive to address the potential issues, so that extended service life of concrete pavement and bridge decks can be achieved.

Performance & Goals: The PI and the Research Team are currently about 30% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M115
PROJECT TITLE	Research on High-RAP Mixtures with Rejuvenators - Field Implementation
PRINCIPAL INVESTIGATOR	Hamzeh Haghshenas – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Bruce Barret, Robert Rea, Mick Reynolds, Mick Syslo, David T. Hansen
PROJECT TOTAL COSTS	$99,950
PROJECT EXPENDITURES TO DATE	$1,004
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	30%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$98,946
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: When using high-RAP in our AC mixtures the key factors to be considered include but are not limited to: (i) the use of right rejuvenators based on their chemical-mechanical properties, (ii) the use of an optimal dosage and blending method of the selected rejuvenator to satisfy desired mixture and pavement performance. Performance indicators such as rutting, cracking and moisture susceptibility are some of the important distresses that need to be evaluated in the laboratory. For the last four years, the PI has conducted NDOT-sponsored research projects on high-RAP mixtures treated with rejuvenators. The research was conducted in two phases and in both, 65% RAP was applied to a typical Nebraska AC mixture. Three different rejuvenators: petroleum-tech based, green-tech based, and agriculture-tech based materials were used, this ensured variability in the chemical properties of the rejuvenators. The research project evaluated various mechanical and chemical properties of AC mixtures, fine aggregate matrix (FAM) mixtures, and binders modified by the rejuvenators. Test results in different length scales (i.e., AC, FAM, and binder) demonstrated that the rejuvenators made high-RAP mixtures are more compliant (ductile), which decreased stiffness and improved the fatigue resistance of high-RAP materials. Also, the recommended practices of different rejuvenators were sought by further investigating properties and performance of mixtures/materials at different treatments (i.e., blending dosages and curing methods) of rejuvenators.

Objective: The objective of this research is to implement the findings from Phase-I and II into field-level and investigate the performance of the high-RAP mixture treated with optimal dosage of selected rejuvenators. Plant production parameters that influence blending of rejuvenators, RAP, and virgin materials will also be investigated. More specifically, we will collect and evaluate plant-produced and field- implemented mixtures where high-RAP (e.g., 50% RAP) was modified by optimal treatment of rejuvenators to evaluate variability, producibility, properties, and performance of AC mixtures placed in pavements.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$6,821	25%
Task 2: Experimental Design: Selection of Mixing Plants and Field Sections	$10,332	50%
Task 3: Laboratory Experiments and Field Monitoring	$34,980	0%
Task 4: Analysis of Test Results	$29,480	0%
Task 5: Documentation and Presentation	$18,337	0%

Deliverables: Research findings will significantly affect our field-level asphaltic pavement practice using recycled materials. Laboratory evaluation of plant-produced and field-implemented mixtures following the recommended treatment of rejuvenating agents will be used to provide useful guidelines of using high-RAP mixtures in actual field projects. This research would bring clear benefits in cost savings and sustainability by expanding the use of recycling materials into our pavement engineering.

Performance & Goals: The PI and the Research Team are currently about 30% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2020.

PROJECT NUMBER	M116
PROJECT TITLE	Effect of Antioxidant Additives and Restorators on Performance of Asphalt Binders and Mixtures – Phase I
PRINCIPAL INVESTIGATOR	Hamzeh F. Haghshenas – UNL and Robert Rea – NDOT Materials & Research
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Mick Syslo, Mike Reynold, John Gude, Jody Paul, Mathew Kumbier, Jasmine Dondlinger, David T. Hansen, Bruce Barrett, Robert Rea, Brandon Varilek, Shin-Che Huang (FHWA)
PROJECT TOTAL COSTS	$170,663.00
PROJECT EXPENDITURES TO DATE	$30,874
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	40%
STATUS	On-Schedule
FY-2021 BUDGET	$139,788
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: The extent and impact of dust in concrete depend not only on quantity, but also the nature of dust. Even though the negative impacts of an excessive amount of dust on concrete performance have been known and reported in different states, the impact of the types and amounts of clays on concrete performance is still not fully understood. In order to effectively prevent the clay dust issue, a more fundamental understanding of the nature of the impact of clay is necessary. Besides traditional tests for fresh, hardened and durability properties, advanced techniques such as scanning electron microscope and energy dispersive X-ray spectroscopy (SEM/EDX) can provide better options to understand the characteristics and mineralogy of aggregate dust as well as the extent of issues, such as ITZ debonding and deterioration inside concrete.

Objective: This research aims to investigate the effect of various RAs and one antioxidant additive on performance of asphalt binders and mixtures. Testing will be performed on various blends of RAs and antioxidants containing laboratory aged materials (up to 100%). The laboratory tests will be performed to evaluate chemical properties (e.g., SARA, FTIR, elemental analysis) of the additives and binders, rheological performance (e.g., PG, Glover-Rowe) of the binders, and mechanical properties (e.g., SCB and TSR) of the mixtures. In addition, the possible correlation between chemical characteristics of the additives and rheological/mechanical properties of the binders/mixtures will be examined.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Materials Selection	$8,207	75%
Task 2: Laboratory Tests	$24,744	50%
Task 3: Analysis of Test Results	$68,002	25%
Task 4: Documentation and Presentation	$11,462	10%

Deliverables: The findings of this research study will affect Nebraska asphalt binder mixtures specifications. Test results and findings will be used to provide useful implementation guidelines of Nebraska asphalt binders and mixtures containing laboratory aged materials. This research would also bring clear benefits in sustainability of pavements by expanding their service life sustainability by expanding the use of recycling materials into our pavement engineering.

Performance & Goals: The PI and the Research Team are currently about 40% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2021.

PROJECT NUMBER	M117
PROJECT TITLE	Research and Education for Optimizing the Development and Implementation of an Unmanned Aircraft Program at the Nebraska Department of Transportation
PRINCIPAL INVESTIGATOR	Wayne Woldt- UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	6/30/2020
TECHNICAL ADVISORY COMMITTEE	Jon Starr, Devin Townsend, Lieska Halsey, Alex Silvey, Cameron Craig, Matthew Baker, Loraine Legg, Dillon Dittmer, Todd Hill and David T. Hansen
PROJECT TOTAL COSTS	$93,475
PROJECT EXPENDITURES TO DATE	$44,193
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	28%
STATUS	On-Schedule
FY-2021 BUDGET	$49,279
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 , 4, 5 & 6

Background: The extent and impact of dust in concrete depend not only on quantity, but also the nature of dust. Even though the negative impacts of an excessive amount of dust on concrete performance have been known and reported in different states, the impact of the types and amounts of clays on concrete performance is still not fully understood. In order to effectively prevent the clay dust issue, a more fundamental understanding of the nature of the impact of clay is necessary. Besides traditional tests for fresh, hardened and durability properties, advanced techniques such as scanning electron microscope and energy dispersive X-ray spectroscopy (SEM/EDX) can provide better options to understand the characteristics and mineralogy of aggregate dust as well as the extent of issues, such as ITZ debonding and deterioration inside concrete.

Objective: The goal of this project is to conduct research and education to optimize and document the development and implementation of a new unmanned aircraft program for the Nebraska Department of Transportation (NDOT). To accomplish this goal, the Nebraska Unmanned Aircraft Innovation, Research and Education (NU-AIRE) laboratory at the University of Nebraska-Lincoln will provide research and education for NDOT so that the Unmanned Aircraft Systems (UAS) Program Manager and affiliated personnel are able to efficiently establish a successful and safe in-house UAS program. This initial phase of the effort will include research and education for: 1) Administrative policy development, 2) Training, and 3) Operations and Use Case analysis, with subsequent phases to be determined, based on status and need.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$8,649	18%
Task 2: Administrative Policy	$38,937	11%
Task 3: Training	$12,093	90%
Task 4: Operations	$19,551	31%
Task 5. Analysis of Use Cases	$5,084	8%
Task 6. Documentation and Presentation	$9,157	37%

Deliverables: This project will result in the development and implementation of an unmanned aircraft program within the NDOT that is built on a comprehensive administrative policy, culture of safety and demonstrated expertise in successfully accomplishing missions. This includes research of high priority use cases where NDOT anticipates the use of UAS to improve efficiencies, provide better data and/or make for safer operations to NDOT and the public. The documentation produced will prove to be helpful not only to NDOT, but to other state departments of transportation that are in the process of building their in-house UAS program.

Performance & Goals: The PI and the Research Team are currently about 28% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 6/30/2020.

PROJECT NUMBER	M118
PROJECT TITLE	Computation of Peak and Low Flow Statistics and StreamStats GIS Implementation in the Elkhorn River Basin in Nebraska
PRINCIPAL INVESTIGATOR	Kellan Strauch - USGS
PROJECT START DATE	9/7/2018
PROJECT COMPLETION DATE	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Mark Traynowicz, Kirk Harvey
PROJECT TOTAL COSTS	$35,000
PROJECT EXPENDITURES TO DATE	$32,420
NUMBER OF EXTENSIONS GRANTED	One
PERCENTAGE OF PROJECT COMPLETE	55%
STATUS	On Approved Revised Schedule
FY-2021 BUDGET	$2,580
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: The project is to develop a model for the Elkhorn River Basin in Nebraska which has not been updated since the 1980's. The model is used by the department in developing flood modeling and allowing better flow and high water elevations for bridge designers.

Objective: This project will develop the Elkhorn River Basin model. Peak and low flow statistic computation will be computed using Bulletin 17C parameters for 20 streamflow gages in the Elkhorn basin. Once computed and analyzed, the information will be incorporated into the web-based StreamStats GIS based format. After testing, the data will be released for publication.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Peak flow statistic computation w/ Bulletin 17C for 20 streamflow gages in Elkhorn Basin	$9,500	90%
Task 2: Low flow statistic computation	$7,500	90%
Task 3: GIS implementation into StreamStats	$12,000	75%
Task 4: Publication	$6,000	50%

Deliverables: This project will result in the development and implementation of peak flow statistic computation, low flow statistic computation, GIS implementation into StreamStats and publication for use.

Performance & Goals: The PI and the Research Team are currently about 55% complete with the project. The team has met all the requirements to date which were established under the original proposal including tasks, quarterly reports, and Technical Advisory Committee update meetings. The final deliverables are expected to be received by 12/31/2021.

Newly Funded Research

CONTROL NUMBER	01021
PROJECT NUMBER	FY21(001)
PROJECT TITLE	An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways
PRINCIPAL INVESTIGATOR	Mark R. Anderson - UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Jesse Schulz, Ty Barger, Julie Ramirez, Claire Inbody and Janie Vrtiska
PROJECT TOTAL COSTS	$164,730
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$82,365
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 ,5, 6 & 7

Background: The main goal of this proposal is to get a better understanding of where the water obstructions take place, as well as the cause of the obstruction in relationship to the weather conditions associated with the increased water levels causing the water obstruction. Recognizing the weather conditions responsible for the obstruction; from winter through spring with ice damming, runoff from heavy precipitation during thunderstorm activity, and water table increases in the Sandhills will be the focus of the research. In addition, the frequency of the water obstruction events will be calculated for the study period.

Objective: The main objective of this investigation is to generate spatial maps of water obstructions on Federal and State highways across Nebraska (NDOT's responsibilities). The spatial maps will provide NDOT with a climatology of where water obstructions have occurred in the past. Composite spatial maps will be generated annually, and a climatology will then be produced for the period of record. An example map is presented in Figure 1 representing the obstructions that occurred during the first half of the 2019 year. In addition to the locations of the water obstructions, meteorological information will be investigated for the cause of the obstruction. Each obstruction needs to be identified and then similar weather situations will be combined. Once the obstructions are identified, then NDOT can determine what form of action might be taken to reduce water obstructions in the future.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature review of water obstructions and weather conditions	$21,315	0%
Task 2: Collection of Nebraska CARS water obstruction data	$23,267	0%
Task 3: Collection of meteorological observations	$31,475	0%
Task 4: GIS analyses of the obstruction information	$26,818	0%
Task 5: Statistical analyses of the water obstruction information	$29,596	0%
Task 6: Examination of the water obstructions and meteorological information	$23,538	0%
Task 7: Final reports and presentations	$8,721	0%

Deliverables: The end result from this research project will be a better understanding of where water obstructions take place and the weather conditions associated with the water obstruction. The proposed project will help benefit all parties in better understanding what weather conditions precede water obstructions so that appropriate actions may be initiated to reduce water obstructions in the future. Actions may be in the form of news releases to the general public, messages displayed on variable message signs before, during or after a weather event. The proposed project may also have implications for maintenance operations for locations of the water obstructions within NDOT for Nebraska roadways.

CONTROL NUMBER	01021A
PROJECT NUMBER	FY21 (002)
PROJECT TITLE	Development of Guideline for the Use of Geosynthetics in Different Pavement Layered System in Nebraska
PRINCIPAL INVESTIGATOR	Jongwan Eun & Seunghee Kim- UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Mick Syslo, Mark Lindemann, Bruce Barret, Kellie Troxel, Brandon Varilek, Jesse De Los Santos, Ray Trujillo and Shin-Che Huang-FHWA
PROJECT TOTAL COSTS	$ 106,536
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$53,268
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: Geosynthetics reinforcement such as geogrid, geotextile, etc. has been used as a viable alternative to stabilize the subgrade of roadway pavement construction in regions with soft and/or problematic subgrade (foundation) soils. Geosynthetics are typically marketed either as having the ability to lengthen the pavement design life through controlling the damage of the pavement or as a cost-saver to reduce the aggregate base thickness while maintaining the same level of design-equivalent single axle loads as with traditional pavement systems.

Objective: The proposed research will pursue the two primary goals:
(1) Evaluate the design properties of geosynthetic reinforced roadway pavement including base, subbase, subgrade in Nebraska; and
(2) Suggest a design guideline of geosynthetic reinforced roadway pavement.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Extensive Review of Geosynthetic-Reinforced Roadway Pavement	$17,810	0%
Task 2: Experimental Characterization of Geosynthetic Reinforced Pavement with Pullout and Direct Shear Tests Task 2.a Fundamental laboratory test, we will characterize and evaluate the fundamental properties of geosynthetics and soils chosen for this study Task 2.b Pullout resistance will be evaluated in the different directions of the geosynthetics, such as the machine and cross-machine direction, by using a large pullout testing device (ASTM D6706). Task 2.c Large-size direct shear test (ASTM D5321) will be conducted to evaluate the shear resistance at the soil-geosynthetic interface	$32,400	0%
Task 3: Large-scale Track Wheel (LSTW) Tests to Evaluate Geosynthetic Reinforced Pavement	$25,986	0%
Task 4: Numerical Study of Geosynthetic-Reinforced Roadway System	$23,193	0%
Task 5: Suggestion of Design Recommendation	$7,147	0%

Deliverables:
(1) It is anticipated that the in-depth review of current practices of geosynthetic reinforced payment in Nebraska and other states will identify an opportunity for improvements in the design and construction with less cost and still superb performance.
(2) The proposed project will provide precise input parameters of the soil-geosynthetic and aggregate-geosynthetic interactions, in accordance with the common design practice of Nebraska.
(3) Via the unprecedented large-scale experimental study and in-depth numerical simulations, the proposed project will lead to the improvement of design practices and the introduction of economically viable roadway pavement strategies. In doing so, it will contribute to effectively preventing the issue of deterioration with less cost tailored to the local soil properties in Nebraska.
(4) Subsequently, the proposed project will greatly help reduce the cost, time, and efforts for maintaining the existing roadways.

CONTROL NUMBER	01021B
PROJECT NUMBER	FY21 (003)
PROJECT TITLE	Effect of Antioxidant Additives and Recycling Agents on Performance of Asphalt Binders and Mixtures – Phase II
PRINCIPAL INVESTIGATOR	Hamzeh Haghshenas-UNL, Robert Rea-NDOT & Jiong Hu-UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Robert Rea, Mick Syslo, Bruce Barrett, Kelly Troxel, Brandon Varilek, Jasmine Dondlinger, David T. Hansen and Shin-Che Huang-FHWA
PROJECT TOTAL COSTS	$145,238
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$72,619
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: The use of recycling agents (RAs) (i.e., rejuvenators or softening agents) has gained significant attention from industry on a global scale. Its recent worldwide interest has grown as the world's population is placing a much larger focus on world climate, pollution, and ways to control the CO2 excess through reduce, reuse, and recycle. The recycling of waste materials and reducing the carbon footprint of manufactured products through the conservation of energy and reduction on the use of raw materials has become a primary focus. The use of properly engineered RA's and mix designs can effectively recover the properties of the aged asphalt binders and provide equivalent and in some cases better performing pavements. Current research has found that RAs can improve the cracking resistance, while being capable of maintaining the rutting resistance of the mixtures. However, there are some concerns about the effect of RAs on the moisture damage resistance [and the long term performance (aging) of these additives.

The idea of modifying the properties of aged binders using RAs and providing long-term age resistance through the addition of antioxidants seems to be a viable solution. Based on the test results that the PI obtained from the previous research (funded proposal number: SPR-P1(20) M116), the combination of these technologies was proved effective and can bring significant pavement life cycle cost savings, provide longer-lasting and more sustainable roadway pavements. However, the focus of this first phase of this research was to investigate if this chemistry combination would work, so it was tested on only one antioxidant, one unmodified asphalt binder and a selection of RAs.

Objective: The second phase of this research will study the effect of various RAs and antioxidant additives and their performance with modified asphalt binders and mixtures. Various tests will be performed on different combinations of RAs and antioxidants containing virgin and RAP materials to characterize physical characteristics and rheological performances of the binders as well as mechanical properties of the mixtures.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$16,968	0%
Task 2: Materials Selection	$16,801	0%
Task 3: Laboratory Tests	$58,119	0%
Task 4: Analysis of Test Results	$33,555	0%
Task 5: Documentation and Presentation	$19,796	0%

Deliverables: Test results and findings will be used to provide implementation guidelines for common binder grades and mixes used in the central United States containing RAP materials. This research will also bring significant pavement life cycle cost savings, provide longer-lasting and more sustainable roadway pavements.

CONTROL NUMBER	01021C
PROJECT NUMBER	FY21 (004)
PROJECT TITLE	Midwest Guardrail System (MGS) Thrie Beam Approach Guardrail Transition (AGT) Retrofit to Existing Concrete Parapets and Bridges
PRINCIPAL INVESTIGATOR	Scott Rosenbaugh
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Joel Rossman, Mark Ahlman, Mike Vigil, Phil TenHulzen, David Mraz-FHWA and Andrew Heuerman-FHWA
PROJECT TOTAL COSTS	$87,978
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$43,989
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: When a roadway/bridge is resurfaced with an overlay, NDOT plans to replace the AGT adjacent to the bridge with a MASH TL-3 crashworthy design. To minimize repair costs, NDOT does not desire to replace or alter any bridge rails with adequate structural capacity and height. Bridge rails installed under NCHRP 230 or earlier standards are likely too short for current standards and need to be replaced, but bridge rails installed to NCHRP Report 350 standards should meet MASH TL-3 criteria and could remain in place. However, this creates a problem of attaching new, 31-in. tall AGTs to existing concrete bridge rails and parapets (after an overlay) that were not designed for such connections and the resulting system may not be crashworthy to current safety standards. Therefore, the development of cost effective retrofit options are desired for attaching new, 31-in. tall AGTs to existing NDOT bridge rail and parapet designs.

Objective: The objective of this project is to develop retrofit options for attachment of 31-in. tall thrie beam AGT systems to existing NDOT bridge rails and concrete parapets. The retrofits may involve the addition of connection plates to attach the thrie beam to the parapet, the addition of deflector plates to prevent vehicle snag, and/or overlapping the AGT on the parapet to prevent contact with the end of the parapet. However, the existing concrete structures are not to be modified except for the installation of anchorage hardware. The new retrofit designs will improve the overall safety of the barrier systems by ensuring its performance satisfies the Manual for Assessing Safety Hardware (MASH) Test Level 3 (TL-3) performance criteria, while preventing costly replacements of concrete structures.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Project Planning and Correspondence a. General project planning and documentation b. TAC meetings	$22,832	0%
Task 2: Design and Analysis a. Review of existing bridge rails, parapets, and end buttresses b. Concept development of retrofit options c. Selection of desired retrofit	$34,399	0%
Task 3: Analysis of Selected Retrofit a. LS-DYNA computer simulation b. Structural design of attachment hardware c. Selection of CIPs d. Development of CAD details	$19,676	0%
Task 4: Reporting and Project Deliverables a. Summary report to document research effort, including conceptual design, selection of desired retrofit, computer simulation, CAD details, and implementation guidance. b. Report editing (internal and sponsor review) c. Technical Brief for NDOR d. PowerPoint presentation of research results following project completion e. Project closing (printing, dissemination, accounting)	$76,907	0%

Deliverables: Development of crashworthy retrofit options for the attachment of thrie beam AGT systems to existing NDOT bridge and concrete parapets will provide NDOT with a safe and cost-effective solution for upgrading guardrail and AGT systems without requiring difficult and costly modifications to the concrete parapets themselves or the addition of a new end buttress adjacent to the current end of the parapet. Further, the retrofit design will reduce installation times and limit the amount of lane closures and exposed workers as compared to reconstructing the concrete parapets. The availability of these retrofit attachments would also improve the long-term safety of the bridge and approach section by conforming to the safety performance criteria of MASH TL-3.

CONTROL NUMBER	01021D
PROJECT NUMBER	FY21 (005)
PROJECT TITLE	UHPC Decked I-Beam for Accelerated Bridge Construction
PRINCIPAL INVESTIGATOR	George Morcous- UNL & Maher Tadros- e.Construct.US
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kent Miller, Joel Rossman, Mark Ahlman, Mike Vigil, Maher Tadros- E. Contruct, Jason Volz, Mark Lafferty-Concrete Industries, Todd Culp-Core Slab, David Mraz – FHWA and Shin-Che Huang - FHWA
PROJECT TOTAL COSTS	$98,251
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$49,126
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: Ultra-High Performance Concrete (UHPC) is an excellent material for bridge construction due to its exceptional durability and superior mechanical properties. Several Departments of Transportations (DOTs), including NDOT, have limited the use of UHPC in bridge construction to joints and connections between bridge components due to the relatively high materials cost of commercially UHPC products. Recently, NDOT has sponsored a research project to develop a non-proprietary UHPC using local materials to reduce materials cost and ensure its availability to local contractors and precast producers. The project was completed successfully and an economical UHPC mix that satisfied all workability, durability, and strength requirements was developed and tested. The cost of the raw materials for this mix was about $700 per cubic yards which is about 30 percent of the cost of pre-bagged commercial UHPC materials. Therefore, it is economically feasible at this time to expand the use of UHPC to bridge components, such as deck slabs and girders, to have a service life of over 150 years. Some researchers (Voo and Foster 2010) estimate the theoretical service life to be about 340 years. Its use will clearly minimize bridge maintenance costs and traffic disruptions.

Objective: The objective of this project is to develop a UHPC superstructure system for bridges in Nebraska that is optimized with respect to structural efficiency, constructability, and economy. Few highway bridges have already been built using UHPC superstructure in France, Korea, Malaysia, USA, and Canada. These bridges had different superstructure systems including pi-girders, bulb-tee girders, tub girders, box girders, decked I-beams, and waffle slabs. These systems will be reviewed and evaluated to determine the system(s) that meet NDOT needs.

The research team will work with NDOT bridge engineers and local bridge producers and contractors in this project. This will include conducting necessary materials testing, structural testing, and formwork design; and addressing issues related to girder shipping and handling, longitudinal joints, differential camber and camber growth, railing connections, cross slope/skewed bridges, and multi span continuity.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Review Existing UHPC Superstructure Systems	$6,657	0%
Task 2: Evaluate System Alternatives	$14,961	0%
Task 3: Develop Final Design and Detailing	$21,618	0%
Task 4: Fabricate and Test Full-Scale Specimen(s)	$41,889	0%
Task 5: Prepare Project Documentation and Technology Transfer	$13,126	0%

Deliverables: The research team currently has a PCI funded research project on nation-wide implementation of UHPC precast/prestressed components in buildings and bridges. This project will supplement the team efforts to develop and implement UHPC superstructure system, which is a great benefit to the state of Nebraska, in particular, and bridge community at large. The use of precast UHPC superstructure system saves construction time of deck forming, reinforcing, casting, and curing, which leads to accelerated bridge construction. It also enhances construction safety, and minimizes traffic disruptions, which is highly needed on interstate highway projects. This project will be conducted by UNL researchers with unpaid consulting services by e.construct.

CONTROL NUMBER	01021E
PROJECT NUMBER	FY21 (006)
PROJECT TITLE	Rapid Concrete Bridge Repair Survey and Patch Material Evaluation
PRINCIPAL INVESTIGATOR	Marc Maguire & Jiong Hu – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Wally Heyen, Fouad Jaber, Mark Traynowicz, Joel Rossman, Mark Ahlman, Mike Vigil, Jason Volz, Mark Lindeman, Lieska Halsey, Sin-Che Huang – FHWA and David Mraz - FHWA
PROJECT TOTAL COSTS	$102,891
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$51,446
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: Tracking the heat of hydration (HoH) of Portland cement concrete has become a widely used and viable technique to characterize cement mixtures hydration behavior for cement producers, practicing engineers, and contractors (ASTM C1679). The Nebraska Department of Transportation (NDOT) is interested in gaining background knowledge on the HoH generated from local cements at different ambient temperatures. This information will be primarily beneficial for troubleshooting field concrete setting issues thereby improving support for Portland cement concrete contractors and ultimately improving project quality. Isothermal calorimetry (IC) has become the method of choice for characterizing cement set and hydration behavior due to its reliability and relatively easy data collection.

Objective: The general objective of this research is to identify the HoH of locally available cements. The specific objectives are to identify HoH in (1) different ambient curing temperatures, (2) different water-to-cement ratios (w/c), (3) different manufacturers. The HoH and Thermal Power Curves developed will be able to identify critical conditions for set times across the NDOT construction situation.
Furthermore, this research will enable additional future research into the behavior of various mineral and chemical admixtures used by NDOT contractors to allow even more specific and continuous contractor support and enhance contractor and Portland cement concrete performance.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review, Sampling and Training	$17,763	0%
Task 2: Experiments	$42,561	0%
Task 3: Data Reduction and Analysis	$21,108	0%
Task 4: Reporting	$21,459	0%

Deliverables: This project will allow NDOT to identify the HoH generation curve and the various metrics associated with different w/c and ambient temperatures. By better understanding the HoH of locally available cements, NDOT will be able to better anticipate early or late setting problems and provide guidance to concrete contractors in different conditions, using different mixtures. Ultimately, this will streamline the construction process, ideally providing better quality final concretes and reduce construction headaches for NDOT and its contractors. Future phases of this project will provide guidance on the combination of various admixtures under different conditions to provide additional information.

Newly Funded Research — FY-2021

CONTROL NUMBER	01021F
PROJECT NUMBER	FY21 (007)
PROJECT TITLE	Intelligent Work Zone Using Automatic Queue Detection Systems
PRINCIPAL INVESTIGATOR	Larry Rilett & Li Zhao - UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Matt Neemann, Matt Baker, Dan Waddle, Jim Knott, Lorraine Legg, Curt Mueting, Eric Klein, Cameron Craig, Kevin Wray, Abe Anshasi-FHWA and Andrew Heuerman-FHWA
PROJECT TOTAL COSTS	$159,466
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$79,733
FY-2021 TASKS TO BE COMPLETED	Task 1, 2, 3 & 4

Background: The proposed research will evaluate the efficacy of the NDOT AQD system. The testbeds for this study will be located at various work zones on Interstate 80 in Nebraska. It is anticipated that four (4) sites will be studied. The effectiveness of the AQD systems will be verified quantitatively. A statistical analysis of crashes at work zones that are equipped and not equipped with the AQD system will be undertaken. In particular, the researchers will examine whether the AQD system had improved safety, e.g., a measured reduction in rear-end crashes. The research will also examine whether other types of crashes increased (or not). The study will also observe driver behavior as a function of the PDMS messages. In particular, the reduction in speed, if any, for the various sign messages will be quantified. Lastly, NDOT uses a cost-benefit analysis when deciding whether to deploy an AQD system at a work zone. This research will validate the assumptions underlying this benefit/cost methodology.

Objective:

The first objective of the study will be to determine whether the AQD system is performing adequately. For example, the researchers will ascertain whether the correct messages are being displayed on the PDMS for given traffic conditions at the AQD detectors. For instance, if the AQD system identifies a queue, the research will confirm that the correct message is displayed on the PDMS upstream of the queue. The hypothesis that will be tested is that the correct message is displayed X percent of the time.

The second objective of the study will be to ascertain how the drivers react to the messages displayed on the PDMS. It is expected that when the drivers are informed that a queue is present ahead of them, they will slow down. The amount of speed reduction will be quantified as a function of distance from the PDMS. The hypothesis that will be tested is that the drivers will, on average, drive slower in response to the queue-related PDMS messages. In other words, the average speed in the vicinity of the PDMS will be lower when a "stop/slow traffic ahead" message is displayed as compared to when a "roadwork ahead" message is displayed. Also, the location of the end-of-queue will be monitored to determine whether the response of drivers is linked to the message on the PDMS and not the tail-light of vehicles at the end-of-queue. The delay associated with the work zone will also be estimated from the empirical data using the Highway Capacity Manual 6th version (HCM6) methodology.

The third objective of the study will be to determine if crash rates are lower on the SWZ equipped with the AQD system, and will compare them to crashes on work zones without the AQD system using statistical theory. Note that the static signage at both types of locations will be consistent with NDOT practice.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Review	$13,949	0%
Task 2: Research on Operation of AQD System 2a. Selection of Primary Test Site(s) 2b. Preliminary Study 2c. Data Collection and Processing 2d. Operational Analysis	 $14,308 $14,308 $55,598 $19,052	0%
Task 3: Safety Analysis 3a. Historical crash data 3b. Surrogate safety measure	 $14,026 $14,069	0%
Task 4: Final Report and Presentation to NDOT	$14,155	0%

Deliverables: The insights gained from this research will improve the safety and efficiency of operations at freeway work zones within the State of Nebraska. There are four main benefits:

a. The functionality of the current AQD system will be validated using empirical data. In addition, any potential modifications and improvements will be identified;
b. The efficacy of the systems as measured by a reduction in average vehicle speed as a function of distance from the PDMS and the message displayed on the PDMS will be quantified;
c. The crash reduction rates associated with the AQD systems will be quantitatively identified; and
d. The NDOT benefit/cost procedure for the AQD system deployment will be validated. This will help NDOT refine the criteria used to justify the deployment of the AQD systems and determine when AQD systems should be used in work zones, etc.

CONTROL NUMBER	01021G
PROJECT NUMBER	FY21 (008)
PROJECT TITLE	Estimating System and Traveler Costs Due to Lane Closures During Construction and Maintenance Operations
PRINCIPAL INVESTIGATOR	Larry Rilett – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Matt Neemann, Dan Waddle, Jim Knott, Lorraine Legg, Curt Mueting, Barbara Gerbino-Bevins, Kevin Wray, Abe Anshasi-FHWA and Justin Luther-FHWA
PROJECT TOTAL COSTS	$179,500
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$89,750
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background: Lane closures are used to facilitate activities related to construction and maintenance/operations. However, there are economic costs associated with lane closures and these may accrue to both the traveling public as well as to traffic agencies. While it is sometimes necessary to prohibit lane closures during the day to alleviate traffic congestion, there are consequences of this decision related to project delivery timelines, construction costs, and safety within the work zone. The Nebraska Governor's office has identified maximizing the effectiveness of lane closures as a priority for Nebraska Department of Transportation (NDOT).

Objective: The specific objectives goals for this research topic identified by NDOT include:
1. Using the 2016 Highway Capacity Manual (e.g. HCM6) methodologies to provide estimates on capacity reduction, delay increases, and fuel usage increases related to various work zone/lane closure conditions. The HCM methodology is based on the VISSIM microsimulation model and this model will be calibrated to Nebraska conditions. Specifically, the following work zone/lane closure scenarios will be examined:
i. 6 Lane Divided: 3 lanes, 1 lane closed
ii. 6 Lane Divided: 3 lanes, 2 lanes closed
iii. 4 Lane Divided: 2 lanes, 1 lane closed
iv. 2 lane (undivided): 1 lane closed (flagging or traffic signal operation)
An analysis of each of the scenarios with respect to length of work zone, percent trucks, speed limit, and time the work zone is active will be conducted; and
2. Conducting a detailed economic analysis of the costs of delay, increased vehicle operating costs, and accident costs for vehicles traveling through lane closures.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Literature Review	$19,663	0%
Task 2: Conduct HCM analysis, under Nebraska conditions for the 4 Lane Divided Highway: 2 lane, 1 lane closed scenario.	$24,655	0%
Task 3: Conduct HCM analysis, under Nebraska conditions for the 6 Lane Divided Highway: 3 lane a) 1 lane closed, and b) 2 lanes closed scenario.	$32,978	0%
Task 4: Conduct HCM analysis, under Nebraska conditions for the 2 lane, undivided highway: 1 lane closed, flagging or traffic signal operation scenario.	$33,090	0%
Task 5: Economic Analyses	$49,236	0%
Task 6: Final Report and Presentation to NDOT	$19,878	0%

Deliverables: This research will aid Nebraska DOT employees in improving safety, cost, and completion times of highway construction projects. This will be accomplished by estimating system and traveler costs associated with lane closures and using state of the art economic analyses to quantify these costs. Further, this project will directly address the recommendations made regarding peak hours versus night work detailed in NDOT's 2017 Work Zone Safety and Mobility Process Review Final Report.

CONTROL NUMBER	01021H
PROJECT NUMBER	FY21 (009)
PROJECT TITLE	Energy Dissipation Optimization for Circular Culverts
PRINCIPAL INVESTIGATOR	David Admiraal – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Julie Ramirez, Phil TenHulzen, Dillon Dittmer, Jason Dayton, Kirk Harvey, John Linbo, Bob Carnazzo and Ben Fischer
PROJECT TOTAL COSTS	$107,088
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$53,544
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10

Background: In 2004, NDOT research examined the use of weir energy dissipators for rectangular culverts. The method has proven valuable and effective for minimizing velocities and decreasing cost and has been included in FHWA's Hydraulic Engineering Circular No. 14: Hydraulic Design of Energy Dissipators for Culverts and Channels. NDOT has already installed similar dissipators (including weir and staggered weir wall dissipators) downstream of circular culverts, but there is no formal design procedure for this application. Although NDOT Roadway Hydraulics has developed methods of analysis for the new application, they do not have any guidance on the validity of the analysis method because no specific research has been conducted. The current method of analysis does not account for energy losses associated with the transition from a round pipe to a concrete box cross section. These additional losses may reduce the necessary size of the dissipation structure. As part of the proposed research, we would like to develop and validate a formal design procedure and simultaneously optimize design details of the resulting dissipator geometry.

Objective: The overarching objective of this research is: to develop and improve energy-dissipation designs for circular culverts in order to mitigate downstream erosion, lessen sedimentation and blockage by debris, minimize the footprint of the energy dissipation structure, and reduce installation cost.

Tasks & Percent to be completed:

Tasks	Budget by Task	Percent Completed
Task 1a: Literature Review	$11,230	0%
Task 1b: Visit existing dissipation structures	-	0%
Task 1c: Document dissipation alternatives	-	0%
Task 2: TAC 1 - Select alternatives	-	0%
Task 3a: Build Alternative I	$42,455	0%
Task 3b: Test Alternative I	-	0%
Task 3c: Analyze data for Alternative I	$14,358	0%
Task 4: TAC 2 - Report results of Alternative I	-	0%
Task 5: Build Alternative 2	$23,858	0%
Task 6a: Test Alternative 2	-	0%
Task 7: TAC 3 – Design implementation meeting	-	0%
Task 8: Analyze data for Alternative 2	$11,273	0%
Task 9a: Finalize report and implement design procedures	$3,913	0%
Task 9B: Produce technical brief	-	0%
Task 10: TAC 4 - Present results to NDOT	-	0%

Deliverables:

1. Documented design detail for all currently used dissipation structure types.
2. Possible extension of the design to include non-traditional applications such as sites with incomplete hydraulic jumps at the outlet.
3. Reduced cost of installation resulting from improved understanding of geometric limitations of the structures.
4. Decreased maintenance for new designs due to reduced sedimentation and clogging.
5. Smaller footprints for completed structures, leading to lessened right-of-way requirements, reduced environmental impacts, and expedited project delivery.
6. Improved effectiveness of the energy dissipation structures will lead to reduced downstream erosion impacts. Reduced erosion will lead to reduced sedimentation in downstream water bodies and wetlands.
7. Quantification of energy losses will include the transition from a circular pipe to a rectangular box structure, potentially resulting in size reductions of energy dissipation structure designs.

CONTROL NUMBER	01021J
PROJECT NUMBER	FY21(010)
PROJECT TITLE	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support
PRINCIPAL INVESTIGATOR	Jennifer Rasmussen- UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Nathan Sorben, Phil TenHulzen and Matt Neemann
PROJECT TOTAL COSTS	$164,927
PROJECT EXPENDITURES TO DATE	NA
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$82,464
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: NDOT desires that the mailbox support be updated to meet MASH 2016 TL-3 safety performance criteria. Very few mailbox supports have been evaluated according to MASH TL-3 specifications. The Texas A&M Transportation Institute (TTI) evaluated locking architectural mailboxes on thin-wall, steel-tube supports to MASH TL-3 (TTI Report No. 9-1002-12-9). A single-mailbox mount was tested and was successful. Two multiple-mailbox (combined standard and locking architectural mailboxes) mounts were tested and both configurations failed to meet MASH TL-3. The mailbox support for multiple mailboxes was subsequently redesigned and resulted in successful MASH TL-3 tests. Due to the limited number of tested mailbox supports, NDOT desired to design and evaluate a MASH TL-3 mailbox support.

Objective: The objective of this research project is to develop a non-proprietary mailbox support using PSST support posts that is MASH TL-3 crashworthy. The design should consider single and multiple mailbox configurations. The design may start with the previous NDOT mailbox support or could be developed independently depending on NDOT's preference. The Phase I objective will be to design and evaluate the mailbox support utilizing bogie testing.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Project Planning and Correspondence a. General project planning and documentation b. Literature search of previous crashworthy mailbox supports and PSST sign supports c. TAC meeting	$17,343	0%
Task 2: Design and Analysis a. Review of previous crashworthy mailbox supports and mailbox connections b. Establish design criteria based on NDOT's needs c. Development of PSST mailbox support concepts d. Preparation of 3D CAD details e. Sponsor comments on proposed concepts f. Recommendation of a proposed design	$43,383	0%
Task 3: Dynamic Component Testing a. Construction of test article – procure mailbox hardware and assembly of mailbox system at MwRSF's Outdoor Testing Facility b. Document material certifications, specifications, and certificates of compliance c. Conduct 6 dynamic component tests on proposed mailbox supports with MwRSF bogie representative of a small car d. Data analysis – Transducer and video analysis for each crash test e. System removal – Removal and disposal of system components	$82,280	0%
Task 4: Reporting and Project Deliverables a. Compile summary report to document research effort, including literature review, concept development, dynamic component tests, and recommendations for further testing b. Report editing (internal and sponsor review) c. Prepare Technical Brief for NDOR d. PowerPoint presentation of research results following project completion e. Project closing (printing, dissemination and accounting).	$21,921	0%

Deliverables: Development of a PSST mailbox support that meets MASH TL-3 requirements will provide NDOT with a crashworthy solution for mailboxes adjacent to state roadways. Additionally, the adoption of a design using PSST similar to current NDOT sign supports will reduce and simplify the state inventory.

CONTROL NUMBER	01021K
PROJECT NUMBER	FY21 (011)
PROJECT TITLE	Establishment of Wildflower Islands to Enhance Roadside Health, Ecological Value, and Aesthetics - Phase II
PRINCIPAL INVESTIGATOR	John Guretzky, Tom Weissling and Judy Wu-Smart - UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Ron Poe, Carol Wienhold, Mercy Manzanares, Jon Soper and Melissa Maiefski-FHWA
PROJECT TOTAL COSTS	$171,275
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$85,638
FY-2021 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6 & 7

Background: A previous study completed by the University of Nebraska-Lincoln (UNL) in collaboration with NDOT has shown that wildflowers compose less than 10% of the botanical composition of highway roadsides 10 years following seeding. More recently in 2016, UNL/NDOT launched a new project to test the use of wildflower islands as a means of increasing the establishment and persistence of wildflowers on roadsides (phase I). These islands varied in size and consisted of segregated stands of diverse mixtures of wildflowers within grass-dominated roadsides. From this two-year study, we demonstrated that islands promoted higher bee abundance and richness than conventionally seeded plots following current NDOT practices.

Objective:

1. Continue to assess the plant community within wildflower islands from phase I to determine the role of island or patch size on longevity of wildflower plots;
2. On newly-seeded roadsides, we will repeat wildflower establishment in varying island sizes or strips (i.e., drill passes) but reduce the number of wildflower species in the seed mixture and introduce mowing regimes to better manage volunteer weeds and assess plant community responses to mowing;
3. Assess attractiveness of wildflower mixtures on pollinators and other beneficial insects from Phase I and Phase II sites to evaluate the ecological impact of wildflower plots.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Meet with NDOT to identify new Phase II sites for project implementation	$10,701	0%
Task 2: Work with NDOT and NDOT-approved contractors to set up experiment design, establish seeding specifications, and mowing regimes	$31,066	0%
Task 3: Collection data, process insects for identification, and prepare quarterly reports	$60,008	0%
Task 4: Apply mowing treatments to phase II sites	$10,701	0%
Task 5: Analyze data	$39,144	0%
Task 6: Write final report	$14,474	0%
Task 7. Present final report to NDOT	$5,183	0%

Deliverables: Current methods of establishing wildflowers in roadside stands are expensive (wildflower seeds account for as much as 30% of seed mixture costs) and commonly unsuccessful. Based on phase I results, we believe there are cost-saving modifications that could be made to the seeding mixture to promote better establishment and longevity of wildflower islands. Deliverables of phase II include refinements to seeding methods, improved maintenance practices, and changes in seeding mixtures that would replace poor-performing species with native plant species that consistently grow well on roadsides and have other ecologically favorable traits (i.e. long bloom periods, positive responses to mowing, attractive to many insects). The proposed research for phase II surveys will include information about which plants are used by insects throughout the season to further demonstrate the ecological value of roadside habitats. Insect and vegetation surveys will be completed at phase I sites and newly-seeded phase II sites to provide more information about establishment and longevity of wildflower islands on roadsides. Additionally, wildflower islands will be evaluated to inform which wildflower mixtures and seeding methods are most favorable for beneficial insects. NDOT has recently become involved with the nationwide Candidate Conservation Agreement with Assurances (CCAA) efforts to promote monarch butterflies utilizing resources on energy and transportation lands illustrating the importance of pollinators to our state. Phase II of this project would align with these interests and priorities (Figure 5). Results generated from this project will improve our understanding of how to most efficiently and cost-effectively establish pollinator-friendly forage and wildlife habitat on roadsides and will inform other state and federal agencies interested in similar projects.

CONTROL NUMBER	01021L
PROJECT NUMBER	FY21 (012)
PROJECT TITLE	Field Demonstration of GPR and UAV technologies for Evaluation of Missouri River Bridge
PRINCIPAL INVESTIGATOR	Jinying Zhu and Chungwook Sim UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kent Miller, Jon Starr and Jason Volz
PROJECT TOTAL COSTS	$25,517
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2021 BUDGET	$25,517
FY-2021 TASKS TO BE COMPLETED	Tasks 1 & 2

Background: Asphalt overlay is increasingly applied on many Nebraska bridges. The asphalt overlay prevents visual inspection and many nondestructive evaluation (NDE) methods. Ground Penetrating RADAR (GPR) is currently the only proven NDE method that can be used to evaluate a concrete bridge deck with asphalt overlays (ASTM 2015). GPR can penetrate though the asphalt layer and the amplitudes of GPR reflection signals from reinforcing bars are used to evaluate the deck condition. In a previous NDOT project (M-065), the PI's team developed a complete procedure of GPR data analysis for bridge deck evaluation, which has been used to evaluate bridge decks with various types of overlays (bare, concrete overlay, asphalt overlay).

Objective:

The goal of this research project is to implement NDE technologies to evaluate the condition of Missouri River bridge deck. Results from this research will help improve the NDE reliability and application to other bridges with asphalt overlays. The objectives in this Phase I research includes:

1. Collect GPR and imaging data on Missouri River bridge prior to removal of asphalt overlay. UAV will be used to acquire imaging data on both top and bottom surfaces.
2. Analyze GPR data, top surface images, and bottom surface images. Estimate repair area and compare to actual repair area.
3. Evaluate performance of UAV aided visual inspection based on GPR results and develop an NDE data analysis system for future application to other Nebraska bridges with overlays.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1. NDE data collection on Missouri River bridge	$15,530	0%
GPR.		0%
UAV application.		0%
Images of bottom surface of bridge deck		0%
Survey of repair		0%
Task 2. Data analysis and report	$9,987	0%
Data analysis		0%
Data comparison and validation		0%
Report		0%

Deliverables: Nebraska is applying asphalt overlay and waterproof membrane on most bridges to improve the lifespan of concrete bridge decks. In order to evaluate the bridge decks with asphalt overlay, we need to develop and validate NDE data analysis methods using field testing data that is essential for future application to large numbers of Nebraska bridges. Data fusion between surface images and in-depth GPR results may provide a quick screening tool based on images and a comprehensive evaluation of bridge decks using multiple NDE methods. This research will aid bridge managers in making decisions about rehabilitation strategies for bridge decks

Recently Completed Research

Recently Completed Research Projects

Project Number	Project Title	Researcher
M026	Long-Term Performance Evaluation of NUDECK	George Morcous – UNO
M040	Improvement of Low Traffic Volume Gravel Roads in Nebraska	Richard Wood – UNL
M058	Establishment of Wildflower Islands to Enhance Roadsides for Pollinators Health and Aesthetics	Walter Schacht – UNL
M062	Performance Evaluation of Inverted Tee (IT) Bridge System	Richard Wood – UNL
M069	Evaluation of Reducing Cement Content in NDOR Class R combined Aggregate Gradations	Jiong Hu – UNO
M070	High-RAP Mixtures with Rejuvenators and WMA Additives - Phase II	Yong-Rak Kim – UNL
M071	Development of High Performance Rapid Patching Materials for Pavement Repair	Jiong Hu – UNO
M072	Feasibility Study of Development of UHPC for Highway Bridge Applications in Nebraska	Jiong Hu – UNO
M073	Development of a DSR Test Method to Determine Binder Low Temperature Properties	Yong-Rak Kim – UNL
M074	Development of a Non-Destructive Testing (NDT) Tool for in-Situ Assessment of Prestressed Components	Jinying Zhu – UNO
M075	Development and Implementation of a Moving Nondestructive Evaluation Platform for Bridge Deck Inspection	Jinying Zhu – UNO
M077	Restricted Crossings on Rural Highways	John Sangster – UNL
M078	Assessing the Impact of Game Day Schedule and Opponents on Travel Patterns and Route	Anuj Sharma– IA State
M079	Remediating Soil for Successful Vegetation Establishment along Nebraska Highways	Martha Mamo – UNL
M081	Correlation Analysis of MDSS and NEWINS	Mark Anderson - UNL
M082	Early Detection of Near-Surface Void Defects in Concrete Pavement Using Drone-Based Thermography and GPR Methods	Zhigang Shen – UNL
M083	Application of Internal Curing to Improve Concrete Bridge Deck Performance	Jiong Hu – UNO
M085	Precast Concrete Deck-to-Girder Connection Using UHPC	George Morcous – UNO
M090	Synthesis of Repair Practices of Damaged Precast/Prestressed Concrete Girders	George Morcous – UNO