NEBRASKA

Good Life. Great Journey.

DEPARTMENT OF TRANSPORTATION

Nebraska Research Work Program

Fiscal Year 2022
July 1, 2021
to
June 30, 2022

NEBRASKA
DEPARTMENT OF TRANSPORTATION
ORGANIZATION CHART

3-2021

GOVERNOR

PETE RICKETTS

HIGHWAY COMMISSION

JOHNSON DISTRICT 1	OMAHA DISTRICT 2	NORFOLK DISTRICT 3	KENESAW DISTRICT 4	GERING DISTRICT 5	NORTH PLATTE DISTRICT 6	McCOOK DISTRICT 7	O'NEILL DISTRICT 8
							
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AERONAUTICS COMMISSION

DIANA SMITH	DICK TRAIL	TOM TRUMBLE	MICHAEL COOK	SCOTT TARRY
				

ASSISTANT ATTORNEY GENERAL FOR NDOT

JEFF SCHROEDER

DIRECTOR

JOHN R. SELMER

DEPUTY DIRECTOR-ENGINEERING

KHALIL JABER

BRIDGE DIVISION	CONTROLLER DIVISION	LOCAL ASSISTANCE DIVISION	PROGRAM MANAGEMENT DIVISION	PROJECT DEVELOPMENT DIVISION
				
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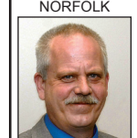
RIGHT-OF-WAY DIVISION	ROADWAY DESIGN DIVISION	STRATEGIC PLANNING DIVISION	TRAFFIC ENGINEERING DIVISION
			
BRENDON SCHMIDT	MIKE OWEN	RYAN HUFF	DAN WADDLE

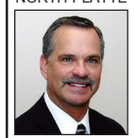
DEPUTY DIRECTOR-OPERATIONS

MOE JAMSHIDI

AERONAUTICS DIVISION	BUSINESS TECHNOLOGY SUPPORT DIVISION	COMMUNICATIONS & PUBLIC POLICY DIVISION	CONSTRUCTION DIVISION
			
ANN RICHART	DEVIN TOWNSEND	VACANT	JAMES J. KNOTT

HUMAN RESOURCES DIVISION	MATERIALS & RESEARCH DIVISION	OPERATIONS DIVISION
		
BARB MCINTYRE	MICK SYSLO	TOM SANDS

DISTRICT 1 LINCOLN	DISTRICT 2 OMAHA	DISTRICT 3 NORFOLK	DISTRICT 4 GRAND ISLAND
			
THOMAS W. GOODBARN	TIMOTHY W. WEANDER	KEVIN DOMOGALLA	WESLEY WAHLGREN

DISTRICT 5 GERING	DISTRICT 6 NORTH PLATTE	DISTRICT 7 McCOOK	DISTRICT 8 AINSWORTH
			
DOUG HOEVET	GARY THAYER	KURT VOSBURG	MARK A. KOVAR

MATERIALS & RESEARCH DIVISION ORGANIZATIONAL CHART
OE 390

JANUARY 2021

- MATERIALS & RESEARCH ENGINEER — ENGINEER VII — MICK SYSLO — OE391
  - ADMINISTRATIVE ASSISTANT I — MICHELLE GREEN
  - SECRETARY ADMINISTRATIVE — HALEY URWIN

CONCRETE & CHEMICAL — ØE 392

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — WALLY HEYEN

- PRECAST — PRESTRESS QUALITY ASSURANCE MANAGER — JOSH KALIN
  - HIGHWAY CONSTRUCTION TECHNICIAN III — RICH EDWARDS
- HIGHWAY CHEMICAL TESTS — HIGHWAY CHEMICAL TESTS MANAGER — JASMINE DONDLINGER
  - CHEMIST II — MARIA OLOMI
    - CHEMIST II — FAHAD QASSIM
- PAVEMENT & PCC TESTS — MAT.& TESTS MANAGER — TIM KRASON
  - HIGHWAY MAT.& TESTS TECHINICAIN III — KIM JIRKOVSKY
  - HIGHWAY MAT.& TESTS TECHNICIAN III — JOHN GUDE
  - HIGHWAY MAT.& TESTS TECHNICIAN II — GRANT GALVAN
  - PROFILING & CORING — HIGHWAY QUALITY ASSURANCE MANAGER — JEREMY WEIGEL
  - HIGHWAY MAT.& TESTS TECHNICIAN III — AARON CODR
  - HIGHWAY MAT.& TESTS TECHNICIAN III — BRYCE HELMS
  - HIGHWAY MAT.& TESTS TECHNICIAN II — JAKE SCHWEITZER

ASPHALT & QUALITY ASSUR. — ØE 393

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — BOB REA

- QUALITY ASSURANCE FIELD LABS
  - LINCOLN — HIGHWAY QUALITY ASSURANCE MANAGER — JAMES SMITH
  - OMAHA — HIGHWAY QUALITY ASSURANCE MANAGER — TERRY BECKER
    - HIGHWAY MAT.& TESTS TECHNICIAN III — KIMBERLY KIRCHNER
  - NORFOLK — HIGHWAY QUALITY ASSURANCE MANAGER — MIKE REYNOLDS
    - HIGHWAY MAT.& TESTS TECHNICIAN III — BRANDON REMM
  - GRAND ISLAND — HIGHWAY QUALITY ASSURANCE MANAGER — CALVIN SPLATTSTOESSER
    - HIGHWAY MAT.& TESTS TECHNICIAN III — KATHERINE FREAD
  - NORTH PLATTE — HIGHWAY QUALITY ASSURANCE MANAGER — JERRY ISOM
    - HIGHWAY MAT.& TESTS TECHNICIAN III — STACY BURFORD
    - HIGHWAY MAT.& TESTS TECHNICIAN II — ALLISSA REINHARD
  - GERING — HIGHWAY MAT.& TESTS TECHNICIAN III — MICHAEL EICH
- FLEXIBLE PAVMENT
  - BITUMINOUS AGGREGATE LABORATORY — HIGHWAY QUALITY ASSURANCE MANAGER — JODY PAUL
    - HIGHWAY MAT.& TESTS TECHNICIAN II — JACOB REYNOLDS
  - BITUMINOUS LABORATORY — HIGHWAY QUALITY ASSURANCE MANAGER — ASAD SAHAK
    - HIGHWAY MAT.& TESTS TECHNICIAN II — AMY TRAN

PAVEMENT DESIGN — ØE 394

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — BRUCE BARRETT

- PAVEMENT DESIGN — HIGHWAY MAT.& TESTS MANAGER — CHRIS DOWDING
  - HIGHWAY MATERIALS DESIGNER — ALLEN PENAS, DEAN DEBUTTS, TIM YATES, MATT BOUWENS, JAMES WENZL, VACANT
- ASSISTANT PAVEMENT DESIGN ENGINEER — ENGINEER IV — KELLIE TROXEL
  - ENGINEER II (Engineer III) — KATHARINE FISCHER
    - ENGINEER I (II) — STEVE NGUYEN
      - HIGHWAY MATERIALS DESIGNER — BRADY DRESSELHAUS
        - HIGHWAY MAT.& TESTS MANAGER — DALE BYRE
          - HIGHWAY MAT.& TESTS TECHNICIAN III — WILL HIPKE

GEOTECHNICAL — ØE 395

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — NIKOLAS GLENNIE

- BRIDGE FOUNDATION ENGINEER — ENGINEER IV — ALEX SILVEY
  - SOIL SURVEY — HIGHWAY QUALITY ASSURANCE MANAGER — DOUG CHURCHWELL
    - HIGHWAY MAT.& TESTS TECHNICIAN III — RICK GLOE
    - HIGHWAY MAT.& TESTS TECHNICIAN I — SCOTT WADDLE
  - ENGINEER III — VACANT
    - ENGINEERING UNIT SUPERVISOR — ALLEN HILLGREN
      - MATERIALS & TESTS TECHNICIAN II — CASEY MILLER, LOGAN SANTIN
- AGGREGATE LABORATORY — HIGHWAY QUALITY ASSURANCE MANAGER — DOUG MACKE
  - ENGINEER I — JOHN EBITO
    - HIGHWAY MAT.& TESTS TECHNICIAN II — JUSTIN STEFFENSMEIER

ROADWAY ASSET MANAGEMENT — ØE 396

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — MARK LINDEMANN

- ENGINEER IV — JARED KREHER
  - TRANSPORTATION PLANNING — HIGHWAY MAT.& TESTS MANAGER — BOB JAEGER
    - TRANSPORTATION PLANNER III — VACANT
    - TRANSPORTATION PLANNER II — JASON CAMPBELL
    - TRANSPORTATION PLANNER III — AMY SMITH
    - TRANSPORTATION PLANNER II — MATT WALKER
    - TRANSPORTATION PLANNER I — TRAVIS GOES
  - DATA COLLECTION & MANAGMENT — HIGHWAY PAVEMENT MANAGEMENT COORDINATOR — BEN TRAN
    - IT BUSINESS SYSTEM ANALYST COORDINATOR — MARSH LEMEN
      - IT BUSINESS SYSTEMS ANALYST — SEAN HIGGINS, ADAM KARRE, BRADY DARBY
- MAPPING — HIGHWAY MAT.& TESTS MANAGER — DANA HARTUNG
  - TRANSPORTATION PLANNER II — ALEX URRUTIA, GLENN WILLIAMS, MIKAL STEWART, MICHAEL BREHM, CINDY WIMMER, KAR SIA

RESEARCH & PHYSICAL TESTS — ØE 399

ASSISTANT MATERIALS & RESEARCH ENGINEER — ENGINEER V — MARK FISCHER

- HIGHWAY CONSTRUCTION TECHNICIAN IV — ANDREA CLARK
- PHYSICAL TESTS — HIGHWAY MAT.& TESTS MANAGER — MARK BURHAM
  - HIGHWAY MAT.& TESTS TECHNICIAN III — TIM MEYER, TOM GERNERT, JEFF GASTON
- RESEARCH — HIGHWAY PROGRAM SPECIALIST — LIESKA HALSEY
  - CHEMICAL ENGINEER — DAVID HANSEN
  - FEDERAL AID ADMINISTRATOR I — ANGELA ANDERSEN

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 highwayusers;
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

Procurement of Equipment

NDOT will follow the approved Standard Operating Procedure for Procurement of equipment and supplies utilizing federal funds for all equipment and supplies in the work program.

Accomplishments FY-2021 (July 1, 2020 to June 30, 2021)

1) In June of 2020, the solicitation was made to the entire State of Nebraska for Statements of Need for FY-2021 funding
2) Virtual meeting were hosted by each Focus group; Materials, Pavements, Maintenance and Construction October 5th Traffic safety and technology October 6th and Structures and Geotechnical- October 7th and Roadway, Hydraulics and Environmental October 15th in 2020 with 59 Statements of Need submitted and discussed. The four meetings were held via WebEx with over 130 attendees including Nebraska Department of Transportation personnel, industry leaders, city and county representatives and the Statement of Need presenters. The Nebraska Transportation Research Council prioritized the Statements of Need in each focus group. NDOT Research Staff requested research proposals for sixteen (16) Statements of Need.
3) November 1 through 15, 2020, NDOT organized and held 12 framework review meetings placing technical experts with the researchers to develop a proposal to help accomplish the department's mission.
4) On January 29, 2021, NDOT's Research Section conducted the RAC meeting and established the FY-2022 Research Program, adding twelve (12) new SPR projects. NDOT expended approximately $1,525,466.00 in FY-2021 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 eighty-six (86) 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) is in the process of closing and TPF-5(430) is in its second year for research.
7) Created a ShareFile for all funded research projects for researcher, TAC and research section use.
8) Completed the Research Guidelines
9) Created Principal Investigator Evaluation. This evaluation will be completed by the NDOT Research Section, the NDOT TAC Lead Member, and the NDOT TAC Project Members. Evaluation should be based on the performance of the Principal Investigator (PI) and not on the PI's institution or Co-PI's.
10) Created the Research section feedback survey- This feedback will be completed by the P.I and Co. Pi's for the project to the research section.
11) Created Project Modification Request Form for cost and no-cost project extensions.
12) Complete and distribute the NDOT Research HUB.
13) Completed 30 Executive Summaries and Implementation standard form for completed research projects with Technology Transfer activities and NDOT recommendations based off research.
    Completed Research Readiness Level (RRL) Assessment
14) Completed 18 Research Projects. Updated presentation email layout for the email distribution of completed published research for projects completed December 2020. Completed Research Executive Summary
15) Co-hosted a three-day virtual peer exchange with North and South Dakota on November 3-5, 2020. We learned about their programs and shared NDOT's program. We also discussed SPR funding fundamentals, research staff development and research program engagement. We had good sessions each day and found applicable ideas to implement in the NDOT research program.

Research Work Program Goals FY-2022

1) Establish the FY-2023 research program.
2) Monitor research projects and assist Technical Advisory Committees.
3) Assist with implementation of research results and create a SharePoint site for the follow up
4) Work closely with our principal investigators on:
    A) Submission of progress and final reports
    B) Presentations to department personnel
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 via the research section website to all States, Federal Highway Administration, Nebraska Transportation Research Council Members, Research Advisory Committee Members and NDOT Divisions and Districts.
7) Continue to collect implementation plans from the lead technical advisory committee member and ask for technology transfer from Principal Investigators. Distribute, collect and publish evaluations on each completed project
8) Send and coordinate the approval of the updated research program manual.
9) Look to include a rapid response research process into the program.

Pooled Fund Participation Summary (100% Federally Funded) and Transfers

Study Titles	Funding Type	Expenditures Last Year (FY21)	Budget Program Year (FY22)
TPF-5(301) Support Services for Peer Exchanges	Z560	$ 4,078	$ -
TPF-5(317) Evaluation of Low Cost Safety Improvements	Z560	$ 5,000	$ 5,000
TPF-5(326) Develop and Support Transportation Performance Management Capacity Development Needs for State DOT's	Z560	$ 147,000	$ 147,000
TPF-5(347) Development of Maintenance Decision Support System	Z560	$ 35,000	$ 30,000
TPF-5(353) Clear Roads Phase II	Z560	$ 25,000	$ 25,000
TPF-5(372) Building Information Modeling (BIM) for Bridges and Structures	Z560	$ 20,000	$ 20,000
TPF-5(430) Midwest Roadside Safety Pooled Fund Program	Z560	$ 65,000	$ 65,000
TPF-5(432) Bridge Element Detrioration for Mid-west States	Z560	$ 20,000	$ 20,000
TPF-5(437) Technology Transfer Concrete Consortium	Z560	$ 12,000	$ 12,000
TPF-5(438) Smart Work Zone Deployment Initiative	Z560	$ 25,000	$ 25,000
TPF-5(447) Traffic Control Device Consortium	Z560	$ 15,000	$ 15,000
TPF-5(448) Improving Specifications to Resist Frost Damage in Modern Concrete Mixes	Z560	$ 20,000	$ 20,000
TPF-5(451) Western Road Usage Charging Consortium	Z560	$ 25,000	$ 25,000
TPF-5(456) EconWorks - Improved Economic Insight	Z550	$ 4,000	$ 4,000
TPF-5(465) Consortium for Asphalt Pavement Research and Implementation (CAPRI)	Z560	$ -	$ 10,000
TPF-5(467) Project Management Software for Research	Z560	$ -	$ 3,500
Solicitation 1536-Guidelines for Determining Traffic Signal Change and Clearance Intervals	Z560	$ -	$ 30,000
Pooled Fund Total		**$ 422,078**	**$ 456,500**
Transportation Research Board (TRB) Annual Transfer	Z560	$ 92,657	$ 94,000
National Cooperative Highway Research Program (NCHRP) Annual Transfer	Z560	$ 341,839	$ 377,000
Total		**$ 856,574**	**$ 927,500**

TPF-5(193) CONTROL NO.: 00778				
SUPPLEMENT NUMBER	**STUDY TITLES**	**TOTAL STUDY BUDGET**	**EXPENDITURES**	**REMAINING BUDGET**
CURRENT PROJECTS				
#91	Design Guidance for MGS Placed on or neat Slopes	$54,309	$32,600	$21,709
#106	Evaluation of the MGS with Curb	$161,926	$95,604	$66,322
#107	Continuation of Standardized Concrete Parapet for Attachments of Thrie Beam AGT's	$128,145	$93,904	$34,241
#123	MASH Testing of Thrie Beam Bullnose System - Phase II	$410,766	$246,857	$163,909
#128	Dynamic Testing and Evaluation of a New York State DOT Transition between Boxed Guardrail Under AASHTO MASH 2016 TL-3 Guidelines	$236,626	$180,790	$55,836
#130	IOWA - Development and Evaluation of a MASH TL-3 Compliance Parapet Mounted	$120,088	$119,088	$1,000
#133	CALTRANS LS-DYNA Simulation Consulting Support	$31,391	$2,719	$28,672
#134	NYSDOT MASH 2016 Safety Hardware Evaluations - Phase 1	$955,951	$538,122	$417,829
#135	MASH 2016 Safety Hardware Evaluation	$1,033,463	$318,574	$714,889
#138	NDOT Redesign of the High-Tension Cable Median Barrier	$241,000	$186,154	$54,846
#139	NDOT Evaluation of Permanent Concrete Barrier	$163,621	$69,193	$94,428
#140	Evaluation of MGS with Curb and Omitted Post - Continuation	$111,133	$79,829	$31,304
#142	NDOT Generic End Terminal - Phase II	$325,393	$143,137	$182,257
#143	MASH 2016 Implementation Support	$401,000	$14,549	$386,451
#144	Midwest Pooled Fund MASH Hardware Clearinghouse	$51,206	$41	$51,165
#145	NDOT Q & A Improvements	$30,852	$5,942	$24,910
#146	Revision to Midwest Pooled Fund Q & A Website	$49,745	$8,446	$41,299
#149	LS-DYNA Modeling Enhancement Support	$42,366	$40,958	$1,408
#151	Development of an Optimized MASH TL-4 Kansas Corral Rail	$401,400	$173,390	$228,010
#152	MASH 2016 Safety Hardware Evaluation - Phase 1	$1,239,301	$350,274	$889,027
#154	MASH Testing of Single Sign Support	$750,000	$114,726	$635,274
		$6,939,682	**$2,814,897**	**$4,124,785**

1. Budget Numbers as of 4/30/2021
2. Budget shows expenses that may not be entered into FMIS
3. Only active projects are shown. Supplements which have been completed are not shown
4. Remaining budget will not match FMIS as there are non-federal funds associated with some of the projects.

TPF-5(430) CONTROL NO.: 01010				
SUPPLEMENT NUMBER	**STUDY TITLES**	**TOTAL STUDY BUDGET**	**EXPENDITURES**	**REMAINING BUDGET**
CURRENT PROJECTS				
#1	RPFP-20-MGS-2: MGS with Reduced Embedment and Post Spacing over Low-Fill Culverts (Indiana)	$185,912	$42,129	$143,783
#2	PFP-20-AGT-1: Additional Retrofit Options for Post Conflicts within AGTs (New Jersey)	$251,429	$8,122	$243,307
#3	Guidelines for Flaring Thrie-Beam Approach Guardrail Transitions - Phase II	$302,783	$44,621	$258,162
#4	RPFP-2--TERM-1: Further Evaluation of the End Terminals Adjacent to Curb (New Jersey)	$257,208	$15,261	$241,947
#5	RPFP-20-SR-1: Development of a Short-Radius Guardrail for Intersecting Driveways or Roadways (New Jersey)	$251,032	$1,870	$249,162
#6	RPFP-20-CONSULT: Annual Consulting Services Support	$60,647	$7,369	$53,278
#7	RPFP-20-PFCHS: Pooled Fund Center for Highway Safety	$14,330	$8,906	$5,424
#8	RPFP-20-LS-DYNA: LS-DYNA Modeling Enhancement Support	$30,616	$0	$30,616
#14	Phase 2 Review of Median Barrier Warrants and ISPE of Cable Median Barriers (CMBs) In Kansas: Median Barrier Warrants	$108,065	$50,748	$57,317
		$1,462,022	**$179,027**	**$1,282,995**

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TPF-5(430) CONTROL NO.: 01010				
SUPPLEMENT NUMBER	**STUDY TITLES**	**TOTAL STUDY BUDGET**	**EXPENDITURES**	**REMAINING BUDGET**
NEW PROJECTS				
#15	RPFP-21-CABLE-1: Redesign of the High-Tension Cable Median Barrier – Phase II	$253,893	$0	$253,893
#16	RPFP-21-CONC-2: Anchoring Temporary Barrier to Asphalt Pavement Phase II (Wisconsin)	$224,325	$0	$224,325
#17	RPFP-21-CONC-3: MASH TL-3 Portable Barrier System (Nebraska/Wyoming)	$148,296	$0	$148,296
#18	RPFP-21-AGT-1: Approach Guardrail Transition behind Curb and Elevated Sidewalk (Indiana)	$146,141	$0	$146,141
#19	RPFP-21-AGT-3: Guidelines for Flaring Thrie-Beam Approach Guardrail Transitions - Phase III (Continuation)	$121,307	$0	$121,307
#20	RPFP-21-SIGN-1: Breakaway Systems for Ground-Mounted, Large Steel Sign Support Structures (New Jersey)	$77,740	$0	$77,740
#21	RPFP-21-POLE-1: Breakaway Pole Research (Wisconsin)	$269,455	$0	$269,455
#22	RPFP-21-CONSULT: Annual Consulting Services Support	$61,446	$0	$61,446
#23	RPFP-21-MPFW: Midwest Pooled Fund Website	$18,573	$0	$18,573
#24	RPFP-21-LS-DYNA: LS-DYNA Modeling Enhancement Support	$43,823	$0	$43,823
		$1,364,999	**$0**	**$1,364,999**

1. Budget Numbers as of 4/30/2021
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3. Only active projects are shown. Supplements which have been completed are not shown

CURRENT OBLIGATION					
SPR-P1(20) CONTROL NO.: 00730L					
PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
CURRENT ACTIVE PROJECTS					
M087	Z560	Design Optimization and Monitoring of Joint-less Integral and Semi-integral abutment bridges in Nebraska	$167,687	$147,854	$19,833
M096	Z560	Evaluating ASCT operations for Dodge Street Corridor	$118,056	$85,455	$32,601
M100	Z560	A Statewide Geographic Information System (GIS) as a Predictive Tool for Locating Deeply Buried Archeological Deposits in Nebraska	$97,398	$23,754	$73,644
M102	Z560	Phase Construction Bridges: Monitoring and Analysis for Traffic-Induced Vibration	$117,482	$82,626	$34,856
M103	Z560	Simple for Dead Continuous for Live (SDCL) Steel Girder Bridges with UHPC and GFRP	$132,358	$70,938	$61,420
M104	Z560	Data-Driven Prioritization and Empirical Predictions for Bridge Scour in Nebraska	$115,662	$21,758	$93,904
M105	Z560	Low-Cost Modal Identification Sensors of Bridge Field Testing	$142,519	$133,477	$9,042
M106	Z560	Feasibility Study: Alternatives to Prevent Settlements and Bumps at Bridge Approaches in Nebraska	$99,469	$88,808	$10,661
M107	Z560	Outdoor Laboratory and Testbed for Bridge health	$115,074	$51,958	$63,116
M108	Z560	Design and Detailing of Cast-in-Place and Precast Concrete Approach Slabs	$78,648	$47,316	$31,332
M110	Z560	Biopolymerized slope/subgrade stabilization and advanced field monitoring	$124,386	$118,552	$5,834
M115	Z560	Research on High-RAP Mixtures with Rejuvenators - Field Implementation	$99,950	$49,796	$50,154
M116	Z560	*Effect of Antioxidant Additives and Restorations on Performance of Asphalt Binders and Mixtures – Phase I	$428,662	$70,755	$357,907
M117	Z560	Research and Education for Optimizing the Development and Implementation of an Unmanned Aircraft Program at the Nebraska Department of Transportation	$93,472	$51,650	$41,822
M118	Z560	Computation of Peak and Low Flow Statistics and StreamStats GIS Implementation in the Elkhorn River Basin in Nebraska	$35,000	$35,000	$0
BUDGET FOR IN PROGRESS SPR-P1(20) PROJECTS			**$1,965,823**	**$1,079,697**	**$886,126**
P100	Z560	Contingencies	$678,826	$40,406	$638,420
P088	Z560	Administration	$6,000		$6,000
P089	Z560	Research Implementation	$50,000		$50,000
TOTAL BUDGET FOR SPR-P1(20)			**$2,700,649**	**$1,120,103**	**$1,580,546**

ALL EXPENDITURES TO-DATE FOR SPR-P1(20)	Total	Federal	State
	$2,929,157	**$2,343,326**	**$585,831**

1. Budget Numbers as of 4/30/2021
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3. Only active projects are shown. Completed projects are not shown.

* Added $258,000 equipment to project.

CURRENT OBLIGATION						
CONTROL NUMBER	PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
CURRENT ACTIVE PROJECTS						
01021	FY21(001)	Z560	An Investigation of Water Obstructions and Related Weather Conditions for Nebraska Roadways	$164,700	$28,845	$135,855
01021A	FY21(002)	Z560	Development of Guideline for the Use of Geosynthetics in Different Roadway Layered System in Nebraska	$106,536	$34,640	$71,896
01021B	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	FY21(004)	Z560	Approach Guardrail Transition Retrofit to Existing Concrete Parapets and Bridges	$87,978	$12,896	$75,082
01021D	FY21(005)	Z560	UHPC Decked I-Beam for Accelerated Bridge Construction	$98,250	$11,222	$87,028
01021E	FY21(006)	Z560	Rapid Concrete Bridge Repair Survey and Patch Material Evaluation	$93,572	$0	$93,572
01021F	FY21(007)	Z560	Intelligent Work Zone Using Automatic Queue Detection (AQD) Systems	$159,466	$36,082	$123,384
01021G	FY21(008)	Z560	Estimating System and Traveler Costs Due to Lane Closures During Construction and Maintenance Operations	$179,500	$70,088	$109,412
01021H	FY21(009)	Z560	Energy Dissipation Optimization for Circular Culverts	$107,088	$28,824	$78,264
01021J	FY21(010)	Z560	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support	$164,927	$8,497	$156,430
01021K	FY21(011)	Z560	Establishment of Wildflower Islands to Enhance Roadside Health, Ecological	$171,275	$25,582	$145,693
01021L	FY21(012)	Z560	Field Demonstration of GPR and UAV technologies for Evaluation of two US75 Bridges	$25,517	$8,728	$16,789
BUDGET FOR IN PROGRESS 01021-FY21 PROJECTS				$1,504,047	$265,404	$1,238,643

1. Budget Numbers as of 4/30/2021
2. Budget shows expenses that may not be entered into FMIS
3. Only active projects are shown. Completed projects are not shown.

FY2022 RESEARCH PROGRAM						
CONTROL NUMBER	PROJECT NUMBER	FUNDING TYPE	STUDY TITLES	TOTAL STUDY BUDGET	EXPENDITURES	REMAINING BUDGET
NEW PROJECTS						
01034A	FY22(001)	Z56E	Low-Cement Concrete Mixture for Bridge Decks and Rails	$112,394	$0	$112,394
01034B	FY22(002)	Z56E	Nebraska Balanced Mix Design	$138,937	$0	$138,937
01034C	FY22(003)	Z56E	WMA Short Term Aging	$140,616	$0	$140,616
01034D	FY22(004)	Z56E	Erosion Resistant Rock Shoulder	$142,907	$0	$142,907
01034E	FY22(005)	Z56E	Application of Remote Sensing and Hydrologic Modeling to Reduce Highway Flooding in the Nebraska Sandhills	$143,166	$0	$143,166
01034F	FY22(006)	Z56E	Evaluation of NDOT's Sediment Barrier Practices Using Performance Data	$191,099	$0	$191,099
01034G	FY22(007)	Z56E	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support - Phase II	$219,556	$0	$219,556
01034H	FY22(008)	Z56E	Production of Cast-in-Place UHPC for Bridge Applications	$83,996	$0	$83,996
01034J	FY22(009)	Z56E	Accelerated Bridge Construction Decision Tool	$90,592	$0	$90,592
01034K	FY22(010)	Z56E	Application of Steel Sheet Piles for the Abutment of Water-crossing Bridges in Nebraska	$155,304	$0	$155,304
01034L	FY22(011)	Z56E	Truck Platooning Effects on Girder Bridges - Phase II	$120,843	$0	$120,843
01034M	FY22(012)	Z56E	Inventory, Operations and Safety at Free Right-Turn Ramps	$182,563	$0	$182,563
BUDGET FOR IN PROGRESS 01021-FY21 PROJECTS				$1,721,973	$0	$1,721,973

1. Budget Numbers as of 4/30/2021

Current Projects in Progress

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, Brandon Varilek, Mike Vigil, Steve Sabra, Lynden Vanderveen, and David Mraz-FHWA
PROJECT TOTAL COSTS	$167,687
PROJECT EXPENDITURES TO DATE	$147,854
NUMBER OF EXTENSIONS GRANTED	Two (2)
PERCENTAGE OF PROJECT COMPLETE	90%
STATUS	Behind Schedule
FY-2022 BUDGET	$19,833
FY-2022 TASKS TO BE COMPLETED	Task 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	100%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	5/31/2020
TECHNICAL ADVISORY COMMITTEE	Alan Swanson, Dan Waddle, Bryan Guy, Matt Neemann, and Abe Anshasi-FHWA
PROJECT TOTAL COSTS	$118,056
PROJECT EXPENDITURES TO DATE	$85,455
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	90%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$32,601
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 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	100%
Task 4: Analysis	$49,025	95%
Task 5: Final Report	$8,000	20%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	6/30/2021
TECHNICAL ADVISORY COMMITTEE	Dillon Dittmer, Stacy Stupka, John Rissetto, John Swigart, and Zach Kresl
PROJECT TOTAL COSTS	$97,398
PROJECT EXPENDITURES TO DATE	$23,754
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	80%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$73,644
FY-2022 TASKS TO BE COMPLETED	Tasks 2, 3, 4, 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	100%
Task 2: Collect and digitize reports and data for Phase II regions	$1,950	0%
Task 3: Field Investigations in western Nebraska	$22,198	20%
Task 4: Refine GIS layer and add Phase II data	$58,450	85%
Task 5: Meet with TAC	$600	100%
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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	5/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Brandon Varilek, and David Mraz-FHWA
PROJECT TOTAL COSTS	$117,482
PROJECT EXPENDITURES TO DATE	$82,626
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	70%
STATUS	Behind Schedule
FY-2022 BUDGET	$34,856
FY-2022 TASKS TO BE COMPLETED	Tasks 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	100%
Task 2: Field Monitoring of Bridges during Phased Construction	$29,649	100%
Task 3: Laboratory Evaluation of Traffic-Induced Vibration	$60,292	67%
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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Brandon Varilek, Maher Tadros-e-Construct, Douglas Gremel-Owens Corning Infrastructure Solutions, and David Mraz-FHWA
PROJECT TOTAL COSTS	$132,358
PROJECT EXPENDITURES TO DATE	$70,938
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	55%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$61,420
FY-2022 TASKS TO BE COMPLETED	Tasks 2, 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	100%
Task 4: GFRP in UHPC Direct Tension Tests	$12,775	50%
Task 5: GFRP Lap Splices in UHPC Deck Joint Tests	$10,778	50%
Task 6: Experimental SDCL Validation	$56,522	30%
Task 7: Software Integration Study	$18,751	0%
Task 8: Documentation and Presentation	$15,138	25%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kirk Harvey, and Jason Dayton
PROJECT TOTAL COSTS	$115,662
PROJECT EXPENDITURES TO DATE	$21,758
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$93,904
FY-2022 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	28%
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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	3/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Babrak Niazi, Wayne Patras, and Kpandji Lakmon
PROJECT TOTAL COSTS	$142,519
PROJECT EXPENDITURES TO DATE	$133,477
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	90%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$9,042
FY-2022 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	30%
Task 5: Model Calibration	$22,145	90%
Task 6: Dynamic Load Rating	$21,822	70%
Task 7: Final Report	$22,777	50%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	5/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Ahlman, Mark Traynowicz, Mike Vigil, Nikolas Glennie, Brandon Varilek, Bruce Barrett, and Kellie Troxel
PROJECT TOTAL COSTS	$99,469
PROJECT EXPENDITURES TO DATE	$88,808
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	85%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$10,661
FY-2022 TASKS TO BE COMPLETED	Tasks 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	100%
Task 2: Review: Cases and Solutions in Other States	$14,970	100%
Task 3: Detailed Analysis: Improvement of Current Bridge Approach Design in Nebraska	$28,697	90%
Task 4: Detailed Analysis: Feasibility of Geosynthetic Reinforcement of Soils	$32,751	75%
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: Project has an approved extension request and is up to date on revised tasks and schedule.

PROJECT NUMBER	M107
PROJECT TITLE	Outdoor Laboratory and Testbed for Bridge Health
PRINCIPAL INVESTIGATOR	Richard Wood, Christine Wittich, Joshua Steelman, Jay Puckett, Dan Linzell and Jinying Zhu – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Babrak Niazi, Kent Miller, Mark Ahlman, Brandon Varilek, Kirk Harvey, Mike Vigil, and David Mraz-FHWA
PROJECT TOTAL COSTS	$115,074
PROJECT EXPENDITURES TO DATE	$51,958
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	56%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$63,116
FY-2022 TASKS TO BE COMPLETED	Task 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	100%
Task 2: Site Characterization	$32,613	57%
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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	5/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Mark Ahlman, Brandon Varilek, and Ben Ptacek
PROJECT TOTAL COSTS	$78,648
PROJECT EXPENDITURES TO DATE	$47,316
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	70%
STATUS	Behind Schedule
FY-2022 BUDGET	$31,332
FY-2022 TASKS TO BE COMPLETED	Tasks 3, 4 & 5

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	100%
Task 2: Conduct Analytical Investigation	$16,747	100%
Task 3: Propose Design Alternatives	$16,747	80%
Task 4: Evaluate Detailing and Constructability	$17,374	50%
Task 5: Develop Specifications and Guidelines	$13,944	90%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	4/15/2021
TECHNICAL ADVISORY COMMITTEE	Mark Lindeman, Nikolas Glennie, Alex Silvey, Bruce Barrett, Kellie Troxell, and Mick Syslo
PROJECT TOTAL COSTS	$124,386
PROJECT EXPENDITURES TO DATE	$118,552
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	93%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$5,834
FY-2022 TASKS TO BE COMPLETED	Tasks 2, 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	97%
Task 3: Application of biopolymers to target sites	$25,197	100%
Task 4: Field monitoring and performance evaluation	$23,767	63%
Task 5: Reporting	$19,272	62%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

PROJECT NUMBER	M115
PROJECT TITLE	Research on High-RAP Mixtures with Rejuvenators - Field Implementation
PRINCIPAL INVESTIGATOR	Hamzeh Haghshenas – UNL and Robert Rea – NDOT Materials & Research
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	12/31/2021
TECHNICAL ADVISORY COMMITTEE	Bruce Barrett, Kellie Troxel, Mick Reynolds, Mick Syslo, Jodi Paul, and David T. Hansen
PROJECT TOTAL COSTS	$99,950
PROJECT EXPENDITURES TO DATE	$49,796
NUMBER OF EXTENSIONS GRANTED	One (1)
PERCENTAGE OF PROJECT COMPLETE	26%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$50,154
FY-2022 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	$4,466	80%
Task 2: Experimental Design: Selection of Mixing Plants and Field Sections	$7,216	45%
Task 3: Laboratory Experiments and Field Monitoring	$40,969	10%
Task 4: Analysis of Test Results	$38,584	0%
Task 5: Documentation and Presentation	$8,737	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: Project has an approved extension request and is up to date on revised tasks and schedule.

PROJECT NUMBER	M116
PROJECT TITLE	Effect of Antioxidant Additives and Restorators on Performance of Asphalt Binders and Mixtures – Phase I
PRINCIPAL INVESTIGATOR	Hamzeh Haghshenas – UNL and Robert Rea – NDOT Materials & Research
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Mick Syslo, Mike Reynold, John Gude, Jody Paul, Mathew Kumbier, Jasmine Dondlinger, David T. Hansen, Bruce Barrett, Kellie Troxell, Robert Rea, Brandon Varilek, and Shin-Che Huang-FHWA
PROJECT TOTAL COSTS	$428,662 Added equipment for $258,000
PROJECT EXPENDITURES TO DATE	$70,755
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	70%
STATUS	On Approved Schedule
FY-2022 BUDGET	$357,907
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background:
The use of recycled materials, such as reclaimed asphalt pavement (RAP), recycled asphalt shingle (RAS), glass, and ground tire rubber, is a cost-effective and environmentally-friendly production method in the asphalt paving industry. The effects of recycled materials on asphalt mixtures have been investigated and reported by many researchers [1-4]. An extensive literature review reveals that the increase in stiffness, which is due to the aged asphalt binder present in RAP, is the main drawback caused by introducing RAP in asphalt mixtures [1, 5]. On the other hand, RAP in asphalt mixtures can result in an improvement in the rutting resistance of RAP blended mixtures [5-7]. The aging of an asphalt binder has a direct relationship with the stiffness and durability of asphalt mixtures [8-11].

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: Literature Review	$19,545	95%
Task 2: Materials Selection	$16,002	85%
Task 3: Laboratory Tests	$54,154	60%
Task 4: Analysis of Test Results	$32,764	75%
Task 5: Documentation and Presentation	$17,324	35%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	Christopher Neale – UNL
PROJECT START DATE	7/1/2019
PROJECT COMPLETION DATE	5/31/2021
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	$93,472
PROJECT EXPENDITURES TO DATE	$51,650
NUMBER OF EXTENSIONS GRANTED	Two (2)
PERCENTAGE OF PROJECT COMPLETE	59%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$41,822
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background:
The opening of National Air Space to UAS has the potential to be a "game changer" for the surface transportation industry, much like GPS, GIS, and associated information technologies. UAS will offer an unparalleled opportunity to place sensors, robotics, and advanced information systems at desired locations for increasing productivity, improving efficiency, and enhancing safety of surface transport systems. The commercial market for UAS is expected to triple in the next 5 years, with a projected increase to $42.5 billion by 2024 from a global perspective. Control of the National Air Space will be achieved through implementation of emerging NextGen technology aligned with Unmanned Aircraft Systems Traffic Management (UTM), which will be based on a GPS foundation. These developments present a compelling motivation for the NDOT to develop and implement an in-house unmanned aircraft program.

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	28%
Task 2: Administrative Policy	$38,937	57%
Task 3: Training	$12,093	93%
Task 4: Operations	$19,551	66%
Task 5. Analysis of Use Cases	$5,084	34%
Task 6. Documentation and Presentation	$9,157	78%

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: Project has an approved extension request and is up to date on revised tasks and schedule.

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	12/31/2023
TECHNICAL ADVISORY COMMITTEE	Mark Traynowicz and Kirk Harvey
PROJECT TOTAL COSTS	$35,000
PROJECT EXPENDITURES TO DATE	$35,000
NUMBER OF EXTENSIONS GRANTED	Two (2)
PERCENTAGE OF PROJECT COMPLETE	55%
STATUS	On Approved Revised Schedule
FY-2022 BUDGET	$0
FY-2022 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 1a: Compilation of peak flow data		100%
Task 1b: Compute peak flow statistics to 2015		100%
Task 1c: Comparison to USACE computations		100%
Task 1d: Compute peak flow statistics to 2018		100%
Task 1e: Update peak flow statistic to 2019 (pending publication of streamflow record and updated regional skew)		75%
Task 2: Low flow statistic computation	$7,500	90%
Task 2a: Compilation of streamgage daily flow data		100%
Task 2b: Low flow statistics computation using R statistical package DV stats		100%
Task 2c: Update low flow statistic (pending publication of streamflow record)		80%
Task 3: GIS implementation into StreamStats	$12,000	75%
Task 3a: Acquire stream center lines for NeDNR		100%
Task 3b: LiDAR prep (burning stream center lines)		80%
Task 3c: Development of flow accumulation and flow direction grids		70%
Task 3d: Online StreamStats implementation		0%
Task 4: Publication	$6,000	50%
Task 4a: USG Scientific Investigations report		50%
Task 4b: GIS date release (data sets and metadata)		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: Project has an approved extension request and is up to date on revised tasks and schedule.

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, Julie Ramirez, Claire Inbody, and Janie Vrtiska
PROJECT TOTAL COSTS	$164,700
PROJECT EXPENDITURES TO DATE	$28,845
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	20%
STATUS	On Schedule
FY-2022 BUDGET	$135,855
FY-2022 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	90%
Task 2: Collection of Nebraska CARS water obstruction data	$23,267	90%
Task 3: Collection of meteorological observations	$31,475	20%
Task 4: GIS analyses of the obstruction information	$26,818	40%
Task 5: Statistical analyses of the water obstruction information	$29,596	10%
Task 6: Examination of the water obstructions and meteorological information	$23,538	10%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

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 Barrett, Kellie Troxel, Brandon Varilek, Jesse De Los Santos, Ray Trujillo, and Shin-Che Huang-FHWA
PROJECT TOTAL COSTS	$106,536
PROJECT EXPENDITURES TO DATE	$34,640
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	15%
STATUS	On Schedule
FY-2022 BUDGET	$71,896
FY-2022 TASKS TO BE COMPLETED	Tasks 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	100%
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	50%
Task 3: Large-scale Track Wheel (LSTW) Tests to Evaluate Geosynthetic Reinforced Pavement	$25,986	15%
Task 4: Numerical Study of Geosynthetic-Reinforced Roadway System	$23,193	10%
Task 5: Suggestion of Design Recommendation	$7,147	0%
Task 6: Final Report	-	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.

Performance & Goals: Project is up to date with the current tasks and progress.

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 & Jiong Hu – UNL and Robert Rea – NDOT Materials & Research
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	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	25%
STATUS	On Schedule
FY-2022 BUDGET	$145,238
FY-2022 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	75%
Task 2: Materials Selection	$16,801	50%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

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 – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Brandon Varilek, Mark Ahlman, Mike Vigil, Phil TenHulzen, Abdul Sidiqi, David Mraz-FHWA, and Andrew Heuerman-FHWA
PROJECT TOTAL COSTS	$87,978
PROJECT EXPENDITURES TO DATE	$12,896
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	20%
STATUS	On Schedule
FY-2022 BUDGET	$75,082
FY-2022 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	$8,763	60%
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	$23,862	40%
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	$33,515	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)	$21,838	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.

Performance & Goals: Project is up to date with the current tasks and progress.

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, Wally Heyen, Kent Miller, Brandon Varilek, Mark Ahlman, Mike Vigil, Mark Lafferty-Concrete Industries, Todd Culp-Core Slab, David Mraz–FHWA, and Shin-Che Huang-FHWA
PROJECT TOTAL COSTS	$98,250
PROJECT EXPENDITURES TO DATE	$11,222
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	40%
STATUS	Ahead of Schedule
FY-2022 BUDGET	$87,028
FY-2022 TASKS TO BE COMPLETED	Tasks 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	$7,480	100%
Task 2: Evaluate System Alternatives	$9,967	100%
Task 3: Develop Final Design and Detailing	$19,954	25%
Task 4: Fabricate and Test Full-Scale Specimen(s)	$46,782	0%
Task 5: Prepare Project Documentation and Technology Transfer	$14,068	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.

Performance & Goals: Project is up to date with the current tasks and progress.

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, Brandon Varilek, Mark Ahlman, Mike Vigil, Logan Sia, David T. Hansen, Lieska Halsey, Shin-Che Huang–FHWA, and David Mraz-FHWA
PROJECT TOTAL COSTS	$93,572
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	15%
STATUS	Behind Schedule
FY-2022 BUDGET	$93,572
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

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 and Survey Development	$14,040	90%
Task 2: Compiling Paper Data Identify Lab Testing	$12,390	10%
Task 3: Site Visits	$14,700	5%
Task 4: Lab Testing and Data Analysis of Collected Data	$28,737	0%
Task 5: Reporting	$23,705	10%

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.

Performance & Goals: Project is up to date with the current tasks and progress.

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	$36,082
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	30%
STATUS	On Schedule
FY-2022 BUDGET	$123,384
FY-2022 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	90%
Task 2: Research on Operation of AQD System		
2a. Selection of Primary Test Sites	$14,308	15%
2b. Preliminary Study of Test Sites	$14,308	45%
2c. Data Collection and Processing	$55,598	25%
2d. Operational Analysis	$19,052	45%
Task 3: Safety Analysis		
3a. Historical Crash Data	$14,026	10%
3b. Surrogate Safety Measure	$14,069	15%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

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	$70,088
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	40%
STATUS	On Schedule
FY-2022 BUDGET	$109,412
FY-2022 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	90%
Task 2: Conduct HCM analysis, under Nebraska conditions for the 4 Lane Divided Highway: 2 lane, 1 lane closed scenario.	$24,655	50%
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	35%
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	60%
Task 5: Economic Analyses	$49,236	10%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

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	$28,824
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	20%
STATUS	On Schedule
FY-2022 BUDGET	$78,264
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 3, 4, 5, 6, 7, 8 & 9

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 1: Literature Review and Existing Structures	$11,230	90%
Task 1a: Literature Review		
Task 1b: Visit existing dissipation structures		
Task 1c: Document dissipation alternatives		
Task 2: TAC 1 - Select Alternatives	$0	100%
Task 3: Construct and Test Energy Dissipation Alternative 1	$42,455	40%
Task 3a: Build Alternative 1		
Task 3b: Test Alternative 1		
Task 4: Analyze data for Alternative 1	$14,358	0%
Task 5: TAC 2 - Report results of Alternative 1	$0	0%
Task 6: Build and Test Alternative 2	$23,858	0%
Task 6a: Build Alternative 2		
Task 6b: Test Alternative 2		
Task 7: TAC 3 – Design implementation meeting	$0	0%
Task 8: Analyze data for Alternative 2	$11,273	0%
Task 9: TAC 4 - Present Experimental Results to NDOT	$0	
Task 10: Complete Report and Technical Brief. TAC 5 - Final Presentation	$3,913	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.

Performance & Goals: Project is up to date with the current tasks and progress.

CONTROL NUMBER	01021J
PROJECT NUMBER	FY21(010)
PROJECT TITLE	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support
PRINCIPAL INVESTIGATOR	Robert Bielenberg, Scott Rosenbaugh, Ron Faller, and Cody Stolle – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2022
TECHNICAL ADVISORY COMMITTEE	Matt Neeman, Phil TenHulzen, Nathan Sorben, and Chris Ford
PROJECT TOTAL COSTS	$164,927
PROJECT EXPENDITURES TO DATE	$8,497
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	6%
STATUS	On Schedule
FY-2022 BUDGET	$156,430
FY-2022 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	59%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

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	$25,582
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	25%
STATUS	On Schedule
FY-2022 BUDGET	$145,693
FY-2022 TASKS TO BE COMPLETED	Tasks 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, and
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	100%
Task 2: Work with NDOT and NDOT-approved contractors to set up experiment design, establish seeding specifications, and mowing regimes	$31,066	50%
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.

Performance & Goals: Project is up to date with the current tasks and progress.

CONTROL NUMBER	01021L
PROJECT NUMBER	FY21 (012)
PROJECT TITLE	Field Demonstration of GPR and UAV Technologies for Evaluation of Two US75 Bridges
PRINCIPAL INVESTIGATOR	Jinying Zhu and Chungwook Sim – UNL
PROJECT START DATE	7/1/2020
PROJECT COMPLETION DATE	5/31/2021
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kent Miller, Jon Starr, Wally Heyen, and Brandon Varilek
PROJECT TOTAL COSTS	$25,517
PROJECT EXPENDITURES TO DATE	$8,728
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	60%
STATUS	On Schedule
FY-2022 BUDGET	$16,789
FY-2022 TASKS TO BE COMPLETED	Tasks 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	$14,699	100%
GPR		
UAV application		
Images of bottom surface of bridge deck		
Survey of repair		
Task 2. Data analysis and report	$10,819	40%
Data analysis		
Data comparison and validation		
Report		

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.

Performance & Goals: Project is up to date with the current tasks and progress.

Newly Funded Research

CONTROL NUMBER	01034A
PROJECT NUMBER	FY22(001)
PROJECT TITLE	Low-Cement Concrete Mixture for Bridge Decks and Rails
PRINCIPAL INVESTIGATOR	George Morcous and Jiong Hu - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Wally Heyen, Mark Traynowicz, Noah Pitts, Wayne Patras, Scott Fischer, Mick Syslo, Lieska Halsey, Mike Willman-GCP Applied Technologies, Kevin Piper-Simon, Mark Deetz-Lyman Richey Corporation, and David Mraz-FHWA
PROJECT TOTAL COSTS	$112,394
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$112,394
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, & 5

Background: Early-age cracking of concrete bridge decks and rails accelerates the penetration of water and chemicals into the concrete, which leads to reinforcement corrosion, delamination, and eventually spalling. This common deterioration problem results in shorter service life, road closures, and costly repairs/replacements. The early-age cracking of concrete decks and rails is primarily attributed to the drying shrinkage of restrained concrete immediately after construction. Concrete mixture design and curing procedure are key factors in reducing drying shrinkage and, consequently, early-age cracking.

Objective: The main objective of this research project is to achieve a cement content reduction in NDOT bridge deck and rail concrete mixture through aggregate particle packing optimization and evaluate the overall performance of the new mixture. The Modified Toufar Model will be used in optimizing particle packing and the combined aggregate void content test will be used to experimentally justify optimized aggregate gradations. Locally available aggregates from both East and West Nebraska will be considered. The experimental program of this study consists of three Phases: Phase 1 focuses on obtaining optimized aggregate blends to reduce cement content by half or full sack, while meeting strength and workability requirements for bridge decks and rails. Phase 2 focuses on the evaluation of the overall performance of concrete with reduced cement content with respect to mechanical, viscoelastic, and durability properties. This will include, but not limited to, air content, setting time, modulus of rupture, modulus of elasticity, bond strength, surface and bulk resistivity, free shrinkage, restrained shrinkage, and freeze/thaw resistance. Phase 3 focuses on demonstrating the use of the developed mixture in the construction of a bridge deck slab and/or rail. This could be accomplished in an actual bridge project or full-scale laboratory specimen, where concrete pumpability, consolidation, and curing procedures are evaluated.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$ 7,565	0%
Task 2: Mix Development	$ 21,0147	0%
Task 3: Performance Evaluation	$ 45,795	0%
Task 4: Demonstration	$ 22,716	0%
Task 5: Report and Presentation	$ 15,270	0%

Deliverables: This study will result in the following benefits: Alternative concrete mixture for bridge decks and rails that is less susceptible to early-age shrinkage cracking, which could increase the service life of bridge decks/rail and reduce road closures/detours associated with repair and replacement activities; and the use of less cement in bridge deck mixes will reduce the concrete cost and its carbon footprint, which are significant economic and environmental advantages.

CONTROL NUMBER	01034B
PROJECT NUMBER	FY22(002)
PROJECT TITLE	Nebraska Balanced Mix Design – Phase I
PRINCIPAL INVESTIGATOR	Hamzeh F. Haghshenas and Mahdieh Khademati - UNL & Robert Rea - NDOT
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Mick Syslo, Bruce Barrett, Kellie Troxel, Lieska Halsey, Mark Fischer, David Hansen, Asadullah Sahak, Jody Paul, and Gregg Leber-Constructors
PROJECT TOTAL COSTS	$138,937
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$138,937
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: Typically, asphalt mixtures are designed under the Superpave system, in which the proportioning of the aggregates and asphalt binder is based on the aggregate quality characteristics and mixture volumetric properties such as air voids, voids in the mineral aggregate, and voids filled with asphalt. Mixtures designed with high amount of asphalt can be susceptible to rutting, while those with low asphalt content are prone to cracking, raveling, or other durability related pavement distresses. One of the largest shortcomings of current design procedures is the lack of long-term materials aging protocol. Therefore, performance tests should be included as part of the mixture design procedure to ensure the desirable field pavement performance. Many performance tests have been proposed for the evaluation of the rutting resistance (e.g., Hamburg Wheel Track Tester, Gyratory Stability, IDEAL Rutting Test, and High-Temp Indirect Tensile Test), cracking resistance (e.g., Semi-circular Bending Test and IDELA Cracking Test, and moisture susceptibility (e.g., Indirect Tensile Strength, Hamburg Wheel Track Tester) of the asphalt mixtures. In Balanced Mix Design (BMD), two or more mechanical tests are coupled to quantify the mixture resistance against different forms of distress.

Objective: The aim of this research is to establish benchmarks for the current and future mixture designs and criteria to address rutting, cracking, and moisture damage resistance in more detail, especially with a focus on high recycled mixtures and major binder modifications through the use of recycling agents and antioxidants. To this end, the BMD performance tests in high-, and mid-temperature used in different states will be considered and some of them will be carried out on various Nebraska mixtures collected from the field projects. In addition, moisture performance tests will be included in the Nebraska BMD. Long-term aging protocols will be applied to the mixtures to address cracking resistance more accurately. The field evaluation will be conducted on pavement sections and field data will be collected to establish pass/fail thresholds for future quality assurance and acceptance purposes. Then the mixtures containing recycled materials, recycling agents, and antioxidant will be designed and evaluated based on the established pass/fail thresholds.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$ 17,570	0%
Task 2: Experimental Plan and Sample Collection	$ 11,687	0%
Task 3: Laboratory Tests	$ 43,290	0%
Task 4: Analysis of Test Results	$ 47,440	0%
Task 5: Documentation and Presentation	$ 18,950	0%

Deliverables: The results of this study will provide significant insights to the current and future mixture designs and criteria by addressing major pavement distresses like rutting, cracking, and moisture damage. A special focus will be given to high recycled mixtures modified by additives like recycling agents and antioxidants. The successful development and implementation of BMD in our state will provide safer, more efficient, trustworthy, and comfortable means for the transportation construction industry. It also can lead to significant cost reduction and provide longer lasting and more sustainable asphalt pavements.

CONTROL NUMBER	01034C
PROJECT NUMBER	FY22(003)
PROJECT TITLE	Asphalt Binder Laboratory Short-Term Aging – Phase II
PRINCIPAL INVESTIGATOR	Hamzeh Haghshenas and Mohammad Ghashami - UNL & Robert Rea - NDOT
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Mick Syslo, Bruce Barrett, Kellie Troxel, Lieska Halsey, Mark Fischer, David Hansen, Asadullah Sahak, and Nick Collins-Jebro
PROJECT TOTAL COSTS	$140,616
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$140,616
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background: While blending hot asphalt binder and aggregates in the plant, transporting, and laying the asphalt mixture, hardening of the binder can potentially occur due to the loss of volatiles and/or oxidation. This process is known as short-term aging. The PI and Co-PI proposed a research project entitled "Asphalt Binder Laboratory Short-Term Aging" to statistically investigate the effect of time, temperature, airflow rate, and asphalt binder weight on the chemical and rheological properties of different asphalt binders in the laboratory short-term aging (RTFO) process. In addition, it was attempted to find an improved RTFO aging protocol, which was applicable on both unmodified and highly modified binders. In continuation with the previous research project, finding short-term aging parameters (i.e., new/improved protocol) that can properly simulate the aging process that occurs during WMA production is vital since nearly all of the asphalt mixtures in our state are produced using WMA technology. Also, there is a need for better understanding of short-term aging of asphalt binders treated by RAs since NDOT is planning to use these chemical additives in the Nebraska asphalt mixtures in the near future.

Objective: The objective of this study is to propose a new/improved RTFO aging protocol, which is applicable on binders produced using WMA and RA technology. To meet the objective of this study, first a comprehensive chemical, rheological, and mechanical evaluation will be performed on binders extracted from plant produced WMA/RA mixtures (field short-term aging). From the same plant and project, we will collect binders and age them by varying the short-term aging parameters; time, temperature, airflow, and weight of binder poured in RTFO jar. Any discrepancies and similarities between field aged binders and lab aged binders will be identified. Then we will attempt to propose a new/improved short-term aging protocol in the lab, based on the tests results.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review	$ 10,686	0%
Task 2: Experimental Design and Sample Collection	$ 11,770	0%
Task 3: Laboratory Tests	$ 64,873	0%
Task 4: Analysis of Test Results	$ 28,956	0%
Task 5: Thermal Modeling and Analysis	$ 9,477	0%
Task 6: Documentation and Presentation	$ 14,854	0%

Deliverables: In this study, binders treated by WMA and RA technology will be extracted from plant produced mixtures and also the same binder that was used in the plant before mixing with aggregate will be conditioned in the laboratory by varying the aging parameters. Then the chemical, rheological, and mechanical properties of both extracted and laboratory aged binders will be compared to identify any possible discrepancies and similarities. The findings of this research will be used to improve the current AASHTO/ASTM short-term aging protocol [AASHTO T240/ASTM D2872] and address concerns which have been raised regarding the limitations of the short-term aging equipment (i.e., RTFO) and protocol in the simulation of the aging process that occurs during asphalt mixture production using WMA and RA technology. The modified protocol will ultimately improve the Nebraska quality control and assurance (QC/QA) procedure for short-term aging of asphalt binder.

CONTROL NUMBER	01034D
PROJECT NUMBER	FY22(004)
PROJECT TITLE	Erosion Resistant Rock Shoulder
PRINCIPAL INVESTIGATOR	Chung Song & Richard Wood - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Bruce Barrett, Kellie Troxel, Nikolas Glennie, Lieska Halsey, Mark Fischer, and Terry Rogers-Martin Marietta
PROJECT TOTAL COSTS	$142,907
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$142,907
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: With the advent of climate change, weather patterns are becoming more unpredictable, and consequently, severe drought and flooding are unavoidable. For highway structures, this new weather pattern created new problems in the pavement system. Techniques to evaluate erosion resistance of these materials are not well developed so far. Consequently, the improved design of erosion resistant aggregate and combinations of soil and aggregate are needed. NDOT currently utilizes the gradation of crushed rock surface course and soils, however, materials with this gradation are not always readily available or perform as intended. This study combines dedicated testing methods and hydrodynamics analysis technique to test, evaluate and obtain the erosion resistant shouldering materials which outperform the current design recommendation.

Objective:

1) Obtain an experimental quantity called "erosion coefficient" for various conditions -three different gradations times five different binding agents. The binding agents include No agent (control), Lignon, Nebraska Soybean-based soap-stock, POSS, Loessy binding soils. These will be characterized using the University of Nebraska-Lincoln Erosion Test Bed (UNLETB) and a Jet Erosion Test (JET). The test will be conducted at the same density as the field crushed rock surface course.
   a. UNLETB is a large erosion testing bed. It will test combined specimen of crushed rock surface course and binding agents. JET is a small erosion testing apparatus, and it will test binding agents only.
   b. Expected products are numerical values of erosion coefficient for different samples.
2) Perform a numerical verification of the experimental results using a Hydro-dynamics analytical platform.
   a. For erosion coefficient obtained in objective 1, Flow3D, a computational fluid dynamics software, will be calibrated to predict the erosion performance of the above 15 different conditions. Ultimately, the calibrated parameters, Flow3D, and HEC-RAS(Hydrological Software) will be used to predict field erosion conditions such as field geometry of shoulder, flow depth, and flow velocity.
   b. Expected products are calibrated erosion parameters for field conditions (geometry, flow depth, and flow velocity).
3) Obtain a simplified field erosion equation for different gradations of crushed rock surface courses with multiple different binding agents.
   a. In addition to the Flow3D based calibrated erosion parameters, hand calculation enabled erosion parameters will be provided by statistical analysis.
   b. Expected products are monograms.
4) Provide an optimized design chart so that NDOT may obtain a conservative gradation of crushed rock surface course (with and without binding agents) from multiple available choices.
   a. Combining output from objectives 1 to 3, a flow chart that can lead engineers to obtain proper crushed rock surface course will be obtained.
   b. Expected products are both in the form of graphical design chart and a computer-based design procedure.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Study	$ 6,829	0%
Task 2: Fabrication of UNL Erosion Testing Bed (UNLETB)	$ 18,694	0%
Task 3: Verification of Testing Technique by Analytical Method	$ 17,217	0%
Task 4: Testing and Recommendations for crushed rock surface course materials	$ 42,348	0%
Task 5: Reporting	$ 57,819	0%

Deliverables:

1) Allow flexibility in selecting crushed rock surface course – multiple available gradation and multiple available rock quarries will reduce supply chain issues.
2) Safer highway by reducing drop-offs and associated lane departure crashes.
3) Reduced maintenance work and cost saving by providing more resilient highway shoulder.
4) Reduced amount of dislodged rocks relieving stress to District Maintenance Operations.

CONTROL NUMBER	01034E
PROJECT NUMBER	FY22(005)
PROJECT TITLE	Application of Remote Sensing and Hydrologic Modeling to Reduce Highway Flooding in the Nebraska Sandhills
PRINCIPAL INVESTIGATOR	Aaron Mittelstet - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Julie Ramirez, Bob Carnazzo, John Linbo, Cara Roesler, Kirk Harvey, Jason Dayton, Mary Schroer, Nick Burnham, Mercy Manzanares, Jon Soper, Mark Kovar, and Jodi Kocher-Felsburg, Holt, & Ullevig, David Mraz-FHWA, and Zach Kresl-FHWA
PROJECT TOTAL COSTS	$143,166
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$143,166
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6, 7 & 8

Background: Hydrologic calculations for the Nebraska Sandhills (NSH) generally assume high infiltration, no runoff, and ignore subsurface runoff (groundwater and interflow). While these assumptions allow for the solution to a complex problem, they are not accurate representations of the complex movement of water in the region. Highways in the Sandhills region are a scarce and vital link that facilitate the movement of people and goods throughout the region. Understanding the Sandhills hydrology and highway flooding is extremely difficult because stream gages and monitoring wells are sparse. The thousands of lakes in the NSH provides an opportunity to develop a detailed monitoring system of surface and ground water. Combined with available climate information (snow melt, precipitation) the higher density of groundwater and surface water elevation measurements (or estimates) from this project will lead to improved estimates of lag times between hydrologic events and water level changes. This research will help NDOT quantify the frequency, duration and depth of highway flooding in the NSH and assist NDOT in identifying the location to place culverts under the highway and where to place the highway elevation relative to the groundwater elevation.

Objective:

1) Identify the location, duration and frequency of highway flooding in the NSH.
2) Determine lag time and climatic conditions of highway flooding.
3) Identify frequency curves of highway flooding.
4) Prioritize highways based on frequency of flooding.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Determine Highways That Flood	$ 28,512	0%
Task 2: Duration and Depth of Flooding	$ 20,020	0%
Task 3: Conditions and Lag Time of Flooding	$ 31,328	0%
Task 4: Prioritize Highways Based on Frequency of Flooding	$ 31,328	0%
Task 5: Identify Most Efficient and Informed Design to Prevent Future Flooding	$ 19,272	0%
Task 6: Write Final Report	$ 12,706	0%
Task 7: Present Findings to NDOT	-	0%
Task 8: Meetings with NDOT	-	0%

Deliverables:

- A better understanding of how to prevent overtopping of state highways in the NSH will be gained by understanding the relationship of rainfall, surface storage, and groundwater depth. Understanding the elevation needs for the roadway profile and drainage structures will help keep roads open and minimize loss to the travelling public.
- Costs can be minimized by knowing the maximum elevation of surface water and minimizing the raise in roadway profile needed to prevent overtopping. By better understanding the hydrology, the number and size of culverts can be reduced, resulting in a reduction in costs.
- Reduction in road closures due to groundwater inundation.
- More efficient and informed hydrologic and hydraulic design processes can be applied to design in the NSH.

CONTROL NUMBER	01034F
PROJECT NUMBER	FY22(006)
PROJECT TITLE	Evaluation of NDOT's Sediment Barrier Practices Using Performance Data
PRINCIPAL INVESTIGATOR	Mike Perez and Wesley Donald - Auburn University & Blake Whitman - Middle Tennessee State University
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Ron Poe, Nick Soper, Brian Anderson, and Jason Henderson-Green Thumb
PROJECT TOTAL COSTS	$191,099
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$191,099
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5, 6, & 7

Background: Construction activities involve heavy earthmoving activities that typically disturb several acres of land. Due to the nature of construction activity, sediment is the predominant pollutant of concern during the clearing and grading stages, which typically exposes large un-vegetated and un-stabilized land areas to erosive elements. Sediment runoff rates from construction sites can be 10 to 20 times higher than those of agricultural lands and 1,000 to 2,000 times greater than those of forested lands. Construction sites have measured erosion rates of approximately 20 to 200 tons per acre (45 to 450 metric tons per ha) per year. In addition to environmental implications, sedimentation can cause vast economic problems. The loss of aquatic habitat and diminished water quality is often difficult to quantify, however some impacts (i.e., cost of dredging and disposing of accumulated sediment) are easier to assess. Furthermore, the cost of eroded soil replacement comes at a high price. Stormwater management has become an increasingly important aspect of construction activities in the state of Nebraska. The National Pollutant Discharge Elimination System Permit for Storm Water Discharges from Construction Sites (NPDES Permit) requires the Nebraska Department of Transportation (NDOT) to develop a stormwater pollution prevention plan (SWPPP) for all construction activities that are covered by the permit. The SWPPP includes the design, installation, and maintenance of erosion and sediment control practices to minimize downstream impact from stormwater discharges. Currently, NDOT has specifications, standard drawings, and guidance for the design of erosion and sediment control practices. Opportunities exist to better understand the performance of standard NDOT erosion and sediment control practices, improve the design and performance of practices, and to develop additional design manual guidance for the proper selection and design of practices.

Objective:
1) Determine a methodology and modeling process to evaluate the performance of various buffer configuration (i.e., length, vegetation type, soil, etc.) typically encountered along NDOT highway construction sites.
2) Conduct large-scale laboratory experiments to determine the performance of sediment barrier practices used by NDOT using estimated soils losses and stormwater runoff volumes associated with NDOT highway construction projects that can be used to supplement buffers that are not able to meet the minimum 50 ft requirement.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Kickoff Meeting	$ 2,850	0%
Task 2: Literature Review	$ 16,150	0%
Task 3: Develop Methodology for Determining Buffer Efficiency	$ 30,400	0%
Task 4: Develop Large-Scale Testing Methodology	$ 7,600	0%
Task 5: Conduct Large-Scale Sediment Barrier Testing	$ 106,399	0%
Task 6: Data Analysis	$ 17,100	0%
Task 7: Final Report	$ 10,600	0%

Deliverables: The proposed project is expected to improve regulatory compliance and further demonstrate NDOTs commitment to environmentally friendly construction practices. Ultimately, the scientifically attained data generated through this research effort will provide designers, contractors, and NDOT inspectors with a comprehensive performance review of NDOTs sediment barrier practices and effective implementable strategies to improve their performance. In addition, recommendations for updates to current erosion and sediment control design tools that will allow NDOT designers to incorporate effective and innovative erosion and sediment control technologies into their stormwater management plans. Enhanced practices will protect water quality downstream of construction activities, reduce regulatory compliance issues, improve overall public perception, and save Nebraska taxpayer dollars. Erosion and sediment control research performed at the AU-ESCTF has led to immediate implementation through updated standard drawings and specification updates by the Alabama DOT.

CONTROL NUMBER	01034G
PROJECT NUMBER	FY22(007)
PROJECT TITLE	Crashworthy Perforated Square Steel Tube (PSST) Mailbox Support – Phase II
PRINCIPAL INVESTIGATOR	Bob Bielenberg - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Phil TenHulzen, Matt Neemann, Nathan Sorben, and Chris Ford
PROJECT TOTAL COSTS	$219,556
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$219,556
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3 & 4

Background: Federal requirements have made it mandatory that safe mailbox support systems be designed to yield or breakaway when impacted by a vehicle. NDOT has previously used a non-proprietary, u-channel post mailbox support that was evaluated at MwRSF in the 1980's to NCHRP 230. This design was implemented into NDOT's standard plans. However, this standard plan is now obsolete. 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 and evaluate the mailbox to MASH TL-3 safety criteria through full-scale crash testing. 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 research to design and evaluate the mailbox support utilizing bogie testing is current ongoing. The research proposed herein will evaluate the PSST mailbox support design to MASH TL-3 through full-scale crash testing.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Project Planning and Correspondence	$ 18,236	0%
1a: General Project planning and documentation		
1b: Develop of CAD details for fabrication and testing		
1c: Sponsor correspondence and TAC meetings		
Task 2: Design and Analysis	$ 8,242	0%
2a: Selection of critical MASH full-scale crash tests and PSST mailbox support configuration for evaluation through full-scale crash testing		
2b: Determination of CIAs for each test		
Task 3: Full-Scale Crash Testing	$ 174,929	0%
3a: Construction of Test Article		
3b: Full-scale Crash Test, MASH 60, 61, 62		
3c: Data and Video Analysis		
3d: System Removal and Disposal		
Task 4: Reporting and Project Deliverables	$ 18,149	0%
4a: Research Report - First Draft		
4b: Report Editing (internal and sponsor)		
4c: TF13 Hardware Guide Drawings		
4d: FHWA Eligibility Submittal		
4e: NDOT Technical Brief		
4f: NDOT PowerPoint presentation of research results		
4g: Project Closing (printing, dissemination, accounting)		

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	01034H
PROJECT NUMBER	FY22(008)
PROJECT TITLE	Production of Cast-in-Place UHPC for Bridge Applications
PRINCIPAL INVESTIGATOR	Jiong Hu & George Morcous - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Wally Heyen, Mark Traynowicz, Wayne Patras, Kyle Zilig, Jordan Wipf, Lieska Halsey, Lynden Vanderveen, Brandon Varilek, Dale Burkhead-Simon, and David Mraz-FHWA
PROJECT TOTAL COSTS	$83,996
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$83,996
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2,3, 4 & 5

Background: Ultra-high performance concrete (UHPC) is a new class of concrete that has mechanical and durability properties that far exceed those of conventional concrete. The use of UHPC will result in significant improvements in the structural capacity and durability of bridge components. Due to its superior characteristics, UHPC has drawn substantial interest in the bridge community at both federal and state levels. Besides the bridge deck connections applications in multiple states, Federal Highway Administration (FHWA) Every Day Counts (EDC-6) program "UHPC for Bridge Preservation and Repair" emphasizes the use of UHPC for bridge applications due to its excellent mechanical and durability properties. The research team has already developed a non-proprietary mix using local materials through a recent completed NDOT project (SPR-P1(18) M072) entitled "Feasibility Study of Development of Ultra-High Performance Concrete (UHPC) for Highway Bridge Applications in Nebraska" with a unit cost at approximately $740/CY. While the development of non-proprietary UHPC mixes could greatly encourage the usage of UHPC, the lack of training and experience in batching and handling the material hinders its widespread use. FHWA and multiple state agencies have recently developed guidelines for the use of UHPC. However, most of these documents are focused on either the design of UHPC components or precast UHPC production. There is a lack of detailed guidelines on cast-in-place (CIP) UHPC production and handling, especially when non-proprietary mixes are used. Due to the large amount of fine powders and the very low water-to-cement ratio in UHPC, the proportioning and batching of UHPC is very different from conventional concrete. Also, while it is generally known that UHPC is very flowable, it is often challenging to achieve the desired workability while maintaining stability and too high flowability could lead to fiber segregation. On the other hand, the viscous nature of UHPC could lead to a lack of flow and consolidation. Another peculiarity of UHPC is the rapid workability loss due to the high content of high-range water-reducing (HRWR) admixture. The self-consolidation properties of UHPC cannot easily stand for an extended period of time, resulting in issues of concrete transportation and placement. A preliminary study from the investigators shows that guidelines need to be developed to better control the workability and stability of UHPC in both static and dynamic conditions.

Objective:

1) Provide technical training for producers, contractors, and NDOT engineers required for batching, mixing, transporting, placing, and testing cast-in-place UHPC with both non-proprietary and proprietary mixes (pre-bagged),
2) Develop guidelines for UHPC production and controlling, and maintaining the workability of UHPC production in on-site conditions, and
3) Develop special provisions for cast-in-place UHPC production and quality control.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: State-of-the-Practice of CIP UHPC Production	$ 16,730	0%
Task 2: UHPC Production and Testing Guidelines Development	$ 20,164	0%
Task 3: Training Material Development and Contractors Training	$ 22,665	0%
Task 4: UHPC Field Production Demonstration	$ 11,724	0%
Task 5: Special Provision, Report and Presentation	$ 12,714	0%

Deliverables:

1. Address the challenges associated with UHPC production and on-site construction. The lack of experience and best practice guidelines often causes concerns for producers and contractors.
2. Provide the necessary knowledge and technical support for UHPC production and construction. The success of this project will greatly encourage producers and contractors to adopt this innovative material in cast-in-place bridge applications.

CONTROL NUMBER	01034J
PROJECT NUMBER	FY22(009)
PROJECT TITLE	Accelerated Bridge Construction (ABC) Decision Tool
PRINCIPAL INVESTIGATOR	Phil Barutha & Marc Maguire - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Wayne Patras, Kyle Zilig, Mike Vigil, Kent Miller, Lynden Vanderveen, and David Mraz-FHWA
PROJECT TOTAL COSTS	$90,592
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$90,592
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4 & 5

Background: A challenge transportation asset managers face is the need to cost effectively prioritize the repair and replacement of the large inventory of deteriorating bridges while considering the increasing budgetary constraints. Accelerated bridge construction (ABC) is defined by the FHWA as bridge construction that uses innovative planning, design, materials, and construction methods in a safe and cost-effective manner to reduce the onsite construction time that occurs when building new bridges or replacing and rehabilitating existing bridges. ABC techniques have a great potential to minimize the traffic disruptions during bridge replacements and construction, promote traffic and worker safety, and improve the overall quality of the built bridges. Despite the major advances in design and construction of ABC techniques, some agencies are hesitant about using ABC techniques due to risks during construction and perceived higher initial costs. In addition, oftentimes the current decision process used to determine and prioritize the candidate bridges for this type of construction can be based solely on average annual daily traffic (AADT), where this may be prudent to evaluate based on several factors. A decision making framework incorporating important factors in determining the suitability of ABC in Nebraska will allow NDOT to find the best fit candidate bridges to maximize the benefits of Accelerated Bridge Construction.

Objective: The main objective of the study is to develop a decision making framework to help inform NDOT on the applicability of ABC methods on the various bridges within the transportation network in Nebraska. The study will obtain data specific to Nebraska and develop a decision model to compare the use of ABC as compared to traditional methods using factors weighted on importance to achieving agency objectives. Weighted factors may include direct costs, user impacts, average daily traffic, site conditions, safety, and other pertinent factors impacting construction methodology. The specific factors and weighting will be determined in coordination with NDOT during the research study.

The project will result in development of an ABC Decision Tool that will serve as a framework to allow NDOT to rigorously determine and prioritize the use of ABC on candidate bridges in need of replacement or new construction which will provide the agency with the most value. The decision tool is intended to be used early in the preliminary project development phase to evaluate design and construction methodology alternatives.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Literature Review of Current ABC Decision Processes	$ 11,013	0%
Task 2: Investigate NDOT Internal Processes to Determine ABC	$ 31,460	0%
Task 3: Obtain Feedback from Nebraska Contractors	$ 8,186	0%
Task 4: Development of Decision Process and Tool	$ 24,304	0%
Task 5: NDOT Review and Validation of Decision Tool	$ 15,629	0%

Deliverables: The results of this study can be used to help NDOT determine the best candidate bridges to utilize ABC early in the design and construction methodology decision making process. The decision tool can serve as a preliminary screening process to identify bridges with attributes that benefit most from the use of ABC. Early identification of good candidate bridges allows the NDOT to better implement ABC methods to maximize the benefits and minimize the costs of ABC in a budget constrained environment.

CONTROL NUMBER	01034K
PROJECT NUMBER	FY22(010)
PROJECT TITLE	Application of Steel Sheet-Piles for the Abutment of Water-Crossing Bridges in Nebraska
PRINCIPAL INVESTIGATOR	Seunghee Kim, Jongwan Eun, Chung Song, and Chungwook Sim - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Wayne Patras, Noah Pitts, Jake Blessen, Matt Eames, Jason Dayton, Mick Syslo, Nikolas Glennie, Alex Silvey, Mark Mainelli -Mainelli Wagner and Associates, Jesse Sire-JEO, and David Mraz-FHWA
PROJECT TOTAL COSTS	$155,304
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$155,304
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2 3, 4, & 5

Background: Sheet piles are recommended to be installed for most water-crossing bridges, along with load-bearing piles, to avoid the scouring problem and protect backfill soils in Nebraska. A specific design procedure related to the axially loaded sheet piling does not exist in most parts of the US. Accordingly, the research team perceived a lack of data and experience in the design and analysis of vertical and lateral load resistance of the axially loaded sheet piling. For example, there is insufficient confidence in the estimate of bending and lateral stresses induced by the axial loading and lateral soil pressure, respectively. There is also uncertainty on how lateral load could be transferred from the superstructure to the sheet pile during a seasonal temperature variation. In terms of the side frictional resistance, it is unknown how the skin frictional resistance of the sheet pile could be mobilized in the different passive and active zones. Moreover, the side frictional resistance could be noticeably different between the dry and submerged soil conditions. For the end bearing resistance, the soil plugging effect may improve the end bearing capacity. Those uncertainties may result in a too conservative design, and thus, an unnecessary increase in the construction cost.

In addition to those general challenges, there are additional research needs perceived by engineers in Nebraska. First, the load transfer from the superstructure to the substructure could be substantially different depending on the connection design that is a unique design of Nebraska DOT compared to other states. The main difference with other states is that Nebraska is no longer using back walls behind the deck for semi-integral abutment bridges. If there is a back wall element, there will be a joint created at the end of the deck before the approach span starts. Nebraska moved from this design and has details which combines the deck, girder, and approach span and creates the joint far away from the end of the deck at the approach span. Due to the difference in details at the end of the deck, the total horizontal force created by temperature loading from the superstructure, which should interact with the lateral soil loads that will create a moment, will differ from other cases. Second, the tie-rod anchor may be avoided depending on the soil condition and bridge design. With that, the reduction or elimination of the anchor will bring the cost and time saving for the construction. Lastly, there is a research need that investigates the feasible length of the superstructure that is compatible with the concept of the axially loaded sheet pile abutment system of a short-span bridge for general geologic conditions and construction practices in Nebraska.

Objective: The overall goal of this study is to investigate the anticipated performance of steel sheet-pile bridge abutment to encourage its wider applications to not only new construction but also repair/replacement of existing water-crossing bridges in Nebraska. To achieve this goal, we set several objectives as follows:

- Suggest an improved analysis method that incorporates the combined effect of axial and lateral loads that are imposed on the sheet pile walls and considers the following aspects:
    - Skin frictional resistance in active/passive zones for either dry or submerged soil conditions
    - Soil plugging effects
    - Different cross-sections of the sheet piles
    - Design configurations (cantilever vs. anchored walls)
    - Effect of seasonal temperature variations
- Elucidate the moment generated by the forces between the horizontal movement of the superstructure of semi-integrals in Nebraska vs. loads caused by the soil behind (e.g., active/passive pressures, the friction of backfill on superstructure end or the shearing resistance of backfill, which could play a role if the bridge has skew and lateral bearings are not provided).
- Assess the feasibility of avoiding the tie-rod anchoring for various design parameters.
- Suggest a range of superstructure length and skew angle that can be supported by the axially loaded sheet pile abutment system.
- Provide the research summary and design recommendations that can be used by engineers and contractors for the water-crossing bridges in Nebraska.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Review on the Sheet Pile Bridge Abutment Systems	$ 14,460	0%
Task 2: Experimental Studies to Obtain Design Parameters	$ 81,354	0%
Task 3: Numerical Studies to Investigate the Performance of Sheet Pile Bridge Abutment Systems	$ 44,677	0%
Task 4: Summary and Design Recommendations	$ 7,846	0%
Task 5: Final Report	$ 6,967	0%

Deliverables: Experimental and numerical modeling data and improved analysis for the axially loaded sheet pile abutment systems, including the anchored design, will be provided; A better understanding of the earth pressure development, the mobilization of skin friction resistance, end-bearing capacity, and load transfer will be provided; Design recommendations to improve the performance of sheet pile abutment systems will be provided; and Based on those outcomes, the research findings can help reduce the construction time and cost for both new and repair/replacement of water-crossing bridges in Nebraska.

CONTROL NUMBER	01034L
PROJECT NUMBER	FY22(011)
PROJECT TITLE	Truck Platooning Effects on Girder Bridges, Phase II
PRINCIPAL INVESTIGATOR	Joshua Steelman, Jay Puckett, and Daniel Linzell - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Fouad Jaber, Mark Traynowicz, Kyle Zilig, Kpandji Lakmon, Emilie Hudon-Olsson and David Mraz-FHWA
PROJECT TOTAL COSTS	$120,843
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$120,843
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background: Connected and Automated Driving System (C/ADS)-equipped vehicles are expected to become increasingly common in the United States and elsewhere globally. Truck platooning with CV technologies places trucks much closer than current design codes anticipate. Truck platooning is expected to be deployed imminently, according to the anticipated timeline provided in Trimble. The density of truck traffic and the implications for structural safety and serviceability should be considered as part of a platooning policy to avoid compromising bridge service lives. Platoons of heavy trucks will be economically advantageous for freight operators in the near future, but information currently available is insufficient for bridge owners to establish platoon operation limitations and guidelines ensuring safe and serviceable loading demands in girder bridge structures in terms of vehicle weights, live load uncertainties, and headways.

Objective:

1. Calibrate appropriate live load factors for use with platoons to address the Service III limit state for concrete girder bridges.
2. Calibrate appropriate live load factors for use with platoons to address the Service II limit state for steel girder bridges.
3. Propose a framework for characterization of uncertainty from individual contributions within live load effects.
4. Facilitate adoption of platoon permitting with illustrative examples.
5. Approximately assess the significance of platoon-induced fatigue with respect to service life.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: Service III Evaluation for Prestressed Concrete Girders	$ 26,703	0%
Task 2: Service II Evaluation for Composite Steel Girders	$ 27,362	0%
Task 3: Operationalize Uncertainty Calibration	$ 8,711	0%
Task 4: Illustrative Examples	$ 18,983	0%
Task 5: Fatigue Platoon vs Design Comparison	$ 6,894	0%
Task 6: Correspondence and Documentation	$ 32,190	0%

Deliverables: This research will enable NDOT to strategically and responsibly incentivize platoon operations along the I-80 corridor by optimizing freight transport efficiency. Additional truck traffic will provide economic benefits from direct sale of vehicle fuel, as well as secondary economic benefits to mechanics and technicians who provide vehicle maintenance and smart vehicle control services. Providing a smart corridor for platoons also positions Nebraska for future benefits if a transportation tax is imposed on a vehicle-miles-traveled basis rather than a direct fuel tax. The results of this research will enable platooning operations to increase vehicle weights without compromising service lives of bridges from overloads and repeated cycles of inelastic behavior. This research will build upon a framework developed in the first phase of the research and thereby capitalize on investments previously allocated by NDOT.

CONTROL NUMBER	01034M
PROJECT NUMBER	FY22(012)
PROJECT TITLE	Inventory, Operations, and Safety at Free Right-Turn Ramps
PRINCIPAL INVESTIGATOR	Aemal Khattak - UNL
PROJECT START DATE	7/1/2021
PROJECT COMPLETION DATE	5/31/2023
TECHNICAL ADVISORY COMMITTEE	Alan Swanson, Scott Milliken, Kris Fornoff, Kyle Christensen, and Abe Anshasi-FHWA
PROJECT TOTAL COSTS	$182,563
PROJECT EXPENDITURES TO DATE	$0
NUMBER OF EXTENSIONS GRANTED	None
PERCENTAGE OF PROJECT COMPLETE	0%
STATUS	Active
FY-2022 BUDGET	$182,563
FY-2022 TASKS TO BE COMPLETED	Tasks 1, 2, 3, 4, 5 & 6

Background: Research on right turns at rural intersections on the state highway system was initiated by the Nebraska Department of Transportation (NDOT) during the 1990's (McCoy et al., 1995) and again during the 2016-2018 period (Khattak and Kang, 2018). In the former study, the authors developed guidelines for the establishment of FRT ramps on rural two-lane highways in Nebraska based on a benefit-cost analysis. They recommended that design-year right-turn AADTs ranging from 440 to 825 vehicles per day (depending on truck percentage) warranted a FRT ramp at unsignalized intersections on rural two-lane highways. Acceleration lanes improved vehicle merge operations and while right-turning traffic moved efficiently, there were no discernable safety improvements from FRT ramps.

In the latter study, the authors looked at safety and economic benefits of rural intersections with offset right-turn lanes (ORTL) compared to rural intersections with no right-turn lanes and those with traditional right-turn lanes. They also investigated drivers' stopping behavior on the minor approaches at ORTLs. Results showed ORTLs had the lowest crash rates; however, the difference was statistically not significant. The cost-benefit analysis indicated that compared to intersections with no right-turn lanes, ORTL intersections had an annual reduction of 0.202 crashes per million entering vehicles, which translated to $22,662 savings in crash costs per year. When compared with intersections having no right-turn lanes, a traditional right-turn lane reduced 0.0758 crashes per million entering vehicles annually or $8,504 savings in crash costs per year. Driver stopping behavior assessment showed that number of through lanes, width of right-turn lane and width of the ORTL offset were statistically associated with driver's stopping position on the minor approach and overall drivers were taking advantage of the ORTLs improved sight distance. In this study, free right-turn (FRT) ramps were excluded due to their uniqueness (compared to traditional right-turn lanes and ORTLs) for a later study.

NDOT has several FRT ramps across the state highway system. The intersection minor approaches stop-controlled and varying driver warning devices may be in place at these locations. There are concerns about the safety and operations of FRT ramps and therefore, there is a need to review the operations and safety of these locations.

Objective:

- Create a statewide inventory of rural free right turn ramp intersections and provide to NDOT in an appropriate format.
- Using NDOT 10-year crash data, conduct statistical safety analyses of rural FRT intersections extending ¼-mile in each direction from the intersection.
- Study vehicular operations at rural intersections with and without FRT ramps. This will include a comparison of recorded vehicular speeds and conflict analysis.
- Develop guidelines for operations and safety tradeoffs to assist with NDOT projects on maintaining similar locations, removing or reconstructing ramps and traffic warning/control signage.

Tasks & Percent Completed:

Tasks	Budget by Task	Percent Completed
Task 1: TAC Meeting and Review of Literature	$ 27,493	0%
Task 2: Inventory of Rural FRT Ramp Intersections	$ 21,456	0%
Task 3: Safety Analysis of Rural FRT Ramp Intersections	$ 32,654	0%
Task 4: Study of Vehicle Interactions and Comparison	$ 42,421	0%
Task 5: Operations and Safety Tradeoffs Analysis	$ 19,090	0%
Task 6: Final Report and TAC Presentation	$ 39,450	0%

Deliverables: The research will assist NDOT Traffic Engineering, District staff, and Roadway Design Divisions with making more informed decisions when dealing with rural intersections with free right turn ramps. The research will also lead to improved public safety on Nebraska highways.

Recently Completed Research

Project Number	Federally Funded Projects Completed and Published	Focus Area	Completed
M030	Truck Platooning Effects on Girder Bridges - Phase I ***NDOT Recommendations Based off Research Project***	Structures	December 2020
M050	Preparing for a Driverless Future ***NDOT Recommendations Based off Research Project***	Planning	December 2020
M068	Cost-Efficient, TL-2 Bridge Rail for Low Volume Roads ***NDOT Recommendations Based off Research Project***	Structures	September 2020
M075	Development and Implementation of a Moving Nondestructive Evaluation Platform for Bridge Deck Inspection ***NDOT Recommendations Based off Research Project***	Structures	September 2020
M080	Feasibility and Implementation of Balanced Mix Design in Nebraska ***NDOT Recommendations Based off Research Project***	Materials	September 2020
M082	Early Detection of Near-Surface Void Defects in Concrete Pavement Using Drone-Based Thermography and GPR Methods ***NDOT Recommendations Based off Research Project***	Construction	June 2020
M084	Evaluation of Mixtures and Pavement Performance for Rehabilitation Methods ***NDOT Recommendations Based off Research Project***	Materials	July 2020
M086	Prototype System for Implementing the Ultrasonic Guided Wave Method on the Field ***NDOT Recommendations Based off Research Project***	Structures	June 2020
M088	Supporting Bridge Management with Advanced Analysis and Machine Learning ***NDOT Recommendations Based off Research Project***	Structures	September 2020
M091	Nebraska Rail Crossing Safety Research ***NDOT Recommendations Based off Research Project***	Safety	December 2020
M092	Research on School Zone Safety ***NDOT Recommendations Based off Research Project***	Safety	June 2020
M095	A Big Data Approach for Improving Nebraska Cycling Routes ***NDOT Recommendations Based off Research Project***	Planning	December 2020
M097	Research on Weather Conditions and Their Relationship to Crashes ***NDOT Recommendations Based off Research Project***	Traffic/ Maintenance	December 2020
M098	Investing in Bicycle Infrastructure to Spur Statewide Economic Growth Through Bicycle Tourism ***NDOT Recommendations Based off Research Project***	Planning	December 2020
M109	To Automate Detecting, Quantifying and Mapping of Delamination of Bridge Decks using Aerial Thermographic NDE ***NDOT Recommendations Based off Research Project***	Technology	December 2020
M111	High Mast Tower Foundation ***NDOT Recommendations Based off Research Project***	Construction	December 2020
M112	Data Analysis of Nebraska Pavements Containing RAP ***NDOT Recommendations Based off Research Project***	Materials	December 2020
M113	Detection of Flaws with Asphalt Overlaid Concrete Decks Using Ultrasonic Guided Waves ***NDOT Recommendations Based off Research Project***	Structures	December 2020
M114	Best Practices to Address Issues of Excess Aggregate Dust in Nebraska ***NDOT Recommendations Based off Research Project***	Materials	December 2020