ANNUAL REPORT
of
Iowa Highway Research Board
Research and Development Activities
FY 2013

Attachment to
FY 2013 Annual Report
Research, Intelligent Transportation Systems, and
Technology Transfer Activities

DECEMBER 2013

ANNUAL REPORT
OF
IOWA HIGHWAY RESEARCH BOARD
RESEARCH AND DEVELOPMENT ACTIVITIES

FOR THE
FISCAL YEAR ENDING JUNE 30, 2013

OFFICE OF RESEARCH AND ANALYTICS
OPERATIONS RESEARCH
(515) 239-1447
www.iowadot.gov/operationsresearch

PERFORMANCE AND TECHNOLOGY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

DECEMBER 2013

TABLE OF CONTENTS

Page

Research and Development 2

Iowa Highway Research Board 2

Table I - Iowa Highway Research Board Members 3

Research and Development Projects 5

In-House Research and Development 5

National Cooperative Highway Research Program 5

Secondary Road Traffic Count Program 6

Secondary Road Research Fund 6

Street Research Fund 7

Primary Road Research Fund 7

Projects Initiated During FY 2013 8

Projects Completed During FY 2013 9

Table II - Financial Summary of Research and Development Project Expenditures 10

Research Project Descriptions 12

LIST OF ACRONYMS

AASHTO - American Association of State Highway and
APWA - American Public Works Association
ASCE - American Society of Civil Engineers
DOT - Department of Transportation
FHWA - Federal Highway Administration
GIS - Geographic Information System
HMA - Hot Mix Asphalt
HPC – High Performance Concrete
IHRB - Iowa Highway Research Board
ISU - Iowa State University
LiDAR – Light Detection and Ranging
LRFD - Load and Resistance Factor Design
LTAP - Local Technical Assistance Program
LVR - Low Volume Road
MOVITE - Missouri Valley Section of the Institute of Transportation Engineers
NCHRP - National Cooperative Highway Research Program
SUDAS - Statewide Urban Designs and Specifications
TAC - Technical Advisory Committee
TRB - Transportation Research Board
UHPC - Ultra High Performance Concrete
USGS - United States Geological Survey
WMA – Warm Mix Asphalt
SPR - Statewide planning and research
AADT - Annual Average Daily Traffic
RFIDS – Motion Sensing Radio Transponders
CBM – Condition-Based Maintenance
MEMS – Micro Electra Mechanical Sensor
LRFR – load and Resistance Factor Rating
RCB – Reinforced Concrete Box
QA – Quality Assurance
DNR – Department of Natural Resources
FWD – Falling Weight Deflectometer
DCP – Dynamic Cone Penetrometer
NBIS – National Bridge Inspection Standards
OBS – Office of Bridge and Structures
BEC – Bridge Engineering Center
BBR – Bending Beam Rheometer
LOS – Level of Service
VE – Viscoelastic
FEA – Finite Element Analysis
LRFR – Load and Resistance Factor Rating

RESEARCH AND DEVELOPMENT

The Iowa DOT engages in research and development for two reasons: first, to find workable solutions to the many problems that require more than ordinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report, entitled "Iowa Highway Research Board Research and Development Activities FY2013" is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which direct the submission of a report of the Secondary Road Research Fund and the Street Research Fund, respectively. It is a report of the status of research and development projects in progress on June 30, 2013. It is also a report on projects completed during the fiscal year beginning July 1, 2012 and ending June 30, 2013. Detailed information on each of the research and development projects mentioned in this report is available from the Office of Research and Analytics, Performance and Technology Division, Iowa Department of Transportation. All approved reports are also online for viewing at: **www.iowadot.gov/research/reports.html**.

THE IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing and coordinated program of research and development, the Iowa DOT is assisted by the IHRB. This advisory group was established in 1949 by the Iowa State Highway Commission to respond to the research denoted in Sections 310.36 and 312.3A of the Code of Iowa.

The Research Board consists of 15 regular members: seven Iowa county engineers, four Iowa DOT engineers, one representative from Iowa State University, one from The University of Iowa, and two engineers employed by Iowa municipalities. Each regular member may have an alternate who will serve at the request of the regular member. The regular members and their alternates are appointed for a three year term. The membership of the Research Board as of June 30, 2013, is listed in Table I.

The Research Board held seven regular meetings during the period from July 1, 2012, through June 30, 2013. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

IHRB
IOWA HIGHWAY
RESEARCH BOARD

Members of the IHRB are serious about the future of transportation. Understanding that every research project has the potential to strengthen the infrastructure, save lives, time and precious resources, they work hard to make sure new methods, technologies and materials are developed efficiently and economically for application in the real world. **The IHRB has received national attention as a leader in transportation research implementation.**

TABLE 1: 2013 IOWA HIGHWAY RESEARCH BOARD

Member	Term Expires	Alternate
Ahmad Abu-Hawash, Chair Chief Structural Engineer Iowa DOT - Bridges and Structures 800 Lincoln Way Ames, IA 50010 (515) 239-1393 Email: Ahmad.Abu-hawash@dot.iowa.gov	12-31-15	Dave Claman Preliminary Bridge Engineer Iowa DOT - Bridges and Structures 800 Lincoln Way Ames, IA 50010 (515) 239-1487 Email: David.Claman@dot.iowa.gov
Kevin Jones Materials Testing Engineer Iowa DOT 800 Lincoln Way Ames, IA 50010 (515) 239-1237 Email: Kevin.Jones@dot.iowa.gov	12-31-15	Scott Schram Bituminous Materials Engineer Iowa DOT 800 Lincoln Way Ames, IA 50010 (515) 239-1604 Email: Scott.Schram@dot.iowa.gov
Vicki Dumdei District 2 Engineer Iowa DOT 1420 Fourth St. S.E. Mason City, IA 50401-4438 (641) 422-9465 Email:Victoria.Dumdei@dot.iowa.gov	12-31-13	David Little Assistant District 2 Engineer Iowa DOT 1420 Fourth St. S.E. Mason City, IA 50401-4438 (641) 422-9464 Email: David.Little@dot.iowa.gov
Robert Younie Director of Maintenance Iowa DOT 800 Lincoln Way Ames, IA 50010 (515) 239-1589 Email: Bob.Younie@dot.iowa.gov	12-31-14	Dan Sprengeler Work Zone Traffic Control Engineer Office of Traffic and Safety 800 Lincoln Way Ames, IA 50010 (515) 239-1823 Email: Dan.Sprengeler@dot.iowa.gov
Sarah Okerlund City Hall 515 Clark Avenue Ames, Iowa 50010 (515) 239-5169 Email: sokerlund@city.ames.ia.us	12-31-14	Dan Whitlow City Engineer 1225 6th Avenue – Suite 200 Marion, Iowa 52302 (319) 713-6340 Email: DWhitlow@cityofmarion.org
Ronald Knoche City Engineer 410 E. Washington Street Iowa City, IA 52240-1825 (319) 356-5138 Email: Ron-Kknoche@iowa-city.org	12-31-15	Bruce Braun Street Maintenance Administrator 216 SE 5th Street Des Moines, IA 50309 (515) 237-1371 Email: BABraun@dmgov.org
Douglas Schnoebelen The University of Iowa – IIHR 323A SHL 300 South Riverside Drive Iowa City, Iowa 52242-1585 (319) 335-6061 Email:Douglas-Schnoebelen@uiowa.edu	----------	

Wade Weiss
Greene County Engineer
114 N. Chestnut Street
Jefferson, IA 50129
(515) 386-5650 SS-037
Email: WWeiss@co.greene.ia.us

Robert Kieffer
Boone County Engineers Office
201 State Street
Boone, IA 50036-3988
(515) 433-0530 SS-008
Email: engineer@co.boone.ia.us

12-31-14
District 1

Russ Stutt
Jasper County Secondary Road Dept.
910 N. 11th Ave. E.
Newton, IA, 50208
(641) 792-5862 SS-050
Email: RSjasper@iowatelecom.net

J.D. King
Fayette County Engineer
114 N. Vine Street, PO Box 269
West Union, IA 52175
(563) 422-3552 SS-033
Email: JamesDKing@co.fayette.ia.us

12-31-13
District 2

Doug Miller
Kossuth County Secondary Rd Dept.
114 W State Street
Algona, IA, 50511
(515) 295-3320 SS-055
Email: engineer@co.kossuth.ia.us

Paul Assman
Crawford County Engineer
1202 Broadway, PO Box 458
Denison , IA 51442
(712) 263-2449 SS-024
Email: cracoeng@frontiernet.net

12-31-15
District 3

Patrick Mouw
Ida County Engineer
1703 W 6th St.
Ida Grove, IA 51445
(712) 364-2920 SS-047
Email: idaengineer@frontiernet.net

Kevin Mayberry, Vice Chair
Mills County Engineers Office
403 Railroad Avenue
Glenwood, IA, 51534
(712) 527-4873 SS-065
Email: KMayberry@millscoia.us

12-31-14
District 4

Todd Hagan
Madison County Engineer
1105 E. Court Ave.
Winterset, Iowa 50273
(515) 462-1136 SS-061
Email: THagan@madisoncoia.us

Ernie Steffensmeier
Lee County Engineer
933 Avenue H
Fort Madison, IA, 52627
(319) 372-2541 SS-056
Email: ErnieS@leecounty.org

12-31-13
District 5

Larry Roehl
Louisa County Engineer
8313 K. Avenue
Wapello, IA, 52653-9279
(319) 319-523-5272 SS-058
Email: LRoehl.locoe@louisacomm.net

Robert Fangmann
Cedar County Engineer
400 Cedar Street
Tipton, IA 52772
(563) 886-6102 SS-016
Email: engineer@cedarcounty.org

12-31-15
District 6

Myron Parizek
Benton County Engineer
1707 W 1st St
PO Box 759
Vinton, IA 52349
(319) 472-2211 SS-006
Email: mparizek@prairieinet.net

Terry Wipf
Dept. of CCEE Engineering
Iowa State University
420 Town Engineering Bldg.
Ames, IA 50011
(515) 294-6979
Email: TJWipf@iastate.edu

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board. The Board's recommendations are transmitted to the director of the Performance and Technology Division of the Iowa Department of Transportation. Expenditure of research and development funds is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Research Fund, Secondary Road Research Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in benefits, the costs are shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 2013. Total expenditure was $2,285,246.11.

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Iowa DOT personnel are termed "in-house" projects. These projects may involve other departmental and field personnel in addition to personnel from The Office of Research and Analytics, Operations Research Section. In many instances, personnel from other offices are designated as a project principal investigator, which means that they have a major role in the planning, performance and analysis of the research.

Contract research funds may be used for material and equipment costs for in-house research, but cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts for in-house projects are relatively small. The Office of Research and Analytics, Operations Research Section, wishes to express its appreciation to other offices for their assistance.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The NCHRP was organized by the AASHTO. The program is administered by the TRB, a branch of the National Academy of Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern. The program is funded annually by all fifty states in an amount equal to 5.5% of the federal aid allocated to the states for (SPR). Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

SECONDARY ROAD TRAFFIC COUNT PROGRAM

Secondary road traffic counts are conducted annually and funded from the Secondary Road Research Fund as Non Contract Engineering Studies. The Office of Transportation Data conducted traffic counts in 25 counties during fiscal year 2013 as part of the Annual Traffic Count Program. This activity consisted of 2100 portable recorder classification counts and 3430 portable recorder volume counts. Traffic volumes from these counts are used to develop Motor Vehicle Traffic Flow Maps for each county showing the (AADT) on specific road sections within each county.

Secondary roads geometrics and current condition inventories were requested from all 99 counties. This data provides county engineers, highway engineers, planners and administrators with essential information needed to determine design standards, to systematically classify highways, and to develop programs for improvement in maintenance of secondary roads.

SECONDARY ROAD RESEARCH FUND

Section 310.34 of the Iowa Code authorizes the Iowa Department of Transportation to set aside each year an amount not to exceed 1½% of the receipts to the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949; it was repealed in 1963, and reinstated in 1965. When the fund was reinstated, the fund was designated to finance engineering studies and research projects. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures.

The fiscal year 2013 financial summary is:

Beginning Balance 7-1-12		$ 914,418.91
Receipts		
State Road Use Tax Fund		
(1½% of receipts)	$1,207,322.93	
Federal Aid Secondary		
(1½% of receipts)	0.00	
Research Income	0.00	
Sub-Total		$1,207,322.93
Total Funds Available		$2,121,741.83
Obligation for Expenditures		
Obligated for		
Contract Research	$1,045,618.59	
Non-Contract		
Engineering Studies	$77,247.67	
Total Expenditures		$1,122,866.26
Ending Balance 6-30-13		$998,875.57

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year $200,000 is set aside from the street construction fund for the sole purpose of financing engineering studies and research projects. The objective of these projects is more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The fiscal year 2013 financial summary is:

Beginning Balance (7-1-12)	$177,820
FY13 Street Research Funding	$200,000
Total Funds Available for Street Research	$377,820
Total Obligated for Expenditure FY13	$249,710
Ending Unobligated Balance 6-30-13	$128,110

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is sourced from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved, such as contracted research and project-specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. The amount expended for contract research from the Primary Road Research Fund for FY13 was $783,852.96 and the estimate for FY14 is $750,000.

PROJECTS INITIATED DURING FY 2013

TR-649 Workshops on the Application of Load and Resistance factor Design of Driven Piles in Iowa

TR-650 Development of Non-Petroleum Based Binders for Use in Flexible Pavements- Phase 2

TR-651 Iowa Pavement Asset Management Decision Framework

TR-652 Durable Pavement Marking and Grooving

TR-653 Assessment of Non-Destructive Testing Technologies for Quality Control/Quality Assurance of Asphalt Mixtures

TR-654 Development of a Subgrade Drainage Model for Unpaved Roads

TR-655 Updating the Iowa Culvert Hydraulics and Iowa Bridge Backwater Software

TR-656 Biofuel Co-Product Use for Pavement Go-Materials Stabilization: Phase II, Comprehensive Laboratory Evaluation & Characterization and Field Demonstration

TR-657 Evaluation of Low-Cost Signalized Intersection Red Light Running Countermeasures in Medium to Large Communities in Iowa

TR-658 Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures - Phase 2

TR-659 Development of Asphalt Dynamic Modulus Master Curve Using Falling Weight Deflectometer (FWD) Measurements

TR-660 Investigation of Negative Moment Reinforcing in Bridge Decks

TR-661 Evaluate the Need for Longitudinal Median Joints in Bridge Decks on Dual Structures

TR-662 Evaluating Roadway Subsurface Drainage Practices – Phase II

TR-663 Short Span County Bridge Standards

TR-664 Low Cost Rural Surface Alternatives: Demonstration Project

16 Projects Initiated

PROJECTS COMPLETED DURING FY 2013

The following projects were completed during FY 2013 and project Final Reports were approved by the Iowa Highway Research Board:

TR-519 Developing Flood-Frequency Discharge Estimation Methods for Small Drainage Basins in Iowa

TR-608 Assessment of Iowa County Roadway Financing Needs, Phases 1-4

TR-612 Wind Loads on Dynamic Message Cabinets and Behavior of Supporting Trusses

TR-616 Timber Abutment Piling and Black Wall Rehabilitation and Repair

TR-623 Quality Control/Quality Assurance Testing for Joint Density and Segregation of Asphalt Mixtures

TR-624 Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures

TR-630 Evaluation and Guidance on Effective Traffic Calming for Small Communities

TR-633 Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays

TR-634 Pilot Construction for Granular shoulder Stabilization

TR-635 Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols

TR-636 Bridge Damage Detection: Integration of Structural Health Monitoring System Concepts and Components – A Statewide Collaboration

TR-638 Western Iowa Missouri River Flooding – Geo-Infrastructure Damage Assessment, Repair and Mitigation Strategies

TR-643 Evaluating Roadway Subsurface Drainage Practices

13 Projects Completed and Approved

Table II

FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES

July 1, 2012 to June 30, 2013

(Active projects with no current fiscal year expenditures are not included)

Project #	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
HR140	Collection & Analysis of Streamflow Data	95,460.00	175,730.00	43,390.00	314,580.00
HR296	ISU Local Technical Assistance Program (LTAP)	36,919.80	94,645.25	18,510.08	150,075.13
HR375	Transportation Research Board Education for County Engineers		2,311.78		2,311.78
TR532	Evaluation of Transverse Joint Forming Methods in PCC Pavement		3,413.79		3,413.79
TR608	Assessment of Iowa County Roadway Financing Needs, Phases 1-4	30,318.63	2,107.17		32,425.80
TR613	Study of the Impacts of Implements of Husbandry on Iowa Bridges	3,418.48			3,418.48
TR614	Structural Characterization of a UHPC Waffle Bridge Deck and its Connections	10,574.71	1,254.96		11,829.67
TR615	Connection Details and Field Implementation of UHPC Piles - Phase II: Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications	36,805.25			36,805.25
TR616	Timber Abutment Piling and Back Wall Rehabilitation and Repair		21,670.12		21,670.12
TR617	An Adaptive Field Detection Method for Bridge Scour Monitoring Using Motion-Sensing Radio Transponders (RFIDs)	67,918.00	29,213.56		97,131.56
TR619	Development of Self-Cleaning Box Culvert Design - Phase II - additional funding for field test approved 6/25/10 $9679	9,053.13	38,116.67	3,380.08	50,549.88
TR620	Update of RCB Culvert Standards to LRFD Specifications	3,602.00	4,462.53	2,773.49	10,838.02
TR622	Maintenance and Design of Steel Abutment Piles in Iowa Bridges	13,116.00	12,351.70	10,259.78	35,727.48
TR623	Quality Control/Quality Assurance Testing for Joint Density and Segregation of Asphalt Mixtures	42,802.61	6,598.93		49,401.54
TR624	Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures	26,973.68			26,973.68
TR625	Improving Accuracy of Deflection & Camber Predictions for Prestressed Concrete Bridge Girders	60,400.23	70,881.74		131,281.97
TR626	Optimization of Snow Drifting Mitigation & Control Methods for Iowa Conditions	7,627.14	34,613.57	25,394.53	67,635.24
TR628	Alkali Content in Fly Ash Measuring & Testing Strategies for Evaluating Compliance	22,262.66	56,675.25	4,934.77	83,872.68
TR630	Evaluation and Guidance on Effective Traffic Calming for Small Communities	16,598.41	16,713.37		33,311.78
TR631	Automation of DEM Cutting for Hydrologic/Hydraulic Modeling	20,516.32	3,270.83		23,787.15
TR632	Low Cost Rural Road Surface Alternatives		18,918.27		18,918.27
TR633	Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays	44,706.67	20,562.54		65,269.21
TR634	Pilot Construction for Granular Shoulder Stabilization	10,479.81			10,479.81
TR635	Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols	50,617.56	42,751.23		93,368.79

Project #	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
TR636	Bridge Damage Detection: Integration of Structural Health Monitoring System Concepts and Components – A Statewide Collaboration	38,650.01	97,259.13		135,909.14
TR637	Development of a Wireless MEMS Multifunction Sensor System and Field Demonstration of Embedded Sensors for Monitoring Concrete Pavements	37,695.19	41,493.00		79,188.19
TR638	Western Iowa Missouri River Flooding — Geo-Infrastructure Damage Assessment, Repair and Mitigation Strategies		24,371.79	1,724.50	26,096.29
TR639	Development of Bio-Based Polymers for Use in Asphalt	59,983.00	35,285.88		95,268.88
TR640	Optimizing Pavement Base, Subbase, and Subgrade Layers for Cost and Performance on Local Roads		38,791.70	25,000.00	63,791.70
TR641	Reflective Crack Mitigation Guide for Flexible Pavements	3,392.30	49,983.00	119.55	53,494.85
TR643	Evaluating Roadway Subsurface Drainage Practices	25,476.78	47,970.24		73,447.02
TR644	Development of Cost-Effective Timber Bridge Repair Techniques		45,000.00		45,000.00
TR645	Development and Integration of Advanced Timber Bridge Inspection Techniques for NBIS		50,000.00	10,000.00	60,000.00
TR646	Development of Bridge Inspection, Load Rating & Maintenance Manuals		131,851.04	25,747.43	157,598.47
TR649	Workshops on the Application of Load and Resistance Factor Design of Driven Piles in Iowa	8,484.59	7,660.00	5,077.00	21,221.59
TR655	Updating the Iowa Culvert Hydraulics and Iowa Bridge Backwater Software		9,578.25	8,100.00	17,678.25
TR657	Evaluation of Low-Cost Signalized Intersection Red Light Running Countermeasures in Medium to Large Communities in Iowa		3,964.99		3,964.99
TR662	Evaluating Roadway Subsurface Drainage Practices – Phase II		261.99		261.99
HR1027	Secondary Road Research Coordinator		77,247.67		77,247.67
	Project Totals	783,852.96	1,316,981.94	184,411.21	2,285,246.11

HR-140

Agency:
United States Geological Survey

Principal Investigator:
Rob Middlemis-Brown

Research Period:
July 1, 1967 to September 30, 2014
Annual Renewal

Research Board Funding:
$260,340

Funding Source:
45% Federal funds, 55% State – 40% Primary funds 50% Secondary funds 10% Street funds

Collection and Analysis of Stream Flow Data

Objective: Collect the data necessary for analytical studies (including flood-frequency discharge estimation) and to define, for any location, the statistical properties and trends in discharge or elevation of streams, lakes, and reservoirs; Define the water-surface-elevation profiles and corresponding discharges along streams in basins with at least 100 mi^2 of drainage area for selected floods and evaluate the flood characteristics and hydraulics at existing and proposed flow structures in basins of all sizes when requested.

Progress: Data collection and annual reporting of stream flow data is ongoing annually.

Reports: Annual Report, Flood Event Reports

Implementation: Flood frequency and discharge data is used for sizing hydraulic structures in Iowa. Structure design agencies use this data for their designs.

U.S. Geological Survey measures the high water mark on the Cedar River at the Janesville stream gage on June 10, 2008. The record discharge for this site was set that day with streamflow measured at 53,400 cfs.
Photo: U.S. Geological Survey

HR-296

Agency:
Iowa State University

Principal Investigator:
Keith Knapp

Research Period:
October 1, 1986 to December 31, 2014

Research Board Funding:
$145,000

Funding Source:
Federal funds, 15.4% Safety funds, State Funds, Workshop income funds State – 40% Primary funds 50% Secondary funds 10% Street funds

promote research - encourage implementation - distribute research data

Iowa State University Local Technical Assistance Program (LTAP)

Objective: Assist Iowa's local governments with growing demands on local roads, streets, bridges, and public transportation. The center provides technical and managerial assistance to Iowa's local transportation officials through a variety of programs.

Progress:

- Publish *Technology News* newsletters
- Conduct training courses and workshops
- Distribute publications
- Provide service and information to users
- Present transportation safety information to rural communities by employing a Transportation Safety Circuit Rider

Reports: Newsletters, Annual Report

Implementation: Implementation of research findings and the proper training of state and county employees will improve the quality and reduce the cost of road construction and maintenance.

HR-375

Agency:
Iowa Department of Transportation, Performance and Technology Division

Principal Investigator:
Mark Dunn

Research Period:
November 1, 1994 to on-going

Research Board Funding:
$37,400

Funding Source:
100% State - 100% Secondary funds

Transportation Research Board Education for County Engineers

Objective: Annually send county engineers to the TRB Annual Meeting in Washington, D.C., for research education. County engineers selected are generally those starting their term as regular members of the IHRB. Attendance at the TRB Annual Meeting gives county engineers serving on the IHRB a better understanding of research at a national and international level. Additional benefits may be gained as the county engineers begin to develop ideas for research from their experience at the TRB meeting.

Progress: Between 1995-2013, 28 County engineers have received funding through IHRB to attend the Annual TRB meeting in Washington, D.C.

Reports: None

Implementation: County engineers who have attended the conference say it was a very good educational experience and that it educates and encourages them to better serve their counties and the IHRB.

Dr. Martin Wachs, Director, Transportation, Space and Technology Program, Rand Corporation, delivers the Thomas B. Deen Distinguished Lecture during TRBs 88th Annual meeting in Washington, D.C. on January 11, 2010.
Photo: Cable Risdon, Transportation Research Board

TR-519
Phase II

Agency:
United States Geological Survey (USGS)

Principal Investigator:
David Eash

Research Period:
June 1, 2004 to September 30, 2013

Research Board Funding:
$464,777

Funding Source:
44.3% Federal funds and 55.7% State - 45% Primary funds, 45% Secondary funds and 10% Street funds

Implementing a StreamStats Web Site for Iowa and Developing Flood-Estimation Equations for Small and Large Drainage Basins

Objective: Develop a comprehensive flood-estimation method for unregulated, rural streams in Iowa. Specifically:

- Implement an interactive StreamStats Web site for all of Iowa that allows users to easily select stream sites and estimate flood-frequency discharges by automating the measurement of basin characteristics and calculation of regression estimates
- Develop two sets of regional regression equations to estimate 2-, 5-, 10-, 25-, 50-, 100-, 200-, and 500-year flood-frequency discharges
- Develop the smallest drainage-area range for a transition zone as possible for Iowa to prevent the possibility of small-basin regression estimates exceeding large-basin regression estimates

Reports: Final Report, September 27, 2013

Implementation: These regression equations will be implemented within the U.S. Geological Survey StreamStats Web-based geographic information system tool. StreamStats allows users to click on any ungaged site on a river and compute estimates of the eight selected statistics; in addition, 90-percent prediction intervals and the measured basin characteristics for the ungaged sites also are provided by the Web-based tool. StreamStats also allows users to click on any streamgage in Iowa and estimates computed for these eight selected statistics are provided for the streamgage.

TR-589

Agency:
National Weather Service

Principal Investigator:
National Weather Service

Research Period:
April 1, 2008 – September 30, 2013

Research Board Funding:
$137,937

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

FHWA Pooled Fund project TPF-5(187)

Updating U.S. Precipitation Frequency Estimates for the Midwestern Region

Objective: Determine annual exceedance probabilities and average recurrence intervals for rainfall durations ranging from five minutes to 60 days and frequencies from 1-500 years. The study results will be a web based publication.

Reports: Final Report, June 28, 2013

Implementation: The National Weather Service rainfall maps have not been updated for approximately 50 years. This means that the designs of storm sewers, culverts, dams, detention basins, etc. have been performed by engineers using outdated data. This project is part of a national effort to update the rainfall/frequency relationships for the entire United States.

Contour maps and high resolution grids will be available for each combination of rainfall frequency and duration. Charts of seasonal distribution of annual rainfall will be developed and documented.

Implementing updated precipitation frequency estimates as a design tool for future projects will help engineers design bridges, culverts, detention basins, storm sewers and other transportation projects more efficiently.
Photo: NOAA

TR-608

Agency:
Iowa County Engineer Association Service Bureau

Principal Investigator:
Steve DeVries

Research Period:
August 1, 2009 – December 31, 2012

Research Board Funding:
$154,316

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Assessment of Iowa County Roadway Financing Needs

Objective: Develop a conceptual model to facilitate accurate forecasting simple enough for presentation to the public, also:

- After the conceptual model is defined, physical and financial data will be gathered from public and private sectors and reviewed to identify and quantify interrelationships between the road network, vehicles that operate on it, and land parcels that adjoin it.

- Define a data structure and processing engine that represent road, traffic and land use entities' relationships and affects on each other.

Reports: Final Report March 4, 2013

Implementation: The model will assist agencies with estimating the cost of a service level, find what service level fits a particular revenue stream, and project what improvements are needed to meet traffic levels. It will also facilitate study and discussion of tradeoffs between road costs, vehicle costs and land use costs, and identify the value of commerce supported by secondary roads.

TR-613

Agency:
Iowa State University

Principal Investigator:
Terry J. Wipf

Research Period:
January 25, 2010 – June 30, 2015

Research Board Funding:
$153,590

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Study of the Impacts of Implements of Husbandry on Iowa Bridges

Objective: The objective of this study is to determine how the implements of husbandry distribute their load within a bridge structural system and to provide recommendations for accurately analyzing bridges for their loading effects. To achieve this objective the distribution of live load and dynamic impact effects for different types of agricultural vehicles will be determined by load testing and evaluating two general types of bridges. The types of equipment studied will include but is not limited to; grain wagons/grain carts, manure tank wagons, agriculture fertilizer applicators, and tractors. Once the effect of these vehicles has been determined, recommendations for the analysis of bridges for these non-traditional vehicles will be developed.

Progress: The project team has completed analyzing the field collected data, creating analytical models for those field tested bridges, and computing experimental and analytical DFs for those bridges. These will be used to create a large database of DFs for many bridges. Code-type equations specific to bridges subjected to implements of husbandry have been developed including load distribution equations for all non-skewed bridges. These were presented to the TAC for their scrutiny. The results for dynamic load allowance were also presented and discussed at length with the TAC.

Reports: None

Implementation: Engineers involved in the rating/evaluation of bridges for live load performance of bridges will be able to immediately be able to use the resulting information as the results will be given in a format commonly used by practicing engineers. The results of this study will most likely supplement existing standards by providing information/guidance not previously available.

TR-614

Agency:
Iowa State University

Principal Investigator:
Sri Sritharan

Research Period:
November 20, 2009 –
August 31, 2012

Research Board Funding:
$50,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Structural Characterization of a UHPC Waffle Bridge Deck and its Connections

Objective: The objectives of this proposed research is to perform structural characterization of the UHPC waffle bridge deck panel designed for the bridge in Wapello County and its critical connections, and evaluate the system performance and ride ability of the panel top surface.

Progress: The Phase 1 Report, which is on the laboratory testing of the UHPC waffle deck, has been completed. The feedback received on the report from TAC and representatives of FHWA's Highway for LIFE program have been incorporated. FHWA has approved the final version of the Phase 1 report, thereby giving authorization for the production of UHPC panels for the field implementation which will take place in the next phase. The final report to IHRB will combine both Phase I and Phase II studies.

Construction of the prototype bridge was delayed, but was completed in fall 2011. Field testing of the Wapello County Bridge was completed in March 2012. The draft of the Phase-II report presenting the analysis and results from the field testing data was submitted to the Coreslab Structures Inc. for review comments. Following analysis of field data, the draft version of the Final report to IHRB has been completed. The final report is anticipated to be completed by end of December 2013.

Reports: None

Implementation: The research findings of the project will be disseminated to designers and practitioners in the fields of structural and construction engineering.

TR-615

Agency:
Iowa State University

Principal Investigator:
Sri Sritharan

Research Period:
December 17, 2009 – December 31, 2013

Research Board Funding:
$210,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Connection Details and Field Implementation of UHPC Piles - Phase II: Use of Ultra-High Performance Concrete in Geotechnical and Substructure Applications

Objective: The objectives chosen for the next phase of the project are to: 1) establish and test connection details to extend the length of UHPC piles in the field; 2) develop and test suitable details that can be used to connect the UHPC pile to concrete pile cap as well as to bridge abutment; 3) study a UHPC pile behavior as part of a bridge foundation in the field and compare its behavior to that of a steel H pile, and 4) develop a preliminary geotechnical design methodology.

Progress: Field monitoring has been completed in Sac County. Implementation problems have led to a project delay. The project team is now collecting data at the site from all of the piles. If data collection addresses the thermal effects adequately, the project will be complete by the year end.

Reports: None

Implementation: This research will contribute to establishing a cost-effective, durable pile for bridge infrastructure. The proposed laboratory tests will allow UHPC piles to be effectively extended without causing any construction delays, while the connection tests will establish details for anchoring the pile into pile caps and abutments, which may also be used for steel piles. The planned fields tests will not only confirm the expected behavior of the UHPC piles under real-world loading conditions, but will also create unique data that will enable preliminary evaluations to be completed on LRFD design of UHPC piles, examination of the effects of setup and understanding the potential benefits of construction control for this pile type.

TR-617

Agency:
The University of Iowa

Principal Investigator:
Thanos Papanicolaou

Research Period:
June 1, 2010 – December 31, 2013

Research Board Funding:
$210,967

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

An Adaptive Field Detection Method for Bridge Scour Monitoring Using Motion-Sensing Radio Transponders (RFIDs)

Objective: The objective is to utilize RFIDS on fully adaptive bridge monitoring and residual life prediction to minimize the problems inherent in human inspections of bridges. This will include an integrated CBM framework integrating RFID sensors and sensing architecture, for in-situ scour monitoring of critically scoured bridge structures. This will provide real-time state awareness datasets that can be used in making decisions on down time, repair cost, and functionality.

Progress: The initial tasks have been completed. The project was extended until December 31, 2013. A request for an additional $40,101 was approved by the IHRB for the following additional tasks:

1. Improve the waterproofing of the new developed transponders
2. Incorporate a MEMS inclinometer to the transponders to enhance the “folding chain” method for bridge scour depth estimation.
3. Incorporate the magnetic and dielectric properties of the river bed material into the software

Reports: None

Implementation: An RFID system fitted with data telemetry equipment can provide the ability to collect and transmit data to a maintenance office. Remote monitoring could mitigate the inefficiencies and dangers inherent in the current practices, as well as provide early warning of impending bridge failure and the ability to track long-term degradation as a result of scouring.

TR-619

Agency:
The University of Iowa

Principal Investigator:
Marian Muste

Research Period:
April 1, 2010 – September 30, 2013

Research Board Funding:
$156,159

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Development of Self-Cleaning Box Culvert Design - Phase II

Objective: The overall objective of this project is to identify and/or develop methods for constructing, or retro-fitting, box culverts so that the typical flow through a culvert will clean the culvert's entrance area and the barrels and keep the structure performing well with little or no maintenance. The new phase of the study will include, but not be limited to, preparing the implementation phase for the self-cleaning design at selected sites in Iowa and continue the multi-prong research on self-cleaning designs for other types of culverts, besides the 3-box culvert investigated in TR 545.

Progress: The routine monitoring at the Hwy 1 three-box culvert is ongoing. A real-time web camera is in place for continuous monitoring of the sedimentation development and real-time stream-gage sensor is also operating continuously for flow monitoring.

Reports: None

Implementation: The primary products of the project would be a practical report that provides design layouts and guidance for self-cleansing methods for use for new culverts and for retrofitting to existing culverts known to have a sedimentation problem. The report prepared will be formatted in a comprehensive and well-illustrated manner that directly helps engineers to select the self-cleansing method best suited for a culvert site.

TR-620

Agency:
Foth Infrastructure

Research Period:
July 26, 2010 – August 27, 2011

Research Board Funding:
$398,032

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Update of Reinforced Concrete Box (RCB) Culvert Standards to LRFD Specifications

Objective: The objectives of the project involve developing software that will design the RCB culvert barrel sections. Using the software, the consultant will design and develop RCB culvert standards to LRFD specifications for single, twin and triple box culverts.

Progress: Barrel Standards are complete and have been submitted to the Iowa DOT Office of Bridges and Structures for approval. Additional tasks have been added to incorporate a Load and Resistance Factor Rating LRFR feature into the RCB culvert design software previously developed by Foth Infrastructure & Environment

Reports: Final Report, June 29, 2012 (Phase I)

Implementation: Updated standards are available at: http://www.iowadot.gov/bridge/v8elrfdculstd.html

TR-622

Agency:
Wiss, Janey, Elstner and Associates (WJE)

Principal Investigator:
Wade Clarke

Research Period:
August 1, 2010 – December 31, 2013

Research Board Funding:
$134,442

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Maintenance and Design of Steel Abutment Piles in Iowa Bridges

Objective: The desired outcome of this research will yield

1. Methods for addressing the problem of pile corrosion in existing bridges, and

2. A cost effective design methodology to prevent steel pile corrosion from occurring in new bridges in the future.

In addressing cost effective methods to prevent steel pile corrosion in new bridges, corrosion protection strategies will be developed that can be readily incorporated into contract specifications. These methods can be used and evaluated on upcoming bridge construction projects where steel pile corrosion is a concern.

Progress: WJE has completed the testing for this project and is currently in the process of preparing the final report. The anticipated date for completing the draft report is December 31, 2013.

Reports: None

Implementation: The project recommendations can be immediately implemented as changes to bridge construction specifications and specifications in maintenance contracts for existing structure repairs or preventive maintenance. Further, the work will provide a basis to develop recommendations to Iowa DOT maintenance staff to assist with optimizing the maintenance of bridge foundations.

TR-623

Agency:
Iowa State University

Principal Investigator:
Chris Williams

Research Period:
August 1, 2010 – December 31, 2012

Research Board Funding:
$150,742

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Quality Control/Quality Assurance Testing for Joint Density and Segregation of Asphalt Mixtures

Objective: The objectives for this project are to identify best practices for joint geometry, joint construction, and for minimizing segregation. Field testing of asphalt pavements during construction as well as existing pavement sections exhibiting open longitudinal joints will be investigated. The project will concurrently compare and evaluate destructive and non-destructive testing methods for identifying segregation and quality control/quality assurance of centerline joints. Testing criteria will then be developed for the most suitable method." Additionally, a test method that can be used to evaluate the permeability of mixtures during the mix design phase will be included.

Reports: Final Report, April 26, 2013

Implementation: The implementation and technology transfer aspects of the project will include the specific items stated in the products above and in particular: (1) Development of draft test methods for laboratory and field permeability testing. (2) Development of draft permeability quality assurance criteria for inclusion in percent within limit specifications.

TR-624

Agency:
The University of Iowa

Principal Investigator:
Hosin David Lee

Research Period:
August 1, 2010 – December 31, 2012

Research Board Funding:
$150,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures

Objective: The objective of this project is to develop quality standards for inclusion of high RAP content in asphalt mixtures. Performance testing and asphalt binder testing will be performed at all temperature regimes to characterize the binder contained in RAP and whether or not results are source dependent. Both laboratory and plant produced mixtures will be examined, which would help answer the question that how much blending occurs between the binder in RAP and virgin binder. In addition, this study will explore the possible role that fractionation may take in increasing RAP usage.

Reports: Final Report, January 25, 2013

Implementation: The implementation outlook for this research effort is very realistic given an increasing number of construction projects of asphalt pavements with RAP in Iowa. The results of this study shall provide a new mix design process with high RAP/Fractionated RAP contents.

TR-625

Agency:
Iowa State University

Principal Investigator:
Sri Sritharan

Research Period:
November 1, 2010 – December 31, 2012

Research Board Funding:
$250,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Improving Accuracy of Deflection & Camber Predictions for Pre-stressed Concrete Bridge Girders

Objective: The primary objective of the proposed research is to provide accurate methods for predicting short-term and time dependent camber during design and, if desired, means of increasing camber for prestressed beams fabricated for Iowa bridges. The approach will be to evaluate existing data and models as well as to systematically understand instantaneous and time dependent components of camber from casting of the PPCBs to construction of the actual bridge and beyond by quantifying the most significant parameters affecting camber of beams used in Iowa.

Progress: A summary of the project progress is as follows: 1) review of literature has focused on creep and shrinkage of concrete, prediction of camber using methods recommended for design practice and finite element modeling of prestressed beams; 2) Gathering of data has focused on historical information collected by precast plants and district engineers; 3) several camber measurements techniques have been studied and decided that a tape measure, a digital level, and a string potentiometer measurement system will be deployed to accurately capture the camber at precast plants; 4) several camber measurements have been taken from precast beams from Andrews Precast, Coreslab Precast, and IPC Precast; 5) detailed analysis of beams to evaluate the cause of discrepancy between measured and expected camber using the design equations is complete; 6) measuring and monitoring of four state bridge projects for long-term camber is complete; and 8) work on the final report is started.

Reports: None

Implementation: Better understanding of camber behavior and improved predictive tools will facilitate smooth construction, avoid difficult field problems for which there may be no good solution, ensure better service performance, and ultimately reduce life-cycle costs for Iowa's prestressed bridge inventory.

TR-626

Agency:
The University of Iowa

Principal Investigator:
George Constantinescu

Research Period:
October 15, 2010 – June 30, 2012

Research Board Funding:
$151,430

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Optimization of Snow Drifting Mitigation & Control Methods for Iowa Conditions

Objective: The overarching goal of the present proposal is to optimize the design of passive snow-control measures for Iowa roadways such that the impact of drifting on the roads is minimized or eliminated. The focus of the research will be on providing optimized solutions for limited-area right of ways and topographies which are favoring snow drifting on roadways. This design optimization should result in cost-effective solutions to the snow drift problem that can be tailored for weather and road conditions that are the most common for the Iowa environment.

Progress: The results for first winter were presented to the TAC. The main result for structural snow fences was that fences with a porosity of 30% appear to perform better than the optimum design identified during Part I for fences of conventional design (porosity of 50%). They also presented preliminary results based on 3D photogrammetry. Unfortunately, we were not able to follow a full event using this technique because of repeated camera failure. It was decided to continue testing the same three fence designs at the Williams site during next winter.

The monitoring performed at the site where a living snow fence was present was not conclusive. Discussions will continue weather that site will be monitored again next winter. The project team presented extension of their method to identify best designs based on results of numerical simulations for living snow fences

Reports: None

Implementation: A series of practical recommendations will be compiled by the project team to include the findings of the study in the Iowa snow fence design guidelines and illustrate the lifecycle cost benefits resulting from the new design implementation. The test cases and set up of the numerical model will be made available to IDOT for future use in new situations where the space constraints and local topography are of concern for the design of snow fences.

TR-628

Agency:
Iowa State University

Principal Investigator:
Scott Schlorholtz

Research Period:
January 1, 2012-December 31, 2014

Research Board Funding:
$156,091

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Alkali Content in Fly Ash Measuring & Testing Strategies for Evaluating Compliance

Objective: The objectives of this research project are as follows:

1. Determine if and at what content level fly ash with soda dosing has increased potential for alkali silica reactivity (ASR) as well as any other potential performance impacts in the concrete both during mixing and placing as well as long-term (good or bad).
2. Evaluate field concrete containing high-alkali fly ash and moderately reactive fine aggregate to see if ASR-related distress has occurred.
3. Determine a better method for determining available alkali in fly ashes with soda dosing. The method should be relatively simple and rapid in order to provide a QC tool for the fly ash marketer and QA test for the DOT. A specification content limit or performance level should be determined and recommended.
4. Perform a literature review and/or a survey to determine if there are other materials and methods for emission control that may impact the mid-west power plants and their fly ash chemistry.

Progress: Literature survey, field site selection, pavement survey, and material selection for lab studies have all been completed. Petrographic examinations of cores have begun. Additional core sites were added to the project, extending the examination timeline into 2014. Lab testing has been conducted and the chemical testing and mortar bar expansion are complete. Rapid mortar bar expansion testing is still in progress.

Reports: None

Implementation: The primary benefit from this research project will consist of an improved procedure for rapidly determining or calculating the available alkali content of fly ash. This will help Iowa DOT engineers to avoid using high-alkali fly ash in projects that could be susceptible to ASR. The improved procedure should also be less expensive to conduct; and hence, can be performed on a higher frequency to provide (QA) information on fly ash.

TR-630

Agency:
Iowa State University

Principal Investigator:
Shauna Hallmark

Research Period:
January 15, 2011 – December 31, 2012

Research Board Funding:
$55,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Evaluation and Guidance on Effective Traffic Calming for Small Communities

Objective: The objectives of this study are:

- Summarize information about effective transition zone planning and design practice
- Identify and summarize techniques used to manage speeds in transition zones
- Demonstrate the effectiveness of techniques that are practical for high- to low-speed transition zones
- Acquire additional information about techniques that may show promise but lack sufficient evidence of effectiveness
- Develop an application toolbox to assist small communities in selecting appropriate transition zones and selecting effective techniques for transitioning from high-speed to low-speed roadways

Reports: Final Report, April 26, 2013

Implementation: The findings from this research will enable practitioners to better design speed transition areas from high- to low-speed roadways, determine when speed management is necessary, and then select and monitor appropriate techniques. This capability is expected to have an impact at the national, state, and local level.

TR-631

Agency:
Iowa State University

Principal Investigator:
Brian Gelder

Research Period:
April 1, 2011 – January 31, 2014

Research Board Funding:
$73,873

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Automation of Digital Element Model (DEM) Cutting for Hydrologic/Hydraulic Modeling

Objective: The primary objectives for this project are:

- Develop and program algorithms to enforce fine scale drainage on LiDAR DEMs for the state
- Accurately enforce drainage on catchments larger than 24 acres in conjunction with the Iowa DNR and Iowa Institute for Hydraulic Research

Progress: Other than documentation/report writing, the DOT portion of this project is nearly complete as the final processes for channel enforcement and watershed boundary enforcement are now complete and work is complete enabling agricultural drainage areas; as a result the model is essentially complete. Further discussion with TAC member Dave Eash, USGS continues regarding potential future work on channel delineation for additional regression capabilities.

Reports: None

Implementation: These DEMs will be used by bridge and culvert engineers during initial design as well as by city and county engineers to correctly contributing area and the hydrologic characteristics of the contributing area as they design water conveyance structures. The actual algorithms for DEM enforcement are not likely to be used by the practicing engineer or administrator but will likely be used by DOT GIS professionals to support LiDAR database maintenance.

TR-632

Agency:
Iowa State University

Principal Investigator:
David White

Research Period:
July 1, 2011 – June 30, 2012

Research Board Funding:
$50,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Low Cost Rural Road Surface Alternatives

Objective: The proposed objectives of this research project are to:

(a) Conduct a comprehensive literature survey of the state of practice for granular surface road construction with respect to freeze/thaw damage resistance
(b) Develop recommendations with respect to conducting a phase 2 study to demonstrate various technologies.

Progress: Significant progress has been made on the report. Literature relevant to the project has been compiled and uploaded to a literature database. The database is being created for sharing with Iowa DOT, with tagged keywords established for the project. The final report is well underway and will be submitted in December 2013.

Reports: None

Implementation: The benefits from this project will be to provide improved knowledge in the state-of-the practice for granular surface stabilization. The project will result in improved decision making and investment.

TR-633

Agency:
Iowa State University

Principal Investigator:
Kejin Wang

Research Period:
August 1, 2011 – May 31, 2013

Research Board Funding:
$124,996

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Investigation into Shrinkage of High Performance Concrete Used for Iowa Bridge Decks and Overlays

Objective: The main objective of the proposed study is to investigate the shrinkage behavior of HPC used for Iowa bridge decks and bridge deck overlays. The specific objectives of this investigation include:

(1) To identify major components of shrinkages (chemical, autogenous, and drying shrinkages) in Iowa concretes;
(2) To evaluate the influence of various constituent materials, such as types and contents of cementitious material and aggregate, and admixtures, on these shrinkages; and
(3) To provide recommendations for improving Iowa HPC mix design and construction practice so as to reduce the concrete shrinkage cracking potential.

Reports: Final Report, September 27, 2013

Implementation: Early age cracking in concrete due to excessive shrinkage is often reported by state DOTs, and the problem is a special concern for HPC used for bridge deck and bridge deck overlays. The most effective way to solve this problem is to select proper concrete materials and mix proportions so that the concrete will have a low tendency to shrink and/or to crack. The observations and conclusions from this proposed study will lead to valuable recommendations on HPC material selection and mix design to reduce the concrete shrinkage cracking potential.

TR-634

Agency:
Iowa State University

Principal Investigator:
Charles Jahren

Research Period:
July 1, 2011 – June 30, 2012

Research Board Funding:
$85,920

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Pilot Construction for Granular Shoulder Stabilization

Objective: The objective of the proposed research project is to assist Iowa DOT in cost effectively mitigating edge ruts on granular shoulders by pilot testing the use of DUSTLOCK in a full scale maintenance setting and continuing to explore other alternatives such as developing standard specifications for a class of products that might have similar effectiveness and using other stabilizing strategies or paving short sections of shoulders.

Reports: Final Report, September 27, 2013

Implementation: The observations and conclusions from this study will provide recommendations on products and procedures available to mitigate edge rut problems for granular shoulders. In particular the use of DUSTLOCK will be investigated as a pilot construction project. State, county, and city transportation agencies/ jurisdictions can implement these recommendations. The results of this research could improve the behavior of granular shoulders, and reduce its maintenance cost.

Full implementation of possible recommendations may require the purchase of new equipment in order to perform the stabilization process. Alternatively, it may be possible to rent equipment or contract out certain operations. Changes for stabilization agent purchasing processes may be necessary to properly specify stabilization agents or to purchase proprietary materials. It is expected that researchers will be able to assist the Iowa DOT with these issues within the scope of this proposal.

TR-635

Agency:
Iowa State University

Principal Investigator:
Chris Williams

Research Period:
June 1, 2011 – May 31, 2013

Research Board Funding:
$174,991

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Warm Mix Asphalt Phase II: Evaluation of WMA Quality Assurance Testing Protocols

Objective: Phase II of this study will evaluate the performance of plant-produced WMA mixtures as compared to HMA using NCHRP 9-43 recommendations. Other objectives involving curing behavior, quality assurance testing, and hybrid technologies are outlined as follows:

1. Compare the predicted and observed field performance of existing WMA trials produced in the previous Phase I study to that of HMA control sections to determine if Phase I conclusions are translating to the field.
2. Identify any curing effect (and timing of the effect) of WMA mixtures and binders in the field. Determine how the field compacted mixture properties and recovered binder properties of WMA compares to those of HMA over time for technologies common to Iowa.
3. Identify protocols for WMA sample preparation for volumetric and performance testing which best simulate field conditions.

Reports: Final Report, September 27, 2013

Implementation: WMA technology may have benefits in providing longer haul distances and or longer construction seasons as well as the ability to place thicker lifts. Lastly, it may also be possible to incorporate higher percentages of RAP although this will need to be carefully examined as to the effect on binder grade selection via reduced aging in production/construction of the virgin binder.

TR-636

Agency:
Iowa State University, the University of Iowa, the University of Northern Iowa

Principal Investigator:
Brent Phares

Research Period:
September 1, 2011 – August 31, 2013

Research Board Funding:
$303,433

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Bridge Damage Detection: Integration of Structural Health Monitoring System Concepts and Components – A Statewide Collaboration

Objective: The objectives are:

1: Final development of the overall SHM system hardware and software
2: Integration of vibration-based measurements into current damage detection algorithm
3: Evaluation and development of energy harvesting techniques

Reports: Final Report, October 25, 2013

Implementation: The area of Structural Health Monitoring has been of significant interest to the Iowa DOT and several Iowa Counties for many years. This is especially true as the DOT moves toward collecting and using more real-time data on the state of the transportation system. This interest and the representation of various DOT offices on the project TAC will ensure a successful completion of the project and implementation of its findings.

Since this topic also has implications to other nearby states, it is anticipated that many other states and counties will be interested in the results of the project. These results will be distributed to the engineering community through the publication of technical papers in the engineering press, and presentations at bridge and transportation conferences and workshops. Posting of pertinent information on the websites of the participating organizations will be made.

TR-638

Agency:
Iowa State University

Principal Investigator:
David White

Research Period:
June 1, 2011 – May 31, 2013

Research Board Funding:
$100,000

Funding Source:
50% Federal – SPR 50 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Western Iowa Missouri River Flooding — Geo-Infrastructure Damage Assessment, Repair and Mitigation Strategies

Objective: The objectives of this research project are:

1. Field Reconnaissance — Review the geotechnical problems and challenges in the affected counties and cities, and prioritize areas for detailed in-situ testing and evaluation.

2. In-Situ Testing and Evaluation — Conduct in-situ testing to conduct a geotechnical assessment of the flood affected areas. The in-situ testing will focus on:
    a. Evaluating roadway support capacities (both paved and unpaved roads)
    b. Evaluating embankment conditions (slope failures)
    c. Identifying settlement problems along roadway segments, and around bridge abutments and culverts.

3. Field Data Report, Repair and Mitigation Strategies, and Recommendations — Develop a field data report, provide repair and mitigation strategies depending on the assessment of the level and extent of the damage, and recommendations for geo-infrastructure monitoring.

4. Guide for Geo-Infrastructure Flood Damage Assessment and Repair Solutions — Develop the emergency response criteria and guidelines for evaluating geo-infrastructure and recommending repair solutions following a flood event.

Reports: Final Report, September 27, 2013

Implementation: The guide's intent is to be used by the County and City Engineers to prepare emergency response plans for future flood events. It will highlight important geo-infrastructure criteria and technologies for damage assessment, emergency response, and repair options. The details of the manual will be developed as an outcome from the research. A detailed data report with lessons learned, repair solutions, and recommendations for geo-infrastructure continuous monitoring will also be provided.

TR-639

Agency:
Iowa State University

Principal Investigator:
Chris Williams

Research Period:
November 22, 2011 – April 30, 2013

Research Board Funding:
$149,958

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Development of Bio-Based Polymers for Use in Asphalt

Objective: The objectives of this project are to:

- Identify the most promising polymerization chemistries for forming linear-chain polymers from vegetable oils.
- Identify the triglycerides most amenable to such polymerization and collaborate with plant scientists to identify/develop agricultural feedstock best suited to express these.
- Develop the structure-property relationships crucial to the use of soybean-oil based thermoplastics in applications currently dominated by petrochemcially-derived polymers.

Progress: Replication of diblock and triblock polymers has been successful with subsequent improvement to the base asphalt. A base asphalt of PG46-34 was improved with 2% of the diblock and 2% of the triblock to PG70-28 and PG64-34 binders, respectively. Although not part of this specific project, the research team has revised several methods for producing biopolymers with the acquisition of a much larger lab reactor. This will allow for the increase in the polymer batch size to go from 80-100 grams to about 2kg. The research team is completing the draft final report and will have a draft to the TAC for review by the end of 2013.

Reports: None

Implementation: The benefits of this research are potentially utilizing Iowa source materials (e.g. soybean oil) for producing biopolymers for use in Iowa asphalt binders. Current market analysis illustrates that the material cost of the biopolymers is 40 percent lower than using butadiene with additional savings being provided via lower production costs. These lower costs will translate into lower costs of polymer modified asphalt. The handling of vegetable oils in producing the bioelastomers and subsequent linking with styrene is also much safer and has less impact on the environment. This should also create improved economic opportunities for soybeans resulting in economic value to the State of Iowa and maintaining soil qualities through a balanced crop rotation.

TR-640

Agency:
Iowa State University

Principal Investigator:
Tom Cackler

Research Period:
November 22, 2011 – May 31, 2014

Research Board Funding:
$150,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Optimizing Pavement Base, Subbase, and Subgrade Layers for Cost and Performance on Local Roads

Objective: The objectives of this study include the following:

1. Determine the level of increased performance on local roads when PCC is placed on granular subbase or treated subgrade and quantify the performance and cost effectiveness.

2. Develop a user guide for various traffic, soils and pavement factors for optimized performance and financial benefits.

Progress: A conference call with the Technical Advisory Committee took place on September 4, 2013. The discussion included key items such as a summary of the field testing and findings, critical pavement design parameters, and determination of reliability using field data. The key design parameters that were studied include loss of support, drainage coefficient and modulus of subgrade reaction. The field data showed that modulus of subgrade reaction was calculated differently between the FWD and the DCP. The FWD test accounts for loss of support while the DCP tests the individual soil layers. Overall, the field measured drainage coefficient and loss of support were lower than assumed design values. The user manual should include discussion on mitigation efforts to guard against weakening of the soils during thaw conditions. Life cycle unit costs for new and rehabilitated PCC were also reviewed.

The next steps include performing life cycle cost analysis and developing a draft of the user guide for TAC review.

Reports: None

Implementation: The guide will be published and circulated statewide by incorporating the findings into Chapter 6 of the SUDAS Design Manual. The guide will also be published on the IHRB and CP Tech Center Website. Upon completion of the study, SUDAS, County Engineers and Municipal Engineers would be responsible for applying the research results. Specific standards or practices that may be affected include SUDAS and the Iowa DOT design manual and specifications.

TR-641

Agency:
Iowa State University

Principal Investigator:
Chris Williams

Research Period:
November 22, 2011 – May 31, 2014

Research Board Funding:
$99,966

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Reflective Crack Mitigation Guide for Flexible Pavements

Objective: The objectives of the study are:

1. Develop guidelines for project selection including but not limited to design considerations such as existing pavement type, thickness, and distress, patching needs, traffic, and minimum subgrade support required.
2. Review preferred practice of rubblization and crack & seat techniques and the selection of proper fracture size and how it relates to performance. Develop quantitative quality acceptance criteria for these projects and recommendations for the use of leveling course material.
3. Develop a mechanistic, performance-based life cycle cost analysis with the MEPDG to further aid in project selection using these crack mitigation techniques based on previously completed studies on reflective crack mitigation techniques.

Progress: The research team was not able to attain FWD test results from some of the sections for completing the project and will need to rely on obtaining the data from the Iowa DOT databases. The three design strategies that have limited data are the rock interlayer, rubblization, and crack and seat. Based upon the direction of the Iowa DOT and local agencies in which they are not using crack and seat because of the challenges of attaining an appropriate seat, the research team will discuss at an upcoming TAC meeting whether or not to include this as a viable option.

The research team has spent a substantial amount of time developing an Excel software program for conducting life cycle cost analysis in conformance with FHWA guidelines and the recent review of these guidelines by the General Accounting Office for improvements. This development of the life cycle cost analysis includes utilizing multiple "activities" beyond utilizing a reflective cracking mitigation strategy.

Reports: None

Implementation: The benefits of this research will be improved pavement performance for Iowa jurisdictional agencies and the Iowa DOT. The project will provide guidelines for assisting engineers in selecting cost effective strategies for mitigating reflective cracking. Further construction guidelines for the strategies for mitigating reflective cracking will also be provided- currently there are no guidelines for crack & seat and rubblization in Iowa.

TR-642

Agency:
The University of Iowa

Principal Investigator:
Witold F. Krajewski

Research Period:
February 1, 2012 – January 31, 2014

Research Board Funding:
$172,721

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Pilot Project for a Hybrid Road-Flooding Forecasting System on Squaw Creek

Objective: This project is a 2-year plan for the design, implementation and evaluation of a hybrid flood forecasting system that combines real-time stream level observations with a state-of-the-art distributed hydrologic models called CUENCAS. The system will, over time, provide accurate predictions of flooding potential for each and every road/stream intersection in a river basin. The observation component of the system is accomplished with a stream-level sensing device, which uses ultrasound technology to measure the distance from the bridge deck to the stream water surface.

Progress: The project team has continually recorded stream stage data at 22 sites using the sonic IFC sensors since the spring of 2012. Due to a major drought Iowa experienced in the summer of 2012, data from that year were of little value for the project. In the spring and summer of 2013 several significant flood events were captured. The largest event occurred on May 27th 2013. The Squaw Creek near Lincoln Way in Ames crested near 10 feet, with an estimated discharge of 4220 cfs. The modeling efforts have concentrated in this event. At the time all of the installed IFC sensors where working and stage time series where collected at the 22 sites. Information collected was used to implement and test three flood forecasting models. Initial validation of the three models has been done, but several steps to revise and fix model parameters remain.

Reports: None

Implementation: A distributed flood-forecasting mathematical model capable of highly accurate predictions (i.e. with errors on the order of 1%) could replace the need for a network of observations by making predictions of flooding in all the intersections of roads and streams in a river network. However, the level of accuracy of current hydrologic models is much lower (~ 50% error) precluding their use as a sole forecasting tool of road conditions. In addition, the architecture of standard hydrologic models precludes the ability of forecasting flood levels on small tributaries. As an example, the National Weather Service provides routine stream level forecasts for about 100 locations in the state of Iowa. These forecasting locations usually correspond to large cities or highly populated regions, but provide no information on small creeks or the multiple intersections of roads and streams.

TR-643

Agency:
Iowa State University

Principal Investigator:
Halil Ceylan,

Research Period:
January 15, 2012 – July 31, 2013

Research Board Funding:
$119,975

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Evaluating Roadway Subsurface Drainage Practices

Objective: The objectives of this project are as follows:

- Conduct a comprehensive performance review of pavement subdrains in Iowa.
- Include the condition of the drains and a determination of whether they are functioning as designed
- Evaluate a corresponding pavement to determine if pavement deterioration is occurring at the drain locations.
- Determine the cause of the problem if there are drains that are not functioning properly.
- Make recommendations for improvements to the pavement drainage system, when appropriate.

Reports: Final Report, May 31, 2013

Implementation: Based on the outcome of this study, the research findings will be directly used by Iowa city, county, and DOT engineers to assess the performance of their pavement subdrains and improve their drainage practices.

TR-644

Agency:
Iowa State University

Principal Investigator:
Brent Phares

Research Period:
August 27, 2012 – December 31, 2015

Research Board Funding:
$90,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

This project is jointly funded with the Minnesota Local Roads Research Board.

Development of Cost-Effective Timber Bridge Repair Techniques

Objective: Currently no sources of guidance for the repair of timber bridges exist. At the same time county engineers have recognized several types of timber bridges that are in need of repair and maintenance; this represents a major concern. This project is to identify the state-of-the-practice of timber bridge repair through national and international search and to marry those repair techniques with the needs of county engineers. The efficacy of those techniques will then be evaluated from both engineering and fiscal perspectives. Through a multi-pronged approach, the most viable techniques will be communicated to engineers through a coordinated outreach effort.

Progress: Literature and county surveys are complete. A number of repair techniques have been identified for evaluation. Cost projections for the individual repair techniques are currently being developed and a repair manual is being written.

Reports: None

Implementation: The principal benefit of the work proposed here will be that local system engineers will have formal guidance for repairing timber bridge components. Currently county and city engineers have little to no State or national sources to which they can turn for guidance on the repair of timber bridges. This represents a significant problem as they strive to ensure the safety of the travelling public. The benefit of having such a resource will be measured by improving the overall condition of the transportation system and reducing system failures through implementation by local officials.

TR-645

Agency:
University of Minnesota - Duluth

Principal Investigator:
Brian K. Brashaw

Research Period:
August 13, 2012 – December 31, 2014

Research Board Funding:
$60,000

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

This project is jointly funded with the Minnesota Local Roads Research Board.

Development and Integration of Advanced Timber Bridge Inspection Techniques for NBIS

Objective: Inspections for timber bridges have been mostly limited to visual inspection, hammer sounding and probing. These techniques have proven appropriate for advanced decay detection, but are inadequate for early stage or internal deterioration. It is critical that efforts be conducted to develop and implement advanced timber inspection techniques into routine bridge inspections in accordance with NBIS requirements.

This project will result in improved assessment information that can be used to improve the safety and reliability of bridges. An experienced research team will identify and help implement an inspection protocol for timber bridges (with an emphasis on timber substructure) that can accurately assess structural condition and support the load rating process. Key milestones include the development of standard inspection protocols, integration of the results into bridge data management software, development of a customized inspection manual, outreach training for districts, recommendation of equipment purchases, and completion of an economic assessment on the use of advanced inspection techniques.

Progress: Various inspection techniques have been identified and inspection protocols are currently being developed. .

Reports: None

Implementation: This project will provide clear implementation strategies that can be used to accurately identify deteriorated structural timber members and provide key information that can be used to adjust load ratings, develop repair strategies and improve maintenance. One outcome from the project will be a recommendation for the purchase of timber inspection equipment for sharing within the State. Training and outreach will be conducted for inspectors and engineers for each District. By providing training and access to advanced timber inspection equipment, the project will improve the safety and reliability of timber bridges.

TR-646

Agency:
HDR Engineering

Principal Investigator:
Phil Rossbach

Research Period:
May 10, 2012 – June 30, 2013

Research Board Funding:
$289,494

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Development of Bridge Inspection, Load Rating & Maintenance Manuals

Objective: Under a project funded by the Iowa Highway Research Board, HDR will provide services to the Iowa Department of Transportation to develop Bridge Inspection, Load Rating and Maintenance manuals with the intent of capturing existing OBS policies and procedures, and summarizing current and past knowledge of DOT staff in these areas. The manuals would utilize a .pdf format in order to have sections or pages that may be linked to Iowa DOT's Structure Inventory and Inspection Management System (SliMS) software.

Progress: A final Load Rating manual was delivered to Iowa Dot July 2013. A draft Maintenance Manual and draft Inspection Manual have been submitted and are currently being reviewed by the Iowa DOT Office of Bridges and Structures. Final documents will be submitted in late 2013 or early 2014.

Reports: None

Implementation: The manuals will provide the required technical information and guidance to allow DOT Bridge staff and District maintenance personnel to consistently inspect, evaluate and maintain on-system bridges. A secondary benefit will be to provide a framework for policy guidance to local municipal and county bridge owners and employees as well as to independent bridge consulting firms working for the State or local entities.

TR-647

Agency:
Iowa State University

Principal Investigator:
Brent Phares

Research Period:
July 1, 2012 – December 31, 2013

Research Board Funding:
$143,391

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Methods for Removing Concrete Decks from Bridge Girders

Objective: The objective of this work is to determine the most, and/or develop new, cost-effective and efficient deck removal techniques for steel and prestressed concrete superstructure bridges. Further, the work proposed herein will include guidance on assessing and repairing steel girders that are damaged during removal of a deck. The following criteria will be considered as part of the evaluation: Impact on the future performance of the superstructure, Cost, Time, Safety, and Noise

Progress: The project team has completed the collection of information (via survey, meetings, and literature search) and has started the laboratory testing phase of the project. Testing of the deck specimens with partial concrete removal was completed and presented to the TAC. Small scale shear connector specimen testing had also been completed. Several "new" removal techniques were selected that will be evaluated in the next quarter.

Reports: None

Implementation: At the conclusion of this project, a suite of tools will exist that will allow bridge owners to make informed decisions regarding the removal of concrete decks from bridges. The outcomes of this work will be immediately implementable as standards of practice will be developed.

TR-648

Agency:
Iowa State University

Principal Investigator:
Peter Taylor

Research Period:
July 1, 2012 – June 30, 2016

Research Board Funding:
$83,049

Funding Source:
100 % State - 40 % Primary funds, 50 % Secondary funds and 10 % Street funds

Evaluation and Testing of a Light-Weight Fine Aggregate (LWA) Concrete Bridge Deck

Objective: The objective of this project is to perform laboratory and field testing and evaluation of a concrete bridge deck constructed with LWA concrete. The CP Tech Center will conduct material tests on the LWA and concrete mixtures used in the bridge deck, both in the lab and during construction. In addition, the BEC will conduct live load field tests to evaluate the performance and condition of the LWA deck and the control deck both at the time of placement and approximately 1 year after construction. Evaluation of performance will be made through comparisons with design assumptions, previous research, and the performance of the LWA deck compared to the control.

Progress: Laboratory tests on two mixtures (control and test) have been prepared. Test data through 28 days are available. An additional mixture is planned with an optimized aggregate gradation.

The bridge was constructed and samples were obtained from the in-place mixture. A load test was conducted on the bridge and the bridge was examined for cracking in September 2013. No cracks were observed in either section. A follow-up load test is scheduled and a long-term evaluation will be conducted over the next two years.

Reports: None

Implementation: The benefits of this research include collected field data and information regarding the structural performance of LWA in concrete bridge decks compared to a similar bridge deck constructed of normal weight concrete. By providing internal moisture to the concrete, the LWA facilitates internal curing of the concrete, in turn, reducing the short and long term shrinkage cracking that often results during concrete curing. With no reduction in strength, concrete with reduced shrinkage cracking has a potential advantage over typical concrete mixtures in our Midwest climates and the subsequent use of deicing salts in the winter months. In addition, there is the potential for improved durability, as well as economic benefits as well.

TR-649

Agency:
Iowa State University

Principal Investigator:
Sri Sritharan

Research Period:
August 28, 2012 – December 31, 2012

Research Board Funding:
$23,012

Funding Source:
100 % State - 80 % Secondary funds and 20 % Street funds

Workshops on the Application of Load and Resistance Factor Design of Driven Piles in Iowa

Objective: The objectives of the proposed 1-day workshops are to 1) enable the application of the advanced LRFD design and construction procedures in Iowa, 2) facilitate Iowa's engineers and practitioners go through a smooth transition from the current use of interim foundation design procedure to the advanced LRFD procedure, and 3) transfer the state-of-art knowledge on foundation piles to both design and construction community, so that each group understands its responsibilities and future bridge foundations are designed and constructed in Iowa in accordance with the AASHTO specifications.

Progress: The workshops were completed in the Fall of 2012.

Reports: None

Implementation: The two 1-day LRFD workshops will have several direct benefits to bridge infrastructures, especially bridge foundations, in Iowa. First, the workshop will train Iowa DOT, county, and city engineers as well as regional consultant films to design bridge foundations in accordance with the LRFD procedure that aligns with the AASHTO framework that has been mandated by the FHWA. Second, the workshop will ensure engineers and practitioners having a smooth transition from the current interim design procedure to the proposed LRFD procedure without influencing their design efficiencies and increasing the cost of future bridge infrastructure. Third, the workshop will facilitate the application of the LRFD procedure that will provide a uniform and reliable design and construction control of bridges across Iowa. Through the proposed LRFD workshops, the aforementioned benefits will be realized, and the efficiency of future bridge infrastructures in Iowa will be eventually improved.

TR-650

Agency:
Iowa State University

Principal Investigator:
Chris Williams

Research Period:
October 31, 2012-March 31, 2014

Research Board Funding:
$144,882

Funding Source:
100 % Federal

Development of Non-Petroleum Based Binders for Use in Flexible Pavements-Phase 2

Objective: The objective of this research is to use combinations of bio-oil and other polymers such as rubber for partial replacement in asphalt. Laboratory studies of full replacement blends will be on-going. The optimal blend will be used in a demonstration project. The optimal blend should show improved shear resistance, reduced temperature susceptibility, and resistance to deformation.

Progress: There have been problems with the project regarding the adequate aging methods for this material. This difficulty impairs the low temperature characterization of the bio-binders. BBR bath is alcohol based (methanol and ethylene glycol), and cannot be used as it dissolves the bio-oil. Efforts are being done to pursue a suitable bath for the BBR. A demonstration paving project was not identified for the 2013 paving season- a fixed plant with either vertical mixing storage tanks (for asphalt) or a recirculation pump system is needed to react the tire rubber with the bio-oil and then blend with asphalt for partial replacement. An extension will likely be needed.

The research team continued working with to identify a viable demonstration project that would utilize an appropriate asphalt tank system for reacting the bio-oil with ground tire rubber and for subsequent blending with asphalt. Mix designs were completed for the project with the initiation of performance testing. Dynamic modulus testing has been done and analysis of the results is in progress. Samples for low temperature testing will be procured for testing in the next quarter.

Reports: None

Implementation:
A demonstration project will be done utilizing the bio-oil binder blends at approximately 5-6% asphalt replacement. The results of the project will provide useful information for future demonstration 6 projects at higher asphalt replacement amounts such as 10%, 25%, 50% and ultimately 100% replacement.

TR-651

Agency:
Iowa State University

Principal Investigator:
David Jeong

Research Period:
January 1, 2013-
December 31, 2014

Research Board Funding:
$120,000

Funding Source:
100 % Federal

Iowa Pavement Asset Management Decision Framework

Objective: The project has five objectives to accomplish the final goal of developing a pavement asset management framework for selecting a pavement treatment through evaluating benefits of various treatment options from "do nothing" to full replacement.

a. Develop a framework for selecting feasible treatment options when the conditions of a pavement section is given
b. Develop a methodology in assessing return on investment values of various treatment options available for Iowa pavements
c. Develop a spreadsheet based decision aid tool for selecting the most appropriate treatment option that can be used by Iowa DOT as input to current system and used in a stand-alone mode by local transportation agencies.
d. Conduct case studies using the tool developed in this project and validate the tool.
e. Train Iowa DOT and local agency engineers for rapid dissemination of the tool

Progress: Literature review on pavement treatments in terms of expected life, unit cost, and triggers was completed and documented. However, a need for the following two issues were identified from TAC members' comments: a) Literature review on best practices in other DOTs on the decision making process of pavement treatment selection, and b) Literature review on other DOTs' practices in determining the LOS of pavements - threshold value of each distress that triggers intervention. Additional literature review on these two issues will be completed in the next quarter. Also, from the TAC meeting, comments on the draft questionnaire were obtained. The questionnaire will be finalized and sent to local engineers in the next quarter.

Reports: None

Implementation: One of the primary outputs of this research project will be a spreadsheet based tool that will assist the Iowa DOT pavement management engineers in evaluating feasible treatment options. The output of this project will be immediately available to the Iowa DOT through a training session. Iowa Cities and Counties will be able to use the tool as a stand-alone mode as well. This new tool will promote a more cost effective use of highway construction funds through defendable decisions on pavement treatments.

TR-652

Agency:
Iowa State University

Principal Investigator:
Neal Hawkins

Research Period:
January 1, 2013-December 31, 2015

Research Board Funding:
$125,000

Funding Source:
100 % Federal

Durable Pavement Marking and Grooving

Objective: The project objectives are to evaluate the pavement marking materials and installation procedures, including:

- Installation of a durable pavement marking test deck to evaluate these materials under Iowa roadway conditions. Use different combinations of marking materials, beads, and installation practices (surface applied and grooved). Monitor pavement marking performance in terms of durability (presence) and retroreflectivity over 24 months or 2 winters using high-speed video, under wet and dry conditions.
- Develop a performance versus cost guideline to assist state and local agencies in making more informed pavement marking selection decisions.
- Include test sections with short segments for each combination with a control section of surface applied markings in-between each. Dimensions of the groove should vary in depth, width and shape (90 degree vertical edges versus a groove which is more concave in shape).

Progress: The team developed test deck methodologies and began the organization process for installations. The test deck installation is anticipated for spring 2014. A meeting is planned with project TAC for next quarter to confirm the methodology and project test deck details/costs.

Reports: None

Implementation: This implementation and transferability of this work will support decision making on the selection, budgeting, and management of pavement marking guidance on public roadways. The results will be applicable to any roadway agency or authority.

TR-653

Agency:
Iowa State University

Principal Investigator:
Jeremy Ashlock

Research Period:
January 1, 2013-June 30, 2014

Research Board Funding:
$82,707

Funding Source:
100 % Federal

Assessment of Non-Destructive Testing Technologies for Quality Control/Quality Assurance of Asphalt Mixtures

Objective: The primary objective of the proposed research is to assess the accuracy and suitability of a range of NDE technologies for QC/QA of asphalt pavement. As described above, off the-shelf technologies to be examined include Geogauge, low-radiation nuclear, and EM systems. Additionally, customized surface wave testing methods will be examined using ground-coupled and air-coupled sensors. Analyses of the surface wave tests will be performed using programs written by the ISU researchers.

Progress: The literature review was initiated and a surface wave method (SWM) data acquisition hardware and software testing system was developed. Field testing was performed at the five project sites. The testing system was significantly improved by switching to a multi-channel configuration, which greatly increased the useful maximum frequency. Additionally, tests are being repeated periodically at the Boone site to study the effects of seasonal ambient temperature variation. The Universal Testing Machine in the Asphalt Materials Laboratory at ISU was modified to enable performance of dynamic modulus tests using diametrical loading on the core specimens.

Reports: None

Implementation:
The anticipated research results will be applied by Iowa DOT engineers to improve the state of practice in QC/QA of asphalt pavements. Research findings will be reported in the form of NDE test procedures and recommendations. Assuming one or more of the NDE technologies are identified as suitable replacements for destructive coring, an Implementation plan will be formulated to include recommendations for calibration procedures, methods for assessing measurement variability, and procedures for routine performance of the NDE tests by Iowa DOT personnel.

TR-654

Agency:
The University of Iowa

Principal Investigator:
Thanos Papanicolaou

Research Period:
January 15, 2013-December 31, 2014

Research Board Funding:
$73,653

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Development of a Subgrade Drainage Model for Unpaved Roads

Objective: The objectives of this project are the following:

1. Determine if county roads are exhibiting moisture related distress or frost boil failure that can be attributed to poor subgrade drainage performance.
2. Determine whether there are design and/or maintenance alternatives that will improve subgrade drainage performance.
3. Develop a model for evaluating post-construction subdrain performance using soil borings and/or NRCS soil maps. The model should work under saturated and unsaturated conditions and for a wide range of key design hydraulic and geotechnical parameters. The model reliability should be tested by using NRCS maps for identifying the soil type in the problem areas and comparing the maps to the collected soil cores from the problem areas.

Progress: The project team has determined the saturated hydraulic conductivity of the soils in Iowa using texture and bulk density. The Ksat provides a reflection of the drainability of the sub-grade soil. Investigators are currently evaluating the effects of the range of conductivity values in the model on the length of time needed to drain the sub-grade material of gravel roads. They are identifying the problems soils that take a longer time period to drain.

Reports: None

Implementation: The final products of the proposed research are the following:

1. Provide an efficiency evaluation of current design of subbase drainage system which contains information of the different response of materials and drains to different hydrologic and climatic conditions.
2. A new and simple to use drainage model to evaluate subdrain performances of alternative designs to enhance the decision process of future roadway projects.
3. Provide improved specifications to design subsurface drainage systems able to ensure an excellent drainage under the climate and groundwater conditions of Iowa.

TR-655

Agency:
Digital Control, Inc.

Principal Investigator:
LaDon Jones

Research Period:
January 1, 2013-
March 31, 2014

Research Board Funding:
$48,600

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Updating the Iowa Culvert Hydraulics and Iowa Bridge Backwater Software

Objective: The objective of this project is to:

1) Convert the Iowa Culvert Hydraulics and Iowa Bridge Backwater software from the visual basic 6.0 programming language to the Microsoft .Net programming system using the VB.NET programming language and .NET framework 4.0.

2) Add the latest U.S.G.S. methods (IHRB TR-519) for estimating design flow rates at ungaged sites in Iowa to both software programs.

3) Update the standard culverts included in the culvert software and associated head loss estimates.

4) Review the methodology in the Bridge Backwater software to see if any changes or additions are needed.

Progress: The update to visual basic 6.0 is complete. Due to a delay in the implementation of Streamstats, the project has been delayed until early spring 2014 to complete the update in design flow rates.

Reports: None

Implementation: The updated culvert and bridge software will be utilized by city and county engineers, the Iowa DOT staff, the IDNR, and consultants, for the design of culverts and evaluation of bridge hydraulics along the State's primary and secondary road system. The programs will continue to be valuable tools for city and county engineers, the Iowa DOT and consulting engineers in Iowa. The updated programs will be available for downloading from the Iowa DOT website.

TR-656

Agency:
Iowa State University

Principal Investigator:
Halil Ceylan

Research Period:
May 9, 2013-
April 30, 2015

Research Board Funding:
$167,967

Funding Source:
100 % Federal

Biofuel Co-Product Use for Pavement Go-Materials Stabilization: Phase II, Comprehensive Laboratory Evaluation & characterization and field Demonstration

Objective: The proposed research is a follow-up investigation of the IHRB research project entitled "Biofuel Co-product Uses for Pavement Geo-materials Stabilization". The objectives of this proposed Phase II research are to gain a deeper understanding of how BCP-soil stabilization works for different soil types and under a variety of conditions encountered in the field before this technology can be put into practice successfully. This research also seeks to address the potential challenges and issues that could arise with the introduction of a new soil stabilizer in the field. The specific objectives are: Evaluate the effect of BCP addition on strength performance for a wide range of soils encountered in Iowa

- Evaluate the durability (moisture sensitivity and freeze-thaw condition) of BCP treated soils
- Evaluate the effect of BCP addition to soils on environment
- Characterize the microstructure of BCP-soil mixture to better understand the mechanism of BCP soil stabilization
- Establishing a laboratory test protocol for mixture design and testing procedures for BCP stabilized soil
- Execute a field demonstration project using the developed BCP-soil stabilization technology

Progress: The research team conducted comprehensive review of soil mix design procedures and micro-structural characterization of chemically stabilized soils (both traditional and nontraditional) to implement the laboratory test program. During the next quarter, research team will focus on soil sampling from Buchanan County which will be the location of the field demonstration project. Using the sampled soils, soil engineering property and moisture-density relationships will be characterized as well.

Reports: None

Implementation: If the research results are successful, the research findings will be directly used by Iowa's city, county, and DOT engineers to improve their soil stabilization practice. The research findings will be reported in the form of a final report as well as recommended design practice. The procedure for applying and storing lignocellulosic based soil stabilizers will also be described in the final report which will be useful for the practicing engineer.

TR-657

Agency:
Kansas University

Principal Investigator:
Steven Schrock

Research Period:
May 15, 2013-
April 30, 2014

Research Board Funding:
$70,000

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Evaluation of Low-Cost Signalized Intersection Red Light Running Countermeasures in Medium to Large Communities in Iowa

Objective: The proposed research is to study the effectiveness of the confirmation light system at two to four high crash/high violation Iowa intersections in either medium or large communities. This study is designed to complement the studies being conducted in the Kansas communities of Lawrence and Overland Park in an effort to reduce red light running in the Midwest. Moreover, effectiveness of the confirmation light system will be evaluating the change in number of red light running violations over a short and long period using video data in collaboration with interested communities. The evaluation method will be a before-after study design along with the use of control intersections and spillover intersections to determine if the countermeasure is positively or negatively affecting the treated intersections and/or other intersections in the study communities.

Progress: The blue confirmation lights were installed at one signalized intersection in Altoona and one signalized intersection in Waterloo. After consulting with the city, one approach at the treatment intersection in Waterloo was not equipped because the signal was protected/permitted. The research team has received positive feedback from residents of both cities.

The one month video study was conducted and data is currently being reduced. A 3 month study is scheduled for the first week of December. The research team also provided the City of Altoona turning movement volumes for signal timing. Currently the data reduction is underway and at this time do not have immediate results from the 1 month study. However, based on the study underway in Kansas, the research team is seeing a considerable reduction in red light running violations, which we hope will be the same for both Iowa communities at the treatment intersections.

Reports: None

Implementation: These methods are intended to support rapid deployment of more confirmation light systems in Iowa if the study shows significant effectiveness. A key component to the research project deliverables is the tech transfer summary which the research team expects the Iowa DOT office of traffic and safety to champion to disseminate throughout Iowa.

TR-658

Agency:
University of Iowa

Principal Investigator:
Hosin Lee

Research Period:
May 15, 2013-
January 31, 2015

Research Board Funding:
$150,000

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Development of Quality Standards for Inclusion of High Recycled Asphalt Pavement Content in Asphalt Mixtures – Phase 2

Objective: The objective of this phase 2 study is to 1) build a test section utilizing HMA mix designs with up to 50% RAP materials, 2) evaluate the moisture sensitivity of High-RAP mixtures, 3) characterize the low-temperature fracture behavior of High-RAP mixtures, 4) monitor the condition of the field test section in one year after the construction and 5) develop a design guide for High-RAP mixtures including fractionation process and construction quality control. Both laboratory and field mixtures will be examined, which would help answer the question that how much blending occurs between the binder in RAP and virgin binder.

Progress: Test sections have been built with 20, 25% and 30% binder replacement using Fractionated RAP materials. The project team is performing the moisture susceptibility behavior testing using samples collected from the field. There will be a TAC meeting in early January to review the test results.

Reports: None

Implementation: The implementation outlook for this research effort is very realistic given a field test section with varying RAP amounts up to 50% to be constructed in Iowa. The results of this study shall provide a foundation leading to a modified mix design process with High-RAP contents.

TR-659

Agency:
Iowa State University

Principal Investigator:
Halil Ceylan

Research Period:
May 15, 2013-
May 14, 2014

Research Board Funding:
$49,956

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Development of Asphalt dynamic Modulus Master Curve Using Falling Weight Deflectometer (FWD) Measurements

Objective: The objective of this study is to develop the asphalt dynamic modulus master curve directly from time histories of routinely collected FWD test data for use in MEPDG/DARWin M-E flexible pavement analysis and rehabilitation design.

Progress: The research team has carried out a comprehensive literature review focusing on the undamaged/damaged |E*| master curve development procedure in AASHTO Pavement ME design (formerly, MEPDG) and the state-of-the-art methodologies that exist for back calculating damaged |E*| master curve from time histories of FWD surface deflections. Based on the literature review findings, the proposed research approach based on layered VE forward analysis algorithm has been developed with an effort to formulate efficient and simplified overall frameworks for deriving asphalt dynamic modulus master curve from FWD time-history data. The detailed development approach was presented at the project TAC meeting held on September 23, 2013.

Reports: None

Implementation: Based on the outcome of this study, the research findings will be directly used by Iowa City, county, and DOT engineers to efficiently develop HMA dynamic modulus master curves from routine FWD data. The research findings will be reported in the form of a final report as well as recommended alternatives that will improve the characterization of HMA dynamic modulus master curve.

TR-660

Agency:
Iowa State University

Principal Investigator:
Brent Phares

Research Period:
May 1, 2013-
April 30, 2015

Research Board Funding:
$99,970

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Investigation of Negative Moment Reinforcing in Bridge Decks

Objective: The objectives of this work are to:

- Investigate OBS policy concerning the amount of negative moment reinforcing required, over piers, to provide continuity in a bridge deck. Specifically, determine if the office policy regarding the amount of negative moment reinforcing steel over the piers is conservative.
- Investigate the OBS policy regarding terminating negative moment steel at the eighth points of bridge spans.
- Investigate the impact of terminating the negative moment reinforcing steel at one cross-section versus staggering the termination points.
- Investigate the contribution of secondary moments to bridge performance in negative moment regions.

Progress: Five bridges have been tested and the data is currently being analyzed.

Reports: None

Implementation: The results of this work should be immediately implementable as the project has the very specific goal of examining very specific portions of the current Iowa DOT OBS bridge design process. Should the research results show that change is necessary, warranted, or allowable, the form and format of the research plan will allow for direct identification of sources of change and their impact.

TR-661

Agency:
Iowa State University

Principal Investigator:
Brent Phares

Research Period:
May 1, 2013-
April 30, 2015

Research Board Funding:
$119,857

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Evaluate the Need for Longitudinal Median Joints in Bridge Decks on dual Structures

Objective: The main objective of this research is to determine the maximum width of a continuous deck that can be used without overstress. To achieve this objective, analytical techniques including FEA will be used to investigate the true behavior of decks with various widths under typical loadings due to temperature change, concrete shrinkage, and live loads. Experimental testing will be conducted in order to provide validation of the analytical models. Based on the outcome of the analytical and experimental investigations, the maximum continuous deck width will be recommended for different types of bridges and guidelines will be developed for the usage of longitudinal deck joints on dual structures.

Progress: The project team has started developing preliminary modeling concepts and has designed an instrumentation plan for the selected bridge.

Reports: None

Implementation: Engineers involved in designing bridges will immediately be able to use the resulting information as the results will be given in a format commonly used by design engineers. The results of this study will improve bridge construction for the Iowa DOT, counties, and cities. The results of this study will likely provide design guidelines based upon the rigorous analytical study.

TR-662

Agency:
Iowa State University

Principal Investigator:
Halil Ceylan

Research Period:
June 10, 2013-
Dec 31, 2014

Research Board Funding:
$126,878

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Evaluating Roadway Subsurface Drainage Practices – Phase II

Objective: The proposed research is a follow-up investigation of the IHRP research project entitled "Evaluating Roadway Subsurface Drainage Practices". The primary objectives of this proposed Phase II research are listed below:

- Evaluate the seasonal variation effects (dry Fall 2012 vs. wet Spring/Summer 2013, etc.) on subdrain outlet condition and performance
- Investigate the characteristics of tufa formation in Iowa subdrain outlets (i.e., identify the factors influencing the tufa formation and prevention, at what stage does tufa formation start influencing subdrain outlet performance, etc.)
- Investigate the condition of composite pavement subdrain outlets
- Examine the effect of resurfacing/widening/rehabilitation on subdrain outlets (e.g., the effects of patching on subdrain outlet performance)
- Identify a suitable drain outlet protection mechanism (like a headwall) and design for Iowa subdrain outlets based on a survey of nearby states

Progress: The research team conducted field inspections on a total of 60 new JPCP and HMA pavement drainage sites investigated during Phase I. One composite pavement site was investigated as well. During field investigation, the research team inspected types and size of outlet pipe, condition of outlet opening, screen presence and type, water presence and condition (staying/moving) inside drain, Tufa/pH/dead zone presence, etc.

During the next quarter of the project, research team will continue to identify problematic drainage sites and composite pavement sites for field investigation in consultation with the project TAC and district engineers. The research team will also focus on organizing the collected inspection results in summary format to present to the TAC.

Reports: None

Implementation: Based on the outcome of this study, the research findings will be directly used by Iowa City, county, and DOT engineers to assess the performance of their pavement subdrains and improve their drainage practices. The research findings will be reported in the form of a final report as well as recommended alternatives that will improve the performance of pavement subsurface drainage systems.

TR-663

Agency:
HDR Engineering

Principal Investigator:
Phil Rossbach

Research Period:
July 16, 2013-
Feb 28, 2014

Research Board Funding:
$46,164

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Short Span County Bridge Standards

Objective: The Phase 1 effort involves researching short span prefabricated bridge components, developing a preferred concept for the superstructure and abutments, developing working sketches of proposed components, refining those concepts, and identifying elements or details to be tested. Research of the prefabricated components will begin by assembling information already developed and accumulated by Iowa DOT as well as researching prefabricated components developed by other agencies.

From this information, HDR will develop or short list concepts and details for further refinement. Although a concrete box superstructure has been identified as a viable alternative, other structure types will be considered in Phase I prior to refinement of the structure type.

Progress: An initial project concept was presented to the TAC and approved for further development. Preliminary engineering on the concept is currently ongoing, to determine the constraints on the design.

Reports: None

Implementation: These prefabricated bridge standards is to provide a bridge system that has the potential to improve bridge construction, accelerate project delivery, improve worker safety, be cost effective, reduce impacts to the traveling public by reducing traffic disruptions and duration of detours, and allow local forces to construct the bridges.

TR-664

Agency:
Iowa State University

Principal Investigator:
Jeremey Ashlock

Research Period:
July 8, 2013-
Jan 31, 2015

Research Board Funding:
$121,974

Funding Source:
100 % State - 83 % Secondary funds and 17 % Street funds

Low Cost Rural Surface Alternatives: Demonstration Project

Objective: The proposed demonstration project will implement and monitor a selected set of these technologies over a two-mile section of Vail Avenue from Highway 175 to 310th street in Hamilton County, IA. The objectives of the proposed research project are to:

- Perform field testing of a range of granular surface stabilization technologies on a two-mile long demonstration project in Hamilton County, Iowa.
- Measure and document the performance of the demonstration roadway sections before, during, and after a seasonal freeze/thaw cycle.
- Assess the initial cost, relative performance, maintenance requirements, and long term life-cycle costs of the different stabilization techniques.
- Identify the most effective and most economical alternatives for minimizing or eliminating frost heave/boil issues before they occur.

Progress: The literature review is currently being performed, and laboratory classification, Proctor density, and horizontal permeability tests have been performed on samples taken from the project site. A trial run of the aggregate column installation was successfully performed in Greene County on August 21. Aggregate columns were then installed on Sections 12 and 13 of the Hamilton County demo project on September 26. FWD and DCP tests were performed to characterize the initial conditions of the unbound materials and subgrade prior to modification. FWD tests were also performed on the first mile Sections 1-8 containing the macadam base courses following their construction. DCP tests will also be performed on the first mile within the next week. The Geocomposite drain was installed in Section 19 on October 1. Out of the 21 planned sections, Sections 1 through 14, 19, and 20 are presently completed.

Reports: None

Implementation: For the benefit of the public, it is important that the results of the research can be easily implemented by the Iowa DOT. To ensure translation of the research results into practice, technology transfer documents will be created with the assistance of the publications division at ISU's Institute for Transportation.

HR-1027

Agency:
Iowa Department of Transportation

Principal Investigator:
Vanessa A. Goetz

Research Period:
March 1980 – On-going

Research Board Funding:
$85,000/year (covers salary and state share of costs for FICA, IPERS, health insurance, vehicle costs and expenses)

Funding Source:
100% State - 100% Secondary funds

Secondary Road Research Coordinator

Objective: This is a full-time position at the Iowa DOT. The coordinator's jobs are to act as a research liaison with all of the county engineers and solicit new, innovative and progressive ideas. He or she also actively promotes research for solutions to problems and ideas that will improve quality and reduce costs on the secondary road system.

Progress: Vanessa Goetz continues communications with county engineers to discuss problems encountered by secondary road departments and to discuss current research projects throughout the year.

At any one time as much as 50 percent of IHRB projects involve the secondary road system, including secondary projects with consultants. The coordinator assists these counties with special testing, evaluation and writing of reports necessary to the research and keeps county engineers updated on the latest important research results.

Reports: None

Implementation: There are many problems that are unique to the secondary road system in Iowa. These problems are often common to several counties. Coordination between counties is necessary for understanding the problems and formulating solutions. Proper documentation and dissemination of research results allows for timely technology transfer to and between the counties.