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Annual Report of Highway Research and Development in Iowa

Highway Division
Office of Materials
November 1988

Iowa Department of Transportation

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ANNUAL REPORT
OF
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1988

OFFICE OF MATERIALS
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IOWA DEPARTMENT OF TRANSPORTATION
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Table I

1988 IOWA HIGHWAY RESEARCH BOARD

Member	Term Expires	Alternate
Donald A. Anderson Deputy Director, Operations Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1491	12-31-88	Bernard C. Brown State Materials Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1452
Gerhard W. Anderson Deputy Director, Development Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1461	12-31-88	George F. Sisson Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
David Anthoney Boone County Engineer Courthouse Boone, IA 50036 (515) 432-6321 SS#-008	12-31-90	Steven J. Holcomb Grundy County Engineer Courthouse Grundy Center, IA 50638 (319) 824-6912 SS#-038
David R. Boylan, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-88	Paul W. Peterson Assoc. Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-2336
James R. Bump District 3 Engineer Iowa DOT - Highway Division P.O. Box 987 Sioux City, IA 51102 (712) 276-1451 SS#-230	12-31-90	Robert I. Bortle District 2 Engineer Iowa DOT - Highway Division P.O. Box 741 Mason City, IA 50401 (515) 423-7584 SS#-220
Robert DeWys Scott County Engineer Courthouse Davenport, IA 52801 (319) 326-8640 SS#-082	12-31-88	Russell A. Krieg Buchanan County Engineer R. R. 2 Independence, IA 50644 (319) 334-6031 SS#-010
Robert Haylock Butler County Engineer Courthouse Allison, IA 50602 (319) 267-2630 SS#-012	12-31-89	Richard O. Schiek Kossuth County Engineer Courthouse Algona, IA 50511 (515) 295-3320 SS#-055
Robert G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 335-5766	12-31-90	Jerald L. Schnoor Dept. of Civil & Envir. Engr. University of Iowa Iowa City, IA 52242 (319) 335-5649
Raymond L. Holland City Engineer Bettendorf, IA 52722 (319) 344-4055	12-31-88	Charles J. Schmadeke Director of Public Works Iowa City, IA 52240 (319) 356-5141
Orville D. Ives Monona County Engineer Box 236 Onawa, IA 51040 (712) 423-2284 SS#-067	12-31-88	Thomas G. Rohe Plymouth County Engineer Courthouse Le Mars, IA 51031 (712) 546-8956 SS#-075
Mike McClain Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004	12-31-89	S. J. Klassen Des Moines County Engineer 513 N. Main, RM B-11 Burlington, IA 52601 (319) 753-8241 SS#-029
Richard Ransom City Engineer City Hall Cedar Rapids, IA 52401 (319) 398-5026	12-31-90	Larry Stevens City Engineer Box 1010 Oskaloosa, IA 52577 (515) 673-7472
Eldon Rike Adams County Engineer Courthouse Corning, IA 50841 (515) 322-3910 SS-#002	12-31-90	Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS-#073

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division and the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farm-to-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, the costs are shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1988. Total expenditure was $1,134,161.43

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Highway Division personnel are termed "in-house" projects. These projects may involve other departmental and district personnel, in addition to personnel from the Office of Materials, Research Section. In many instances, personnel from other offices are designated as principal investigators, 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 shown for in-house projects are relatively small and the Office of Materials, Research Section, wishes to express its appreciation to other offices and districts for their assistance.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials (now the American Association of State Highway and Transportation Officials--AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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 of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices. The secondary obligations to NCHRP are paid from the Secondary Road Research Fund.

Project Number: HR-140

Project Title: Collection and Analysis of Stream Flow Data

Agency: Iowa City Office, Water Resources Div., U.S. Geological Survey, Dept. of Interior

Principal Investigator: Richard Engberg, U.S.G.S.

Research Period: Project continued to September 30, 1988

Research Board Funding: $92,475 per year (matched by $92,475 from the Department of the Interior)

Funding Source: 100 percent State funds--50 percent Primary, 50 percent Farm-to-Market

Iowa DOT Project Control: Bradley C. Barrett, Bridge Design

Objectives: The objectives of Project HR-140 are to obtain information about the flow of water in Iowa streams with particular emphasis on the magnitude and frequency of floods and to compile and analyze this information for use by highway engineers engaged in the design of bridges, culverts and embankments.

Progress: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of gaging stations on Iowa streams. These measurements, along with data from special studies of selected streams and floods, are compiled and analyzed to form the basis for predictions of future streamflow. The progress during 1987-1988 was in accordance with schedules established by the Water Resources Division.

Reports: A summary report of magnitude and frequency of Iowa floods is prepared annually. Reports of selected floods are also available.

Implementation: The information obtained from Project HR-140 is used daily by DOT personnel in the design of bridges and culverts.

Project Number: HR-165

Project Title: Experimental Steel Fiber Reinforced Concrete Overlay

Agency: Greene County and the Iowa Department of Transportation, Highway Division

Principal Investigators: Ronald Betterton and Vernon Marks

Research Period: April 1, 1984 to March 31, 1989

Research Board Funding: $185,586

Funding Source: 67 percent State--Farm-to-Market funds, 33% Federal Funds

Objective: To evaluate the long term performance of fibrous and nonfibrous PC concrete overlays.

Progress: This project on Greene County Road E-53 just east of Jefferson was constructed in 1973. It included 33 fibrous and nine nonfibrous overlay sections over an old, badly broken portland cement concrete pavement. A final report on the original project was written in 1978. The overlay sections were evaluated again in 1983 at 10 years. The project has been extended to maintain the overlay sections as research through 15 years.

Reports: Ten year report, February 1984 & January 1985 (TRB).

Implementation: The long term performance data will provide design and planning data for other PC concrete overlays.

Project Number: HR-268

Project Title: Evaluation of Magnitude and Frequency of Floods in Iowa.

Agency: Iowa City Office, Water Resources Division, United States Geological Survey, Department of the Interior.

Principal Investigator: J. J. Klein, U.S.G.S.

Research Period: June 1, 1984 to September 30, 1987

Research Board Funding: $110,500 (matched by $110,500 from the Department of the Interior)

Funding Source: 100 percent State funds -- 50 percent Primary, 50 percent Farm-to-Market

Iowa DOT Project Control: Bradley Barrett

Objective: To evaluate all available surface water data from Iowa streams and publish a comprehensive methodology for statistically estimating the magnitude and frequency of floods in Iowa.

Progress: Flood stage data have been compiled. A literature search for the latest method of stream flow and flood stage calculation has been completed. Flood magnitude and frequency prediction methodology has been developed. A final report is being reviewed by U.S.G.S. personnel.

Reports: Final Report, 1987

Implementation: Updated information and improved methods of estimating floods will result in more accurate determination of the size of drainage structure needed and thereby yield a monetary savings.

Project Number: HR-270

Project Title: Development of Training Aids and Demonstration of Portland Cement Concrete Pavement Rehabilitation

Agency: Iowa Concrete Paving Association

Principal Investigator: Robert Given

Research Period: September 21, 1984 to September 30, 1988

Research Board Funding: $ 2,000

Funding Source: 2% State--Primary Funds, 98% Federal Funds

Objective: To demonstrate various Concrete Pavement Rehabilitation techniques, to develop specifications and evaluate various materials and to educate those responsible for maintenance of PCCP roads, streets and airports.

Progress: The rehabilitation has been completed on 63rd Street (Iowa Route 28) south of Interstate 235 in Des Moines. The first demonstration was held on October 25, 1984. The second demonstration was held on February 28, 1985. Slide-tape and video training aids have been developed. Periodic testing and evaluation of pavement condition is continuing.

Reports: Progress Report, May 1986

Implementation: The training aids will promote more effective maintenance of our pavements and subsequently longer serviceable life.

Project Number: HR-279

Project Title: Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflective Cracking

Agency: Fremont County and the Iowa Department of Transportation, Highway Division

Principal Investigators: Charles Marker and Glenn Miller

Research Period: June 1, 1985 to July 1, 1996

Research Board Funding: $76,175

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: To evaluate the effect of crack spacing and seating of pcc pavement prior to resurfacing on reflective cracking and structural rating

Progress: The project included breaking a 2-mile pcc pavement section with transverse cracking at 3 foot intervals. A portion of the project was overlaid with 3 inches of asphaltic concrete and a portion overlaid with 4 inches of asphaltic concrete. The project is located on Fremont County road J-46. Construction was completed in October 1986.

Reports: Construction Report, April 1987

Implementation: If cracking and seating can alleviate or reduce the reflective cracking in asphaltic concrete overlays, it would reduce routine maintenance and prolong the life of the overlay.

Project Number: HR-280

Project Title: An Engineering Study to Update the Box Culvert Standards

Agency: The Highway Division of the Iowa DOT and Stanley Consultants, Inc.

Principal Investigator: William Lundquist

Research Period: July 31, 1985 to January 31, 1988

Research Board Funding: $300,000

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: To develop single and twin span box culvert standards, headwalls and bell joints for use by the Iowa counties.

Progress: Stanley Consultants, Inc. of Muscatine, Iowa began work in February 1986. Twenty four different single barrel box culverts have been designed for sizes from 5'x3' to 12'x12', with 9 different fills and 4 different skewed headwalls (0^{o}, 15^{o}, 30^{o} and 45^{o}). These have been distributed to the counties. Similar work has also been completed on the twin box culverts.

Reports: Single and Twin Box Culvert Standards

Implementation: The Iowa counties make extensive use of standard design plans. The standard designs eliminate the need for extensive design work by individual counties for most culvert projects.

Project Number: HR-282

Project Title: A Low Cost Automatic Weight and Classification System

Agency: Iowa Department of Transportation, Minnesota Department of Transportation and the Federal Highway Administration

Principal Investigator: Bill McCall

Research Period: August 1, 1985 to June 30, 1988

Research Board Funding: $100,000

Funding Source: State--Primary funds-34%; Minnesota DOT-25%; FHWA-41%

Objective: To examine the reliability of the low cost WIM system through field trials, to evaluate the accuracy of axle and gross vehicle weight measurements and to investigate the performance of the classification system.

Progress: The advisory panel selected Castle Rock Consultants as the contractor for this project. The Weigh-in-Motion System has been installed on Interstate 35 in Iowa and US 10 in Minnesota. Weight, speed and classification data from both of these sites are being analyzed. The project is considered complete for a system which will function in PCC and ACC.

Reports: Final Report, May 1988.

Implementation: A low cost WIM system will provide improved truck monitoring which will aid enforcement and design to extend pavement life thereby yielding substantial savings.

Project Number: HR-284

Project Title: Development of Multiplan Microcomputer Spreadsheets for County Hydraulic and Highway Engineering Computations

Agency: Iowa State University

Principal Investigator: Ken Brewer

Research Period: November 1, 1985 to August 31, 1987

Research Board Funding: $50,790

Funding Source: 100 percent State--Farm-to-Market funds

Objective: To develop "Multiplan" spreadsheet solutions to a set of selected hydraulic and highway engineering computations of common interest to county engineers and to make them available to each county through a series of one-day workshops.

Progress: An advisory committee of county engineering personnel has been formed to help direct the research effort. The committee has met twice with the principal investigator and established priorities for specific program solutions to be developed. Several programs have been developed. A list of workshops was scheduled during early 1987 to help users become familiar with the programs. Fifty-eight county representatives attended the workshops. Six sets of Microsoft Multiplan were transferred to the Iowa DOT.

Reports: Final report, July 1987

Implementation: Many counties lack the time and personnel to write all the needed programs for their specific brand of computer. Spreadsheet solutions operate nearly identically in all computer spreadsheet versions, allowing easy training, use and trouble shooting of programs.

Project Number: HR-285

Project Title: Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods

Agency: Iowa City Office, Water Resources Div., U.S. Geological Survey, Dept. of Interior

Principal Investigator: Phil Soenksen

Research Period: November 1, 1985 to September 30, 1988

Research Board Funding: $91,950

Funding Source: 100 percent State funds--50 percent Primary, 50 percent Farm-to-Market (Matched by USGS)

Objective: To obtain complete stage and discharge hydrographs on small streams without the use of manpower at the sites during the flood event.

Progress: Equipment has been obtained and was installed on selected streams to obtain low data during the high flows of the 1986-1987 period. Data collection is continuing.

Reports: None

Implementation: Improved flood discharge data will permit more accurate design and reduce the design factor of safety necessary, thereby generating a cost savings in the construction of future structures.

Project Number: HR-286

Project Title: Development of a Rational Characterization Method for Iowa Fly Ash

Agency: Iowa State University

Principal Investigator: Turgut Demirel

Research Period: December 1, 1985 to November 30, 1988

Research Board Funding: $174,200

Funding Source: 100 percent State Funds--50 percent Primary, 50 percent Farm-to-Market

Objective: To develop a test method to characterize Class C fly ash and ensure consistent performance.

Progress: X-ray diffraction techniques are being used to analyze numerous samples of fly ash from selected power plants that provide fly ash for Iowa DOT projects. Chemical compound contents are determined. Scanning electron microscopy and thermal analysis are also being used.

Reports: Annual Progress Reports No. 1, November 1986 and No. 2, November 1987

Implementation: There is a substantial cost savings from substituting fly ash for portland cement. This research will ensure proper quality of concrete with fly ash substitution.

Project Number: HR-287

Project Title: Strengthening of Existing Continuous Composite Bridges

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber and Kenneth Dunker

Research Period: November 1, 1985 to July 31, 1987

Research Board Funding: $87,430

Funding Source: 100 percent State - 50 percent Primary, 50 percent Farm-to-Market

Objective: To determine the feasibility of strengthening continuous composite bridges.

Progress: A 1/3 scale model bridge was constructed in the Iowa State University Structural Laboratory and tested by various methods of strengthening.

Reports: Final Report, July 1987

Implementation: Strengthening of continuous composite bridges would reduce the number of bridges requiring posting of maximum traffic weights.

Project Number: HR-288

Project Title: Field Evaluation of Bonded Concrete Resurfacing

Agency: Construction Technology Laboratories

Principal Investigator: Shiraz D. Tayabji

Research Period: January 1, 1986 to November 30, 1986

Research Board Funding: $39,857.81

Funding Source: 100 percent State Funds--67 percent Primary, 33 percent Farm-to-Market

Objective: To perform condition surveys and load testing of pavement overlays and to verify design procedures for bonded resurfacings.

Progress: Field testing of five sites for this project has been completed. Deflections and stresses in the concrete were determined under both an 18,000 pound single axle and a 34,000 pound tandem axle. The data are now being analyzed.

Reports: Final Report, November 1986

Implementation: This research will improve the design of bonded overlay rehabilitation of pavement. There will be a savings through reduced overdesign and through extended life by avoiding under design.

Project Number: HR-289

Project Title: Engineering Study - Training Aids to Reduce Potential County Liability

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Mark Callahan

Research Period: January 1, 1986 to December 31, 1988

Research Board Funding: $12,800

Funding Source: 100 percent State--Farm-to-Market funds

Objective: To develop a training slide/tape presentation which will illustrate situations and actions that could potentially contribute to highway accidents. The presentation will also show what remedial actions can be taken to improve highway safety.

Progress: An advisory committee of county engineers was formed to help direct the research effort. With assistance from the committee, a script was developed. Modifications proposed by the DOT Legal Division have been made to the script and 35mm slides of relevant conditions are being taken.

Reports: None

Implementation: Proper planning, design, construction and maintenance will improve safety, avoid mitigating situations and reduce highway-related tort claims

Project Number: HR-290

Project Title: Ice Retardant Pavement

Agency: City of Des Moines

Principal Investigator: John P. Bellizzi

Research Period: February 3, 1986 to March 31, 1991

Research Board Funding: $25,200

Funding Source: 100 percent State--Primary Funds

Objective: To evaluate the effectiveness of ice-retardant additives to the surface course of asphalt pavement in Iowa; to develop operational procedures for placing and maintaining asphalt concrete containing ice-retardant additives.

Progress: The location for use of the ice-retardant additive has been selected and a similar intersection has been identified for accident history comparison. The experimental Verglimit section was constructed on Euclid Avenue from 1st Street to Columbia Street in August 1986. Very few periods of evaluation were presented during the winter of 1986-87 due to the mild winter. During the high humidity summer seasons the surface sometimes became wet.

Reports: Interim Report, May 1988

Implementation: Use of the ice-retardant additive will improve safety by providing continuous deicing at selected high frequency snow and ice related accident locations.

Project Number: HR-291

Project Title: Performance of Nongrouted Thin, Bonded PCC Overlays

Agency: Iowa Concrete Paving Association, Monroe County and the Iowa Department of Transportation, Highway Division

Principal Investigators: Wapello County Engineer, currently Wendell Folkerts; Iowa Concrete Paving Association Construction Engineer, currently Gordon Smith; and the DOT Portland Cement Concrete Engineer, currently Jim Grove.

Research Period: March 1, 1986 to October 1, 1990

Research Board Funding: $14,200

Funding Source: 100 percent State Funds--Farm-to-Market funds

Objective: To evaluate the performance of the nongrouted sections of a thin, bonded PCC overlay in Monroe and Wapello Counties.

Progress: A contract has been initiated with the Iowa Concrete Paving Association. Road Rater testing was conducted to determine the structural rating. Two series of cores were obtained and tested for bond shear strength.

Reports: Construction Report, August 1986

Implementation: PCC bonded overlays are currently bonded to the existing surface by placing a thin film of sand-cement grout ahead of the paving operation. If adequate bond without grout can be achieved for the overlay, approximately $1.00 per square yard of overlay could be saved.

Project Number: HR-292

Project Title: Field Evaluation of Integral Abutment Bridges

Agency: Iowa State University

Principal Investigator: Darrel D. Girton

Research Period: March 1, 1986 to June 30, 1989

Research Board Funding: $167,905

Funding Source: 100 percent State funds--50 percent Primary, 50 percent Farm-to-Market

Objective: To determine expansion or contraction of integral abutment bridges as related to air and deck temperatures; to measure the effects of abutment movement on stresses in the bridge; to develop guidelines that will permit safe design of longer integral abutment bridges.

Progress: Methods and needed equipment for evaluation of integral abutment bridges have been developed. Two integral abutment bridges have been selected for field evaluation during substantial temperature variations. Field testing is underway.

Reports: Task 1 Report, September 1986

Implementation: This research will allow longer bridges without expansion assemblies which will result in substantial savings due to longer maintenance free bridge life.

Project Number: HR-293

Project Title: Pavement Instrumentation

Agency: Iowa Department of Transportation, Highway Division, Iowa State University, Federal Highway Administration

Principal Investigator: Roman Dankbar

Research Period: May 1, 1986 to May 1, 1989

Research Board Funding: $75,000

Funding Sources: 100 percent State--Primary Funds (Matched by $113,000 FHWA Funds)

Objective: To evaluate the magnitude and frequency of dynamic loads applied to the pavement as related to the static loads used in pavement design and the demonstration of instrumentation for evaluation of pavement design and performance.

Progress: A contract has been executed with Iowa State University for their participation. A review has been conducted to identify the most effective current technology in evaluation instrumentation. Five tubes were placed, evenly spaced, in the subbase crossing the westbound lane of I-80 in Pottawattamie County. Nuclear instruments are pulled through the tubes at set time intervals to get recordings of moisture content and density of the subbase. Some 120 instruments have been installed in a 40 ft. segment of reconstructed pavement.

Reports: Interim Report, March 1988

Implementation: Improved design data from long term monitoring instrumentation will extend pavement life and will make possible the selection of the most economical design.

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agencies: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to July 1991

Research Board Funding: $80,175

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: To evaluate construction and service performance of ammonium phosphate fly ash treated base courses of limestone aggregate and unprocessed sand.

Progress: A 1.8 mile section of R-63 north of its intersection with E-29 in Story County was selected for the project. Construction of the project was completed in September 1986. Two mixes, two thicknesses and two wearing courses are being tested.

Reports: Construction Report, April 1987

Implementation: Trace chemicals have the ability to increase the strength of fly ash dramatically and to affect its set time. The inexpensive modification of Iowa fly ashes can increase the economic benefit of fly ash for many highway related uses.

Project Number: HR-295

Project Title: Field Measurement of Bridges for Long Term Structural Movement

Agency: Iowa State University

Principal Investigator: Terry J. Wipf

Research Period: June 1, 1986 to December 31, 1987

Research Board Funding: $114,606

Funding Source: 100 percent State--Primary Funds

Objective: To design a data acquisition system for tilt sensing equipment and to monitor pier movement on two bridges and to assess effects of the movements on the entire structure.

Progress: Tilt Sensor Systems have been attached to the Karl King Bridge over the Des Moines River in Fort Dodge and on a pier of the Mississippi River bridge at Lansing. Data is being collected. The tilt sensors are showing movements that appear to be related to temperature.

Reports: None

Implementation: An effective system of monitoring long term movement of structures will reduce the potential of serious failure and emergency closure of critical river crossings.

Project Number: HR-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1988

Research Board Funding: $52,083

Funding Source: 100 percent State Funds--33 percent Primary, 67 percent Farm-to-Market

Objective: To promote research, encourage implementation and distribute research data.

Progress: The major tasks are:

1. publishing at least four newsletters per year
2. conducting at least 10 training courses per year
3. distribute publications
4. provide service and information to users

Reports: Newsletters

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.

Project Number: HR-297

Project Title: Development of an Economic Dust Palliative for Limestone Surfaced Secondary Roads

Agency: Iowa State University and the Iowa Department of Transportation, Highway Division

Principal Investigators: Kenneth Burgeson and Turgut Demirel

Research Period: December 1, 1986 to November 30, 1988

Research Board Funding: $71,440

Funding Source: 100 percent State Farm-to-Market Funds

Objective: To identify a cost-effective dust palliative for use on limestone surfaced secondary roads in competition with or as an alternate to sodium chloride or calcium chloride.

Progress: Bentonite treated limestone samples show potential as an economical and effective dust palliative. Testing will continue to determine the optimum bentonite concentration, followed by field testing.

Reports: Progress Report, Task II, February 1988

Implementation: Finding a low cost dust palliative to treat Iowa's 70,000 miles of limestone surfaced roads can save the counties a substantial amount of money each year.

Project Number: HR-298

Project Title: Correlation of Locally-Based Performance of Asphalts With Their Physicochemical Parameters

Agency: Iowa State University

Principal Investigator: Dah-Yinn Lee

Research Period: January 26, 1987 to May 31, 1989

Research Board Funding: $142,785

Funding Source: 100 percent State funds - 50% Primary, 50% Farm-to-Market

Objective: To establish test criteria and specifications for asphalts based on simple physicochemical methods.

Progress: A contract for conduct of the research has been executed. The High Pressure Liquid Chromatography (HPLC) equipment has been obtained. Twelve asphalt samples and 6 core samples have been obtained from a variety of sources and have been tested.

Reports: Task I Report, January 1988

Implementation: The ability to identify those asphalts which would not crack in the highway would effect significant savings of highway maintenance funds.

Project Number: HR-299

Project Title: Control of Concrete Deterioration Due to Trace Compounds in Deicers

Agency: Iowa State University

Principal Investigator: John Pitt

Research Period: April 1, 1987 to December 31, 1988

Research Board Funding: $74,610

Funding Source: 100 percent State funds--75 percent Primary, 25 percent Farm-to-Market

Objective: To:

1. Characterize deicing salts used in Iowa.
2. Determine how deicer induced concrete deterioration is influenced by field factors.
3. Define the deterioration mechanism

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates is in progress.

Reports: Progress Report, June 1988

Implementation: The research will identify compounds which cause the deterioration and support changes in specifications to reduce the amount or eliminate these compounds from deicing salts. This will extend pavement life and reduce maintenance.

Project Number: HR-300

Project Title: Iowa Development of Roller Compacted Concrete

Agency: Highway Division, Iowa Dept. of Transportation and Manatt's, Inc.

Principal Investigators: O. J. Lane and Mark Callahan

Research Period: April 13, 1987 to December 31, 1988

Research Board Funding: $25,122

Funding Source: 100 percent State funds--10 percent Primary, 90 percent Farm-to-Market

Objective: To investigate the performance of a roller compacted concrete test section subjected to continuous loading by a legally loaded truck.

Progress: Manatt's, Inc. of Brooklyn, Iowa, agreed to construct an RCC test section in its Ames facility yard. The slab was placed and loaded in April 1987. The section will be monitored for nine months.

Reports: None

Implementation: Roller compacted concrete is a zero slump portland cement concrete mixture that is spread with asphalt concrete equipment. Because of the ease and simplicity of RCC pavement construction, savings of up to one third the cost of portland cement concrete pavement construction are possible.

Project Number: HR-302

Project Title: Alternate Methods of Bridge Strengthening

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber, Kenneth F. Dunker, and Terry J. Wipf

Research Period: June 8, 1987 to September 30, 1988

Research Board Funding: $129,980

Funding Source: 100 percent State Funds, 50 percent Primary, 50 percent Farm-to-Market

Objective: To determine the feasibility of strengthening stringer bridges by the addition of partial end restraint, to determine the most efficient location of end restraint brackets, and the effect of end restraint on the supporting substructure unit.

Progress: The project has been primarily aimed at two methods of strengthening. These two methods are providing partial end restraint and post-compression of stringers. Laboratory testing of these methods is in progress.

Reports: Progress Report, January 1988

Implementation: Alternate methods will be available for strengthening bridges which are structurally deficient according to current standards.

Project Number: HR-303

Project Title: Field Evaluation of Cold In-Place Recycling of Asphalt Concrete

Agency: Tama County

Principal Investigators: Robert Gumbert and Richard Mumm

Research Period: June 1, 1987 to June 1, 1994

Research Board Funding: $100,000

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: To identify an effective, affordable method of widening an existing 18 feet wide pavement (AC resurfacing over PCC) to provide a 24 feet wide finished surface capable of carrying traffic satisfactorily.

Progress: The plans have been developed. Construction is planned for the spring of 1989.

Reports: None

Implementation: A successful cold in-place recycling will provide a cost effective method of rehabilitating older resurfaced roadways. This will provide improved safety.

Project Number: HR-304

Project Title: Production of Acetic Acid for CMA Deicer

Agency: University of Iowa

Principal Investigator: Paul L. Peterschmidt

Research Period: June 1, 1987 to June 30, 1988

Research Board Funding: $16,852

Funding Source: 100 percent State Funds--90% Primary, 10% Farm-to-Market

Objective: To find the optimum method of producing acetic acid from corn for the production of CMA deicer

Progress: The research identified three by-products of corn wet milling as potential inexpensive food stocks to produce acetic acid. The most promising bacteria identified were acetobacterium woodii, acetobacterium carbinolicum and acetogenium kivui.

Reports: Final report, May 1988

Implementation: The potential of CMA deicer is tied directly to finding an economical method of producing acetic acid.

Project Number: HR-305

Project Title: Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa

Agency: Iowa State University

Principal Investigator: Eugene Takle

Research Period: July 6, 1987 to June 30, 1989

Research Board Funding: $93,084

Funding Source: 100 percent State--Primary Funds

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of meteorologcial data, frost-occurrence data, numerical modeling and operational experience, achieved by combining standard analysis methods with a tool from the general area of artificial intelligence known as an expert system.

Progress: A contract has been executed for the conduct of the research. A questionnaire has been completed.

Reports: Summary of questionnaire

Implementation: The development of a system which would improved the reliability of frost predictions would lead to improvements in road safety and reduce costs of manpower and deicing materials spent on false alarms.

Project Number: HR-306

Project Title: Investigation of Uplift Failures in Flexible Pipe Culverts

Agency: Iowa State University

Principal Investigators: T. Al Austin, F. Wayne Klaiber, and Robert A. Lohnes

Research Period: January 1, 1988 to June 30, 1989

Research Board Funding: $110,415

Funding Source: 100 percent State--10% Primary, 90% Secondary

Objective: A number of large CMP culverts have failed in Iowa in recent years. The objective of the proposed research is to analyze the forces to which large CMP culverts are subjected. Once this is accomplished, new culvert tie down designs can be developed to prevent future culvert failures.

Progress: Field trips to culvert failure locations have been made to study the causes of the failures. Also, a computer program has been developed to aid in analyzing appropriate tie down guidelines based on worst case scenerios of forces acting on culverts.

Reports: None

Implementation: Proper tie down designs is essential in preventing CMP culvert floatation failures. New design guides for retrofitting existing culverts and anchoring new culverts will prevent future failures.

Project Number: HR-307

Project Title: Sediment Control in Bridge Waterways

Agency: University of Iowa

Principal Investigator: A. Jacob Odgaard

Research Period: January 15, 1988 to March 31, 1989

Research Board Funding: $35,000

Funding Source: 100 percent State--10% Primary, 90% Secondary

Objective: To develop guidelines for the application of the vane technique for sediment control at bridge waterways. The guidelines will make the technique readily applicable to engineers charged with the construction and maintenance of river crossings.

Progress: A contract for conduct of the research has been executed.

Reports: None

Implementation: Proper placement of water vanes will redirect water flow under the center spans of bridges, thereby preventing sedimentation from restricting proper water flow.

Project Number: HR-308

Project Title: Strengthening of an Existing Continuous Span Steel Beam-Concrete Deck Bridge by Post-Tensioning

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber and Kenneth F. Dunker

Research Period: February 1, 1988 to October 31, 1989

Research Board Funding: $142,435

Funding Source: 100 percent State funds--34% Primary, 66% Farm-to-Market

Objective: The objective is to design and install a post-tensioning strengthening system on a continuous span, steel beam-concrete bridge deck instrument the bridge for determination of deflections and strains, and document the bridges behavior.

Progress: A contract has been executed and research is underway.

Reports: None

Implementation: Strengthening of existing continuous span, steel beam-concrete deck bridges could restore load carrying capacity, reduce the number of bridges requiring posting or increase the limits for maximum traffic weights.

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

Agency: Linn County and the Iowa Department of Transportation, Highway Division

Principal Investigator: Jerry Nelson, James M. Hoover, and Mark Callahan

Research Period: May 20, 1988 to January 31, 1994

Research Board Funding: $78,760

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: The objective of project HR-309 is to construct an experimental base using several variations of a waste limestone screenings/emulsion mix. Residual asphalt contents of 2.5%, 3.5%, and 4.5% will be used on test sections of 4 inch and 6 inch compacted thicknesses. A control section of 6 inches of untreated limestone screenings will be included for comparative purposes.

Progress: Project plans have been developed and a contract awarded. Construction is scheduled to begin the first week of August 1988.

Reports: None

Implementation: Finding useful ways of incorporating waste aggregate into construction of lower level roads will ease the burden of disposal for contractors and reduce the cost of construction for counties.

Project Number: HR-310

Project Title: Precast, Prestressed Concrete Panel Subdecks in Skewed Bridges

Agency: Iowa State University

Principal Investigator: Dr. Robert E. Abendroth

Research Period: June 1, 1988 to November 30, 1989

Research Board Funding: $96,088

Funding Source: 100 percent State--30% Primary, 70% Farm-to-Market Funds

Objective: The objective is to determine the behavior of precast, prestressed concrete panels used as permanent forms for reinforced concrete bridges at abutment or pier diaphragm locations

Progress: A contract has been signed with Iowa State University to conduct the research. A literature review is under way.

Reports: None

Implementation: This research will reduce the potential for cracking near skewed piers and abutments and extend the maintenance-free life of these bridge decks.

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: June 15, 1988 to December 31, 1990

Research Board Funding: $25,000

Funding Source: 100 percent State--Primary Funds

Objective: The objective of this research is to determine if a correlation exists between creep and/or resilient modulus testing and field performance.

Progress: Construction of a creep testing device that will test three specimen simultaneously is nearing completion. A Retsina Mark VI resilient modulus apparatus has been ordered. Four and six inch diameter cores are being obtained from asphalt concrete pavements that exhibit substantial rutting and some with negligable rutting.

Reports: None

Implementation: The improved testing methods will enable more accurate prediction of performance of asphalt concrete mix designs and thereby reduce rutting of asphalt concrete pavements.

Project Number: HR-312

Project Title: Low Cost Techniques of Base Stabilization in Dubuque County

Agency: Dubuque County and the Iowa Department of Transportation, Highway Division

Principal Investigator: Mark C. Jobgen and Mark Callahan

Research Period: August 22, 1988 to December 31, 1993

Research Board Funding: $93,913

Funding Source: 100 percent State--Farm-to-Market Funds

Objective: To evaluate four base stabilization techniques and determine which, if any, will provide enough strength to carry local heavy vehicle loads.

Progress: A contract has been signed with Dubuque County to perform the work. Work is scheduled to begin in early fall, 1988.

Reports: None

Implementation: If an inexpensive base stabilization technique can be developed, a significant number of secondary roads could be improved without requiring asphalt or portland cement concrete paving.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Mark Callahan

Research Period: March 5, 1980 to present

Research Board Funding: $32,500.00/yr.

Funding Source: 100 percent State--Farm-to-Market funds

Objective: To maintain research liaison with all county engineers and solicit new, innovative and progressive ideas; to actively promote secondary research for solutions to problems and ideas that will improve quality and reduce costs.

Progress: Mark Callahan has visited with many county engineers to discuss problems being encountered by the secondary road departments and to discuss present research projects during the year. At present, there are 10 active research projects that involve experimental construction by counties. The coordinator assists these counties with special testing, evaluation, and writing of construction and final reports necessary to the research.

Reports: None

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