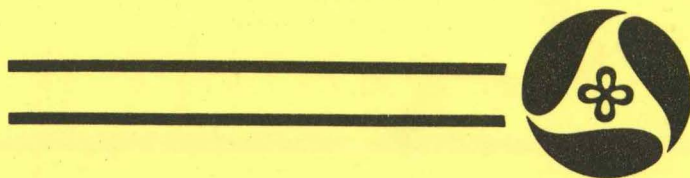


FEB 6 1987

TE
192
.M37
1985/86

Annual Report of Highway Research and Development in Iowa

STATE LIBRARY OF IOWA Highway Division
Historical Building Office of Materials
DES MOINES, IOWA 50319 December 1986



**Iowa Department
of Transportation**

ANNUAL REPORT
OF
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1986

OFFICE OF MATERIALS
(515)239-1447

HIGHWAY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

DECEMBER 1986

STATE LIBRARY OF IOWA
17 T772HD 1 yr. 1985/86 sdoc
/Annual report of highway research and d



3 1723 00038 0832

TABLE OF CONTENTS

	Page
Research and Development.....	1
Iowa Highway Research Board.....	1
Table I - Iowa Highway Research Board Members.....	2
Research and Development Projects.....	3
In-House Research and Development.....	3
National Cooperative Highway Research Program.....	3
Secondary Road Traffic Count Program.....	4
Secondary Road Research Fund.....	4
Primary Road Research Fund.....	5
Table II - Financial Summary of Research and Development Projects	6
Research Project Descriptions.....	8

RESEARCH AND DEVELOPMENT

The Highway Division of the Iowa Department of Transportation 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, "Highway Research and Development in Iowa", is submitted in compliance with Section 310.36, Code of Iowa, which directs the submission of a report of the Secondary Road Research Fund. It is a report of the status of research and development projects which were in progress on June 30, 1986; it is also a report on projects completed during the fiscal year beginning July 1, 1985, and ending June 30, 1986. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials, Highway Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established in 1949 by the Iowa State Highway Commission to respond to the research denoted in Section 310.36 of the Code of Iowa.

The Research Board consists of 13 regular members; six county engineers, three DOT Highway Division 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 by the Iowa Department of Transportation Highway Division Director for a three-year term. The membership of the Research Board as of June 30, 1986, is listed in Table I.

The Research Board held seven regular meetings during the period of July 1, 1985 to June 30, 1986. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

TABLE 1

1986 IOWA HIGHWAY RESEARCH BOARD

Member	Term Expires	Alternate
Steven W. Akes Guthrie County Engineer 200 N. 5th Street Guthrie Center, IA 50115 (515) 747-2274 SS#-039	12-31-87	Dale E. Miller Fremont County Engineer R.R. 2, Box 19 Sidney, IA 51652 (712) 374-2886 SS#-036
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
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
George Calvert Director of Operations Research 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
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 Gumbert Tama County Engineer 101 S. Main Toledo, IA 52342 (515) 484-3341 SS#-086	12-31-87	Royce J. Fichtner Marshall County Engineer Courthouse Marshalltown, IA 50158 (515) 754-6343 SS#-064
Robert Haylock Butler County Engineer Courthouse Allison, IA 50602 (319) 267-2630 SS#-012	12-31-86	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) 353-6603	12-31-87	Jerald L. Schnoor Dept. of Civil & Envir. Engr. University of Iowa Iowa City, IA 52242 (319) 353-7262
Raymond L. Holland City Engineer Bettendorf, IA 52722 (319) 359-0347	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
Wm. Jay Schreiner City Engineer 211 S.W. Walnut Ankeny, IA 50021 (515) 964-5500	12-31-87	Richard Ransom City Engineer City Hall Cedar Rapids, IA 52401 (319) 398-5026
Robert Simmering Muscatine County Engineer 3610 Park Avenue W. Muscatine, IA 52761 (319) 263-6351 SS#-070	12-31-86	Milton L. Johnson Wapello County Engineer 501 S. Union Street Ottumwa, IA 52501 (515) 684-5425 ex. 147 SS#-090
Van R. Snyder District 4 Engineer Iowa DOT - Highway Division Atlantic, IA 50022 (712) 243-3355 SS#-240	12-31-87	James R. Bump District 3 Engineer Iowa DOT - Highway Division Sioux City, IA 51102 (712) 276-1451 SS#-230

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, 1986. Total expenditure was \$826,347.06, including support of the National Cooperative Highway Research Program.

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.

Table II con't.)

277	92,210.00	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflection Cracking			
278	89,700.00	Beneficial Effects of Selected Additives on Asphalt Cement	11,025.92	7,510.12	18,536.04
279	76,175	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflective Cracking			
280	300,000	An Engineering Study to Update the Box Culvert Standards			
281	35,000	Effects of Pavement Surface Texture on Noise and Frictional Characteristics			
282	295,000	A Low Cost Automatic Weight and Classification System	3,310.55		3,310.55
283	15,000	Pavement Texturing by Milling	14,644.67		14,644.67
284	50,790	Development of Multiplan Microcomputer Spreadsheets for County Hydraulic and Highway Engineering Computations		10,602.79	10,602.79
285	91,950	Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods	21,250.00		21,250.00
286	174,200	Development of a Rational Characterization Method for Iowa Fly Ash	3,227.08	6,664.15	9,891.23
287	87,430	Strengthening of Existing Continuous Composite Bridges	4,702.41	7,071.93	11,774.34
288	39,750	Field Evaluation of Bonded Concrete Resurfacing	25,684.24		25,684.24
289	12,800	Engineering Study - Training Aids to Reduce Potential County Liability			
290	25,200	Ice Retardant Pavement	22,420.00		22,420.00
291	14,200	Performance of Nongrouted Thin, Bonded PCC Overlays		2,261.94	2,261.94
292	19,350	Field Evaluation of Integral Abutment Bridges			
293	150,000	Pavement Instrumentation			
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction			
1027	32,500.00/yr.	Secondary Road Research Coordinator		27,860.50	27,860.50
		Contract Research Sub-Total	\$309,904.97	\$336,901.94	\$646,806.91
HPR-2 (121)		NCHRP pooled fund project for National Program for Skid Test and Calibration Centers	10,040.25	1,502.80	11,543.05
HPR-2 (127)		NCHRP pooled fund project for Cost Effective Geometric Design Standards for RRR Projects	1,514.20	231.22	1,745.42
HPR-4 (183)		NCHRP FY83 General Project Funding	9,854.87	1,188.33	11,043.20
HPR-4 (184)		NCHRP FY84 General Project Funding	35,414.02	4,114.09	39,528.11
HPR-4 (185)		NCHRP FY85 General Project Funding	17,284.48	2,090.56	19,375.04
HPR-PR-PL-1 (21)		FY 1985 Planning & Research Program (Transportation Inventory Engineering Studies)		96,305.33	96,305.33
		Noncontract Engineering Studies Sub-Total	\$ 74,107.82	\$105,432.33	\$179,540.15
		Grand Total of Expenditures	\$384,012.79	\$442,334.27	\$826,347.06

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is one of four programs included in the Contingency Programs Fund from 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. There is no balance carried forward to the next fiscal year and uncommitted funds remain in the Primary Road Fund. The amount committed to contract research from the Primary Road Research Fund for FY86 was \$385,000 and the estimate for FY87 is \$600,000.

Project Number: HR-140

Project Title: Collection and Analysis of Stream Flow Data

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

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

Research Period: Project continued to September 30, 1986

Research Funding: \$85,625 per year (matched by \$85,625 from the Department of the Interior)

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

Iowa DOT Project Control: Mark F. Looschen, 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 1985-1986 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 Funding: \$150,000

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 now been reopened 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-198

Project Title: Preliminary Archaeological Investigation Along Proposed Highway Right of Way

Agency: State Archaeologist (University of Iowa)

Principal Investigator: D. Anderson, State Archaeologist

Research Period: July 1, 1977, to June 30, 1987

Research Funding: \$75,000 (Revolving Fund)

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

Objective: To determine well in advance of highway construction if proposed planning corridors contain known or probable sites of archaeological value; to locate such sites and describe their limits as accurately as possible without resorting to excavation or other detailed examination.

Progress: The Iowa Department of Transportation contracts with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary reports. Secondary road construction sites with archaeological value are being examined in advance of construction. Under a new Iowa DOT policy, a revolving fund has been established within the Secondary Road Research Fund to initially pay for the services of a survey contractor. Billings are then made to the counties and cities for their proportionate share of costs incurred. The program has been very effective in facilitating archaeological investigations of local system projects.

Reports: Annual reports are completed, giving a county-by-county summary of archaeological survey activities.

Implementation: The project will be beneficial because counties will know what type of projects should be reviewed and the reviews can be conducted in a more timely manner.

Project Number: HR-205

Project Title: Effects of Special Aggregate on Bridge Deck Overlay Frictional Properties

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Research Period: December 14, 1978, to March 31, 1986

Research Funding: \$3,150

Funding Source: 100 percent State--Primary funds

Objective: To evaluate the benefit of incorporating a hard, durable aggregate in a dense pc concrete bridge deck overlay to provide frictional property longevity.

Progress: Special coarse aggregate was used in two bridge deck overlay projects on Interstate 35 near Ankeny. Resurfacing of the bridge decks was completed in the summer of 1979. The use of special aggregates resulted in a more consistent mix with improved workability and greater ease of finishing and texturing. Friction testing is being conducted on the bridges on a regular basis.

Reports: Friction Testing Summary

Implementation: Hard, durable aggregates will help to provide improved frictional property longevity in bridge deck overlays.

Project Number: HR-208A

Project Title: Evaluation of Control Structures for Stabilizing Degrading Stream Channels in Western Iowa

Agency: Iowa State University

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

Research Period: December 1, 1980, to September 30, 1985

Research Funding: \$137,725

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

Objective: To design and install several types of grade stabilization control structures in at least two streams in western Iowa, instrument them, and scientifically document their effectiveness.

Progress: Six demonstration sites, three in Shelby County and three in Pottawattamie County, were selected for initial field installation and operational studies. Preliminary designs for the control structures were completed. The designs included three vertical sheet-pile structures, two soil-cement structures, and one pre-cast concrete structure. Hydraulic and structural analyses of the proposed structures were performed. One structure in Pottawattamie County, originally designed as a sheet-pile structure, was changed to a gabion structure and was completed in 1983.

Reports: Final Report, July 1985

Implementation: Bridge structures are expensive to construct and maintain. If more economical methods of grade stabilization can be developed, it will result in shorter bridges and save millions of dollars for counties in western Iowa.

Project Number: HR-213

Project Title: Improved Asphalt Surfaces and Asphalt Resurfacing Performance Through Crack Maintenance

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Dwight Rorholm

Research Period: November 12, 1979, to March 31, 1987

Research Funding: \$13,550

Funding Source: 100 percent State--Primary funds

Objective: To provide better asphalt roadways through evaluation of various combinations of cleaning and crack preparation, and to identify the most effective maintenance procedure and the most effective preparation in providing improved resurfacing performance.

Progress: A Vanguard 2000 PSI waterblaster was purchased from a Des Moines distributor. This high-pressure washer was used extensively for joint and crack maintenance on various primary and interstate highways. An experimental section was established on Iowa 7 west of Fort Dodge.

Reports: Progress Report, October 1983

Implementation: Better methods of joint and crack maintenance will result in improved riding qualities and may permit the use of thinner overlays on asphalt roadways.

Project Number: HR-215

Project Title: Improvement of Longitudinal Joints in Asphalt Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. W. Monroe

Research Period: March 5, 1980, to January 31, 1987

Research Funding: \$10,700

Funding Source: 100 percent State--Primary funds

Objective: To identify construction procedures that will provide an improved longitudinal centerline joint.

Progress: Asphalt widening and resurfacing were completed on Iowa 44 in Guthrie and Dallas counties in August 1980. Repetitive sections of seven different treatments of the longitudinal joint were included in the project. Core samples to determine densities were taken that fall. Visual observations are made annually. A graph of % of longitudinal cracking versus age is being maintained for each treatment.

Reports: Construction Report, February 1981

Implementation: Improved methods for construction of longitudinal joints will result in increased life of asphalt resurfacing by reducing joint deterioration.

Project Number: HR-220

Project Title: Protection of Structural Concrete Substructures

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: John Risch

Research Period: May 1980, to July 15, 1989

Research Funding: \$8,000

Funding Source: 100 percent State--Primary funds

Objective: To field test the long-term effectiveness of several available products or procedures for their ability to protect concrete surfaces against the intrusion of chloride ions.

Progress: A substantial number of cores were drilled from bridge pier columns on I-235 in Des Moines and I-380 in Cedar Rapids to determine the chloride contamination. Relatively new pier columns of two bridges over I-380 in Cedar Rapids were selected for treatment to prevent chloride intrusion. A number of commercially available waterproofing products were used, with varying application rates and surface preparation methods, to determine their potential for preventing chloride intrusion. Cores are being taken periodically to monitor the chloride content of the pier column concrete. Chloride intrusion into these columns which are farther from the roadway is at a slower rate than anticipated. This requires a longer research period.

Reports: Progress Report, December 1984

Implementation: A protective system will prevent the intrusion of chlorides into structural concrete and will help to prevent the need for repairs which are both difficult and expensive.

Project Number: HR-222

Project Title: Retardation of Reflection Cracking Using Stabilizing Additive 5990

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Roderick Monroe

Research Period: July 1, 1980, to February 28, 1987

Research Funding: \$17,500

Funding Source: 100 percent State--Primary funds

Objective: To evaluate the use of Stabilizing Additive 5990 (a mixed polymer in granular form) as a method of reducing cracking in asphaltic concrete overlays.

Progress: A crack survey was made of the existing portland cement concrete prior to construction. The asphaltic concrete resurfacing has been laid. Sections with varying percentages of stabilizing Additive 5990 in the asphalt concrete mixture were incorporated into the project. Periodic crack surveys have been made. A substantial amount of the joints and cracks have reflected through the surface.

Reports: None

Implementation: Any product or method that will prevent reflection cracking will save maintenance funds spent for crack sealing.

Project Number: HR-224

Project Title: Restoration of Frictional Characteristics on Older PCC Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Research Period: July 1, 1980 to June 30, 1986

Research Funding: \$8,000

Funding Source: 100 percent State--Primary funds

Objective: To identify a cost-effective method of restoring the friction characteristics on older pcc pavement.

Progress: Three experimental applications of systems to improve the texture of pcc have been applied to older pavement. Transverse grooving was cut into a northbound lane of I-29 at the north edge of Council Bluffs adjacent to a longitudinal grooving safety enhancement project in July 1980. A very thin lift (about 1/2 inch) of hot sand asphalt was placed on I-80/I-35 at the north edge of Des Moines in September 1980. A small patch (4' x 4') of latex modified concrete surface dressing was placed on northbound I-35 just south of Ames to determine its durability. Friction testing of the grooving and hot sand asphalt was conducted annually.

Reports: Final Report, June 1986.

Implementation: A cost-effective method of restoration of pcc friction properties will yield substantial savings.

Project Number: HR-229

Project Title: Alternative Flexible Overlays

Agency: Osceola County and Iowa Department of Transportation, Highway Division

Principal Investigators: Rolly Glasgow, and Clyde Leonard

Research Period: March 1981, to October 1987

Research Funding: \$130,000

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

Objective: To construct and evaluate several bituminous concrete base overlays which have the potential to reduce future maintenance and construction costs.

Progress: Eight different test sections of cold-laid bituminous overlays were constructed in September 1981 on Osceola County Roads A-34 and A-46. Aggregate for four of the test sections consisted of salvaged asphalt pavement and new aggregate combined. The other four test sections contained only new aggregate. Four types of asphalt binder were mixed with each aggregate to develop the eight test sections. A seal coat has been placed on all test sections to provide a wearing surface. Evaluation will continue for six years.

Reports: Construction Report, February 1983

Implementation: Identification of a surface which is less prone to transverse cracking will result in a substantial savings due to increased life and reduced maintenance of asphalt concrete pavements.

Project Number: HR-231

Project Title: Special Surface Preparation Prior to Bituminous Overlay

Agency: Cerro Gordo County and Iowa Department of Transportation, Highway Division

Principal Investigator: Warren Davison

Research Period: May 1981, to April 1987

Research Funding: \$45,340

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

Objective: To identify an effective crack sealing procedure which will extend the service life of a roadway and lower maintenance costs.

Progress: Four crack sealing methods were done in May 1982, on Cerro Gordo County Road S-25. The crack filling materials were standard emulsion sealer, rubberized asphalt sealer, pressure-injected fly ash-cement slurry and pressure-injected limestone-emulsion slurry. Three test sections were formed by repeating the four crack sealing procedures along the length of the project. Overlays for the three sections were 2" of Type "B" asphalt cement concrete, 1 1/2 of Type "B" asphalt cement concrete, and a limestone-emulsion slurry seal. Crack sealing with the limestone-emulsion slurry injection was discontinued after several unsuccessful attempts at mixing the material. Evaluation will continue for a five-year period.

Reports: Construction Report, January 1983

Implementation: A procedure of properly sealing transverse cracks prior to a bituminous overlay should extend the life of the overlay, reduce maintenance costs, and improve the ride quality of the roadway.

Project Number: HR-233

Project Title: Field Demonstration and Evaluation of Foamed Asphalt

Agency: Iowa State University.

Principal Investigator: D. Y. Lee

Research Period: May 1, 1981, to September 30, 1985

Research Funding: \$40,232.88

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

Objective: To evaluate the performance of foamed asphalt mixes using local materials as base and surface courses; to correlate field strength characteristics and performances of foamed mixes with laboratory strength characteristics and performances; and to develop specifications and evaluate construction procedures and inspection tests.

Progress: Iowa State University conducted laboratory evaluation of foamed asphalt with various aggregate and soil-aggregate mixtures. Preliminary evaluation was conducted for a Shelby County project. It was determined that additional aggregate was necessary in a Shelby County soil-aggregate roadbed material to achieve a satisfactory foamed mix. Funds for the additional aggregate were not available and the Shelby County project was dropped. A Muscatine County foamed asphalt project (HR-257) utilizing 3/8" minus limestone tailings and pit run sand is being evaluated. Nine different test sections were constructed on 4.2 miles of county road A-91 in 1983.

Reports: Final Report, July 1985

Implementation: Foamed asphalt offers potential for energy conservation and the utilization of marginal locally available aggregates.

Project Number: HR-234

Project Title: Compilation of Iowa Highway Laws

Agency: Iowa Department of Transportation, Office of General Counsel

Principal Investigators: L. Paff

Research Period: April 1, 1985 to January 1, 1986

Research Funding: \$6,268

Funding Source: 100 percent State funds--40 percent Primary, 60 percent Farm-to-Market

Objective: To provide a current annotated Iowa Transportation Law manual.

Progress: Two law clerks were retained on a temporary basis to search out the laws and pertinent court cases and produce an "Iowa Transportation Laws (Annotated)" manual in 1982. To keep the manual current, a law clerk has been retained during the summer of 1985 to make changes and updates. The summary has been compiled in a manner to allow for periodic updating.

Reports: The compilation was updated June 1985

Implementation: With this handy reference to ascertain applicable laws and decisions, transportation engineers will avoid oversight that may result in costly legal claims.

Project Number: HR-236

Project Title: Pottawattamie County Evaluation of Control Structures for Stabilizing Degrading Stream Channels

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

Principal Investigators: Charles Hales, Robert Lohnes, Fred Klaiber and Tom Austin

Research Period: July 10, 1981, to June 1, 1987

Research Funding: \$88,143

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

Objective: To design and construct three types of grade stabilization control structures for Keg Creek, instrument them, and scientifically document their effectiveness.

Progress: Preliminary designs for the control structures have been completed. The designs include a vertical sheet-pile structure, a soil-cement structure, and a pre-cast concrete structure. Hydraulic and structural analyses of the proposed structures have been completed. Because of higher than anticipated construction costs and difficulty in obtaining additional funds, only one structure has been built. The structure, originally designed as a sheet-pile structure, was changed to a gabion structure and completed in 1983.

Reports: Construction Report, January 1985

Implementation: Bridge structures are expensive to construct and maintain. If more economical methods of grade stabilization can be developed, it will result in shorter bridges and savings of millions of dollars for counties in western Iowa.

Project Number: HR-237

Project Title: Shelby County Evaluation of Control Structures for Stabilizing Degrading Stream Channels

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

Principal Investigators: Eldo Schornhorst, Robert Lohnes, Fred Klaiber and Tom Austin

Research Period: July 10, 1981, to June 1, 1987

Research Funding: \$87,065

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

Objective: To design and construct three types of grade stabilization control structures for two creeks in Shelby County, instrument them, and scientifically document their effectiveness.

Progress: Preliminary designs for the control structures have been completed. The designs include two vertical sheet-pile structures and a soil-cement structure. Hydraulic and structural analyses of the proposed structures were completed. One structure was designed and carried to a letting but no bids were received. A sheet-pile structure is currently being designed for construction during 1987. A proposal to extend the research period to include this construction will be made in the near future.

Reports: None

Implementation: Bridge structures are expensive to construct and maintain. If more economical methods of grade stabilization can be developed, it will result in shorter bridges and savings of millions of dollars for counties in western Iowa.

Project Number: HR-238

Project Title: Strengthening Existing Single Span Steel Beam Concrete Deck Bridges

Agency: Iowa State University

Principal Investigator: F. W. Klaiber

Research Period: July 1, 1981, to March 31, 1985

Research Funding: \$162,898

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

Objective: To design and install post-tensioning strengthening on two single span steel beam concrete deck bridges, instrument them, and document their performance over a period of two years following post-tensioning.

Progress: A bridge on a Farm-to-Market road in Dickinson County and a bridge on Iowa 144 in Greene County have been post-tensioned. Strain measurements were determined under a heavily loaded truck after post-tensioning.

Reports: Final Report - Part I, February 1983, Part II and Part III, March 1985

Implementation: Bridges that do not meet current standards for live load carrying capacity could have the capacity restored, causing posted limits to be raised or removed. In some cases, bridges which have been restricted to one-lane traffic could have the restriction removed.

Project Number: HR-242

Project Title: Economics of Alternative Solutions to the Secondary Road Problem*

Agency: Iowa State University and Linn County

Principal Investigator: Phillip Baumel

Research Period: July 1, 1982 to July 31, 1987

Research Funding: \$296,305.50

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

Objective: To estimate the benefits and costs of alternative investment strategies in solving the rural road and bridge problem.

Progress: An advisory board of county engineers was established and three counties were selected to evaluate the cost-benefit investment strategies. Surveys were conducted in Shelby, Hamilton and Linn Counties. Data have been analyzed and costs for various vehicles have been established. A User's Manual has been developed which permits computer modeling of traffic on a road system to determine benefit-cost ratios of abandoning selected road segments from the system.

Reports: Final Report, December 1985, User's Manual, January 1986.

Implementation: A procedure will be developed that will allow county governments to best utilize limited funding in maintaining necessary roadways in a cost-effective program.

*This project is part of a larger project funded by the Program of University Research, U.S. Department of Transportation.

Project Number: HR-244

Project Title: Detection of Concrete Delaminations by Infrared Thermography

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: B. Brown

Research Period: May 1, 1982 to January 31, 1986

Research Funding: \$9,700

Funding Source: 100 percent State--Primary funds

Objective: To assess the accuracy, dependability, and potential of the infrared thermographic technique of detecting bridge deck delaminations.

Progress: Complete

Reports: Final Report, January 1986

Implementation: Surveys of a great number of structures could be made in a given amount of time, thereby assisting in the timely programming of deck replacement or repair projects.

Project Number: HR-246

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Mark Callahan

Research Period: June 14, 1982, to February 1988

Research Funding: \$118,000

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

Objective: To reduce the incidence and cost of sign vandalism.

Progress: Research was conducted at Iowa State University. From the findings of that research, a public awareness campaign has been established. Posters and tri-fold leaflets have been developed to be distributed to public schools and driver license offices throughout the state. Television and radio public service announcements have also been developed to be aired in the near future. Several counties have been selected to participate in a study to evaluate the effectiveness of this campaign.

Reports: Progress Report, September 1984

Implementation: It is estimated that over \$1 million is spent in Iowa each year on replacing vandalized signs. One state achieved over a 50% reduction in sign vandalism through the use of an aggressive public awareness campaign.

Project Number: HR-253

Project Title: Experimental Use of Calcium Magnesium Acetate (CMA)

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Wallace Rippie

Research Period: October 15, 1982 to June 30, 1987

Research Finding: \$72,000

Funding Source: 100 percent State--Primary funds

Objective: To develop and evaluate continuous CMA mixing technology to reduce cost of production and further evaluate its deicing capabilities.

Progress: Bids were taken in 1982 for the production of 100 tons of CMA. The low bidder, W. G. Block Co., produced 61 tons of a 1 part sand, 1 part CMA mix. This was delivered to Ames and used on four miles of U.S. 30 and 3.5 miles of U.S. 69. The CMA was effective as a deicing product, but not as effective as sodium chloride. The project was extended to develop lower cost methods of production. Bulk handling of materials and continuous production through a heated pugmill was demonstrated by Cedarapids, Inc. while producing 50 tons of CMA deicer. Additional CMA deicer will be produced in 1986. This material will be evaluated in the Davenport area.

Reports: Final Report, June 1983, Addendum to Final Report September 1984, Progress Report, June 1985

Implementation: Identification, development and subsequent use of a non-corrosive deicing material would reduce the deterioration of highway structures and reduce environmental damage.

Project Number: HR-254

Project Title: Highway/Railroad Grade Crossings - Identification and Signing

Agency: Iowa Department of Transportation, Railroad Division

Principal Investigator: Neil Volmer, Peggy Baer

Research Period: February 4, 1983, to January 31, 1987

Research Funding: \$17,500

Funding Source: State--10% Primary, 90% Farm-to-Market funds. These funds were used for Phase I to obtain \$157,000 FHWA funds which are 90% of the total Phase I cost.

Objective: To improve safety at highway/railroad crossings throughout the state by ensuring accurate accident records and upgrading passive signs.

Progress: New metal identification tags were obtained and were installed at all active crossings. Accident data is being collected.

Reports: Progress Report, January 1984.

Implementation: Accurate accident records will prioritize crossings for allocation of crossing safety improvement funds and thereby improve highway safety.

Project Number: HR-256

Project Title: Perception and Interpretation of Advance Warning Signs on County Roads

Agency: Iowa State University

Principal Investigator: K. A. Brewer

Research Period: February 1, 1983, to June 30, 1985

Research Funding: \$101,960

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

Objective: To analyze the detection, recognition and decision process characteristics of drivers for the symbol stop-ahead advance warning sign in contrast to a small set of other signs.

Progress: The main thrust of the research was to design and conduct two laboratory experiments. The first experiment tested speed of detection and speed of recognition of the signs from an array of signs. The second experiment determined whether there are differences among signs in communicating to a driver that a stop sign is ahead. Data gathered from the experiments were analyzed to determine the effectiveness of the symbol stop-ahead advance warning sign in Iowa.

Reports: Final Report, March 1984, Addendum to Final Report, June 1985

Implementation: By identifying the most effective advance warning sign, intersection safety may be improved.

Project Number: HR-257

Project Title: Field Demonstration of Foamed Asphalt - Muscatine County

Agency: Muscatine County and Iowa Department of Transportation, Highway Division

Principal Investigators: Robert Simmering and Howard Konrady

Research Period: April 18, 1983, to July 1, 1988

Research Funding: \$132,740

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

Objective: To evaluate the performance of foamed asphalt as a stabilizing agent using locally available 3/8" minus limestone tailings and pit run sand to construct a bituminous base course; to correlate field strength characteristics and performances of foamed asphalt mixes with laboratory strength characteristics and performances; and to develop specifications and evaluate construction procedures and inspection tests.

Progress: The project is a 4.2-mile section of Muscatine County Road A-91. Nine test sections comprised of a base 4 inches thick, using locally available sand and 3/8" minus limestone material mixed with AC-5 foamed asphalt cement were constructed in September of 1983. The nine test sections include two levels of moisture content, two levels of asphalt content and three levels of surface treatments.

Reports: Construction Report, December 1984

Implementation: Foamed asphalt offers potential for energy conservation and the utilization of marginal locally available aggregates.

Project Number: HR-258

Project Title: Frost Action in Rocks and Concrete

Agency: Iowa State University

Principal Investigator: Turgut Demirel

Research Period: April 1, 1983, to April 30, 1986

Research Funding: \$115,870

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

Objective: To develop a new methodology for estimating the frost susceptibility of porous rocks and concrete material.

Progress: Research is being conducted utilizing experimental methods for determining expansive pressures, rate of expansion and pore structure of rocks and concrete. Vycor samples have been used with conductometric testing to verify the ice porosimeter system. Preliminary results were promising and construction of the ice porosimeter was successful.

Reports: Final Report, April 1986

Implementation: The development of a better method of determining the frost susceptibility of aggregates will prevent the use of nondurable aggregate and yield greater pcc pavement life.

Project Number: HR-259

Project Title: Low Cost Fly Ash-Sand Stabilized Roadway

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

Principal Investigators: Sylvester Klassen and Howard Konrady

Research Period: April, 1983, to July 1, 1988

Research Funding: \$89,390

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

Objective: To develop a low cost fly ash stabilized roadway using locally available unprocessed sands and to correlate field strength characteristics and performance of the base with laboratory strength characteristics and pavement design assumptions.

Progress: The project is a 1-mile section of Des Moines County Road H-40. Various thicknesses of fly ash-cement-sand base were constructed using a locally available dredge sand from the Mississippi River. A three-inch thick acc overlay was placed over the base.

Reports: Construction Report, January 1986

Implementation: There are plentiful supplies of blow sand, fine pit run sand and the by-products from the production of concrete sand available in many areas of Iowa. Fly ash is also available to many areas of Iowa and is considered a waste product. The combination of these two materials has the potential for use as a low-cost base material for secondary road construction.

Project Number: HR-260

Project Title: Optimization of Soil Stabilization with Type C Fly Ash

Agency: Iowa State University

Principal Investigator: John Pitt

Research Period: May 1, 1983, to January 31, 1986

Research Funding: \$158,235

Funding Source: 100 percent State funds--80% Farm-to-Market, 20% Primary

Objective: To identify cost effective methods by which the newer varieties of fly ash can be used more efficiently for stabilized bases and subbases.

Progress: Laboratory testing has identified some chemicals that may provide beneficial reactions when used with fly ash. Various chemicals have been used with various sources of fly ash. Some chemicals have yielded substantial increases in compressive strength.

Reports: Progress Report, April 1985.

Implementation: Improvement in the cementitious characteristics of fly ash will increase utilization of fly ash, a waste product, and reduce roadway construction costs by decreasing the demand for more expensive portland cement.

Project Number: HR-263

Project Title: An Engineering Study to Update Secondary Bridge Standards

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

Principal Investigator: William Lundquist

Research Period: June 1, 1983, to June 30, 1988

Research Funding: \$740,800

Funding Source: \$440,800 State--Farm-to-Market funds; \$300,000 Federal Funds*

Objective: To redesign the secondary bridge standard plans to HS20 loading and make other appropriate changes to meet current design standards.

Progress: Stanley Consultants, Inc. of Muscatine, Iowa, has completed the redesign of the 24' wide multi-span prestressed concrete, the continuous concrete slab, and the simple span concrete slab secondary bridge standards. Crash testing of the secondary bridge rail has been included in a FHWA project. The redesign of the 30' wide multi-span prestressed concrete, the continuous concrete slab, and the simple span concrete slab secondary bridge standards is in progress. Additional redesign is underway to bring both the 24' and 30' widths to meet HS20 loadings.

Reports: New bridge standards

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

*This project includes 80 percent matching money from Federal Bridge Replacement Funds.

Project Number: HR-264

Project Title: Development of a Sufficiency Rating System for Secondary Roads

Agency: Iowa State University

Principal Investigator: C. R. Mercier

Research Period: June 1, 1983, to July 31, 1985

Research Funding: \$41,660

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

Objective: To develop a system for rating secondary roadways to determine project priorities and budgetary needs.

Progress: An inventory of data sources has been conducted. Current practices in Iowa and other states were reviewed. A mathematical calculation procedure was developed for use by the Iowa counties.

Reports: Final Report, June 1985

Implementation: A sufficiency rating system will improve the cost effectiveness of secondary roadway planning and budgeting.

Project Number: HR-265

Project Title: Engineering Study for the Evaluation of Public Road Administration and Maintenance Alternatives

Agency: Iowa Department of Transportation, Highway Division and DeLeuw-Cather Engineering Management Services

Principal Investigators: V. Marks and J. Banks

Research Period: October 11, 1983, to August 31, 1985

Research Funding: \$300,000

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

Objective: To evaluate the economic and other impacts associated with uniform design standards, consolidation of maintenance and transfer of roads with regard to state, county and city jurisdictions.

Progress: A 12-member advisory panel including four state, four county and four municipal representatives has been appointed. Proposals were received from consultants. The advisory panel selected DeLeuw-Cather Engineering Management services to conduct the project. The contractor has met periodically with the advisory panel. Data have been collected by a questionnaire and personal interviews. The contractor visited four other states with different administrative and maintenance practices.

Reports: Final Report and Executive Summary, August 1985

Implementation: Public road administration and maintenance options will be identified which will yield economic benefits.

Project Number: HR-266

Project Title: X-Ray Analysis of Carbonate Aggregates to Predict Concrete Durability

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W. Dubberke

Research Period: November 1, 1983, to January 31, 1987

Research Funding: \$30,000

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

Objective: To determine if a thorough analysis of the pore and chemical properties of an aggregate is sufficient to predict the service life of concrete produced with same.

Progress: Testing of various carbonate aggregates before and after treatment with sodium chloride and before and after freeze and thaw testing is being conducted with the x-ray equipment at Iowa State University. Tests have shown poorer durability after salt treatment. Some additives reduce the effect of salt treatment on lower quality coarse aggregate. Fly ash has beneficial results in many cases. Durability of crushed stone correlates with at least two trace mineral contents. X-ray diffraction and fluorescence evaluation of many carbonate aggregate samples have been conducted. Iron in the dolomite crystal structure causes a shift in the d-spacing of dolomite peaks. The resulting d-spacing correlates with service records.

Reports: Progress Report, January, 1985

Implementation: More rapid and reliable methods of predicting service life of PCC pavement would result in reduced maintenance and lower life cycle costs for paved roadways.

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 March 31, 1987

Research 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: Mark F. Looschen

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 is being developed. A draft final report has been completed.

Reports: None

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-269

Project Title: Data Acquisition and Computer Plotting of Delamtect Data

Agency: D & D Digital Systems

Principal Investigators: Douglas Jacobson, Richard E. Horton

Research Period: August 23, 1984 to July 31, 1985

Research Funding: \$24,250

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

Objective: To develop an electronic system to record Delamtect data for analysis by personal computers available in Iowa DOT field offices.

Progress: Complete and equipment is being used routinely.

Reports: Final Report - September 1985

Implementation: An electronic method of reducing and plotting Delamtect data will reduce the labor and time required for determining the amount and location of bridge deck delamination.

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 March 31, 1988

Research Funding: \$100,000

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-271

Project Title: Effects of Deicing Salt Compounds on Deterioration of Portland Cement Concrete

Agency: Iowa State University

Principal Investigators: John Pitt, Dah-Yinn Lee and Wendell Dubberke

Research Period: December 1, 1984 to November 30, 1986

Research Funding: \$103,870

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

Objective: To define deleterious mechanisms resulting from harmful trace compounds introduced into Portland cement concrete via deicing salts, to define the extent and economic significance of trace compound poisoning in Iowa, and to determine quantitative salt specification parameters aimed at reducing the harmful influence of deicers. The loss of durability does not correlate with sodium chloride, but does correlate with sulphate content.

Progress: Laboratory testing is continuing. Tests have been conducted with various deicing salts.

Reports: Phase I Report, January 1986

Implementation: The reduction or elimination of deterioration of Portland cement concrete at pavement joints would cause money to become available for other areas of pavement maintenance and construction.

Project Number: HR-272

Project Title: Development of a Conductometric Test for Frost Resistance of Concrete

Agency: Iowa State University

Principal Investigators: Turgut Demirel, B. V. Enustun, Scott Schlorholtz, and Sam Moussalli

Research Period: February 1, 1985, to January 31, 1987

Research Funding: \$106,845

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

Objective: To develop a laboratory test method that would rapidly and accurately predict the performance of concrete subjected to freeze-thaw action.

Progress: Initial durability testing using conductivity has appeared promising. There was a change noted in conductivity of non-air entrained concrete specimens after only a few freeze/thaw cycles that indicates potential of predicting durability. There is an interesting relationship of the relative conductivity of concrete between electrodes at different spacing.

Reports: Progress Report, November 1985

Implementation: A rapid accurate test of Portland cement concrete durability would prevent the use of nondurable aggregates thereby increasing pavement life and reducing maintenance costs.

Project Number: HR-273

Project Title: Piling Stresses in Bridges with Integral Abutments - Phase 3

Agency: Iowa State University

Principal Investigators: Lowell Greimann, Fouad Fanous

Research Period: March 1, 1985 to June 30, 1987

Research Funding: \$138,514

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

Objective: To further increase confidence in the design of longer integral abutment bridges by experimental verification of previous analytical models.

Progress: The field evaluation is being conducted on special piling driven near the Town Engineering Building on the Iowa State University Campus.

Reports: None

Implementation: The use of integral abutments for longer bridges will reduce maintenance costs and increase the life before rehabilitation.

Project Number: HR-274

Project Title: Construction and Evaluation of Submerged Vanes for Stream Control

Agency: Iowa department of Transportation Highway Division and the University of Iowa

Principal Investigator: Jacob Odgaard

Research Period: April 1, 1985, to October 31, 1987

Research Funding: \$66,000.

Funding Source: 100 percent State - Primary Funds

Objective: To determine the practicality and effectiveness of using Iowa Vanes to control bank erosion on Iowa Streams.

Progress: Construction was completed in 1985 in the West Nishna River near US 34 at Red Oak. Evaluation is continuing.

Reports: None

Implementation: Stream control with Iowa vanes will prevent damage to highway structures by providing more effective stream control than previous methods.

Project Number: HR-275

Project Title: Long Term Structural Movement

Agency: Iowa State University

Principal Investigator: Terry Wipf

Research Period: May 1, 1985 to February 28, 1986

Research Funding: \$41,577.

Funding Source: 100 percent State--81 percent Primary, 19 percent Farm-to-Market

Objective: To identify and determine the effectiveness of various techniques for measuring long term structural deformations.

Progress: The three methods of measuring long term structural movement evaluated as part of this project were surveying, analytical photogrammetry and tilt sensors. The study showed that either tilt sensors or analytical photogrammetry could be used to accurately measure long-term structural movement. It was recommended that these two systems be used to monitor one or more bridges for two years.

Reports: Final Report, February 1986

Implementation: Monitoring long term structural movement will decrease the potential of emergency closing of critical major river crossings.

Project Number: HR-276

Project Title: Transverse Joint Sealing With Improved Sealants

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

Principal Investigators: Charles Cabalka and Mark Callahan

Research Period: April 1, 1985, to July 1, 1990

Research Funding: \$32,000

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

Objective: To evaluate several types of contraction-joint sealers, most of which meet Iowa DOT Standard Specification for material for filling and sealing sawn contraction joints.

Progress: An extra work order has been negotiated to include 22,000 linear feet of experimental contraction joint work on a Jasper County project. Special sawing and cleaning was performed and eight different sealants were installed on a pcc paving project on county route T-12 in 1985. Visual evaluation of the joints is being made semi-annually.

Reports: Construction Report, April 1986

Implementation: Deterioration of joints and joint related distress of pcc pavements has continued to be a major maintenance problem. The project will identify the most effective joint preparation and sealant.

Project Number: HR-277

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

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

Principal Investigators: Wes Smith and Ken Meeks

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

Research Funding: \$92,210

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

Objectives: To evaluate the effect of various sizes of cracking and seating of pcc pavement prior to resurfacing on reflective cracking and structural rating

Progress: The project includes breaking a 2.5-mile pcc pavement section into 2-to 3-foot and 4-to 5-foot size pieces. A portion of the project will be overlaid with 2 inches, a portion with 3 inches and a portion with 4 inches of asphaltic concrete. The project is being constructed on Hamilton County Road R-33. The cracking and seating of the PCC pavement have been completed. The asphalt overlays will soon be completed as well.

Reports: None

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

Project Number: HR-278

Project Title: Beneficial Effects of Selected Additives on Asphalt Cement Mixes

Agency: Iowa State University

Principal Investigator: Dah-Yinn Lee

Research Period: June 1, 1985, to May 31, 1987

Research Funding: \$89,700

Funding Source: 100 percent State Funds--60 percent Primary, 40 percent Farm-to-Market

Objective: To review the state of knowledge on asphalt additives and to evaluate the most promising additives in their effects on relevant properties of asphalt cements and to identify the specific benefits of the additives and establish guidelines for optimal use.

Progress: Laboratory evaluation of AC-13 polymer additive, 3M additive 5990 (Asphadur) and hydrated lime in asphalt cement has begun. The properties appear to be quite different.

Reports: None

Implementation: The research will provide the testing capabilities to evaluate polymer additives for asphalt cement and identify those with economic benefits. The use of effective polymer additives will extend asphalt pavement life and reduce maintenance which will yield substantial savings.

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: Dale Miller and Ken Pesch

Research Period: June 1, 1985, to July 1, 1991

Research 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 will include breaking a 2-mile pcc pavement section with transverse cracking at 2, 3 & 5 feet intervals. A portion of the project will be overlaid with 3 inches of asphaltic concrete and a portion will be overlaid with 4 inches of asphaltic concrete. The project is to be constructed on Fremont County Road J-46 in 1986.

Reports: None

Implementation: If cracking and seating can alleviate or 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 July 31, 1987

Research Funding: \$300,000

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

Objective: To develop single 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 will be designed for sizes from 5'x3' to 12'x12', with 9 different fills and 4 different skewed headwalls (0°, 15°, 30° and 45°). Approximately 90% of the work has been completed to date. A proposal to expand this project to include the development of twin box culvert standards has been presented to the Highway Research Board.

Reports: None

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-281

Project Title: Effects of Pavement Surface Texture on Noise and Frictional Characteristics

Agency: Iowa Department of Transportation

Principal Investigator: Roman Dankbar

Research Period: July 16, 1985, to January 31, 1987

Research Funding: \$35,000

Funding Source: 100 percent State--Primary funds

Objective: To measure the effects of modified surface texturing on traffic noise and frictional characteristics.

Progress: An area of I-380 southbound from Cold Stream Avenue south 2000 ft. was selected for texturing by diamond grinding. Noise and friction measurements were made before and after texturing and continue to be made periodically.

Reports: None

Implementation: If noise levels and friction values can be maintained at acceptable levels, diamond grinding may be a method to prevent complaints of traffic noise caused by transverse comb texturing in urban areas.

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 April 1, 1987

Research Funding: \$295,000

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 Contractor has completed the review of related research. They are now developing the test program.

Reports: None

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-283

Project Title: Pavement Texturing by Milling

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Cedarapids, Inc., Vernon Marks

Research Period: September 15, 1985, to January 31, 1986

Research Funding: \$15,000

Funding Source: 100 percent State--Primary Funds

Objective: To produce an acceptable surface texture with a milling machine modified with an increased number of cutting teeth.

Progress: A Cedarapids-Wirtgen 1900c mill with 412 teeth (3 times the standard number) was used to rehabilitate the surface of one AC and two PC pavements. The texture varies with the forward speed of the mill with a slower speed yielding smoother texture. The resulting texture was relatively smooth, but did increase the tire noise.

Reports: None

Implementation: Achieving an acceptable texture by milling would result in substantial savings from profiling the many miles of rutted AC pavement and faulted PC pavements when compared to current profiling costs.

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 April 30, 1987

Research 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 and are in the process of being revised to meet the specific needs of the counties. A list of workshops has been scheduled for early 1987 to help users become familiar with the programs

Reports: None

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

Principal Investigator: Phil Soenksen

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

Research Funding: \$91,950

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

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 will be installed on selected streams to obtain flow data during the high flows of the 1986 spring period.

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 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: None

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 January 31, 1987

Research 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: Materials have been obtained to construct the 1/3 scale model bridge.
Construction in the Iowa State University Structural Laboratory is beginning.

Reports: None

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 September 30, 1986

Research Funding: \$39,750

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: None

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 June 1, 1987

Research 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 has been formed to help direct the research effort. With assistance from the committee, a script will be developed.

Reports: None

Implementation: Proper planning, design, construction and maintenance will 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 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 Verglimit has been purchased and has been stored in City of Des Moines facilities.

Reports: None

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: Mark Kaler, Wendell Folkerts, Milt Johnson and John Lane

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

Research 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 has been conducted to determine the structural rating. The first series of cores have been obtained and tested for bond strength.

Reports: None

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 July 31, 1986

Research Funding: \$19,350

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

Objective: To determine expansion or contraction of integral 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.

Reports: None

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: April 1, 1986, to December 31, 1988

Research Funding: \$150,000

Funding Sources: 50 percent State--Primary Funds, 50 percent FHWA

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 review has been conducted to identify the most effective current technology in evaluation instrumentation. A contract has been executed with Iowa State University for their participation.

Reports: None

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 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 has been selected for the project. Two mixes, two thicknesses and two wearing courses are to be tested.

Reports: None

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-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Kevin Jones

Research Period: March 5, 1980, to present

Research 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: Kevin Jones, the present Secondary Road Research Coordinator, will soon be promoted to another position. A replacement for Mr. Jones is currently being sought. Mr. Jones 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 12 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.

