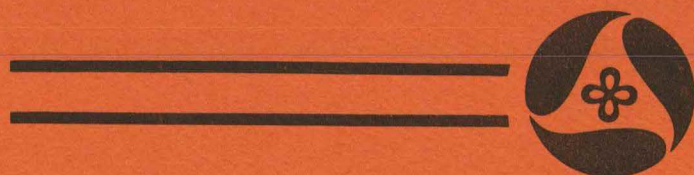


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Annual Report of Highway Research and Development in Iowa

Highway Division
Office of Materials
October 1987



**Iowa Department
of Transportation**

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ANNUAL REPORT
OF
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1987

OFFICE OF MATERIALS
(515)239-1447

HIGHWAY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

OCTOBER 1987

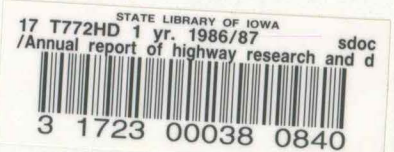


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RESEARCH AND DEVELOPMENT

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, 1987; it is also a report on projects completed during the fiscal year beginning July 1, 1986, and ending June 30, 1987. 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, 1987, is listed in Table I.

The Research Board held ten regular meetings during the period of July 1, 1986 to June 30, 1987. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

TABLE 1
1987 IOWA HIGHWAY RESEARCH BOARD

<u>Member</u>	<u>Term Expires</u>	<u>Alternate</u>
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 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
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	David Anthony Boone County Engineer Courthouse Boone, IA 50036 (515) 432-6321 SS#-008
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	12-31-87	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) 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
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
Eldon Rike Adams County Engineer Courthouse Corning, IA 50841 (515) 322-3910 SS#-002	12-31-87	Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS#-073
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
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, 1987. Total expenditure was \$1,688,287.04

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.

SECONDARY ROAD TRAFFIC COUNT PROGRAM

Secondary road traffic counts and road inventories are conducted annually and funded from the Secondary Road Research Fund as "Non-Contract Engineering Studies". The Office of Transportation Inventory conducted traffic counts in twenty-five counties during fiscal year 1987 as part of the Annual Traffic Count Program. This activity consisted of 24 eight-hour manual counts, 50 sixteen-hour manual counts, and 4,150 recorder counts. Traffic volumes from these counts are used to develop Motor Vehicle Traffic Flow Maps for each county showing the Average Annual Daily Traffic "AADT" on specific road sections within each county.

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

SECONDARY ROAD RESEARCH FUND

Section 310.34 of the Iowa Code authorizes the Iowa Department of Transportation to set aside each year an amount not to exceed 1 1/2 percent of the receipts to the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund is itemized in Table II.

The values shown in Table II are actual research expenditures for fiscal year 1987. The Office of Transportation Inventory engineering studies include traffic counts and secondary road inventories. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditure. The Fiscal Year 1987 financial summary is.

Beginning Balance 7-1-86		\$ 333,981
Receipts		
Interest	\$ 14,997	
Federal Aid Secondary (1 1/2% of receipts)..	75,998	
State Road Use Tax Fund (1 1/2% of receipts)...	615,366	
Research Income	<u>320,822</u>	
Sub-Total		1,027,183
Total Funds Available		<u>\$1,361,164</u>
Obligation for Expenditures		
Obligated for		
Contract Research...	763,708	
Non-Contract Engineering Studies...	<u>468,812</u>	
Total Expenditures		<u>\$1,232,520</u>
BALANCE 6-30-87		\$ 128,644

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 expended for contract research from the Primary Road Research Fund for FY87 was \$420,645.55 and the estimate for FY88 is \$575,000.

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1986 to June 30, 1987
(Active projects with no current fiscal year expenditures are included)

<u>Project</u>	<u>Total Funds Committed</u>	<u>Project Title</u>	<u>Primary Road Research Fund Expenditures</u>	<u>Secondary Road Research Fund Expenditures</u>	<u>Total Expenditures</u>
140	85,625.00	Collection and Analysis of Stream Flow Data	42,812.50	42,812.50	85,625.00
165	150,000.00	Experimental Steel Fiber Reinforced Concrete Overlay			
198	75,000.00	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way			
213	13,550.00	Improved Asphalt Pavement Performance Through Crack Maintenance			
215	10,700.00	Improvement of Longitudinal Joints in Asphalt Pavements			
220	8,000.00	Protection of Structural Concrete Substructures			
222	17,500.00	Retardation of Reflection Cracking Using Stabilizing Additive 5990			
229	130,000.00	Alternate Flexible Overlays		335.23	335.23
231	45,340.00	Special Surface Preparation Prior to Bituminous Overlays		628.70	628.70
236	88,143.00	Pottawattamie Co. Evaluation of Stabilizing Degrading Stream Channels			
237	87,065.00	Shelby Co. Stabilization of Degrading Stream Channels			
238	162,898.00	Strengthening Existing Single Span Steel Beam Concrete Deck Bridges	1,600.00		1,600.00
242	296,305.50	Economics of Alternative Solutions to the Secondary Roadway Problem		91,065.43	91,065.43
246	118,000.00	Engineering Study - Reducing Sign Vandalism		6,325.61	6,325.61
253	72,000.00	Experimental Use of Calcium Magnesium Acetate (CMA)	3,175.42		3,175.42
254	17,500.00	Highway/Railroad Grade Crossings - Identification and Signing			
257	132,740.00	Field Demonstration of Foamed Asphalt - Muscatine County		1,448.82	1,448.82
258	115,870.00	Frost Action in Rocks and Concrete	6,433.75	5,510.33	11,944.08
259	89,390.00	Low Cost Fly Ash-Sand Stabilized Roadway		176.42	176.42
260	158,235.00	Optimization of Soil Stabilization with Type C Fly Ash	4,773.14	21,664.63	26,437.77
263	740,800.00	Engineering Study to Redesign the 24-Foot Secondary Bridge Standards		70,528.99	70,528.99
265	300,000.00	Engineering Study for the Evaluation of Public Road Administration & Maintenance Alternatives	7,097.06	6,598.74	13,695.80
266	30,000.00	X-Ray Analysis of Carbonate Aggregate to Predict Concrete Durability			
268	110,500.00	Evaluation of Magnitude and Frequency of Floods in Iowa	9,375.00	375.00	9,750.00
270	100,000.00	Development of Training Aids and Demonstration of Portland Cement Concrete Pavement Rehabilitation	2,000.00		2,000.00
271	103,870.00	Effects of Deicing Salt Compounds on Deterioration of PC Concrete	26,279.11	13,152.73	39,431.84
272	154,295.00	Development of a Conductometric Test for Frost Resistance of Concrete	25,518.60	23,614.68	49,133.28
273	138,514.00	Piling Stresses in Bridges With Integral Abutments - Phase 3	36,058.78	38,066.08	74,124.86
274	66,000.00	Construction and Evaluation of Submerged Vanes for Stream Control			
276	32,000.00	Transverse Joint Sealing With Improved Sealants			
277	92,210.00	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflection Cracking		5,699.85	5,699.85
278	89,700.00	Beneficial Effects of Selected Additives on Asphalt Cement	23,626.79	14,319.27	37,946.06
279	76,175.00	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflective Cracking		75,947.30	75,947.30

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280	300,000.00	An Engineering Study to Update the Box Culvert Standards		185,066.23	185,066.23
281	35,000.00	Effects of Pavement Surface Texture on Noise and Frictional Characteristics			
282	295,000.00	A Low Cost Automatic Weight and Classification System	65,241.45		65,241.45
283	15,000.00	Pavement Texturing by Milling			
284	50,790.00	Development of Multiplan Microcomputer Spreadsheets for County Hydraulic and Highway Engineering Computations		29,568.21	29,568.21
285	91,950.00	Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods	11,425.00	21,250.00	32,675.00
286	174,200.00	Development of a Rational Characterization Method for Iowa Fly Ash	43,960.77	41,872.84	85,833.61
287	87,430.00	Strengthening of Existing Continuous Composite Bridges	29,201.88	28,441.96	57,643.84
288	39,857.81	Field Evaluation of Bonded Concrete Resurfacing		10,198.57	10,198.57
289	12,800.00	Engineering Study - Training Aids to Reduce Potential County Liability			
290	25,200.00	Ice Retardant Pavement			
291	14,200.00	Performance of Nongrouted Thin, Bonded PCC Overlays		38.41	38.41
292	118,525.00	Field Evaluation of Integral Abutment Bridges	27,932.23	9,828.99	37,761.22
293	150,000.00	Pavement Instrumentation	9,378.66		9,378.66
294	80,175.00	Ammonium Phosphate/Fly Ash Road Base Construction		23,967.01	23,967.01
295	114,606.00	Field Measurement of Bridges for Long Term Structural Movement	37,125.85		37,125.85
296	41,667.00	Iowa State University Technology Transfer Center			
297	71,440.00	Development of an Economic Dust Palliative for Limestone Surfaced Secondary Roads		13,814.67	13,814.67
298	83,495.00	Correlation of Locally-Based Performance of Asphalts With Their Physicochemical Parameters	4,659.52	20,592.99	25,252.51
299	74,610.00	Control of Concrete Deterioration Due to Trace Compounds in Deicers	1,758.04		1,758.04
300	25,122.00	Iowa Development of Roller Compacted Concrete - Benton County	1,212.00	22,610.00	23,822.00
301	61,452.00	Iowa Development of Roller Compacted Concrete - Mills County			
302	129,980.00	Alternate Methods of Bridge Strengthening			
303	100,000.00	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete			
304	16,852.00	Production of Acetic Acid for CMA Deicer			
305	93,084.00	Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa			
1027	32,500.00/yr.	Secondary Road Research Coordinator		19,251.33	19,251.33
		Contract Research Sub-Total	\$420,645.55	\$844,771.52	\$1,265,417.07
HPR-2 (121)		NCHRP pooled fund project for National Program for Skid Test and Calibration Centers		1,194.35	1,194.35
HPR-2 (126)		NCHRP pooled fund project for Integrated Drainage Design Computer System		148.34	148.34
HPR-2 (127)		NCHRP pooled fund project for Cost Effective Geometric Design Standards for RRR Projects		2,235.55	2,235.55
HPR-4 (182)		NCHRP FY82 General Project Funding		858.32	858.32
HPR-4 (183)		NCHRP FY83 General Project Funding		3,389.14	3,389.14
HPR-4 (184)		NCHRP FY84 General Project Funding		4,883.16	4,883.16
HPR-4 (185)		NCHRP FY85 General Project Funding		926.45	926.45
HPR-4 (186)		NCHRP FY86 General Project Funding		482.90	482.90
HPR-PR-PL-1 (23)		FY 1987 Planning & Research Program (Transportation Inventory Engineering Studies)		408,751.76	408,751.76
		Noncontract Engineering Studies Sub-Total		\$422,869.97	\$422,869.97
		Grand Total of Expenditures	\$420,645.55	\$1,267,641.49	\$1,688,287.04

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, 1987

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 1986-1987 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: Stephen Lensink, Acting 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. 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-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 April 30, 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.

Reports: Final Report, April 1987

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 were made annually.

Reports: Final Report, January 1987

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 was placed and sections with varying percentages of stabilizing Additive 5990 in the asphalt concrete mixture were incorporated into the project. Most of the joints and cracks have reflected through the surface.

Reports: Final Report, February 1987

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

Project Number: HR-229

Project Title: Alternative Flexible Overlays

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

Principal Investigators: Tom Snyder and Clyde Leonard

Research Period: March 1981 to November 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 July 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-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 July 31, 1987

Research Funding: \$88,143

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

Objective: To design and construct a grade stabilization control structure for Keg Creek, instrument it, and scientifically document its effectiveness.

Progress: Preliminary designs for three control structures were completed. The designs included a vertical sheet-pile structure, a soil-cement structure, and a pre-cast concrete structure. Hydraulic and structural analyses of the proposed structures were done. Because of higher than anticipated construction costs and difficulty in obtaining additional funds, only one structure was 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, 1992

Research Funding: \$87,065

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

Objective: To design and construct a grade stabilization control structure for Long Branch Creek in Shelby County, instrument it, and scientifically document its effectiveness.

Progress: Preliminary designs for the control structure included 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 1988. 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 1, 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-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 1989

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, tri-fold leaflets and bumper stickers have been developed and distributed to schools, county offices, and driver licensing stations throughout the state. Television and radio public service announcements have also been developed. Several counties have been selected to participate in a study to evaluate the effectiveness of this campaign.

Reports: Progress Report, January 1987

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 April 30, 1988

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 were demonstrated by Cedarapids, Inc. while producing 50 tons of CMA deicer. Additional CMA deicer was produced in 1986. This material is being evaluated in the Davenport area.

Reports: Final Report, June 1983, Addendum to Final Report September 1984, Progress Report, June 1985
Progress Report, March 1987

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. Sign installations at the highway/railroad grade crossings have been completed.

Reports: Final Report, January 1987

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

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 Sam Moussalli

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. Performance Evaluation is continuing.

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 was completed 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 Sam Moussalli

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. Evaluation is continuing.

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, 1987

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: Final Report, January 1987.

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: 60% State--Farm-to-Market funds; 40% FHWA Bridge Replacement 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.

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 florescence 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: Final Report, January 1987

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 September 30, 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 is being reviewed by U.S.G.S. personnel.

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-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 was completed. Tests have been conducted with various deicing salts.

Reports: Final Report, January 1987

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

Research Period: February 1, 1985 to January 31, 1988

Research Funding: \$154,295

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. Testing is now being conducted on air entrained concrete made with marginal aggregate.

Reports: Progress Report, November 1986

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 November 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 was conducted on special piling driven near the Town Engineering Building on the Iowa State University Campus. The data is being analyzed and the final report is being prepared.

Reports: Progress Report, March 1987

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 of a vane system in the West Nishna River near US 34 at Red Oak was completed in 1985. Evaluation is continuing.

Reports: Progress Report, January 1987

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

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 Richard Mumm

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 included 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 was overlaid with 2 inches, a portion with 3 inches and a portion with 4 inches of asphaltic concrete. The project was constructed on Hamilton County Road R-33.

Reports: Construction Report, April 1987

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 September 30, 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. The direction of the project has been modified to include evaluation and analysis of some modifiers that have just recently been introduced to the use of asphalt cement in pavement. Many tests were conducted on the asphalt mixtures containing the additives. These results were compared to the asphalt mixture with no additive.

Reports: Progress Report, August 1986

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: Charles Marker and Glenn Miller

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

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 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 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°, 15°, 30° and 45°). These have been distributed to the counties. Similar work is being done on the twin box culverts.

Reports: Single 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-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 February 28, 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: Final Report, February 1987

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 November 30, 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. 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.

Reports: Task Reports and Monthly Progress Reports through January 1987

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, 1987

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. There was some spalling of the joints in the pcc pavement.

Reports: Final Report, January 1987

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 August 31, 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. 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: 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

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 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 was installed on selected streams to obtain flow data during the high flows of the 1986 spring 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 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 Report No. 1, November 1986

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 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. Testing of various methods of strengthening is in progress.

Reports: Progress Report, March 1986

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 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 June 1, 1988

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 has been developed. Modifications proposed by the DOT Legal Division have been made.

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 experimental Verlimit 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.

Reports: Progress Report, December 1986

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: Wendell Folkerts, Wapello County Engineer 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 was conducted to determine the structural rating. Two series of cores were obtained and tested for bond 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 April 30, 1988

Research Funding: \$118,525

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.

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: April 1, 1986 to May 1, 1989

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 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.

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: IIR-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 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 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: Stanley Ring

Research Period: October 1, 1986 to September 30, 1987

Research Funding: \$41,667

Funding Source: 100 percent State Funds-50 percent primary, 50 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 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, June 1987

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 January 31, 1988

Research Funding: \$83,495

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. Asphalt cements are being obtained from a variety of sources and tested.

Reports: None

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 May 31, 1988

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

Reports: None

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 30, 1987

Research 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 the 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-301

Project Title: Iowa Development of Roller Compacted Concrete - Mills County

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

Principal Investigator: O. J. Lane, Mark Callahan and Jerry Hare

Research Period: May 1, 1987 to April 30, 1992

Research Funding: \$61,452

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

Objective: To investigate the performance of Roller Compacted Concrete (RCC) in carrying traffic loads frequently encountered on Iowa's Secondary road system.

Progress: Construction of a quarter mile section of RCC was to be completed in the summer of 1987 pending the results of research conducted in HR-300. After viewing the HR-300 test section, the Mills County engineer decided not to use RCC on the 1/4 mile section of pavement.

Reports: None

Implementation: Roller compacted concrete is a zero slump portland cement concrete mixture that is placed with asphalt concrete paving equipment. Because of the ease and simplicity of RCC pavement construction, savings of one third or more of 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 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: A contract for services to conduct the research has been executed.

Reports: None

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, 1992

Research 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 1988.

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 December 31, 1987

Research Funding: \$16,852

Funding Source: 100 percent State--Primary Funds

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

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

Reports: None

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 Funding: \$120,303

Funding Source: 77 Percent State--Primary Funds, 13 Percent Freeze Notis, 10 Percent Iowa State University

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of meteorological 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.

Reports: None

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-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 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 11 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.

