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Iowa. Highway Division.
Annual report of Highway
Division highway research

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Annual Report of Highway Research and Development in Iowa

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Highway Division
Office of Materials
November 1989



ANNUAL REPORT
OF
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1989

OFFICE OF MATERIALS
(515) 239-1447

HIGHWAY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

NOVEMBER 1989

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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, 1989; it is also a report on projects completed during the fiscal year beginning July 1, 1988, and ending June 30, 1989. 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 Iowa 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, 1989 is listed in Table I.

The Research Board held eight regular meetings during the period of July 1, 1988 to June 30, 1989. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

Table I
1989 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	12-31-90	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	12-31-91	George F. Sisson Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
David Anthoney Boone County Engineer Courthouse Boone, IA 50036 (515) 432-6321 SS#-008	12-31-90	Steven J. Holcomb Grundy County Engineer Courthouse Grundy Center, IA 50638 (319) 824-6912 SS#-038
James R. Bump District 3 Engineer Iowa DOT - Highway Division P.O. Box 987 Sioux City, IA 51102 (712) 276-1451 SS#-230	12-31-90	Robert I. Bortle District 2 Engineer Iowa DOT - Highway Division P.O. Box 741 Mason City, IA 50401 (515) 423-7584 SS#-220
Robert Haylock Butler County Engineer Courthouse Allison, IA 50602 (319) 267-2630 SS#-012	12-31-89	Richard O. Schiek Kossuth County Engineer Courthouse Algona, IA 50511 (515) 295-3320 SS#-055
Robert G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 335-5766	12-31-90	Jerald L. Schnoor Dept. of Civil & Envir. Engr. University of Iowa Iowa City, IA 52242 (319) 335-5649
David Kao, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-89	Wallace W. Sanders, Jr. Assoc. Dean for Research Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-6617
Russell A. Krieg Buchanan County Engineer R.R. 2 Independence, IA 50644 (319) 334-6031 SS#-010	12-31-91	Steve DeVries Jackson County Engineer Courthouse Maquoketa, IA 52060 (319) 652-4782 SS#-049
Mike McClain Davis County Engineer Courthouse Bloomfield, IA 52537 (515) 664-2542 SS#-026	12-31-89	S. J. Klassen Des Moines County Engineer 513 N. Main, RM B-11 Burlington, IA 52601 (319) 753-8241 SS#-029
Richard Ransom City Engineer 1201 6th Street, S.W. Cedar Rapids, IA 52404 (319) 398-5026	12-31-90	John Erickson City Engineer 19 South Delaware Mason City, IA 50401 (515) 421-3604
Eldon Rike Adams County Engineer Courthouse Corning, IA 50841 (515) 322-3910 SS-#002	12-31-90	Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS-#073
Thomas G. Rohe Plymouth County Engineer Courthouse Le Mars, IA 51031 (712) 546-8956 SS#-075	12-31-91	Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072
Larry Stevens City Engineer Box 1010 Oskaloosa, IA 52577 (515) 673-7472	12-31-91	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000

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, 1989. Total expenditure was \$1,360,386.64

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 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 Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern.

The program is funded annually by all 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 1989 as part of the Annual Traffic Count Program. This activity consisted of 13 eight-hour manual counts, 47 sixteen-hour manual counts, and 4,194 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 nine 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1989 financial summary is:

Beginning Balance 7-1-88

\$ 432,687

Receipts

State Road Use Tax Fund (1 1/2% of receipts)...	\$705,949
Federal Aid Secondary (1 1/2% of receipts)...	180,193
Interest	24,389
Research Income	160,278
	=====

Sub-Total

1,070,809
=====

Total Funds Available

\$1,503,496

Obligation for Expenditures

Obligated for Contract Research...	383,793
Non-Contract Engineering Studies...	279,483
	=====

Total Expenditures

\$ 663,276
=====

BALANCE 6-30-89

\$ 840,220

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 FY89 was \$392,722.81 and the estimate for FY90 is \$500,000.

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1988 to June 30, 1989
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Total Expenditure
140	94,985 (FY89)	Collection and Analysis of Stream Flow Data	46,237.50		46,237.50
165	185,586	Experimental Steel Fiber Reinforced Concrete Overlay			
198	75,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way			
220	8,000	Protection of Structural Concrete Substructures			
231	45,340	Special Surface Preparation Prior to Bituminous Overlays		9.75	9.75
242	296,305	Economics of Alternative Solutions to the Secondary Roadway Problem		44,848.99	44,848.99
246	118,000	Engineering Study - Reducing Sign Vandalism		3,423.69	3,423.69
257	132,740	Field Demonstration of Foamed Asphalt - Muscatine County		180.05	180.05
259	89,390	Low Cost Fly Ash-Sand Stabilized Roadway		363.46	363.46
263	440,800	Engineering Study to Redesign the 24-Foot Secondary Bridge Standards		31,605.19	31,605.19
273	138,514	Piling Stresses in Bridges With Integral Abutments - Phase 3	6,901.52	11,441.95	18,343.47
274	66,000	Construction and Evaluation of Submerged Vanes for Stream Control	870.00		870.00
276	32,000	Transverse Joint Sealing With Improved Sealants		2,737.80	2,737.80
277	92,210	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflection Cracking		152.20	152.20
279	76,175	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflective Cracking		152.20	152.20
280	300,000	An Engineering Study to Update the Box Culvert Standards		30,352.93	30,352.93
285	91,950	Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods		13,300.00	13,300.00
286	174,200	Development of a Rational Characterization Method for Iowa Fly Ash	21,534.74	27,041.58	48,576.32
289	12,800	Engineering Study - Training Aids to Reduce Potential County Liability		513.05	513.05
290	25,200	Ice Retardant Pavement			
291	14,200	Performance of Nongrouted Thin, Bonded PCC Overlays		1,547.56	1,547.56
292	167,905	Field Evaluation of Integral Abutment Bridges	21,017.41	30,452.21	51,469.62
293	75,000	Pavement Instrumentation	6,842.00		6,842.00
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction		390.61	390.61
295	114,606	Field Measurement of Bridges for Long Term Structural Movement	11,290.27		11,290.27
296	60,000 (FY89)	Iowa State University Technology Transfer Center	14,237.83	28,963.59	43,201.42
297	71,440	Development of an Economic Dust Palliative for Limestone Surfaced Secondary Roads		23,318.78	23,318.78
298	205,415	Correlation of Locally-Based Performance of Asphalts With Their Physicochemical Parameters	18,142.47	28,017.68	46,160.15
299	130,360	Control of Concrete Deterioration Due to Trace Compounds in Deicers	32,765.55	13,818.12	46,583.67
300	25,122	Iowa Development of Roller Compacted Concrete			
302	129,980	Alternate Methods of Bridge Strengthening	19,476.80	44,981.06	64,457.86
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete			
304	16,852	Production of Acetic Acid for CMA Deicer	2,450.81	1,685.00	4,135.81
305	93,084	Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa	24,901.89		24,901.89
306	110,415	Investigation of Uplift Failures in Flexible Pipe Culverts	7,372.67	38,158.43	45,531.10

Table II con't.)

35,000	Sediment Control in Bridge Waterways		7,094.01	7,094.01
142,435	Strengthening of an Existing Continuous Span Steel Beam-Concrete Deck Bridge by Post-Tensioning	37,832.67	58,597.59	96,430.26
78,760	An Investigation of Emulsion Stabilized Limestone Screenings		75,548.31	75,548.31
96,088	Precast, Prestressed Concrete Panel Subdecks in Skewed Bridges	18,103.29	25,877.89	43,981.18
25,000	Creep and Resilient Modulus Testing of Asphalt Mixtures	21,379.57		21,379.57
93,913	Low Cost Techniques of Base Stabilization in Dubuque County		75,796.84	75,796.84
28,900	Air Formed Arch Culvert Construction - Washington County		27,124.16	27,124.16
16,500	Air Formed Arch Culvert Construction - Crawford County			
98,529	Iowa Development of Rubbilized Concrete - Mills County		4.35	4.35
142,840	Maximized Utility of the Global Positioning System	69,465.82		69,465.82
60,100	Evaluation of Edge Drains	11,900.00		11,900.00
20,800	Evaluation of Preformed Neoprene Joints Seals			
35,000.00/yr.	Secondary Road Research Coordinator		50,525.83	50,525.83
	Contract Research Sub-Total	\$392,722.81	\$698,024.86	\$1,090,747.67
(126)	Pooled fund project for Integrated Drainage Design Computer System		6.26	6.26
(127)	Pooled fund project for Cost Effective Geometric Design Standards for RRR Projects		54.18	54.18
(129)	Pooled fund project for Evaluation of Wetland Mitigation Measures		70.97	70.97
(134)	Pooled fund project for Test an Evaluation of Bridge Rail		765.68	765.68
(136)	Pooled Fund Project for Evaluation and Performance of Experimental Noise Barriers		(-36.76)	(-36.76)
(138)	Pooled Fund Project for Safety of Wide Trucks on Narrow Roadways		43.96	43.96
(140)	Pooled Fund Project for Research and Development Needs in Construction Engineering Management		455.05	455.05
(010)	Pooled Fund Project for Crescent Study		962.41	962.41
(186)	NCHRP FY86 General Project Funding		8,319.65	8,319.65
(187)	NCHRP FY87 General Project Funding		1,372.65	1,372.65
(188)	NCHRP FY88 General Project Funding		1005.92	1005.92
R-PL-1 (25)	FY 1989 Planning & Research Program (Transportation Inventory Engineering Studies)		256,619.00	256,619.00
	Noncontract Engineering Studies Sub-Total		\$269,638.97	\$269,638.97
	Grand Total of Expenditures	\$392,722.81	\$967,663.83	\$1,360,386.64

Projects Initiated During FY 1989

The new projects initiated during FY 1989 were:

HR-313, "Air Formed Arch Culvert Construction - Wash. Co."	\$ 28,900
HR-314, "Air Formed Arch Culvert Construction - Crawford Co."	16,500
HR-315, "Iowa Development of Rubbilized Concrete - Mills Co."	98,529
HR-316, "Maximized Utility of the Global Positioning System"	142,840
HR-317, "Evaluation of Edge Drains"	60,100
HR-318, "Evaluation of Preformed Neoprene Joint Seals"	20,800
	=====
6 projects	\$367,669

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, 1990

Research Board Funding: \$94,985 per year (matched by \$94,985 from the Department of the Interior)

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

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

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

Progress: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of gaging stations on Iowa streams. These measurements, along with data from special studies of selected streams and floods, are compiled and analyzed to form the basis for predictions of future streamflow. The progress during 1989-1990 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 Investigator: Russ Helms and Vernon Marks

Research Period: January 1, 1973 to October 31, 1989

Research Board Funding: \$185,586

Funding Source: 67 percent State--Farm-to-Market funds,
33 percent 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 and 1988 at 15 years. Some full depth patching in 1984 was necessary to extend the evaluation period through 15 years. Most of the deterioration occurred in the first five years. The overlay performed better than expected from five through 15 years. A final report will be distributed in October 1989.

Reports: Fifteen year report, second quarter 1989

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: State Archaeologist

Research Period: July 1, 1977 to December 31, 1989

Research Board 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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

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 Board 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 was 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-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 Board 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 reduce 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. After five years of research, it was evident crack sealing does extend the life of an overlay. However, the benefits of crack filling with any of the materials used in this research project are not beneficial enough to warrant the added cost of the crack filling operation. Improved materials and better crack filling techniques need to be developed before this operation can become successful.

Reports: Final Report, September 1987

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-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 January 31, 1989

Research Board Funding: \$296,305

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. Educational program material is being developed in order to train county personnel in the use of the software. Reports entitled "Alternatives for Rural Roads" and "The Local Rural Road System" were issued during 1989.

Reports: Final Report, April 1989, 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 large 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: Andrew Jensen

Research Period: June 14, 1982 to December 1992

Research Board 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. 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-257

Project Title: Field Demonstration of Foamed Asphalt -
Muscatine County

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

Principal Investigator: Robert Simmering and Sam Moussalli

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

Research Board 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 included two levels of moisture content, two levels of asphalt content and three levels of surface treatments.

Reports: Final Report, September 1988

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

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 Investigator: Sylvester Klassen and Sam Moussalli

Research Period: April 1983 to December 31, 1989

Research Board 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-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 July 31, 1988

Research Board Funding: \$440,800

Funding Source: 60 percent State--Farm-to-Market funds;
40 percent 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 was awarded a contract to update the Iowa DOT secondary road 24 foot and 30 foot wide bridge standards to meet HS20 loadings. All work on these standards has been completed.

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-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 July 31, 1988

Research Board Funding: \$138,514

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

Objective: To further increase confidence in the design of
longer integral abutment bridges by experimental verifica-
tion 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 were analyzed and the final
report was presented.

Reports: Final Report, December 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 Board 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.

Reports: Final Report, March 1988

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 Andrew Jensen

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

Research Board 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 materials for filling and sealing sawn contraction joints.

Progress: An extra work order was negotiated to include 22,000 linear feet of experimental contraction joint work on a Jasper County project. Special sawing and cleaning were performed and eight different sealants were installed on a pcc paving project on county route T-12 in 1985. 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 Board Funding: \$92,210

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

Objective: 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 section of PCC pavement into pieces ranging in size from 2 to 3 feet and from 4 to 5 feet. Also, overlay thicknesses of 2 inches, 3 inches, and 4 inches were placed on the broken slab. The project was constructed on Hamilton County route R-33. Performance evaluation is continuing.

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-279

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

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

Principal Investigators: Charles Marker and Glenn Miller

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

Research Board Funding: \$76,175

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

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

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

Reports: Construction Report, April 1987

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

Project Number: HR-280

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

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

Principal Investigator: William Lundquist

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

Research Board Funding: \$300,00

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 has also been completed on the twin box culverts.

Reports: Single and Twin Box Culvert Standards

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

Project Number: HR-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, Department of Interior

Principal Investigator: Phil Soenksen

Research Period: November 1, 1985 to November 30, 1989

Research Board Funding: \$91,950

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

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

Progress: Equipment has been obtained and was installed on
selected streams to obtain flow data during the high flows
of the 1986-87 period. Data collection has been completed.
The final report has been written and is in the U.S.
Geological Survey review process.

Reports: None

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

Project Number: HR-286

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

Agency: Iowa State University

Principal Investigator: Turgut Demirel

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

Research Board Funding: \$174,200

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

Objective: To develop a test method to characterize Class C 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 were determined. Scanning electron microscopy and
thermal analysis were also used.

Reports: Final Report, November 1988

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

Project Number: HR-289

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

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Andrew Jensen

Research Period: January 1, 1986 to March 31, 1989

Research Board Funding: \$12,800

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

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

Progress: The final slide/tape presentation has been completed. Subsequently, a video tape version of the presentation is also being produced. Copies of either format will be sent to the counties in the near future.

Reports: Final Report, March 1989

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

Project Number: HR-290

Project Title: Ice Retardant Pavement

Agency: City of Des Moines

Principal Investigator: John P. Bellizzi

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

Research Board Funding: \$25,200

Funding Source: 100 percent State--Primary funds

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

Progress: The experimental Verglimit section was constructed on Euclid Avenue from 1st Street to Columbia Street in August 1986. A similar intersection has been identified for accident history comparison. Very few periods of evaluation were presented during the winters of 1986-87-88 due to the mild winters. During the high humidity summer seasons the surface sometimes became wet.

Reports: Interim Report, May 1988

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

Project Number: HR-291

Project Title: Performance of Nongrouted Thin, Bonded PCC
Overlays

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

Principal Investigators: Wapello County Engineer, currently
Wendell Folkerts; Iowa Concrete Paving Exec-
utive Vice President, currently Gordon
Smith; and the DOT Portland Cement Concrete
Engineer, currently Jim Grove

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

Research Board Funding: \$14,200

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

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

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

Reports: Progress Report, September 1988

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 ade-
quate bond without grout can be achieved for the
overlay, approximately \$1.00 per square yard of over-
lay could be saved.

Project Number: HR-292

Project Title: Field Evaluation of Integral Abutment Bridges

Agency: Iowa State University

Principal Investigator: Lowell F. Greimann

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

Research Board Funding: \$167,905

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

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

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

Reports: Task 1 Report, September 1986

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

Project Number: HR-293

Project Title: Pavement Instrumentation

Agency: Iowa Department of Transportation, Planning and
Research Division, Iowa State University, Federal Highway Ad-
ministration

Principal Investigator: Roman Dankbar

Research Period: May 1, 1986 to December 31, 1989

Research Board Funding: \$75,000

Funding Source: 100 percent State--Primary funds (Matched by
\$113,000 FHWA funds)

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

Progress: A contract has been executed with Iowa State University for their participation. Five tubes were placed in the subbase crossing the westbound lane of I-80 at the test site to get recordings of moisture and density of the subbase. Some 120 instruments have been installed in a 40 ft. segment of reconstructed pavement. A weigh-in-motion and classification system has been installed and is integrated with strain gage data collection equipment. Software has also been installed to gather data from strain gages. Limited test data have been collected. System debugging is now in progress. A time extension has been requested.

Reports: Interim Report, March 1988

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

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agency: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to July 1991

Research Board Funding: \$80,175

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

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

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

Reports: Construction Report, April 1987

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

Project Number: HR-295

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

Agency: Iowa State University

Principal Investigator: Terry J. Wipf

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

Research Board Funding: \$114,606

Funding Source: 100 percent State--Primary funds

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

Progress: Tilt Sensor Systems were 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. The tilt sensors showed movements that appear to be related to temperature.

Reports: Final Report, November 1988

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

Project Number: HR-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1989

Research Board Funding: \$60,000

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

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
5. present transportation safety information to rural communities by employing a Transportation Safety Circuit Rider

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, 1989

Research Board Funding: \$71,440

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

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

Progress: Bentonite treated limestone samples show potential as
an economical and effective dust palliative. Testing will
continue to determine the optimum bentonite concentration.
Construction and evaluation of a test road in Dallas County
seems to confirm bentonite's potential as a dust
palliative.

Reports: Progress Report, Task II, November 1988

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

Project Number: HR-298

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

Agency: Iowa State University

Principal Investigator: Dah-Yinn Lee

Research Period: January 26, 1987 to March 31, 1990

Research Board Funding: \$205,415

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

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

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

Reports: Progress Report No. 2, March 1989

Implementation: The ability to identify those asphalts which
would not crack in the highway would effect signif-
icant 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 October 31, 1989

Research Board Funding: \$130,360

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

Objective: To:

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

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates has been completed. Phase II is now in progress evaluating various types of fly ash and portland cement composition.

Reports: Phase I Report, June 1988

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

Project Number: HR-300

Project Title: Iowa Development of Roller Compacted Concrete

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

Principal Investigators: O. J. Lane and Mark Callahan

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

Research Board Funding: \$25,122

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

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

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

Reports: Final report, March 1989

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

Project Number: HR-302

Project Title: Alternate Methods of Bridge Strengthening

Agency: Iowa State University

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

Research Period: June 8, 1987 to February 28, 1989

Research Board Funding: \$129,980

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

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

Progress: The project was primarily aimed at two methods of strengthening. These two methods are providing partial end restraint and post-compression of stringers.

Reports: Final Report, February 1989

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

Project Number: HR-303

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

Agency: Tama County

Principal Investigators: Robert Gumbert and Richard Mumm

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

Research Board Funding: \$100,000

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

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

Progress: Construction started in the middle of June 1989. Some problems have been encountered with the compaction of the material in the widening trench. This is most likely due to the trenchers inability to keep pace with the milling machine.

Reports: None

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

Project Number: HR-304

Project Title: Production of Acetic Acid for CMA Deicer

Agency: University of Iowa

Principal Investigator: Paul L. Peterschmidt

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

Research Board Funding: \$16,852

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

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

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

Reports: Final report, May 1988

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

Project Number: HR-305

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

Agency: Iowa State University

Principal Investigator: Eugene Takle

Research Period: July 6, 1987 to June 30, 1990

Research Board Funding: \$93,084

Funding Source: 100 percent State--Primary funds

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of 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 questionnaire has been completed and results are summarized. Analyses of the survey data and actual frost occurrence conditions are in progress. The expert system has been developed. Testing and evaluation of the system will be conducted during the 1989-90 winter period.

Reports: Summary of questionnaire results, June 1988

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

Project Number: HR-306

Project Title: Investigation of Uplift Failures in Flexible Pipe Culverts

Agency: Iowa State University

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

Research Period: January 1, 1988 to January 15, 1990

Research Board Funding: \$110,415

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

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

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

Reports: Progress Report, September 1988

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

Project Number: HR-307

Project Title: Sediment Control in Bridge Waterways

Agency: University of Iowa

Principal Investigator: A. Jacob Odgaard

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

Research Board Funding: \$35,000

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

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

Progress: Some modifications in the design and concept of the vanes have been made. They will be installed in 1989.

Reports: None

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

Project Number: HR-308

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

Agency: Iowa State University

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

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

Research Board Funding: \$142,435

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

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

Progress: The post-tensioning system was developed and tested in the laboratory. In 1988, the system was used to strengthen a Pocahontas County Bridge on N26 just south of Fonda. Some deflection testing of the strengthened bridge has been conducted.

Reports: None

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

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover, and
Andrew Jensen

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

Research Board Funding: \$78,760

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

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

Progress: Construction of the 1.27 mile research project was completed in August 1988.

Reports: Construction Report, February 1989

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

Project Number: HR-310

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

Agency: Iowa State University

Principal Investigator: Dr. Robert E. Abendroth

Research Period: June 1, 1988 to September 30, 1990

Research Board Funding: \$96,088

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

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

Progress: A contract has been signed with Iowa State University to conduct the research. A literature review has been completed. Steel I-beams have been obtained for laboratory testing.

Reports: None

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

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

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

Research Board Funding: \$25,000

Funding Source: 100 percent State--Primary funds

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

Progress: Construction of a creep testing device that will test three specimens simultaneously has been completed. A Retsina Mark VI resilient modulus apparatus has been obtained. Four and six inch diameter cores have been obtained from asphalt concrete pavements that exhibit substantial rutting and some with negligible rutting. Mixes with different amounts of crushed and uncrushed aggregates have been made. Marshall cylinders have been made for creep and resilient modulus testing. Creep and resilient modulus testing is in progress. Much of the testing has been completed and graphs of relationship to percent of crushed particles are available.

Reports: None

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

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen and Andrew Jensen

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

Research Board Funding: \$93,913

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

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

Progress: A contract was signed with Dubuque County to perform
the work. Construction of the project was completed in Oc-
tober 1988.

Reports: Construction Report, March 1989

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

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction -
Washington County

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

Principal Investigator: R. G. Huber and Andrew Jensen

Research Period: August 15, 1988 to December 31, 1993

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the
air form method of arched culvert construction.

Progress: The arch culvert has been constructed in
Washington County. Evaluation of performance is in
progress.

Reports: Construction Report, February 1989

Implementation: Building an arch culvert using the
air form method will use less concrete and steel and
less time will be required for forming than the con-
ventional box culvert. A more efficient and stronger
culvert may be built at a lower cost than a conven-
tional box culvert.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction -
Crawford County

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

Principal Investigator: H. Dale Wight and Andrew Jensen

Research Period: September 15, 1988 to December 31, 1993

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability
of the Air-O-Form method of arch culvert construction.

Progress: Plans are being prepared and construction
is scheduled for the summer of 1990. Construction has been
delayed so that the county can find ways to make this
project more affordable. The Air-O-Form method still has
higher costs when compared to other types of culvert con-
struction. This is probably due to the fact that very few
contractors are qualified to use this method.

Reports: None

Implementation: The air formed method of arch culvert
construction can be less time consuming, use less
steel and concrete, and result in a stronger struc-
ture compared to conventional box culvert con-
struction. Such a structure can also be
hydraulically more efficient and aesthetically more
pleasing than a box culvert.

Project Number: HR-315

Project Title: Iowa Development of Rubblized
Concrete - Mills Co.

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

Principal Investigator: James Ebmeier and Andrew Jensen

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

Funding Source: 100 Percent State--Farm-to-Market fund

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: Plans have been developed and construction is expected to begin in August 1989.

Reports: None

Implementation: Through the development and success of this rehabilitation procedure we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-316

Project Title: Maximized Utility of the Global Positioning System

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: January 1, 1989 to December 31, 1990

Research Board Funding: \$142,840

Funding Source: 100 Percent State--Primary funds

Objective: The objective of this research is to improve the accuracy of Global Positioning System (GPS) for use in Iowa and to train Iowa Department of Transportation personnel in the GPS field.

Progress: Iowa State University has purchased GPS receivers and has begun to collect and analyze data.

Reports: None

Implementation: Global Positioning System has a great potential for both preliminary and final survey for highway locations. It would provide more accurate data with reduced man power.

Project Number: HR-317

Project Title: Evaluation of Edge Drains

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Vernon J. Marks, Kermit L. Dirks
and Robert F. Steffes

Research Period: April 5, 1989 to July 31, 1992

Research Board Funding: \$60,100

Funding Source: 100 percent State--Primary funds

Objective: To use new technology to inspect the inside
of the existing edge drains.

Progress: A review of available inspection equipment has been made. A 2 3/4" diameter video camera with 300 ft. of push cable and a 1/2" diameter video probe with 50 ft. of cable were purchased. TV monitoring and recording facilities are included. Evaluations of selected drains are in progress and a variety of drain problems has been viewed. On a trial basis, the 2 3/4" camera was used in a small culvert and underwater at a bridge pier.

Reports: None

Implementation: New construction, inspection and a review of performance and problems with existing edge drains will reduce pavement deterioration and future edge drain maintenance.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene
Joint Seals

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to April 30, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants in the best section.

Progress: Four projects with new paving were selected, having a wide range of average daily traffic. Sections of Neoprene, silicone, urethane and hot pour types of sealing materials were installed during 1989.

Reports: None

Implementation: Results from the evaluation will help to determine which joint seals should be selected as cost effective or best for long term performance in future projects.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Andrew Jensen

Research Period: March 5, 1980 to present

Research Board Funding: \$32,500.00/yr.

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

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

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

Reports: None

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

Annual Report of Highway Research and Development in Iowa

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ANNUAL REPORT
OF
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1990

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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 Sections 310.36 and 312.3A, Code of Iowa, which directs the submission of a report of the Secondary Road Research Fund and the Street Research Fund respectively. It is a report of the status of research and development projects which were in progress on June 30, 1990; it is also a report on projects completed during the fiscal year beginning July 1, 1989, and ending June 30, 1990. 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.

HIGHWAY RESEARCH ADVISORY BOARD

In developing a progressive, continuing, coordinated program of research and development, the Highway Division is assisted by the Highway Research Advisory 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 and now that denoted by 312.3A.

The Research Board consists of 13 regular members; six county engineers, three Iowa 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, 1990 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1989 to June 30, 1990. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

1990 HIGHWAY RESEARCH ADVISORY 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	12-31-90	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	12-31-91	George F. Sisson Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
David Anthony Boone County Engineer Courthouse Boone, IA 50036 (515) 432-6321 SS#-008	12-31-90	Steven J. Holcomb Grundy County Engineer Courthouse Grundy Center, IA 50638 (319) 824-6912 SS#-038
James R. Bump District 3 Engineer Iowa DOT - Highway Division P.O. Box 987 Sioux City, IA 51102 (712) 276-1451 SS#-230	12-31-90	Robert I. Bortle District 2 Engineer Iowa DOT - Highway Division P.O. Box 741 Mason City, IA 50401 (515) 423-7584 SS#-220
Robert G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 335-5766	12-31-90	Jerald L. Schnoor Dept. of Civil & Envir. Engr. University of Iowa Iowa City, IA 52242 (319) 335-5649
David Kao, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-92	Wallace W. Sanders, Jr. Assoc. Dean for Research Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-6617
Russell A. Krieg Buchanan County Engineer R.R. 2 Independence, IA 50644 (319) 334-6031 SS#-010	12-31-91	Steve DeVries Jackson County Engineer Courthouse Maquoketa, IA 52060 (319) 652-4782 SS#-049
Mike McClain Davis County Engineer Courthouse Bloomfield, IA 52537 (515) 664-2542 SS#-026	12-31-92	E. D. Tice Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004
Richard Ransom City Engineer 1201 6th Street, S.W. Cedar Rapids, IA 52404 (319) 398-5026	12-31-90	John Erickson City Engineer 19 South Delaware Mason City, IA 50401 (515) 421-3604
Eldon Rike Adams County Engineer Courthouse Corning, IA 50841 (515) 322-3910 SS#-002	12-31-90	Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS#-073
Thomas G. Rohe Plymouth County Engineer Courthouse Le Mars, IA 51031 (712) 546-8956 SS#-075	12-31-91	Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072
Richard O. Schiek Kossuth County Engineer Courthouse Algona, IA 50511 (515) 295-3320 SS#-055	12-31-92	Lyle Laartz Chickasaw County Engineer P.O. Box 316 New Hampton, IA 50659 (515) 394-2321 SS#-019
Larry Stevens City Engineer Box 1010 Oskaloosa, IA 52577 (515) 673-7472	12-31-91	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Highway Research Advisory 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, Farm-to-Market Road Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in 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, 1990. Total expenditure was \$1,121,466.25.

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 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 Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern.

The program is funded annually by all 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 1990 as part of the Annual Traffic Count Program. This activity consisted of 96 four-hour manual counts, 35 eight-hour manual counts, and 5,442 portable 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 nine 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1990 financial summary is:

Beginning Balance 7-1-89		\$ 840,220
Receipts		
State Road Use Tax Fund (1 1/2% of receipts)...	\$739,096	
Federal Aid Secondary (1 1/2% of receipts)...	200,611	
Interest	47,970	
Research Income	97,480	
	=====	
Sub-Total		1,085,157
		=====
Total Funds Available		\$1,925,377
Obligation for Expenditures		
Obligated for		
Contract Research...	464,434	
Non-Contract		
Engineering Studies...	304,625	
	=====	
Total Expenditures		\$ 769,059
		=====
BALANCE 6-30-90		\$1,156,318

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year two hundred thousand dollars are set aside from the street construction fund solely for the purpose of financing engineering studies and research projects, which have as their objective the more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1990 financial summary is:

Beginning Balance (9-12-89)		\$200,000
Obligated for Expenditure		
HR-296	\$36,000	
HR-321	9,785	
HR-322	9,147	
HR-323	34,510	
HR-324	8,315	
HR-325	34,125	
HR-327	22,000	
HR-330	9,895	
	=====	
Total Obligated for Expenditure	163,777	
Ending Unobligated Balance 6-30-90		\$ 36,223

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved such as contracted research and project specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. 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 FY90 was \$386,965.71 and the Estimate for FY91 is \$500,000.

PROJECTS INITIATED DURING FY 1990

The new projects initiated during FY 1990 were:

- HR-239, Engineering Study - "Ratings for Secondary Bridge Standards"
- HR-319, "Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges"
- HR-320, "Constructability in the Bridge Design Process"
- HR-321, "Production of Acetic Acid by Fermentation With Propionibacteria"
- HR-322, "Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics"
- HR-323, "Development of Evaluation Rehabilitation and Strengthening Concepts for Low Volume Bridges"
- HR-324, "Construction Plan Reading Course Update"
- HR-325, "Thermoset Composite Concrete Reinforcement"
- HR-327, "Evaluation of the Chemical Durability of Iowa Fly Ash Concretes"
- HR-328, Engineering Study - "Guardrail Attachment Details for Existing Bridges"
- HR-329, "Hydrodemolition Preparation for Dense Concrete Bridge Overlays"
- HR-330, "Evaluation of Recycled Rubber in Asphalt Concrete"

12 projects

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1989 to June 30, 1990
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
140	94,985/yr.	Collection and Analysis of Stream Flow Data	93,093.00	45,600.00		138,693.00
165	185,586	Experimental Steel Fiber Reinforced Concrete Overlay				
198	125,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way		50,000.00		50,000.00
220	8,000	Protection of Structural Concrete Substructures				
239	110,000	Engineering Study - Ratings for Secondary Bridge Standards				
246	118,000	Engineering Study - Reducing Sign Vandalism		12.69		12.69
259	89,390	Low Cost Fly Ash-Sand Stabilized Roadway				
276	32,000	Transverse Joint Sealing With Improved Sealants				
277	92,210	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflection Cracking				
279	76,175	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflective Cracking --Fremont County				
285	91,950	Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods				
289	12,800	Engineering Study - Training Aids for Maintaining Iowa's Secondary Road Environment		3,684.10		3,684.10
290	25,200	Ice-Retardant Pavement				
291	14,200	Performance of Nongrouted Thin, Bonded PCC Overlays				
292	167,905	Field Evaluation of Integral Abutment Bridges	8,855.76	17,451.09		26,306.85
293	75,000	Pavement Instrumentation				
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction				
296	80,000/yr	ISU Technology Transfer	17,548.79	37,805.10	4,873.52	60,227.41
297	71,440	Development of an Economic Dust Palliative for Limestone Surfaced Secondary Roads		6,259.18		6,259.18
298	205,415	Correlation of Locally-Based Performance of Asphalts With Their Physicochemical Parameters	26,262.10	24,361.82		50,623.92
299	130,360	Control of Concrete Deterioration Due to Trace Compounds in Deicers	13,335.11	8,200.57		21,535.68
302	129,980	Alternate Methods of Bridge Strengthening	12,804.66	193.35		12,998.01
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete				
305	93,084	Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa	16,303.97			16,303.97
306	110,415	Investigation of Uplift Failures in Flexible Pipe Culverts	3,669.33	58,872.81		62,542.14
307	35,000	Sediment Control in Bridge Waterways		24,405.99		24,405.99
308	142,435	Strengthening of an Existing Continuous Span Steel Beam-Concrete Deck Bridge by Post-Tensioning	10,292.33	35,213.80		45,506.13
309	78,760	An Investigation of Emulsion Stabilized Limestone Screenings				
310	105,538	Precast, Prestressed Concrete Panel Subdecks in Skewed Bridges	6,939.91	22,080.39		29,020.30
311	25,000	Creep and Resilient Modulus Testing of Asphalt Mixtures	1,385.44			1,385.44
312	93,913	Low Cost Techniques of Base Stabilization - Dubuque Co.		8,287.67		8,287.67
313	28,900	Air Formed Arch Culvert Construction - Washington Co.				
314	16,500	Air Formed Arch Culvert Construction - Crawford Co.				
315	98,529	Iowa Development of Rubblized Concrete - Mills Co.		62,984.00		62,984.00
316	142,840	Maximized Utility of the Global Positioning System	25,431.70			25,431.70
317	60,100	Evaluation of Edge Drains	47,755.50			47,755.50
318	20,800	Evaluation of Preformed Neoprene Joint Seals	415.83	44.18		460.01
319	139,860	Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges	24,013.78	2,301.63		26,315.41

320	89,120	Constructability in the Bridge Design Process	13,938.27	2,024.32	15,962.5
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria	29,724.15		29,724.1
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics	20,490.00		20,490.0
323	172,548	Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges		13,170.41	13,170.4
324	41,579	Construction Plan Reading Course Update	362.16		362.1
325	97,500	Thermoset Composite Concrete Reinforcement	9,529.15		9,529.1
327	110,000	Evaluation of Chemical Durability of Iowa Fly Ash Concretes	4,814.37		4,814.3
328	100,000	Engineering Study - Guardrail Attachment Details for Existing Bridges			
329	22,000	Hydrodemolition Preparation for Dense Concrete Bridges			
330	98,956	Evaluation of Recycled Rubber in Asphalt Concrete			
1027	40,000/yr.	Secondary Road Research Coordinator		17,952.32	17,952.3
Contract Research Sub-Total			386,965.31	440,905.42	832,744.2
HPR-PR-PL-1(26)		FY 1990 Planning & Research Program (Transportation Inventory Engineering Studies)		288,722.00	288,722.0
Noncontract Engineering Studies Sub-Total				288,722.00	288,722.0
Grand Total of Expenditures			386,965.71	729,627.42	1,121,466.2

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: Nick Melcher, U.S.G.S.

Research Period: Project continued to September 30, 1990

Research Board Funding: \$94,985 per year (matched by \$94,985 from the Department of the Interior)

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

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

Objective: 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 1989-1990 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: Russ Helms and Vernon Marks

Research Period: January 1, 1973 to August 31, 1989

Research Board Funding: \$185,586

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

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

Progress: This project on Greene County road E53 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 and 1988 at 15 years. Some full depth patching in 1984 was necessary to extend the evaluation period through 15 years. Most of the deterioration occurred in the first five years. The overlay performed better than expected from five through 15 years. A final report was distributed in August 1989.

Reports: Fifteen year report, August 1989

Implementation: The long term performance data provided 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: State Archaeologist

Research Period: July 1, 1977 to December 31, 1990

Research Board Funding: \$125,000

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 examinations.

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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

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 June 30, 1991

Research Board 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. Plans are to submit the final report in June 1991.

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-239

Project Title: Engineering Study to Evaluate Secondary Bridges
With Respect to Current Truck Length and Weight
Laws

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald

Research Period: May 9, 1990 to June 1991

Research Board Funding: \$110,000

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

Objective: To engage a consulting firm to rate approximately 22 bridge standards that will contain the inventory rating, operating rating, and load capacities for each bridge standard.

This is a reopening of a 1982 project for bridge ratings. The initial project expenditure was \$66,091 producing a 1982 report of bridge ratings.

Progress: A consultant selection committee has been formed and work is expected to begin late in 1990.

Reports: None

Implementation: Much attention is being focused on our bridges today. Many old bridges are in need of rehabilitation or replacement. With the increase in truck volume and weight over the last decade, it becomes apparent that there is an urgency to verify the load carrying capacity of our bridges. With the recent revisions to the National Bridge Inspection Standards (NBIS), there is a need to report the operating and inventory ratings in an equivalent HS loading.

Project Number: HR-246

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: June 14, 1982 to December 31, 1991

Research Board 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. Data is being collected from several counties to evaluate the effectiveness of this campaign.

Reports: Progress Report, January 1987

Implementation: It is estimated that approximately \$2 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-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 June 30, 1991

Research Board 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 H40. 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 material for secondary road construction.

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 Gary Harris

Research Period: April 1, 1985 to April 30, 1991

Research Board 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 materials for filling and sealing sawn contraction joints.

Progress: An extra work order was negotiated to include 22,000 linear feet of experimental contraction joint work on a Jasper County project. Special sawing and cleaning were performed and eight different sealants were installed on a pcc paving project on county route T12 in 1985. 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 Board Funding: \$92,210

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

Objective: 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 section of PCC pavement into pieces ranging in size from 2 to 3 feet and from 4 to 5 feet. Also, overlay thicknesses of 2 inches, 3 inches, and 4 inches were placed on the broken slab. The project was constructed on Hamilton County route R33. Construction was completed in June 1986. Performance evaluation is continuing.

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-279

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

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

Principal Investigators: Charles Marker and Glenn Miller

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

Research Board Funding: \$76,175

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

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

Progress: The project included breaking a 2-mile pcc pavement section with transverse cracking at 3 feet intervals. A portion of the project was overlaid with 3 inches of asphalt concrete and a portion overlaid with 4 inches of asphalt concrete. The project is located on Fremont County road J46. Construction was completed in October 1986. Performance evaluation is continuing.

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-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, Department of Interior

Principal Investigator: Phil Soenksen

Research Period: November 1, 1985 to June 30, 1990

Research Board Funding: \$91,950

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

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

Progress: Equipment was installed on eight selected streams
to obtain flow data during the high flows of the
1986-88 water years. A fluorescent dye, rhodamine-WT,
was used as the tracer. The research demonstrated the
potential for automatic stream gaging, but there was
variation in the accuracy of the measurements. Incom-
plete mixing and dye loss to sediment apparently were
problems at some stations. The automatic gaging needs
further development for use in the future.

Reports: Final Report, 1990 (June 1990)

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 struc-
tures.

Project Number: HR-289

Project Title: Engineering Study - Training Aids for Maintaining
Iowa's Secondary Road Environment

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: January 1, 1986 to June 30, 1990

Research Board Funding: \$12,800

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

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

Progress: The final slide/tape presentation has been completed. A videotape version of the presentation has also been produced. Copies of either format have been sent to the counties.

Reports: Final Report, March 1989

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

Project Number: HR-290

Project Title: Ice Retardant Pavement

Agency: City of Des Moines

Principal Investigator: John P. Bellizzi

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

Research Board Funding: \$25,200

Funding Source: 100 percent State--Primary funds

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

Progress: The experimental Verglimit section was constructed on Euclid Avenue from 1st Street to Columbia Street in August 1986. A similar intersection has been identified for accident history comparison. Very few periods of evaluation were presented during the winters of 1986-87-88 due to the mild winters. Effectiveness of the ice retardant is noticed, in a limited manner only: 1) during a frost; 2) at the beginning of a storm; 3) in a light storm. During the high humidity summer seasons the surface sometimes became wet.

Reports: Interim Report, May 1988

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

Project Number: HR-291

Project Title: Performance of Nongrouted Thin, Bonded PCC
Overlays

Agency: Iowa Concrete Paving Association, Wapello County, Monroe
County and the Iowa Department of Transportation, High-
way Division

Principal Investigators: Wapello County Engineer,
Wendell Folkerts; Iowa Concrete Paving
Executive Vice President, Gordon Smith;
and the DOT Portland Cement Concrete
Engineer, Jim Grove

Research Period: March 1, 1986 to April 30, 1991

Research Board Funding: \$14,200

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

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

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

Reports: Progress Report, September 1988

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: Lowell F. Greimann

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

Research Board Funding: \$167,905

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

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. Measurement of movements of two integral abutment bridges have been made for field evaluation during substantial temperature variations. Field testing has been completed.

Reports: Final Report, September 1989

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, Planning and Research
Division, Iowa State University, Federal Highway Admin-
istration

Principal Investigator: Roman Dankbar

Research Period: May 1, 1986 to June 31, 1992

Research Board Funding: \$75,000

Funding Source: 100 percent State--Primary funds (Matched by
\$113,000 FHWA funds)

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

Progress: A contract has been executed with Iowa State University for their participation. Five conduits were placed in the subbase crossing the westbound lane of I-80 at the test site to get recordings of moisture and density of the subbase. Some 120 instruments have been installed in a 40 ft. segment of reconstructed pavement. A weigh-in-motion and classification system has been installed and is integrated with strain gage and deflection gage data collection equipment. Software has also been installed to gather data. Limited test data have been collected. System debugging is in progress. A time extension has been granted.

Reports: Interim Report, March 1988

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

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agency: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to July 1991

Research Board Funding: \$80,175

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

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

Progress: A 1.8 mile section of R63 north of its intersection with E29 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-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1990

Research Board Funding: \$80,000

Funding Source: 100 percent State--10 percent Primary funds,
45 percent Farm-to-Market funds, 45 percent
Street Research funds

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
5. present transportation safety information to rural
communities by employing a Transportation Safety
Circuit Rider

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 February 28, 1990

Research Board Funding: \$71,440

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

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 treatment at the 2 to 3 percent level is estimated to provide a 30 to 40 percent dust reduction over the long term (18-24 months). Soda ash dispersed Bentonite treatment is approximately 10 times more cost effective per percent dust reduction than conventional chloride treatments with respect to time. The public may not accept the 40% dust reduction with 3% Bentonite in contrast to 70% dust reduction with calcium chloride.

Reports: Final Report, February 1990

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 March 31, 1990

Research Board Funding: \$205,415

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

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

Progress: The High Pressure Liquid Chromatography (HPLC)
equipment was obtained. Twelve asphalt samples and 6
core samples were obtained from a variety of sources
and were tested. Nuclear magnetic resonance testing
was evaluated. Testing and evaluation have been com-
pleted.

Reports: Final Report, March 1990

Implementation: The ability to identify those asphalts which
would result in fewer cracks 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 October 31, 1991

Research Board Funding: \$130,360

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

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
4. Establish a correlation between an efficient laboratory test and field performance of concrete.

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates has been completed. Phase II concluded that 15% fly ash replacement significantly improved the freeze-thaw resistance of mortar in sulfate-tainted brines. Evaluation of concrete beams with various aggregates in brine solutions is in progress as part of Phase III.

Reports: Phase I Report, June 1988; Phase II Report, July 1989

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-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 February 28, 1989

Research Board Funding: \$129,980

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

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

Progress: The project was primarily aimed at two methods of strengthening. These two methods are providing partial end restraint and post-compression of stringers. The research has shown these to be effective methods of bridge strengthening.

Reports: Final Report, February 1989

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 and the Iowa Department of Transportation,
Highway Division

Principal Investigators: Robert Gumbert and Richard Mumm

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

Research Board Funding: \$100,000

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

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

Progress: Construction started in the middle of June 1989. Some problems have been encountered with the compaction of the material in the widening trench. This is most likely due to the trenchers ability to keep pace with the milling machine. The finished surface is carrying traffic well, but there are some areas causing concern due to movement and evidence of marginal stability. A construction report will be distributed in December 1990.

Reports: None

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

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, 1991

Research Board Funding: \$93,084

Funding Source: 100 percent State--Primary funds

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of 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 questionnaire has been completed and results are summarized. Analyses of the survey data and actual frost occurrence conditions are in progress. The expert system has been developed. Testing and evaluation of the system was conducted during the 1989-90 winter period. The Freese-Notis weather forecasters evaluated the system during that period and intend to continue to evaluate it during the 1990-91 winter season.

Reports: Progress Report, May 1989

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

Project Number: HR-306

Project Title: Investigation of Uplift Failures in Flexible
Pipe Culverts

Agency: Iowa State University

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

Research Period: January 1, 1988 to March 31, 1990

Research Board Funding: \$110,415

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

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

Progress: Field trips to culvert failure locations were made to study the causes of the failures. Also, a computer program was developed to aid in analyzing appropriate tie down guidelines based on worst case scenarios of forces acting on culverts. Concrete headwalls or slope collars are recommended for most pipes over 4 feet in diameter.

Reports: Final Report, March 1990

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

Project Number: HR-307

Project Title: Sediment Control in Bridge Waterways

Agency: University of Iowa

Principal Investigator: A. Jacob Odgaard

Research Period: January 15, 1988 to February 28, 1990

Research Board Funding: \$35,000

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

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

Progress: Research results of laboratory and field tests have been determined and the resulting design procedure presented. Design graphs have been developed based on the basic theory defined in this research. The graphs are entered with basic flow variables and desired bed topography. Twelve vanes were installed at a highway crossing of the West Fork Cedar River in Butler County. They have been effective in holding the flow in the middle of the channel and preventing scour at the abutment.

Reports: Final Report, February 1990

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

Project Number: HR-308

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

Agency: Iowa State University

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

Research Period: February 1, 1988 to February 28, 1990

Research Board Funding: \$142,435

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

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

Progress: The post-tensioning system was developed and tested in the laboratory. In 1988, the system was used to strengthen a Pocahontas County bridge on N26 just south of Fonda. Some deflection testing of the strengthened bridge has been conducted. The bridge was retested in 1989. The strengthening system is functioning well.

Reports: Final Report, February 1990

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

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover and
Gary Harris

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

Research Board Funding: \$78,760

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

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

Progress: Construction of the 1.27 mile research project was completed in August 1988. There has been some potholing, but it is generally performing well. Evaluation is continuing.

Reports: Construction Report, February 1989

Implementation: Finding useful ways of incorporating by-product aggregate into construction of lower traffic volume roads will ease the burden of disposal for contractors and reduce the cost of construction for counties.

Project Number: HR-310

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

Agency: Iowa State University

Principal Investigator: Dr. Robert E. Abendroth

Research Period: June 1, 1988 to February 28, 1991

Research Board Funding: \$105,538

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

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

Progress: A contract has been signed with Iowa State University to conduct the research. A literature review (Task 1) has been completed. Field investigations (Task 2) on 3 bridges containing precast panel subdecks has been completed. Monitoring behavior (Task 3) of full scale composite deck slabs is underway.

Reports: Interim Report, January 1990

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

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: June 15, 1988 to December 31, 1991

Research Board Funding: \$25,000

Funding Source: 100 percent State--Primary funds (Federal Highway Administration funds have been received for testing and evaluation)

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

Progress: Construction of a creep testing device that will test three specimens simultaneously has been completed. A Retsina Mark VI resilient modulus apparatus has been obtained. The creep and resilient modulus testing is in three parts. The first part was "The Effects of Crushed Particles in Asphalt Mixtures". Hot mix asphalt mixtures were made with 0, 30, 60, 85 and 100% crushed gravel, crushed limestone and crushed quartzite combined with uncrushed sand and gravel. These aggregate combinations were used with 4%, 5% and 6% asphalt cement. A creep resistance factor (CRF) developed during the research related very well to the amount of crushed particles and the perceived resistance to rutting.

Part II, currently in progress, is creep and resilient modulus testing of 2 1/2 inch thick slices of four and six inch diameter drilled cores. These cores were taken from pavements with varying amounts of rutting and pavements of an improved design to resist rutting.

Part III of the research will be an effort to compare creep and resilient modulus testing of 1) laboratory mixed and compacted specimens; 2) project mixed, laboratory compacted; and 3) drilled cores on five projects ranging from a low volume road to an interstate.

Reports: Final Report, Part I, January 1990

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

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen and Gary Harris

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

Research Board Funding: \$93,913

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

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

Progress: A contract was signed with Dubuque County to perform the work. Construction of the project was completed in October 1988. Overall, the project went well. It is recommended these materials be used to construct roadways during the summer because of the better drying weather. The days were cool and this may have hindered efforts to achieve adequate compaction. Performance evaluation is continuing.

Reports: Construction Report, March 1989

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

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction -
Washington County

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

Principal Investigators: R. G. Huber and Gary Harris

Research Period: August 15, 1988 to December 31, 1993

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the air form
method of arched culvert construction.

Progress: The arch culvert was constructed in Washington
County in October 1988. Post construction inspection
of the air formed arch culvert showed the Air-O-Form
method can be used to construct a structurally sound
arch culvert. However, this method must become more
economical if it is to compete with box culvert con-
struction for county and state culvert projects.
Evaluation of performance is in progress.

Reports: Construction Report, February 1989

Implementation: Building an arch culvert using the air form
method will use less concrete and steel and less
time will be required for forming than the con-
ventional box culvert. A more efficient and
stronger culvert may be built at a lower cost
than a conventional box culvert.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction -
Crawford County

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

Principal Investigators: H. Dale Wight and Gary Harris

Research Period: September 15, 1988 to December 31, 1993

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability
of the Air-O-Form method of arch culvert con-
struction.

Progress: Construction was delayed until October of 1990 so
that the county could find ways to make this project
more affordable. The Air-O-Form method still has
higher costs when compared to other types of culvert
construction. This is probably due to the fact that
very few contractors are qualified to use this method.

Reports: None

Implementation: The air formed method of arch culvert
construction can be less time consuming, use
less steel and concrete, and result in a
stronger structure compared to conventional box
culvert construction. Such a structure can also
be hydraulically more efficient and aesthet-
ically more pleasing than a box culvert.

Project Number: HR-315

Project Title: Iowa Development of Rubblized Concrete
- Mills Co.

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

Principal Investigators: James Ebmeier and Gary Harris

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

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

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: The project was constructed in the fall of 1989 and to date the performance of the test sections have been very satisfactory. While there are some areas where the rideability is not the most desirable, it has improved greatly and no cracks have developed in the surface.

Reports: Construction Report, March 1990

Implementation: Through the development and success of this rehabilitation procedure, we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-316

Project Title: Maximized Utility of the Global Positioning System

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: January 1, 1989 to December 31, 1990

Research Board Funding: \$142,840

Funding Source: 100 percent State--Primary funds

Objective: The objective of this research is to improve the accuracy of Global Positioning System (GPS) for use in Iowa and to train Iowa Department of Transportation personnel in the GPS field.

Progress: Iowa State University has purchased GPS receivers and has conducted three surveys of one mile, five mile and 30 mile radii. Horizontal and vertical accuracies are within 0.2 ft. The data is very encouraging.

Reports: Progress Report, January 1990

Implementation: Global Positioning System has a great potential for both preliminary and final survey for highway locations. It would provide more accurate data and greater survey capability with current staff.

Project Number: HR-317

Project Title: Evaluation of Edge Drains

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: Vernon J. Marks, Kermit L. Dirks
and Robert F. Steffes

Research Period: April 5, 1989 to July 31, 1992

Research Board Funding: \$60,100

Funding Source: 100 percent State--Primary funds

Objective: To use new technology to inspect the inside of the existing edge drains.

Progress: A review of available inspection equipment has been made. A 2 3/4" diameter video camera with 300 ft. of push cable and a 1/2" diameter video probe with 50 ft. of cable were purchased. TV monitoring and recording facilities are included. Evaluations of selected drains are in progress and a variety of drain problems have been viewed. Some edge drain design specifications have been modified due to video evaluation results. Demand for video evaluations has increased for culverts and new edge drain construction. In the past year approximately 100 drains were inspected.

Reports: Produced 10 minute videotape

Implementation: New construction, inspection and a review of performance and problems with existing edge drains will reduce pavement deterioration and future edge drain maintenance.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene Joint Seals

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to April 30, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants.

Progress: Four new paving projects with a wide range of average daily traffic were selected for sealant research. Sections of Neoprene, silicone, urethane and hot pour types of sealing materials were installed during 1989. Three additional sites were added in 1990. Evaluation of sealant performance is in progress.

Reports: None

Implementation: Results from the evaluation will help to determine which joint sealants should be selected as cost effective or best for long term performance in future projects.

Project Number: HR-319

Project Title: Lateral Load Resistance of Diaphragms in
Prestressed Concrete Girder Bridges

Agency: Iowa State University

Principal Investigators: Robert E. Abendroth, F. Wayne Klaiber

Research Period: July 1, 1989 to October 31, 1990

Research Board Funding: \$139,860

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

Objective: To investigate the effectiveness of reinforced concrete and steel intermediate diaphragms to lateral load and to determine whether steel diaphragms of any conventional configuration can provide adequate protection to minimize the damage to prestressed concrete girders caused by lateral impact.

Progress: A contract was signed with Iowa State University. The test bridge has been constructed and the experimental work with diaphragms has begun.

Reports: None

Implementation: Steel diaphragms could provide the same protection to the prestressed concrete girders as the reinforced concrete diaphragms that are currently being used by the Iowa DOT. Use of steel diaphragms would reduce bridge construction costs.

Project Number: HR-320

Project Title: Constructability in the Bridge Design Process

Agency: Iowa State University

Principal Investigator: Dr. James Rowings

Research Period: July 17, 1989 to January 31, 1991

Research Board Funding: \$89,120

Funding Source: 100 percent State--70 percent Primary funds
and 30 percent Secondary funds

Objective: To analyze constructability opportunities for bridge projects and develop an initial constructability knowledge-base. This knowledge-base provides a mechanism to collect construction knowledge and transfer it from completed projects to future projects. The knowledge-base will be developed for use on a microcomputer and could be made interactive with other computer-aided design software in the future.

Progress: A contract has been signed with Iowa State University for their participation. A comprehensive literature review was made. A survey on constructability considerations was mailed to 36 contractors and designers.

Reports: Progress Report, April 30, 1990

Implementation: The development of a constructability knowledge-base, to be used in the design phase for bridges will reduce costs and time for construction, along with materials and labor without compromising quality, safety and project scope.

Project Number: HR-321

Project Title: Production of Acetic Acid by Fermentation
With Propionibacteria

Agency: Iowa State University

Principal Investigators: Earl Hammond, Bonita Glatz and
Charles Glatz

Research Period: November 2, 1989 to January 31, 1993

Research Board Funding: \$97,850

Funding Source: 100 percent State--90 percent Primary funds,
10 percent Street Research funds

Objective: To find an economically favorable route to the
production of acetic acid by fermentation with
propionibacteria.

Progress: A bench-scale fermenter was purchased for use
with fermentation studies. An ultrafiltration appara-
tus was purchased and attempts are being made to adapt
this into an ultrafiltration apparatus for removing
acetic and propionic acids from the fermentation mix-
tures. The intent is to produce less expensive acetic
acid for use in producing less expensive calcium
magnesium acetate (CMA) deicer.

Reports: Progress Report, May 1990

Implementation: Reduced costs of acetic acid will allow the
use of CMA deicer at selected locations to pre-
vent corrosion.

Project Number: HR-322

Project Title: Estimating Design Flood Discharge for Iowa Using
Drainage Basin and Channel Geometry Character-
istics

Agency: Water Resources Division of the United States
Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1989 to September 30, 1992

Research Board Funding: \$91,471

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: To develop a single set of equations for Iowa that
relate measurable basin and channel characteristics
to flood peaks of 5, 10, 25, 50 and 100 year frequen-
cies

Progress: A contract has been signed with Water Resources
Division of the United States Geological Survey. Data
is being collected.

Reports: None

Implementation: More reliable estimates of design flood
discharges will allow selection of the required
size of bridges and culverts which will reduce
the cost by avoiding overdesign.

Project Number: HR-323

Project Title: Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber and Terry J. Wipf

Research Period: October 31, 1989 to November 1991

Research Board Funding: \$172,548

Funding Source: 100 percent State--20 percent Street Research funds, 80 percent Farm-to-Market funds

Objective: To develop a design manual for evaluating, rehabilitating and/or strengthening low volume bridges.

Progress: Phase I involving data collection and Phase II dealing with what types of bridges have the most problems and what those problems entail are now being conducted.

Reports: None

Implementation: There are over 24,000 rural bridges in Iowa. One-half of these are structurally deficient or obsolete. These bridges are generally on low volume roads and are low priority for expenditures for rehabilitation. A design manual for engineers to use would help address this problem of rehabilitating and/or strengthening of secondary bridges.

Project Number: HR-324

Project Title: Construction Plan Reading Course Update

Agency: Iowa State University

Principal Investigator: Gerald W. Chase

Research Period: December 1, 1989 to March 31, 1991

Research Board Funding: \$41,579

Funding Source: 100 percent State--45 percent Primary funds,
35 percent Farm-to-Market funds, 20 percent
Street Research funds

Objective: To update a basic construction plan reading course.

Progress: A contract was signed with Iowa State University.
Updated plans and the training instructions are being
developed.

Reports: None

Implementation: When new employees are hired at entry level in
both state and local government construction
jobs, they will be able to attend a course that
will help them in plan reading on new con-
struction and also repair, reconstruction and
restoration. This improved training will yield
better construction inspection which in turn
will improve quality of construction.

Project Number: HR-325

Project Title: Thermoset Composite Concrete Reinforcement

Agency: Iowa State University

Principal Investigator: Max Porter

Research Period: January 1, 1990 to January 31, 1992

Research Board Funding: \$97,500

Funding Source: 100 percent State--35 percent Primary funds
30 percent Farm-to-Market funds and 35 percent
Street Research funds

Objective: To determine shear behavior and strength on dowel
Fibercomposite (FC) bars with and without aging, and
to determine the potential aging effects on bond of
FC reinforcing bars.

Progress: A contract has been executed with Iowa State
University. Testing and evaluation of composite rein-
forcing is in progress.

Reports: None

Implementation: FC reinforcing bars in structures such as
bridge decks can offer a valuable alternative
against failures from corrosion. Results from
tests on long term exposure and aging of FC re-
inforcing bars will influence the scope of their
use.

Project Number: HR-327

Project Title: Evaluation of Chemical Durability of Iowa Fly Ash Concretes

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: April 1, 1990 to March 31, 1993

Research Board Funding: \$110,000

Funding Source: 100 percent State--40 percent Primary funds
40 percent Farm-to-Market funds and 20 percent
Street Research funds

Objective: To evaluate the chemical durability (sulfate/alkali) of Iowa Class C fly ash concretes at varying fly ash replacement levels ranging from 0 percent to 50 percent.

Progress: A contract has been executed with Iowa State University. Aggregate for the research is being collected.

Reports: None

Implementation: The determination of maximum percentage of low cost Iowa fly ash which can be used to produce quality concrete for Iowa highways will optimize savings for Iowa taxpayers as well as promote use of a waste material.

Project Number: HR-328

Project Title: Engineering Study - Guardrail Attachment Details
for Existing Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald

Research Period: April 5, 1990 to April 1992

Research Board Funding: \$100,000

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

Objective: To develop standard designs for retrofitting W-beam
to thrie-beam rail at the end posts of secondary
bridges.

Progress: The DOT is presently considering the potential
liability associated with research to design attach-
ment details for a guardrail design that may not con-
form to current standard crash tests or accepted
procedures.

Reports: None

Implementation: To meet today's safety requirements, county
engineers need to install thrie-beam rail with a
different and more difficult fastening design
than the W-beam rail. This engineering study
seeks to provide county engineers with standard
designs they can utilize to make these improve-
ments.

Project Number: HR-329

Project Title: Hydrodemolition Preparation for Dense Concrete
Bridge Overlays

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: May 1990 to December 1994

Research Board Funding: \$22,000

Funding Source: 100 percent State--Primary funds

Objective: To evaluate hydrodemolition preparation of an Iowa
bridge deck.

Progress: Arrangements were made to add the research to a 1990
project by extra work order. Due to lack of experience in control of equipment the operation was postponed, pending a 1991 project.

Reports: None

Implementation: Hydrodemolition preparation offers an
improved method for bridge deck surface removal
and preparation for a new overlay.

Project Number: HR-330

Project Title: Evaluation of Recycled Rubber in Asphalt Concrete

Agency: University of Northern Iowa and Iowa Department of Transportation, Highway Division

Principal Investigators: Shahram Varzavand, Dr. Stephan Egger and Vernon Marks

Research Period: June 11, 1990 to December 31, 1995

Research Board Funding: \$98,956

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: To evaluate the use of asphalt-rubber binders and recycled rubber granules in Iowa asphalt concrete pavements.

Progress: Four experimental sections will be constructed on Muscatine County project F-61-4(49)--20-70 on US 61 from Muscatine to Blue Grass. The asphalt concrete overlay will be two inches of surface over two inches of binder. A contract will be negotiated with the University of Northern Iowa for laboratory evaluation of the asphalt-rubber binder.

Reports: None

Implementation: This research will provide information on whether an asphalt-rubber binder yields significantly improved performance and if it is cost-effective. It will provide information on the use of recycled rubber in asphalt concrete.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: March 5, 1980 to present

Research Board Funding: \$40,000.00/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: Gary Harris 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.

Annual Report of Highway Division Highway Research and Development in Iowa

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Highway Division
Office of Materials
September 1991



**Iowa Department
of Transportation**

ANNUAL REPORT
OF HIGHWAY DIVISION
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1991

OFFICE OF MATERIALS
(515) 239-1447

HIGHWAY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

SEPTEMBER 1991

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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 Division Highway Research and Development in Iowa", is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which directs the submission of a report of the Secondary Road Research Fund and the Street Research Fund respectively. It is a report of the status of research and development projects which were in progress on June 30, 1991; it is also a report on projects completed during the fiscal year beginning July 1, 1990, and ending June 30, 1991. 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.

HIGHWAY RESEARCH ADVISORY BOARD

In developing a progressive, continuing, coordinated program of research and development, the Highway Division is assisted by the Highway Research Advisory 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 and now that denoted by 312.3A.

The Research Board consists of 13 regular members; six county engineers, three Iowa 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, 1991 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1990 to June 30, 1991. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

Member	Term Expires	Alternate
Donald A. Anderson Deputy Director, Operations Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1491	12-31-93	Bernard C. Brown State Materials Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1452
Robert I. Bortle District 2 Engineer Iowa DOT - Highway Division P.O. Box 741 Mason City, IA 50401 (515) 423-7584 SS#-220	12-31-93	Kenneth M. Meeks District 1 Engineer Iowa DOT - Highway Division 1020 S. Fourth Street Ames, IA, 50010 (515) 239-1635
Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS-#073	12-31-93	J. Brian Morrissey Madison County Engineer P.O. Box 152 Winterset, IA 50273 (515) 462-1136 SS-#061
John Erickson City Engineer 19 South Delaware Mason City, IA 50401 (515) 421-3604	12-31-93	Paul Wiegand Director of Public Works 515 Clark Avenue Ames, IA 50010 (515) 239-5162
Robert G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 335-5766	12-31-93	Gene F. Parkin Dept. of Civil & Envir. Engr. 1134 Engineering Bldg. The University of Iowa Iowa City, IA 52242 (319) 335-5655
Steven J. Holcomb Grundy County Engineer Courthouse Grundy Center, IA 50638 (319) 824-6912 SS#-038	12-31-93	Royce J. Fichtner Marshall County Engineer Courthouse Marshalltown, IA 50158 (515) 754-6343 SS#-064
David Kao, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-92	Wallace W. Sanders, Jr. Iowa State University Dept. of Civil & Const. Engr. 394 Town Engineering Bld. Ames, IA 50011-3232 (515) 294-6048
Russell A. Krieg Buchanan County Engineer R.R. 2 Independence, IA 50644 (319) 334-6031 SS#-010	12-31-91	Steve DeVries Jackson County Engineer Courthouse Maquoketa, IA 52060 (319) 652-4782 SS#-049
Mike McClain Davis County Engineer Courthouse Bloomfield, IA 52537 (515) 664-2542 SS#-026	12-31-92	E. D. Tice Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004
Thomas G. Rohe Plymouth County Engineer Courthouse Le Mars, IA 51031 (712) 546-8956 SS#-075	12-31-91	Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072
Richard O. Schiek Kossuth County Engineer Courthouse Algona, IA 50511 (515) 295-3320 SS#-055	12-31-92	Lyle Laartz Chickasaw County Engineer P.O. Box 316 New Hampton, IA 50659 (515) 394-2321 SS#-019
George F. Sisson Deputy Director, Development Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1461	12-31-91	Donald East Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
Larry Stevens City Engineer P.O. Box 1010 Oskaloosa, IA 52577 (515) 673-7472	12-31-91	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Highway Research Advisory 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, Farm-to-Market Road Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in 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, 1991. Total expenditure was \$1,346,865.98.

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 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 Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern.

The program is funded annually by all 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-four counties during fiscal year 1991 as part of the Annual Traffic Count Program. This activity consisted of 5 eight-hour manual counts, and 5,381 portable 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 eleven 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1991 financial summary is:

Beginning Balance 7-1-90		\$1,156,318
Receipts		
State Road Use Tax Fund (1 1/2% of receipts)...	\$757,385	
Federal Aid Secondary (1 1/2% of receipts) ..	244,551	
Research Income	245,411	
	=====	
Sub-Total		1,247,347
		=====
Total Funds Available		\$2,403,665
Obligation for Expenditures		
Obligated for		
Contract Research...	1,130,572	
Non-Contract		
Engineering Studies...	262,456	
	=====	
Total Expenditures		\$1,393,028
		=====
BALANCE 6-30-91		\$1,010,637

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year two hundred thousand dollars are set aside from the street construction fund solely for the purpose of financing engineering studies and research projects, which have as their objective the more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1991 financial summary is:

Beginning Balance (7-1-90)		\$236,223
Obligated for Expenditure		
HR-332	\$16,590	
HR-333	77,355	
HR-334	34,480	
HR-335	17,325	
HR-336	12,000	
HR-337	47,106	
HR-342	10,276	
	=====	
Total Obligated for Expenditure	215,132	
Ending Unobligated Balance 6-30-91		\$ 21,091

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved such as contracted research and project specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. 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 FY91 was \$453,210.98 and the Estimate for FY92 is \$750,000.

PROJECTS INITIATED DURING FY 1991

The new projects initiated during FY 1990 were:

- HR-331, Engineering Study - "Skewed Tee Piers for Secondary Bridges"
- HR-332, "Design Methodology for Corrugated Metal Pipe Tiedowns: Phase I"
- HR-333, "Design Methodology for Post-Tensioning Strengthening of Continuous Span Bridges"
- HR-334, "Field Measurements of Plow Loads During Ice Removal Operations"
- HR-335, "Driver Behavior at Railroad Grade Crossings: Before and After Safety Campaign"
- HR-336, "Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability"
- HR-337, "Investigation of Rapid Thermal Analysis Procedures for Prediction of the Service Life of PCCP Carbonate Coarse Aggregate"
- HR-338, "The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool"
- HR-341, "Bond Enhancement Techniques for PCC Whitetopping"
- HR-342, "Use of GPS for Photogrammetry"

10 projects

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1990 to June 30, 1991
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
140	94,985/yr.	Collection and Analysis of Stream Flow Data	44,027.00	47,492.00	4,892.00	96,411.00
198	125,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way				
220	8,000	Protection of Structural Concrete Substructures				
239	110,000	Engineering Study - Ratings for Secondary Bridge Standards		68,153.95		68,153.95
246	118,000	Engineering Study - Reducing Sign Vandalism				
259	89,390	Low Cost Fly Ash-Sand Stabilized Roadway				
276	32,000	Transverse Joint Sealing With Improved Sealants		19.80		19.80
277	92,210	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflection Cracking				
279	76,175	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflective Cracking --Fremont County				
285	91,950	Measuring Discharge at Crest-Stage Gaging Stations Using Tracer-Dilution Methods				
290	25,200	Ice-Retardant Pavement				
291	14,200	Performance of Nongrouted Thin, Bonded PCC Overlays		1,719.68		1,719.68
293	75,000	Pavement Instrumentation	2,415.65			2,415.65
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction		370.52		370.52
296	80,000/yr	ISU Technology Transfer	10,171.10	45,775.08	44,630.35	100,576.53
298	205,415	Correlation of Locally-Based Performance of Asphalts With Their Physicochemical Parameters	7,073.39	13,468.16		20,541.55
299	130,360	Control of Concrete Deterioration Due to Trace Compounds in Deicers	27,594.60	9,611.42		37,206.02
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete		100,000.00		100,000.00
305	93,084	Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa	15,490.94			15,490.94
307	35,000	Sediment Control in Bridge Waterways	3,500.00			3,500.00
309	78,760	An Investigation of Emulsion Stabilized Limestone Screenings		320.25		320.25
310	105,538	Precast, Prestressed Concrete Panel Subdecks in Skewed Bridges	4,045.16	15,023.49		19,068.65
311	25,000	Creep and Resilient Modulus Testing of Asphalt Mixtures				
312	93,913	Low Cost Techniques of Base Stabilization - Dubuque Co.				
313	28,900	Air Formed Arch Culvert Construction - Washington Co.				
314	16,500	Air Formed Arch Culvert Construction - Crawford Co.		13,500.00		13,500.00
315	98,529	Iowa Development of Rubblized Concrete - Mills Co.				
316	142,840	Maximized Utility of the Global Positioning System	47,814.80			47,814.80
317	60,100	Evaluation of Edge Drains	444.12			444.12
318	20,800	Evaluation of Preformed Neoprene Joint Seals				
319	139,860	Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges	71,467.30	24,305.74		95,773.04
320	89,120	Constructability in the Bridge Design Process	40,689.22	12,483.84		53,173.06
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria	18,957.20	2,936.20		21,893.40
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics	17,398.00	20,489.00		37,887.00
323	172,548	Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges		65,077.25	16,889.12	81,966.37
324	41,579	Construction Plan Reading Course Update	17,847.00	5,381.08	1,881.55	25,109.63
325	97,500	Thermoset Composite Concrete Reinforcement	23,423.16	9,271.85	12,422.18	45,117.19
327	110,000	Evaluation of Chemical Durability of Iowa Fly Ash Concretes	36,442.06	36,405.52	14,653.91	87,501.49
328	100,000	Engineering Study - Guardrail Attachment Details for Existing Bridges				
329	22,000	Hydrodemolition Preparation for Dense Concrete Bridges				
330	98,956	Evaluation of Recycled Rubber in Asphalt Concrete				

331	200,000	Engineering Study - Skewed Tee Piers for Secondary Bridges				
332	165,900	Design Methodology for Corrugated Metal Pipe Tiedowns: Phase I	14,309.26	16,028.32		30,337.58
333	247,850	Design Methodology for Post-Tensioning Strengthening of Continuous Span Bridges	10,254.53	2,918.47	2,932.92	16,105.92
334	137,921	Field Measurements of Plow Loads During Ice Removal Operations	31,927.92			31,927.92
335	49,500	Driver Behavior at Railroad Grade Crossings: Before and After Safety Campaign	4,419.37	3,441.89	3,400.49	11,261.75
336	40,000	Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability	3,499.20			3,499.20
337	157,020	Investigation of Rapid Thermal Analysis Procedures for Prediction of the Service Life of PCCP Carbonate Coarse Aggregate				
338	116,527	The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool				
341	25,000	Bond Enhancement Techniques for PCC Whitetopping				
342	102,755	Use of GPS for Photogrammetry				
1027	40,000/yr.	Secondary Road Research Coordinator		35,228.73		35,228.73
Contract Research Sub-Total			453,210.98	546,486.04	104,638.72	1,104,335.74
HPR-2 (1)		Pooled fund project - GPS for Transportation Planning		1,136.84		1,136.84
HPR-2 (129)		Pooled fund project - Wetland Mitigation Measures		1,129.03		1,129.03
HPR-2 (133)		Pooled fund project - Culvert Repair Practices		628.04		628.04
HPR-2 (134)		Pooled fund project - Test and Evaluation of Bridge Rails and Transitions		156.95		156.95
HPR-2 (136)		Pooled fund project - Noise Barriers		744.79		744.79
HPR-2 (138)		Pooled fund project - Safety of Wider Trucks on Narrow Roadways		2,035.38		2,035.38
HPR-2 (140)		Pooled fund project - Construction Engineering Management		216.98		216.98
HPR-2 (144)		Pooled fund project - Testing of Small and Large Sign Supports		1,357.89		1,357.89
HPR-2 (147)		Pooled fund project - Disposal of Wastes from Highway Materials Testing Laboratories		276.85		276.85
HPR-2 (148)		Pooled fund project - Arterial Analysis Package - Signal Timing Update & Support		1,840.42		1,840.42
HPR-2 (150)		Pooled fund project - Design, Construction & Rehabilitation of Continuously Reinforced Concrete Pavements		141.50		141.50
HPR-3 (10)		Pooled fund project - Crescent Study		1,563.86		1,563.86
HPR-4 (186)		NCHRP FY86 General Project Funding		1,160.43		1,160.43
HPR-4 (187)		NCHRP FY87 General Project Funding		6,296.91		6,296.91
HPR-4 (188)		NCHRP FY88 General Project Funding		8,089.18		8,089.18
HPR-4 (189)		NCHRP FY89 General Project Funding		6,145.31		6,145.31
HPR-4 (190)		NCHRP FY90 General Project Funding		964.00		964.00
HPR-PR-PL-1 (27)		FY 1991 Planning & Research Program (Transportation Inventory Engineering Studies)		208,645.88		208,645.88
Noncontract Engineering Studies Sub-Total				242,530.24		242,530.24
Grand Total of Expenditures			453,210.98	789,016.28	104,638.72	1,346,865.98

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: Nick Melcher, U.S.G.S.

Research Period: Project continued to September 30, 1991

Research Board Funding: \$97,838 per year (matched by \$97,838 from the Department of the Interior)

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market funds and 10 percent Street Research funds

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

Objective: 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 1990-1991 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. A special report entitled "Floods in the Nishnabotna River Basin, Iowa" was distributed in 1991.

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

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: State Archaeologist

Research Period: July 1, 1977 to June 30, 1991

Research Board Funding: \$125,000

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 examinations.

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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

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 December 31, 1991

Research Board 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. Plans are to submit the final report in December 1991.

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-239

Project Title: Engineering Study to Evaluate Secondary Bridges
With Respect to Current Truck Length and Weight
Laws

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald

Research Period: May 9, 1990 to May 31, 1991

Research Board Funding: \$110,000

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

Objective: To engage a consulting firm to rate approximately
22 bridge standards that will contain the inventory
rating, operating rating, and load capacities for
each bridge standard.

This is a reopening of a 1982 project for bridge
ratings. The initial project expenditure was \$66,091
producing a 1982 report of bridge ratings.

Progress: A consultant selection committee chose Stanley
Consultants Inc. to perform the work. The load
ratings for the additional secondary bridges have been
completed.

Reports: Final Report, May 1991

Implementation: Much attention is being focused on our bridges
today. Many old bridges are in need of rehabil-
itation or replacement. With the increase in
truck volume and weight over the last decade, it
becomes apparent that there is an urgency to
verify the load carrying capacity of our
bridges. With the recent revisions to the Na-
tional Bridge Inspection Standards (NBIS), there
is a need to report the operating and inventory
ratings in an equivalent HS loading.

Project Number: HR-246

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: June 14, 1982 to December 31, 1991

Research Board 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 was established. Posters, tri-fold leaflets and bumper stickers have been developed and distributed to schools, county offices, and driver licensing stations throughout the state. New material is being developed to reflect a change made by the 1991 Iowa Legislature to stiffen the penalty for possession of a stolen sign. It is now considered a serious misdemeanor instead of a simple misdemeanor.

Reports: Progress Report, January 1987

Implementation: It is estimated that approximately \$2 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-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 June 30, 1991

Research Board 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 H40. 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. The research section has performed well with very little rutting. It would appear to be capable of many more years without significant maintenance.

Reports: Final Report, June 1991

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 material for secondary road construction.

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 Gary Harris

Research Period: April 1, 1985 to September 30, 1991

Research Board 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 materials for filling and sealing sawn contraction joints.

Progress: An extra work order was negotiated to include 22,000 linear feet of experimental contraction joint work on a Jasper County project. Special sawing and cleaning were performed and eight different sealants were installed on a pcc paving project on county route T12 in 1985. Some joint sealants have failed while others are performing well. A final report will be submitted in September 1991.

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 Board Funding: \$92,210

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

Objective: To evaluate the effect of cracking PC pavement to various sized pieces and seating prior to resurfacing and its influence on reflective cracking and structural rating.

Progress: The project included breaking a 2.5 mile section of PCC pavement into pieces ranging in size from 2 to 3 feet and from 4 to 5 feet. Also, overlay thicknesses of 2 inches, 3 inches, and 4 inches were placed on the broken slab. The project was constructed on Hamilton County route R33. Construction was completed in June 1986. The most recent crack survey indicated predominant cracking to be in the 2-inch overlay section where no crack and seat work was performed. There doesn't seem to be much difference in performance of the various crack and seat test sections. Performance evaluation is continuing.

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-279

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

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

Principal Investigators: Charles Marker and Glenn Miller

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

Research Board Funding: \$76,175

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

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

Progress: The project included breaking a 2-mile pcc pavement section with transverse cracking at 3 feet intervals. A portion of the project was overlaid with 3 inches of asphalt concrete and a portion overlaid with 4 inches of asphalt concrete. The project is located on Fremont County road J46. Construction was completed in October 1986. The most recent crack survey indicated predominant cracking to be in the 3-inch overlay sections where no crack and seat work was performed. There seemed to be substantial reflective cracking in the 3-inch overlay crack and seat sections. Performance evaluation is continuing.

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-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, Department of Interior

Principal Investigator: Phil Soenksen

Research Period: November 1, 1985 to June 30, 1990

Research Board Funding: \$91,950

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

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

Progress: Equipment was installed on eight selected streams
to obtain flow data during the high flows of the
1986-88 water years. A fluorescent dye, rhodamine-WT,
was used as the tracer. The research demonstrated the
potential for automatic stream gaging, but there was
variation in the accuracy of the measurements. Incom-
plete mixing and dye loss to sediment apparently were
problems at some stations. The automatic gaging needs
further development for use in the future.

Reports: Final Report, 1990 (June 1990)

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 struc-
tures.

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 October 31, 1991

Research Board Funding: \$25,200

Funding Source: 100 percent State--Primary funds

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

Progress: The experimental Verglimit section was constructed on Euclid Avenue from 1st Street to Columbia Street in August 1986. A similar intersection has been identified for accident history comparison. Very few periods of evaluation were presented during the winters of 1986-87-88 due to the mild winters. Effectiveness of the ice retardant is noticed, in a limited manner only: 1) during a frost; 2) at the beginning of a storm; 3) in a light storm. During the high humidity summer seasons the surface sometimes became wet.

Reports: Interim Report, May 1988

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

Project Number: HR-291

Project Title: Performance of Nongrouted, Thin Bonded PCC
Overlays

Agency: Iowa Concrete Paving Association, Wapello County, Monroe
County and the Iowa Department of Transportation, High-
way Division

Principal Investigators: Wapello County Engineer,
Wendell Folkerts; Iowa Concrete Paving
Executive Vice President, Gordon Smith;
and the DOT Portland Cement Concrete
Engineer, Jim Grove

Research Period: March 1, 1986 to October 31, 1991

Research Board Funding: \$14,200

Funding Source: 100 percent State--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 was initiated with the Iowa Concrete
Paving Association. Road Rater testing was conducted
to determine the structural rating. Two series of
cores were obtained and tested for bond shear
strength. There is some debonding near a few trans-
verse joints. A final report will be submitted in Oc-
tober 1991.

Reports: Progress Report, September 1988

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-293

Project Title: Pavement Instrumentation

Agency: Iowa Department of Transportation, Planning and Research
Division, Iowa State University, Federal Highway Admin-
istration

Principal Investigator: Marlee Walton

Research Period: May 1, 1986 to June 31, 1992

Research Board Funding: \$75,000

Funding Source: 100 percent State--Primary funds (Matched by
\$113,000 FHWA funds)

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

Progress: A contract has been executed with Iowa State University for their participation. Five conduits were placed in the subbase crossing the westbound lane of I-80 at the test site to get recordings of moisture and density of the subbase. Some 120 instruments have been installed in a 40 ft. segment of reconstructed pavement. A weigh-in-motion and classification system has been installed and is integrated with strain gage and deflection gage data collection equipment. Software has also been installed to gather data. Limited test data have been collected. System debugging is in progress. A time extension has been granted.

Reports: Interim Report, March 1988

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

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agency: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to December 31, 1991

Research Board Funding: \$80,175

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

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

Progress: A 1.8 mile section of R63 north of its intersection with E29 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. The Type B base is performing superbly, while the ammonium phosphate/fly ash base mixes have lent to substantial surface cracking. A final report will be submitted in November 1991.

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-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1991

Research Board Funding: \$90,000

Funding Source: 100 percent State--10 percent Primary funds,
45 percent Farm-to-Market funds, 45 percent
Street Research funds

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
5. present transportation safety information to rural
communities by employing a Transportation Safety
Circuit Rider

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-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 March 31, 1990

Research Board Funding: \$205,415

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

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

Progress: The High Pressure Liquid Chromatography (HPLC)
equipment was obtained. Twelve asphalt samples and 6
core samples were obtained from a variety of sources
and were tested. Nuclear magnetic resonance testing
was evaluated. Testing and evaluation have been com-
pleted.

Reports: Final Report, March 1990

Implementation: The ability to identify those asphalts which
would result in fewer cracks 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, 1992

Research Board Funding: \$192,390

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

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
4. Establish a correlation between an efficient laboratory test and field performance of concrete.

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates has been completed. Phase II concluded that 15% fly ash replacement significantly improved the freeze-thaw resistance of mortar in sulfate-tainted brines. Evaluation of concrete beams with various aggregates in brine solutions is in progress as part of Phase III.

Reports: Phase I Report, June 1988; Phase II Report, July 1989

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-303

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

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

Principal Investigators: Robert Gumbert, Richard Mumm and Gary Harris

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

Research Board Funding: \$100,000

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

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

Progress: Construction started in the middle of June 1989. Some problems were encountered with the compaction of the material in the widening trench. This was most likely due to the trenchers inability to keep pace with the milling machine. The finished surface is carrying traffic well, but there are some areas causing concern due to movement and evidence of marginal stability. Performance has been satisfactory to date.

Reports: Construction Report, December 1990

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

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, 1991

Research Board Funding: \$93,084

Funding Source: 100 percent State--Primary funds

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of 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 questionnaire has been completed and results are summarized. Analyses of the survey data and actual frost occurrence conditions have been completed. The expert system has been developed. Testing and evaluation of the system was conducted during the 1989-90 winter period. The Freese-Notis weather forecasters evaluated the system during the 1989-91 winter seasons. The computer program was a valuable assistance to forecasters in considering all factors in frost prediction.

Reports: Final Report, June 1991

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

Project Number: HR-307

Project Title: Sediment Control in Bridge Waterways

Agency: University of Iowa

Principal Investigator: A. Jacob Odgaard

Research Period: January 15, 1988 to February 28, 1990

Research Board Funding: \$35,000

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

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

Progress: Research results of laboratory and field tests have been determined and the resulting design procedure presented. Design graphs have been developed based on the basic theory defined in this research. The graphs are entered with basic flow variables and desired bed topography. Twelve vanes were installed at a highway crossing of the West Fork Cedar River in Butler County. They have been effective in holding the flow in the middle of the channel and preventing scour at the abutment.

Reports: Final Report, February 1990

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

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover and
Gary Harris

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

Research Board Funding: \$78,760

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

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

Progress: Construction of the 1.27 mile research project was completed in August 1988. There has been some potholing, but it is generally performing well. Evaluation is continuing.

Reports: Construction Report, February 1989

Implementation: Finding useful ways of incorporating by-product aggregate into construction of lower traffic volume roads will ease the burden of disposal for contractors and reduce the cost of construction for counties.

Project Number: HR-310

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

Agency: Iowa State University

Principal Investigator: Dr. Robert E. Abendroth

Research Period: June 1, 1988 to September 30, 1991

Research Board Funding: \$105,538

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

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

Progress: A contract has been signed with Iowa State University to conduct the research. A literature review (Task 1) has been completed. Field investigations (Task 2) on 3 bridges containing precast panel subdecks has been completed. Monitoring behavior (Task 3) of 5 full scale composite deck slabs has been completed. The final report will be submitted in September 1991.

Reports: Interim Report, January 1990

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

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: June 15, 1988 to December 31, 1991

Research Board Funding: \$25,000

Funding Source: 100 percent State--Primary funds (Federal Highway Administration funds have been received for testing and evaluation)

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

Progress: A Retsina Mark VI resilient modulus apparatus was obtained and a creep test unit was built. The creep and resilient modulus testing is in three parts. The first part was "The Effects of Crushed Particles in Asphalt Mixtures". Hot mix asphalt mixtures were made with 0, 30, 60, 85 and 100% crushed gravel, crushed limestone and crushed quartzite combined with uncrushed sand and gravel. These aggregate combinations were used with 4%, 5% and 6% asphalt cement. A creep resistance factor (CRF) developed during the research related very well to the amount of crushed particles and the perceived resistance to rutting.

Part II was creep and resilient modulus testing of 2 1/2 inch thick slices of four and six inch diameter drilled cores. These cores were taken from pavements with varying amounts of rutting and pavements of an improved design to resist rutting. An effort was made to relate creep and resilient modulus to rutting per million equivalent single axle loadings. There was a very poor correlation.

Part III, currently in progress, was be an effort to compare creep and resilient modulus testing of 1) laboratory mixed and compacted specimens; 2) project mixed, laboratory compacted; and 3) drilled cores on five projects ranging from a low volume road to an interstate.

Reports: Final Report, Part I, January 1990
Final Report, Part II, January 1991

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

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen and Gary Harris

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

Research Board Funding: \$93,913

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

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

Progress: A contract was signed with Dubuque County to perform the work. Construction of the project was completed in October 1988. Overall, the project went well. it is recommended these materials be used to construct roadways during the summer because of the better drying weather. The days were cool and this may have hindered efforts to achieve adequate compaction. One of the bioenzyme stabilizers, Consolid, is not performing well and that section has been retrofitted with longitudinal underdrains to facilitate drainage. Performance evaluation is continuing.

Reports: Construction Report, March 1989

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

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction -
Washington County

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

Principal Investigators: R. G. Huber and Gary Harris

Research Period: August 15, 1988 to December 31, 1993

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the air form
method of arched culvert construction.

Progress: The arch culvert was constructed in Washington
County in October 1988. Post construction inspection
of the air formed arch culvert showed the Air-O-Form
method can be used to construct a structurally sound
arch culvert. However, this method must become more
economical if it is to compete with box culvert con-
struction for county and state culvert projects. The
arch culvert has been performing well. Trees and
brush pass through and cleaning is not required.
Evaluation of performance is in progress.

Reports: Construction Report, February 1989

Implementation: Building an arch culvert using the air form
method will use less concrete and steel and less
time will be required for forming than the con-
ventional box culvert. A more efficient and
stronger culvert may be built at a lower cost
than a conventional box culvert.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction -
Crawford County

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

Principal Investigators: H. Dale Wight and Gary Harris

Research Period: September 15, 1988 to December 31, 1993

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability
of the Air-O-Form method of arch culvert con-
struction.

Progress: Construction was delayed until October of 1990 so
that the county could find ways to make this project
more affordable. The Air-O-Form method still has
higher costs when compared to other types of culvert
construction. This is probably due to the fact that
very few contractors are qualified to use this method.

Reports: Construction Report, May 1991

Implementation: The air formed method of arch culvert
construction can be less time consuming, use
less steel and concrete, and result in a
stronger structure compared to conventional box
culvert construction. Such a structure can also
be hydraulically more efficient and aesthet-
ically more pleasing than a box culvert.

Project Number: HR-315

Project Title: Iowa Development of Rubblized Concrete
- Mills Co.

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

Principal Investigators: James Ebmeier and Gary Harris

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

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

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: The project was constructed in the fall of 1989 and to date the performance of the test sections have been very satisfactory. While there are some areas where the rideability is not the most desirable, it has improved greatly and few cracks have developed in the surface.

Reports: Construction Report, March 1990

Implementation: Through the development and success of this rehabilitation procedure, we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-316

Project Title: Maximized Utility of the Global Positioning System

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: January 1, 1989 to February 28, 1991

Research Board Funding: \$142,840

Funding Source: 100 percent State--Primary funds

Objective: The objective of this research is to improve the accuracy of Global Positioning System (GPS) for use in Iowa and to train Iowa Department of Transportation personnel in the GPS field.

Progress: Iowa State University has purchased GPS receivers and has conducted three surveys of one mile, five mile and 30 mile radii. Horizontal and vertical accuracies are within 0.2 ft. The data is very encouraging. A gravimetric method of correcting for undulation was used. Iowa DOT personnel were trained to use the GPS equipment.

Reports: Final Report, February 1991

Implementation: Global Positioning System has a great potential for both preliminary and final survey for highway locations. It would provide more accurate data and greater survey capability with current staff.

Project Number: HR-317

Project Title: Evaluation of Edge Drains

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: Vernon J. Marks, Kermit L. Dirks
and Robert F. Steffes

Research Period: April 5, 1989 to January 1991

Research Board Funding: \$60,100

Funding Source: 100 percent State--Primary funds

Objective: To use new technology to inspect the inside of the existing edge drains.

Progress: A review of available inspection equipment has been made. A 2 3/4" diameter video camera with 300 ft. of push cable and a 1/2" diameter video probe with 50 ft. of cable were purchased. TV monitoring and recording facilities are included. Evaluations of selected drains are in progress and a variety of drain problems have been viewed. Some edge drain design specifications have been modified due to video evaluation results. Demand for video evaluations has increased for culverts and new edge drain construction. In the past 2 years approximately 200 drains were inspected.

Reports: Produced 10 minute videotape and final report January 1991.

Implementation: New construction, inspection and a review of performance and problems with existing edge drains will reduce pavement deterioration and future edge drain maintenance.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene Joint Seals

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to April 30, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants.

Progress: Four new paving projects with a wide range of average daily traffic were selected for sealant research for 1989. Three sites were added in 1990 plus one site in 1991, which included Soff-cut joint sawing. Sections of neoprene, silicone, urethane and hot pour types of sealing materials were installed. Evaluation of sealant performance is in progress.

Reports: None

Implementation: Results from the evaluation will help to determine which joint sealants should be selected as cost effective or best for long term performance in future projects.

Project Number: HR-319

Project Title: Lateral Load Resistance of Diaphragms in
Prestressed Concrete Girder Bridges

Agency: Iowa State University

Principal Investigators: Robert E. Abendroth, F. Wayne Klaiber

Research Period: July 1, 1989 to November 30, 1991

Research Board Funding: \$146,860

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

Objective: To investigate the effectiveness of reinforced concrete and steel intermediate diaphragms to lateral load and to determine whether steel diaphragms of any conventional configuration can provide adequate protection to minimize the damage to prestressed concrete girders caused by lateral impact.

Progress: A contract was signed with Iowa State University. The test bridge has been constructed and the experimental work with diaphragms has begun. As of June 1991, three-quarters of the test work and analysis had been completed.

Reports: None

Implementation: Steel diaphragms could provide the same protection to the prestressed concrete girders as the reinforced concrete diaphragms that are currently being used by the Iowa DOT. Use of steel diaphragms would reduce bridge construction costs.

Project Number: HR-320

Project Title: Constructability in the Bridge Design Process

Agency: Iowa State University

Principal Investigator: Dr. James Rowings

Research Period: July 17, 1989 to June 30, 1991

Research Board Funding: \$89,120

Funding Source: 100 percent State--70 percent Primary funds
and 30 percent Secondary funds

Objective: To analyze constructability opportunities for bridge projects and develop an initial constructability knowledge-base. This knowledge-base provides a mechanism to collect construction knowledge and transfer it from completed projects to future projects. The knowledge-base will be developed for use on a microcomputer and could be made interactive with other computer-aided design software in the future.

Progress: A contract has been signed with Iowa State University for their participation. A comprehensive literature review was made. A survey on constructability considerations was mailed to 36 contractors and designers. A constructability system was developed.

Reports: Final Report, June 1991

Implementation: The development of a constructability knowledge-base, to be used in the design phase for bridges will reduce costs and time for construction, along with materials and labor without compromising quality, safety and project scope.

Project Number: HR-321

Project Title: Production of Acetic Acid by Fermentation
With Propionibacteria

Agency: Iowa State University

Principal Investigators: Earl Hammond, Bonita Glatz and
Charles Glatz

Research Period: November 2, 1989 to January 31, 1993

Research Board Funding: \$97,850

Funding Source: 100 percent State--90 percent Primary funds,
10 percent Street Research funds

Objective: To find an economically favorable route to the
production of acetic acid by fermentation with
propionibacteria.

Progress: A bench-scale fermenter was purchased for use
with fermentation studies. An ultrafiltration appara-
tus was purchased and attempts are being made to adapt
this into an ultrafiltration apparatus for removing
acetic and propionic acids from the fermentation mix-
tures. The intent is to produce less expensive acetic
acid for use in producing less expensive calcium
magnesium acetate (CMA) deicer. Some improved methods
of removing the acetic acid from the fermenter have
been identified.

Reports: Progress Report, January 1991

Implementation: Reduced costs of acetic acid will allow the
use of CMA deicer at selected locations to pre-
vent corrosion.

Project Number: HR-322

Project Title: Estimating Design Flood Discharge for Iowa Using
Drainage Basin and Channel Geometry Character-
istics

Agency: Water Resources Division of the United States
Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1989 to September 30, 1992

Research Board Funding: \$91,471

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: To develop a single set of equations for Iowa that
relate measurable basin and channel characteristics
to flood peaks of 5, 10, 25, 50 and 100 year frequen-
cies

Progress: A contract has been signed with Water Resources
Division of the United States Geological Survey. Data
is being collected. An automated procedure for quan-
tifying basin characteristics using a GIS has been de-
veloped.

Reports: None

Implementation: More reliable estimates of design flood
discharges will allow selection of the required
size of bridges and culverts which will reduce
the cost by avoiding overdesign.

Project Number: HR-323

Project Title: Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber and Terry J. Wipf

Research Period: December 1, 1989 to January 31, 1992

Research Board Funding: \$172,548

Funding Source: 100 percent State--20 percent Street Research funds, 80 percent Farm-to-Market funds

Objective: To develop a design manual for evaluating, rehabilitating and/or strengthening low volume bridges.

Progress: Phase I involving data collection and Phase II dealing with what types of bridges have the most problems and what those problems entail are now being conducted. Methods of rehabilitating low volume road bridges are being developed.

Reports: Progress Report, September 1990

Implementation: There are over 24,000 rural bridges in Iowa. One-half of these are structurally deficient or obsolete. These bridges are generally on low volume roads and are low priority for expenditures for rehabilitation. A design manual for engineers to use would help address this problem of rehabilitating and/or strengthening of secondary bridges.

Project Number: HR-324

Project Title: Construction Plan Reading Course Update

Agency: Iowa State University

Principal Investigator: Gerald W. Chase

Research Period: December 1, 1989 to October 31, 1991

Research Board Funding: \$41,579

Funding Source: 100 percent State--45 percent Primary funds,
35 percent Farm-to-Market funds, 20 percent
Street Research funds

Objective: To update a basic construction plan reading course.

Progress: A contract was signed with Iowa State University.
Updated plans and the training instructions are being
developed. The Highway Plan Reading Course will be
available in July 1991.

Reports: None

Implementation: When new employees are hired at entry level in
both state and local government construction
jobs, they will be able to attend a course that
will help them in plan reading on new con-
struction and also repair, reconstruction and
restoration. This improved training will yield
better construction inspection which in turn
will improve quality of construction.

Project Number: HR-325

Project Title: Thermoset Composite Concrete Reinforcement

Agency: Iowa State University

Principal Investigator: Max Porter

Research Period: January 1, 1990 to January 31, 1992

Research Board Funding: \$97,500

Funding Source: 100 percent State--35 percent Primary funds
30 percent Farm-to-Market funds and 35 percent
Street Research funds

Objective: To determine shear behavior and strength on dowel
Fibercomposite (FC) bars with and without aging, and
to determine the potential aging effects on bond of
FC reinforcing bars.

Progress: A contract has been executed with Iowa State
University. Testing and evaluation of composite rein-
forcing is in progress. Specimens have been cast.
Most of the testing has been completed. The composite
reinforcing has not shown any adverse chemical prob-
lems.

Reports: Progress Report, 1990

Implementation: FC reinforcing bars in structures such as
bridge decks can offer a valuable alternative
against failures from corrosion. Results from
tests on long term exposure and aging of FC re-
inforcing bars will influence the scope of their
use.

Project Number: HR-327

Project Title: Evaluation of Chemical Durability of Iowa Fly Ash
Concretes

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: April 1, 1990 to March 31, 1993

Research Board Funding: \$110,000

Funding Source: 100 percent State--40 percent Primary funds
40 percent Farm-to-Market funds and 20 percent
Street Research funds

Objective: To evaluate the chemical durability (sulfate/alkali)
of Iowa Class C fly ash concretes at varying fly ash
replacement levels ranging from 0 percent to 50 per-
cent.

Progress: A contract has been executed with Iowa State
University. The specimens are being aged in sulfate
solutions. Testing is in progress.

Reports: Progress Report, March 31, 1991

Implementation: The determination of maximum percentage of
low cost Iowa fly ash which can be used to
produce quality concrete for Iowa highways will
optimize savings for Iowa taxpayers as well as
promote use of a waste material.

Project Number: HR-328

Project Title: Engineering Study - Guardrail Attachment Details
for Existing Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald

Research Period: April 5, 1990 to April 30, 1991

Research Board Funding: \$100,000

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

Objective: To develop standard designs for retrofiting W-beam
to thrie-beam rail at the end posts of secondary
bridges.

Progress: It was determined that of the dozens of bridge
standards, only 12 would have an end post design that
would accept a thrie-beam rail. These have already
been revised for that purpose. Consequently, the ini-
tial aim of retrofiting rail on many older county
bridges where the need is greatest was no longer the
case. This engineering study has been discontinued.

Reports: None

Implementation: None

Project Number: HR-329

Project Title: Hydrodemolition Preparation for Dense Concrete
Bridge Overlays

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: May 1990 to December 1994

Research Board Funding: \$22,000

Funding Source: 100 percent State--Primary funds

Objective: To evaluate hydrodemolition preparation of an Iowa
bridge deck.

Progress: Arrangements were made to add the research to a 1990
project by extra work order. Due to lack of experi-
ence in control of equipment the operation was post-
poned, pending selection of another mutually
acceptable project. An effort will be made to select
a 1992 project.

Reports: None

Implementation: Hydrodemolition preparation offers an
improved method for bridge deck surface removal
and preparation for a new overlay.

Project Number: HR-330

Project Title: Evaluation of Recycled Rubber in Asphalt Concrete

Agency: University of Northern Iowa and Iowa Department of Transportation, Highway Division

Principal Investigators: Shahram Varzavand, Dr. Stephan Egger and Vernon Marks

Research Period: June 11, 1990 to December 31, 1995

Research Board Funding: \$98,956

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: To evaluate the use of asphalt-rubber binders and recycled rubber granules in Iowa asphalt concrete pavements.

Progress: Four experimental sections will be constructed on Muscatine County project F-61-4(49)--20-70 on US 61 from Muscatine to Blue Grass. The asphalt concrete overlay will be two inches of surface over two inches of binder. A contract was executed with the University of Northern Iowa for laboratory evaluation of the asphalt-rubber binder.

Reports: None

Implementation: This research will provide information on whether an asphalt-rubber binder yields significantly improved performance and if it is cost-effective. It will provide information on the use of recycled rubber in asphalt concrete.

Project Number: HR-331

Project Title: Engineering Study: Skewed Tee Piers
for Secondary Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald and Gary Harris

Research Period: June 26, 1991 to May 31, 1992

Research Board Funding: \$210,000

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

Objective: To develop standard designs which county engineers across Iowa can utilize on secondary bridges. This will avoid the duplication of costs and designs among the 99 counties.

Progress: Calhoun-Burns and Associates, Inc. has been contracted to perform this work and it is expected to be completed the summer of 1992.

Reports: None

Implementation: Iowa's grid pattern of roads and meandering rivers pose special considerations in the design of bridges across the state. At the present time, there are no standard designs for 15°, 30°, or 45° skewed tee piers that county engineers can use. These tee piers withstand ice, logs and debris better than pile bent piers.

Project Number: HR-332

Project Title: Design Methodology for Corrugated Metal
Pipe Tiedowns

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber

Research Period: August 1, 1990 to January 31, 1992

Research Board Funding: \$165,900

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds, and 10 percent
Street Research funds

Objective: a) Synthesize design standards from other state
DOT's; b) determine longitudinal stiffness of corru-
gated metal pipe; and c) obtain experimental data on
soil-pipe interaction.

Progress: A contract has been signed with Iowa State
University to conduct the research. Research is in
progress.

Reports: None

Implementation: Through the development of a rational
methodology for the design of tiedowns and the
provision of design standards of tiedowns for
large corrugated metal pipe, the rate of pipe
uplift failures can be reduced.

Project Number: HR-333

Project Title: Design Methodology for Post-Tensioning
Strengthening of Continuous Span Bridges

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber, Foud Fanous,
and Terry Wipf

Research Period: November 1, 1990 to October 31, 1992

Research Board Funding: \$247,850

Funding Source: 100 percent State--30 percent Primary funds,
40 percent Farm-to-Market funds, 30% Street Re-
search funds

Objective: To develop a design methodology that practicing
engineers can use to design the post-tensioning sys-
tem required to strengthen various continuous span
bridges.

Progress: A contract has been signed with Iowa State
University to conduct the research. Research is in
progress.

Reports: None

Implementation: The design methodology will make it possible
for the practicing engineer to determine the
post-tensioning system required through use of
graphs, nomographs, personal computer software,
etc., rather than having to use complex analyt-
ical techniques.

Project Number: HR-334

Project Title: Field Measurement of Plow Loads During
Ice Removal Operations

Agency: University of Iowa

Principal Investigator: Wilfred A. Nixon

Research Period: December 1, 1990 to November 30, 1992

Research Board Funding: \$137.921

Funding Source: 100 percent State--50 percent Primary funds,
25 percent Farm-to-Market funds and 25 percent
Street Research funds

Objective: To determine the optimum plow blade loading
through instrumentation of the hydraulic system of a
conventional truck.

Progress: A contract has been executed with The
University of Iowa. Testing was done during the
1990-1991 winter season and data was collected. The
data is currently being analyzed.

Reports: None

Implementation: Improvements of the ice blade or equipment
will allow the removal of ice using fewer chemi-
cals and less damage to roadway surfaces.

Project Number: HR-335

Project Title: Driver Behavior at Railroad Grade Crossings:
Before and After Safety Campaign

Agency: Iowa State University

Principal Investigator: Kenneth Brewer

Research Period: January 1, 1991 to December 31, 1991

Research Board Funding: \$49,500

Funding Source: 100 percent State--30 percent Primary funds,
35 percent Farm-to-Market funds, and 35 percent
Street Research funds

Objective: To compare driver behavior at selected railroad
crossings before and after "Operation Lifesaver."

Progress: A contract has been signed with Iowa State
University. A data collection method has been estab-
lished. Driver behavior and traffic characteristics
have been recorded at 16 of the 24 crossings. Two of
the crossings that were in the original survey were
found to be inappropriate. There are still 24
crossings at 22 sites for factor analysis.

Reports: Quarterly Report, April 1, 1991

Implementation: Data collection at the railroad crossings
should enable you to see the effect the safety
campaign has on railroad crossing related acci-
dents.

Project Number: HR-336

Project Title: Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability

Agency: Iowa Department of Transportation

Principal Investigator: Wendell Dubberke

Research Period: March 1, 1991 to February 29, 1992

Research Board Funding: \$40,000

Funding Source: 100 percent State--40 percent Primary funds, 30 percent Farm-to-Market funds and 30 percent Street Research funds

Objective: The objective of the research is to determine if thermogravimetric analysis will differentiate between durable and nondurable carbonate aggregate for portland cement concrete.

Progress: Samples from selected crushed carbonate coarse aggregate for portland cement concrete have been obtained. Thermogravimetric testing of more than 200 samples has been conducted on Iowa State University equipment. An improved software program allows relatively quick testing without loss of resolution. Both limestones and dolomites have been tested. Efforts have been made to relate the slope of the weight loss or the temperature when the carbon dioxide is burned off to durability of the aggregate

Reports: None

Implementation: Improved evaluation of coarse aggregate for concrete will yield economic benefits by allowing the use of all durable source and preventing the use of nondurable aggregate that would result in decreased pavement life.

Project Number: HR-337

Project Title: Investigation of Rapid Thermal Analysis
Procedures for Prediction of the Service Life of
Portland Cement Concrete Pavement Carbonate
Coarse Aggregate

Agency: Iowa State University

Principal Investigator: Scott Schlorholtz and
Kenneth L. Bergeson

Research Period: May 1, 1991 to April 30, 1993

Research Board Funding: \$157,020

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and 30 percent
Street Research funds

Objective: To evaluate thermogravimetric analysis as a
potential test of the durability of aggregate and to
analyze the chemical changes that result.

Progress: A contract has been executed with Iowa State
University. Iowa DOT personnel have obtained samples
for the research from 19 crushed carbonate sources
(quarries). Some thermogravimetric testing has been
conducted.

Reports: None

Implementation: Improved evaluation of coarse aggregate for
concrete will yield economic benefits by allow-
ing the use of all durable source and preventing
the use of nondurable aggregate that would re-
sult in decreased pavement life.

Project Number: HR-338

Project Title: The Value of the County Engineer:
Strategies for Expanding the Shrinking Employment
Pool

Agency: Iowa State University

Principal Investigator: Kathleen M. Waggoner

Research Period: May 1, 1991 to April 30, 1993

Research Board Funding: \$116,527

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

Objective: The first goal of the project is to examine the responsibilities, goals, and effectiveness of persons in charge of secondary roads in eight participating states. The second goal is to develop a program by which bright and motivated high school students as well as university students majoring in civil engineering can be encouraging to consider county engineer positions as career choices.

Progress: A review of applicable state statutes has been completed regarding the obligations of registered professional engineers in the state of Iowa.

Reports: None

Implementation: Working carefully with the panel of experts, proposed solutions and new strategies will be identified and explored. Moreover, workshops and seminars will be held in order to provide counties with insights and proposed solutions to the "supply problem" presented by retirements and the difficulty of attracting replacements to county engineer positions.

Project Number: HR-341

Project Title: Bond Enhancement Techniques for PCC
Whitetopping

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

Principal Investigator: Brad Skinner, Jim Grove, and
Gary Harris

Research Period: June 20, 1991 to June 1996

Research Board Funding: \$25,000

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

Objective: To determine what techniques can be used to
ensure the bond between the old asphalt concrete and
the new portland cement concrete overlay.

Progress: Construction was completed in late June 1991 on
13 different test sections on R16 south of Dallas Cen-
ter as part of a 4-mile project. Testing and evalu-
ation are continuing.

Reports: None

Implementation: The bond between the two surfaces is the
key to determining what procedure should be used
to properly design the thickness of the PCC
overlay. If sufficient bond strength can be es-
tablished, the pavement can be designed as a
bonded overlay, thereby taking into account the
structure of existing pavement.

Project Number: HR-342

Project Title: Use of Global Positioning System (GPS)
for Photogrammetry

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: June 1, 1991 to November 30, 1992

Research Board Funding: \$102,755

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: Determine the efficiency of using GPS, the advantages and disadvantages of flying one versus two flight strips on a project, the optimum flying height for a specific accuracy for control points, the XYZ coordinate of the aerial camera at the instant a photo was taken, the rotational orientation of the camera in addition to the XY and Z coordinates, the efficiency of available software used in aerotriangulation computations.

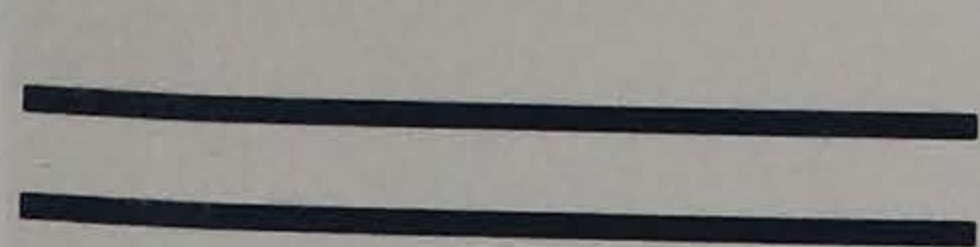
Progress: A contract has been signed with Iowa State University to conduct the research.

Reports: None

Implementation: GPS can establish the XY and Z coordinate of any point without the need to traverse or level from any other point. This could provide for possible cost savings while still providing the required accuracy.

Annual Report of Highway Division Highway Research and Development in Iowa

Highway Division
Office of Materials
September 1992



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ANNUAL REPORT
OF HIGHWAY DIVISION
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1992

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IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

SEPTEMBER 1992

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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 Division Highway Research and Development in Iowa", is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which directs the submission of a report of the Secondary Road Research Fund and the Street Research Fund respectively. It is a report of the status of research and development projects which were in progress on June 30, 1992; it is also a report on projects completed during the fiscal year beginning July 1, 1991, and ending June 30, 1992. 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 and 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 and now that denoted by 312.3A.

The Research Board consists of 13 regular members; six county engineers, three Iowa 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, 1992 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1991 to June 30, 1992. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

Table I

1992 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	12-31-93	Bernard C. Brown State Materials Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1452
Robert I. Bortle District 2 Engineer Iowa DOT - Highway Division P.O. Box 741 Mason City, IA 50401 (515) 423-7584 SS#-220	12-31-93	Kenneth M. Meeks District 1 Engineer Iowa DOT - Highway Division 1020 S. Fourth Street Ames, IA, 50010 (515) 239-1635
Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS-#073	12-31-93	J. Brian Morrissey Madison County Engineer P.O. Box 152 Winterset, IA 50273 (515) 462-1136 SS-#061
Steve DeVries Jackson County Engineer Courthouse Maquoketa, IA 52060 (319) 652-4782 SS#-049	12-31-94	Mark Nahra Cedar County Engineer Courthouse Tipton, IA 52772 (319) 886-6102 SS#-016
Robert G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 335-5766	12-31-93	Gene F. Parkin Dept. of Civil & Envir. Engr. 1134 Engineering Bldg. The University of Iowa Iowa City, IA 52242 (319) 335-5655
Steven J. Holcomb Grundy County Engineer Courthouse Grundy Center, IA 50638 (319) 824-6912 SS#-038	12-31-93	Royce J. Fichtner Marshall County Engineer Courthouse Marshalltown, IA 50158 (515) 754-6343 SS#-064
David Kao, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-92	Wallace W. Sanders, Jr. Iowa State University Dept. of Civil & Const. Engr. 394 Town Engineering Bld. Ames, IA 50011-323 (515) 294-6048
Mike McClain Davis County Engineer Courthouse Bloomfield, IA 52537 (515) 664-2542 SS#-026	12-31-92	E. D. Tice Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004
Richard O. Schiek Kossuth County Engineer Courthouse Algona, IA 50511 (515) 295-3320 SS#-055	12-31-92	Lyle Laartz Chickasaw County Engineer P.O. Box 316 New Hampton, IA 50659 (515) 394-2321 SS#-019
George F. Sisson Deputy Director, Development Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1461	12-31-94	Donald East Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072	12-31-94	Keith White Ida/Sac County Engineer 1703 W. 6th, RR 1 Ida Grove, IA 51445 (712) 364-2920 SS#-047
Larry Stevens City Engineer P.O. Box 1010 Oskaloosa, IA 52577 (515) 673-7472	12-31-94	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000
Paul Wiegand Director of Public Works 515 Clark Avenue Ames, IA 50010 (515) 239-5162	12-31-93	Neal Guess City Engineer 1700 N. 4th Avenue W. Newton, IA 50208 (515) 792-6622

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, Farm-to-Market Road Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in 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, 1992. Total expenditure was \$1,330,564.05.

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 for in-house projects are relatively small. 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 Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern.

The program is funded annually by all 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 1992 as part of the Annual Traffic Count Program. This activity consisted of 13 eight-hour manual counts, and 6,160 portable 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1992 financial summary is:

Beginning Balance 7-1-91		\$1,010,637
Receipts		
State Road Use Tax Fund (1 1/2% of receipts)...	\$715,068	
Federal Aid Secondary (1 1/2% of receipts)...	82,228	
Research Income	135,925	
	=====	
Sub-Total		933,221
		=====
Total Funds Available		\$1,943,858
Obligation for Expenditures		
Obligated for		
Contract Research...	383,224	
Non-Contract		
Engineering Studies...	266,004	
	=====	
Total Expenditures		\$ 649,228
		=====
BALANCE 6-30-92		\$1,294,630

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year two hundred thousand dollars are set aside from the street construction fund solely for the purpose of financing engineering studies and research projects, which have as their objective the more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1992 financial summary is:

Beginning Balance (7-1-91)		\$221,091
Obligated for Expenditure		
HR-140	\$10,189	
HR-296	41,794	
HR-343	14,996	
HR-344	31,254	
HR-345	10,075	
HR-346	34,903	
HR-347	30,707	
HR-348	13,893	
HR-349	4,000	
HR-350	7,655	
	=====	
Total Obligated for Expenditure	199,466	
Ending Unobligated Balance 6-30-92		\$ 21,625

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved such as contracted research and project specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. 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 FY92 was \$363,951.02 and the Estimate for FY93 is \$750,000.

PROJECTS INITIATED DURING FY 1992

The new projects initiated during FY 1992 were:

- HR-239, "Engineering Study to Evaluate Secondary Bridges With Respect to Current Truck Length and Weight Laws"
- HR-343, "Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavement Slabs"
- HR-344, "Scour Susceptibility at Bridges in the State of Iowa"
- HR-345, "Electronic Bulletin Board System"
- HR-346, "Image Analysis for the Characterization of Materials for Highway Construction"
- HR-347, "Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections"
- HR-348, "Recruiting and Retaining Women/Minorities for Public Sector Engineering Positions"
- HR-349, "Recycled Paper Erosion Control Mats"
- HR-350, "Channel & Flood Plain Aggradation in the Iowa River Basin"

9 projects

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1991 to June 30, 1992
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
140	101,890/yr.	Collection and Analysis of Stream Flow Data	45,851.00	44,027.00	9,986.00	99,864.00
198	125,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way				
220	8,000	Protection of Structural Concrete Substructures				
239	110,000	Engineering Study - Ratings for Secondary Bridge Standards		18,644.67		18,644.67
246	118,000	Engineering Study - Reducing Sign Vandalism		429.68		429.68
276	32,000	Transverse Joint Sealing With Improved Sealants				
277	92,210	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflection Cracking				
279	76,175	Cracking and Seating PCC Pavement Prior to Resurfacing to Retard Reflective Cracking --Fremont County				
290	25,200	Ice-Retardant Pavement				
291	14,200	Performance of Nongrouted Thin, Bonded PCC Overlays				
293	75,000	Pavement Instrumentation				
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction				
296	92,875/yr	ISU Technology Transfer	4,966.60	21,916.16	22,138.98	49,021.74
299	192,390	Control of Concrete Deterioration Due to Trace Compounds in Deicers	19,684.43	1,365.25		21,049.68
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete				
305	93,084	Development of an Expert System for Forecasting Frost on Bridges and Roadways in Iowa	9,536.38			9,536.38
309	78,760	An Investigation of Emulsion Stabilized Limestone Screenings				
310	105,538	Precast, Prestressed Concrete Panel Subdecks in Skewed Bridges	2,572.64	10,895.23		13,467.87
311	25,000	Creep and Resilient Modulus Testing of Asphalt Mixtures				
312	93,913	Low Cost Techniques of Base Stabilization - Dubuque Co.				
313	28,900	Air Formed Arch Culvert Construction - Washington Co.				
314	16,500	Air Formed Arch Culvert Construction - Crawford Co.				
315	98,529	Iowa Development of Rubblized Concrete - Mills Co.				
316	142,840	Maximized Utility of the Global Positioning System				
317	60,100	Evaluation of Edge Drains				
318	20,800	Evaluation of Preformed Neoprene Joint Seals				
319	146,860	Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges		10,085.58		10,085.58
320	89,120	Constructability in the Bridge Design Process	7,244.59	11,715.92		18,960.51
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria	25,628.13		2,385.31	28,013.44
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics		17,377.00	7,869.00	25,246.00
323	172,548	Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges		40,847.20	16,000.38	56,847.58
324	41,579	Construction Plan Reading Course Update	164.44	8,909.50	6,283.49	15,357.43
325	97,500	Thermoset Composite Concrete Reinforcement		19,978.15	13,125.49	33,103.64
327	110,000	Evaluation of Chemical Durability of Iowa Fly Ash Concretes		1,642.23	5,041.89	6,684.12
329	22,000	Hydrodemolition Preparation for Dense Concrete Bridges				

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
330	98,956	Evaluation of Recycled Rubber in Asphalt Concrete	18,780.10			18,780.10
331	210,000	Engineering Study - Skewed Tee Piers for Secondary Bridges		156,086.82		156,086.82
332	165,900	Design Methodology for Corrugated Metal Pipe Tiedowns: Phase I		67,439.95		67,439.95
333	247,850	Design Methodology for Post-Tensioning Strengthening of Continuous Span Bridges	22,557.98	33,162.46	9,878.16	65,598.60
334	137,921	Field Measurements of Flow Loads During Ice Removal Operations	16,347.26	11,727.77	9,186.03	37,261.06
335	49,500	Driver Behavior at Railroad Grade Crossings: Before and After Safety Campaign	5,312.39	9,594.20	11,862.81	26,769.40
336	40,000	Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability	12,460.80	9,180.00	5,460.00	27,100.80
337	157,020	Investigation of Rapid Thermal Analysis Procedures for Prediction of the Service Life of PCCP Carbonate Coarse Aggregate	30,054.15	6,303.39	6,087.02	42,444.56
338	116,527	The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool		55,681.44		55,681.44
339	90,730	Multi-Project Scheduling Procedure for Transportation Projects	22,821.66			22,821.66
341	25,000	Bond Enhancement Techniques for PCC Whitetopping				
342	102,755	Use of GPS for Photogrammetry	45,071.82	1,870.06		46,941.88
343	149,955	Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavement Slabs	20,191.25	435.27		20,626.52
344	156,272	Scour Susceptibility at Bridges in the State of Iowa	32,200.00			32,200.00
345	100,753	Electronic Bulletin Board System	2,270.91	12,136.64		14,407.55
346	67,085	Image Analysis for the Characterization of Materials for Highway Construction	10,868.09	4,676.65	4,998.29	20,543.03
347	61,414	Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections	3,459.76		5,848.27	9,308.03
348	138,932	Recruiting and Retaining Women/Minorities for Public Sector Engineering Positions	676.54			676.54
349	20,000	Recycled Paper Erosion Control Mats	5,230.10	3,137.50		8,367.60
350	76,550	Channel & Flood Plain Aggradation in the				
1027	40,000/yr.	Secondary Road Research Coordinator		41,233.63		41,233.63
Contract Research Sub-Total			363,951.02	620,499.35	136,151.12	1,120,601.49
HPR-2 (133)		Pooled fund project - Culvert Repair Practices		192.34		192.34
HPR-2 (136)		Pooled fund project - Noise Barriers		231.62		231.62
HPR-2 (144)		Pooled fund project - Testing of Small and Large Sign Supports		512.78		512.78
HPR-2 (147)		Pooled fund project - Disposal of Wastes from Highway Materials Testing Laboratories		131.28		131.28
HPR-2 (148)		Pooled fund project - Arterial Analysis Package - Signal Timing Update & Support		105.00		105.00
HPR-2 (150)		Pooled fund project - Design, Construction & Rehabilitation of Continuously Reinforced Concrete Pavements		91.67		91.67
HPR-2 (153)		Pooled fund project - Gradation Testing of Asphalt Mixes		26.37		26.37
HPR-3 (10)		Pooled fund project - Crescent Study		1,934.84		1,934.84
HPR-4 (187)		NCHRP FY87 General Project Funding		258.41		258.41
HPR-4 (189)		NCHRP FY89 General Project Funding		2,850.72		2,850.72
HPR-4 (190)		NCHRP FY90 General Project Funding		1,104.00		1,104.00
HPR-PR-PL-1(28)		FY 1992 Planning & Research Program (Transportation Inventory Engineering Studies)		202,523.53		202,523.53
Noncontract Engineering Studies Sub-Total				209,962.56		209,962.56
Grand Total of Expenditures			363,951.02	830,461.91	136,151.12	1,330,564.05

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: Nick Melcher, U.S.G.S.

Research Period: Project continued to September 30, 1992

Research Board Funding: \$101,890 per year (matched by \$101,890
from the Department of the Interior)

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds and
10 percent Street Research funds

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

Objective: 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 1991-1992 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. Special reports on the Turkey River, Roberts Creek and Volga River were distributed in 1992.

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

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: State Archaeologist

Research Period: July 1, 1977 to June 30, 1992

Research Board Funding: \$125,000

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 examinations.

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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

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 December 31, 1991

Research Board 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. Plans are to submit the final report in December 1991.

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-239

Project Title: Engineering Study to Evaluate Secondary Bridges With Respect to Current Truck Length and Weight Laws

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald

Research Period: May 9, 1990 to May 31, 1991

Research Board Funding: \$110,000

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

Objective: To engage a consulting firm to rate approximately 22 bridge standards that will contain the inventory rating, operating rating, and load capacities for each bridge standard.

This is a reopening of a 1982 project for bridge ratings. The initial project expenditure was \$66,091 producing a 1982 report of bridge ratings.

Progress: A consultant selection committee chose Stanley Consultants Inc. to perform the work. The load ratings for the additional secondary bridges have been completed.

Reports: Final Report, May 1991

Implementation: Much attention is being focused on our bridges today. Many old bridges are in need of rehabilitation or replacement. With the increase in truck volume and weight over the last decade, it becomes apparent that there is an urgency to verify the load carrying capacity of our bridges. With the recent revisions to the National Bridge Inspection Standards (NBIS), there is a need to report the operating and inventory ratings in an equivalent HS loading.

Project Number: HR-246

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: June 14, 1982 to June 25, 1992

Research Board 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 was established. Posters, tri-fold leaflets and bumper stickers have been developed and distributed to schools, county offices, and driver licensing stations throughout the state. New material was developed to reflect a change made by the 1991 Iowa Legislature to stiffen the penalty for possession of a stolen sign. It is now considered a serious misdemeanor instead of a simple misdemeanor. However, attorneys and judges are very lenient with those convicted of sign vandalism. This does not convey the proper seriousness of sign vandalism.

Reports: Final Report, June 1992

Implementation: It was estimated that more than \$1.5 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. This information should motivate attorneys and judges to assess penalties to the full extent set forth by the Code of Iowa.

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 Gary Harris

Research Period: April 1, 1985 to September 30, 1991

Research Board 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 materials for filling and sealing sawn contraction joints.

Progress: An extra work order was negotiated to include 22,000 linear feet of experimental contraction joint work on a Jasper County project. Special sawing and cleaning were performed and eight different sealants were installed on a pcc paving project on county route T12 in 1985. Some joint sealants have failed while others are performing well.

Reports: Final Report, September 1991

Implementation: Deterioration of joints and joint related distress of pcc pavements continues to be a major maintenance problem. This project rated the best and worst performing sealants and the most effective joint preparation to combat premature joint deterioration.

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 October 31, 1992

Research Board Funding: \$92,210

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

Objective: To evaluate the effect of cracking PC pavement to various sized pieces and seating prior to resurfacing and its influence on reflective cracking and structural rating.

Progress: The project included breaking a 2.5 mile section of PCC pavement into pieces ranging in size from 2 to 3 feet and from 4 to 5 feet. Also, overlay thicknesses of 2 inches, 3 inches, and 4 inches were placed on the broken slab. The project was constructed on Hamilton County route R33 just north of Webster City. Construction was completed in June 1986. As of now, all of the test sections have at least 75 percent reflective cracking. Both of the conventional overlay sections have experienced 100 percent reflective cracking over the joints. A final report will be done in October 1992.

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-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 October 31, 1992

Research Board Funding: \$76,175

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

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

Progress: This 1986 project was constructed on Fremont County road J46, two miles south of Farragut between county roads M16 and M18. 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 asphalt concrete and a portion overlaid with 4 inches of asphalt concrete. The crack surveys indicated predominant cracking to be in the 3-inch overlay sections. There seemed to be substantial reflective cracking in the 3-inch overlay crack and seat sections. As of now, all of the test sections and control sections have at least 85 percent reflective cracking. A final report will be done in October 1992.

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-290

Project Title: Ice Retardant Pavement

Agency: City of Des Moines

Principal Investigator: John P. Bellizzi

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

Research Board Funding: \$25,200

Funding Source: 100 percent State--Primary funds

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

Progress: The experimental Verglimit section was constructed on Euclid Avenue from 1st Street to Columbia Street in August 1986. A similar intersection has been identified for accident history comparison. Very few periods of evaluation were presented during the winters of 1986-87-88 due to the mild winters. Effectiveness of the ice retardant is noticed, in a limited manner only: 1) during a frost; 2) at the beginning of a storm; 3) in a light storm. During the high humidity summer seasons the surface sometimes became wet. Due to the high material cost and the pavement wetting, this product may not be cost effective for Iowa.

Reports: Final Report, November 1991

Project Number: HR-291

Project Title: Performance of Nongrouted, Thin Bonded PCC Overlays

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

Principal Investigators: Wapello County Engineer, Wendell Folkerts; Iowa Concrete Paving Executive Vice President, Gordon Smith; and the DOT Portland Cement Concrete Engineer, Jim Grove

Research Period: March 1, 1986 to October 31, 1991

Research Board Funding: \$14,200

Funding Source: 100 percent State--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: The project was constructed on county road T61 located on the Monroe-Wapello County line in southeast Iowa. The research involved two, 250 foot sections of an ungrouted 4 inch thin bonded PCC overlay. Road Rater testing was conducted to determine the structural rating and cores were obtained and tested for bond shear strength. There is some debonding near a few transverse joints, but no surface distress is present.

Reports: Final Report, January 1992

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. This project indicates that adequate bond can be achieved with or without grout, at least on low volume roads.

Project Number: HR-293

Project Title: Pavement Instrumentation

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

Principal Investigator: Marlee Walton

Research Period: May 1, 1986 to October 31, 1992

Research Board Funding: \$75,000

Funding Source: 100 percent State--Primary funds (Matched by
\$113,000 FHWA funds)

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

Progress: A contract has been executed with Iowa State University for their participation. Five conduits were placed in the subbase crossing the westbound lane of I-80 at the test site to get recordings of moisture and density of the subbase. Some 120 instruments have been installed in a 40 ft. segment of reconstructed pavement. A weigh-in-motion and classification system has been installed and is integrated with strain gage and deflection gage data collection equipment. Software has also been installed to gather data. Limited test data have been collected. System debugging is in progress. A time extension has been granted, pending the final report.

Reports: Interim Report, March 1988

Implementation: Even though instrumentation for this research was lacking, it has provided information for improved instrumentation on future projects.

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agency: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to December 31, 1992

Research Board Funding: \$80,175

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

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

Progress: A 1.8 mile section of R63 north of its intersection with E29 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. The Type B base is performing superbly, while the ammonium phosphate/fly ash base mixes have lent to substantial surface cracking.

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 research has not shown substantial benefit of the addition of ammonium phosphate.

Project Number: HR-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1992

Research Board Funding: \$92,875

Funding Source: 100 percent State--10 percent Primary funds,
45 percent Farm-to-Market funds, 45 percent
Street Research funds

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
5. present transportation safety information to
rural communities by employing a Transportation
Safety Circuit Rider

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-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, 1992

Research Board Funding: \$192,390

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

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
4. Establish a correlation between an efficient laboratory test and field performance of concrete.

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates has been completed. Phase II concluded that 15% fly ash replacement significantly improved the freeze-thaw resistance of mortar in sulfate-tainted brines. Evaluation of concrete beams with various aggregates in brine solutions is in progress as part of Phase III.

Reports: Phase I Report, June 1988; Phase II Report, July 1989

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-303

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

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

Principal Investigators: Robert Gumbert, Richard Mumm and Gary Harris

Research Period: June 1, 1989 to June 1, 1993

Research Board Funding: \$100,000

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

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

Progress: The project was constructed on a 4.5 mile portion of Tama County road E66 (formerly IA 212, formerly US 30). Construction started in the middle of June 1989. Some problems were encountered with the compaction of the material in the widening trench. This was most likely due to the trenchers inability to keep pace with the milling machine. The finished surface is carrying traffic well, but there are some areas causing concern due to movement and evidence of marginal stability, and these areas will be rehabilitated.

Reports: Construction Report, December 1990

Implementation: A successful cold in-place recycling method will provide a cost effective method of rehabilitating older resurfaced roadways. This will also provide improved safety. Attention must be given to adequate compaction of the material in the widening trench before overlaying.

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, 1991

Research Board Funding: \$93,084

Funding Source: 100 percent State--Primary funds

Objective: To improve reliability of forecasts of frost on roads and bridges in Iowa, namely through a synthesis of 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 questionnaire was distributed and the results summarized. Analyses of the survey data and actual frost occurrence conditions was completed. The expert system has been developed. Testing and evaluation of the system was conducted during the 1989-90 winter period. The Freese-Notis weather forecasters evaluated the system during the 1989-91 winter seasons. The computer program was a valuable assistance to forecasters in considering all factors in frost prediction.

Reports: Final Report, June 1991

Implementation: The system will improve the reliability of frost predictions, will lead to improvements in road safety and reduce costs of manpower and deicing material spent on false alarms.

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover and Gary Harris

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

Research Board Funding: \$78,760

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

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

Progress: Construction of the 1.27 mile research project was completed in August 1988. There has been some potholing, but it is generally performing well. Evaluation is continuing.

Reports: Construction Report, February 1989

Implementation: Finding useful ways of incorporating by-product aggregate into construction of lower traffic volume roads will ease the burden of disposal for contractors and reduce the cost of construction for counties.

Project Number: HR-310

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

Agency: Iowa State University

Principal Investigator: Dr. Robert E. Abendroth

Research Period: June 1, 1988 to September 30, 1991

Research Board Funding: \$105,538

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

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

Progress: A literature review has been completed. Field investigations on 3 bridges containing precast panel subdecks has been completed. Monitoring behavior of 5 full scale composite deck slabs has been completed. The deck slabs were constructed in the laboratory and tested to failure. Even though strand lengths were not sufficient to fully develop the ultimate strand stress, there was sufficient slab strength. Field review of the bridges with precast panels identified staining which may be from strand corrosion.

Reports: Final Report, August 1991

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

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: June 15, 1988 to December 31, 1992

Research Board Funding: \$25,000

Funding Source: 100 percent State--Primary funds (Federal Highway Administration funds have been received for testing and evaluation)

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

Progress: A Retsina Mark VI resilient modulus apparatus was obtained and a creep test unit was built. The creep and resilient modulus testing is in three parts. The first part was "The Effects of Crushed Particles in Asphalt Mixtures". Hot mix asphalt mixtures were made with 0, 30, 60, 85 and 100% crushed gravel, crushed limestone and crushed quartzite combined with uncrushed sand and gravel. These aggregate combinations were used with 4%, 5% and 6% asphalt cement. A creep resistance factor (CRF) developed during the research related very well to the amount of crushed particles and the perceived resistance to rutting.

Part II was creep and resilient modulus testing of 2 1/2 inch thick slices of four and six inch diameter drilled cores. These cores were taken from pavements with varying amounts of rutting and pavements of an improved design to resist rutting. An effort was made to relate creep and resilient modulus to rutting per million equivalent single axle loadings. There was a very poor correlation.

Part III data collection was completed in 1992. The data will be used to compare creep and resilient modulus testing of 1) laboratory mixed and compacted specimens; 2) project mixed, laboratory compacted; and 3) drilled cores on five projects ranging from a low volume road to an interstate.

Reports: Final Report, Part I, January 1990
Final Report, Part II, January 1991

Implementation: The improved testing methods will enable more accurate prediction of performance of asphalt concrete mix designs and thereby reduce rutting. The research has also demonstrated the value of crushed particles in reducing the potential for rutting of high volume roadways.

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen and Gary Harris

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

Research Board Funding: \$93,913

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

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

Progress: The project is a 2.8 mile section of the Horseshoe Road in Dubuque County between Balltown and Richardsville. Construction of the project was completed in October 1988. Overall, the project went well. It is recommended these materials be used to construct roadways during the summer because of the better drying weather. The days were cool and this may have hindered efforts to achieve adequate compaction. The Consolid and BIO-CAT test sections have not performed well, and they have since been reconstructed similar to the macadam stone control section. Performance evaluation is continuing.

Reports: Construction Report, March 1989

Implementation: The research has demonstrated the superior performance of the macadam section. The chemical soil stabilizations were unsuccessful.

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction - Washington County

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

Principal Investigators: R. G. Huber and Gary Harris

Research Period: August 15, 1988 to December 31, 1993

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the air form method of arched culvert construction.

Progress: The arch culvert was constructed in Washington County in October 1988. Post construction inspection of the air formed arch culvert showed the Air-O-Form method can be used to construct a structurally sound arch culvert. The arch culvert has been performing well. Trees and brush pass through and cleaning is not required. Evaluation of performance is in progress.

Reports: Construction Report, February 1989

Implementation: The arch design reduces cleaning and maintenance costs but construction must become more economical if it is to compete with box culvert construction for county and state culvert projects.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction - Crawford County

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

Principal Investigators: H. Dale Wight and Gary Harris

Research Period: September 15, 1988 to December 31, 1993

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability of the Air-O-Form method of arch culvert construction.

Progress: The project was constructed one mile north of IA 141 and one-half mile east of county road M55 in Nishnabotna Township. The arch culvert has been performing well. Construction was delayed until October of 1990 so that the county could find ways to make this project more affordable. The Air-O-Form method still has higher costs when compared to other types of culvert construction. This is probably due to the fact that very few contractors are qualified to use this method. Trees and brush pass through and cleaning is not required. Evaluation of performance is in progress.

Reports: Construction Report, May 1991

Implementation: The air formed method of arch culvert construction can be less time consuming, use less steel and concrete, and result in a stronger structure compared to conventional box culvert construction. Such a structure can also be hydraulically more efficient and aesthetically more pleasing than a box culvert. However, this method has not proven to be very economical in Iowa as yet.

Project Number: HR-315

Project Title: Iowa Development of Rubblized Concrete - Mills County

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

Principal Investigators: James Ebmeier and Gary Harris

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

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

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: The project was constructed in 1989 on Mills County road L63 from its intersection with county road H40, north and east approximately 1.9 miles to the south corporate limits of Malvern. It is comprised of eight rubblized and nonrubblized test sections varying in ACC thickness from 3 inches to 5 inches. While there are some areas where the rideability is not the most desirable, only a few cracks have developed in the surface. As expected, the five inch sections are performing the best.

Reports: Construction Report, March 1990

Implementation: Through the development and success of this rehabilitation procedure, we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-316

Project Title: Maximized Utility of the Global Positioning System

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: January 1, 1989 to February 28, 1991

Research Board Funding: \$142,840

Funding Source: 100 percent State--Primary funds

Objective: The objective of this research is to improve the accuracy of Global Positioning System (GPS) for use in Iowa and to train Iowa Department of Transportation personnel in the GPS field.

Progress: Iowa State University has purchased GPS receivers and has conducted three surveys of one mile, five mile and 30 mile radii. Horizontal and vertical accuracies are within 0.2 ft. The data is very encouraging. A gravimetric method of correcting for undulation was used. Iowa DOT personnel were trained to use the GPS equipment.

Reports: Final Report, February 1991

Implementation: Global Positioning System has a great potential for both preliminary and final survey for highway locations. It would provide more accurate data and greater survey capability with current staff.

Project Number: HR-317

Project Title: Evaluation of Edge Drains

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: Vernon J. Marks, Kermit L. Dirks and Robert F. Steffes

Research Period: April 5, 1989 to January 1991

Research Board Funding: \$60,100

Funding Source: 100 percent State--Primary funds

Objective: To use new technology to inspect the inside of the existing edge drains.

Progress: A review of available inspection equipment was made. A 2 3/4" diameter video camera with 300 ft. of push cable and a 1/2" diameter video probe with 50 ft. of cable were purchased. TV monitoring and recording facilities are included. Evaluations of selected drains are in progress and a variety of drain problems have been viewed. Some edge drain design specifications have been modified due to video evaluation results. Demand for video evaluations has increased for culverts and new edge drain construction. Currently, most operations are post construction inspection of new edge drain installations. In the past 3 years approximately 400 drains were inspected with the camera, covering 100,000 ft.

Reports: Produced 10 minute videotape and final report January 1991.

Implementation: New construction, inspection and a review of performance and problems with existing edge drains will reduce pavement deterioration and future edge drain maintenance.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene Joint Seals

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to April 30, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants.

Progress: Four new paving projects with a wide range of average daily traffic were selected for sealant research for 1989. Three sites were added in 1990, one site in 1991 (which included Soff-cut joint sawing) and two more sites in 1992. Some joint seals have failed while others are performing well. The neoprene seals are providing very good performance. The vacuum joint tester has identified poor quality workmanship that has resulted in joint seal failure. Due to this testing, the quality of joint sawing and sealing by the contractor has improved. Sections of neoprene, silicone, urethane and hot pour types of sealing materials were installed. Evaluation of sealant performance is in progress. The development of the Iowa Vacuum Joint Seal Tester (IA-VAC) is being done under this project.

Reports: None

Implementation: Results from the evaluation will help to determine which joint sealants should be selected as cost effective or best for long term performance in future projects.

Project Number: HR-319

Project Title: Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges

Agency: Iowa State University

Principal Investigators: Robert E. Abendroth, F. Wayne Klaiber

Research Period: July 1, 1989 to November 30, 1991

Research Board Funding: \$146,860

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

Objective: To investigate the effectiveness of reinforced concrete and steel intermediate diaphragms to lateral load and to determine whether steel diaphragms of any conventional configuration can provide adequate protection to minimize the damage to prestressed concrete girders caused by lateral impact.

Progress: The research began with an extensive literature search. A survey questionnaire was distributed to define the state-of-the-art. A full scale simple span, prestressed concrete girder bridge model containing three beams was constructed in the laboratory. Several types of intermediate diaphragms were tested in this model. The research indicated that replacement of concrete diaphragms with properly designed steel diaphragms is possible.

Reports: Final Report, December 1991

Implementation: Steel diaphragms could provide the same protection to the prestressed concrete girders as the reinforced concrete diaphragms that are currently being used by the Iowa DOT. Use of steel diaphragms would reduce bridge construction costs.

Project Number: HR-320

Project Title: Constructability in the Bridge Design Process

Agency: Iowa State University

Principal Investigator: Dr. James Rowings

Research Period: July 17, 1989 to June 30, 1991

Research Board Funding: \$89,120

Funding Source: 100 percent State--70 percent Primary funds and 30 percent Secondary funds

Objective: To analyze constructability opportunities for bridge projects and develop an initial constructability knowledge-base. This knowledge-base provides a mechanism to collect construction knowledge and transfer it from completed projects to future projects. The knowledge-base will be developed for use on a microcomputer and could be made interactive with other computer-aided design software in the future.

Progress: A contract has been signed with Iowa State University for their participation. A comprehensive literature review was made. A survey on constructability considerations was mailed to 36 contractors and designers. A constructability system was developed.

Reports: Final Report, June 1991

Implementation: The development of a constructability knowledge-base, to be used in the design phase for bridges will reduce costs and time for construction, along with materials and labor without compromising quality, safety and project scope.

Project Number: HR-321

Project Title: Production of Acetic Acid by Fermentation With Propionibacteria

Agency: Iowa State University

Principal Investigators: Earl Hammond, Bonita Glatz and Charles Glatz

Research Period: November 2, 1989 to January 31, 1993

Research Board Funding: \$97,850

Funding Source: 100 percent State--90 percent Primary funds,
10 percent Street Research funds

Objective: To find an economically favorable route to the production of acetic acid by fermentation with propionibacteria.

Progress: A bench-scale fermenter was purchased for use with fermentation studies. An ultrafiltration apparatus was purchased and attempts are being made to adapt this into an ultrafiltration apparatus for removing acetic and propionic acids from the fermentation mixtures. The intent is to produce less expensive acetic acid for use in producing less expensive calcium magnesium acetate (CMA) deicer. Some improved methods of removing the acetic acid from the fermenter have been identified. Most of the FY92 research efforts were directed at improving fermentation conditions. A new system that employs cells immobilized in solid beads of calcium alginate is being developed. Hopefully, this will increase the acetic acid production rate. An improved hollow fiber acid recovery system was built. Fermentation experiments are continuing.

Reports: Progress Reports, January 1991; January 1992

Implementation: Reduced costs of acetic acid will allow the use of CMA deicer at selected locations to prevent corrosion.

Project Number: HR-322

Project Title: Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics

Agency: Water Resources Division of the United States Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1989 to December 31, 1992

Research Board Funding: \$91,471

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market funds, 10 percent Street Research funds

Objective: To develop a single set of equations for Iowa that relate measurable basin and channel characteristics to flood peaks of 5, 10, 25, 50 and 100 year frequencies

Progress: The research was conducted by the with Water Resources Division of the United States Geological Survey (USGS). An automated procedure for quantifying basin characteristics using a GIS has been developed. All data has been collected and the analysis has been completed. The final report has been written and is in the USGS review process.

Reports: None

Implementation: More reliable estimates of design flood discharges will allow selection of the required size of bridges and culverts which will reduce the cost by avoiding overdesign.

Project Number: HR-323

Project Title: Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber and Terry J. Wipf

Research Period: December 1, 1989 to October 31, 1992

Research Board Funding: \$172,548

Funding Source: 100 percent State--20 percent Street Research funds, 80 percent Farm-to-Market funds

Objective: To develop a design manual for evaluating, rehabilitating and/or strengthening low volume bridges.

Progress: Phase I involving data collection and Phase II dealing with what types of bridges have the most problems and what those problems entail are now being conducted. Methods of rehabilitating low volume road bridges are being developed. Computer software has been developed. The final revisions of the design manual are being made.

Reports: Progress Report, August 1991

Implementation: There are over 24,000 rural bridges in Iowa. One-half of these are structurally deficient or obsolete. These bridges are generally on low volume roads and are low priority for expenditures for rehabilitation. A design manual for engineers to use would help address this problem of rehabilitating and/or strengthening of secondary bridges.

Project Number: HR-324

Project Title: Construction Plan Reading Course Update

Agency: Iowa State University

Principal Investigator: Gerald W. Chase

Research Period: December 1, 1989 to October 31, 1991

Research Board Funding: \$41,579

Funding Source: 100 percent State--45 percent Primary funds,
35 percent Farm-to-Market funds, 20 percent
Street Research funds

Objective: To update the 1964 basic construction plan reading course.

Progress: Updated plans and the training instructions have been developed. They include bridge and highway plan reading material with an instructional manual, half-size plans, workbook and solutions manual for each. Their use has been widely accepted and many have been distributed.

Reports: 1991 Highway and Bridge Plan Reading Courses

Implementation: When new employees are hired at entry level in both state and local government construction jobs, they will be able to attend a course that will help them in plan reading on new construction and also repair, reconstruction and restoration. This improved training will yield better construction inspection which in turn will improve quality of construction.

Project Number: HR-325

Project Title: Thermoset Composite Concrete Reinforcement

Agency: Iowa State University

Principal Investigator: Max Porter

Research Period: January 1, 1990 to January 31, 1992

Research Board Funding: \$97,500

Funding Source: 100 percent State--35 percent Primary funds
30 percent Farm-to-Market funds and 35 percent
Street Research funds

Objective: To determine shear behavior and strength on dowel
Fibercomposite (FC) bars with and without aging, and
to determine the potential aging effects on bond of
FC reinforcing bars.

Progress: Testing and evaluation of composite reinforcing is in
progress. Specimens have been cast. Most of the
testing has been completed. The composite reinforcing
has not shown any adverse chemical problems. The
chemical aging at elevated temperatures caused loss of
strength of some concrete beams. Due to this, some
specimens were remade and retesting is in progress.
The fibercomposite dowels were found to provide
strengths and behavioral characteristics that appear
promising as a potential substitute for steel dowels.

Reports: Final Report - Part I, May 1992

Implementation: FC reinforcing bars in structures such as bridge
decks can offer a valuable alternative against
failures from corrosion. Results from tests on
long term exposure and aging of FC reinforcing
bars will influence the scope of their use.

Project Number: HR-327

Project Title: Evaluation of Chemical Durability of Iowa Fly Ash Concretes

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: April 1, 1990 to March 31, 1993

Research Board Funding: \$110,000

Funding Source: 100 percent State--40 percent Primary funds
40 percent Farm-to-Market funds and 20 percent
Street Research funds

Objective: To evaluate the chemical durability (sulfate/alkali) of Iowa Class C fly ash concretes at varying fly ash replacement levels ranging from 0 percent to 50 percent.

Progress: The research is being conducted by Iowa State University. The specimens are being aged in sulfate solutions. Testing is in progress. Data comparison is being conducted with the Iowa DOT. Curing studies and deicing salt solution studies are being conducted. The research has been directed at the chemical constituents of Iowa fly ashes and their effect on performance of portland cement concrete.

Reports: Progress Report, March 31, 1991

Implementation: The determination of maximum percentage of low cost Iowa fly ash which can be used to produce quality concrete for Iowa highways will optimize savings for Iowa taxpayers as well as promote use of a waste material.

Project Number: HR-329

Project Title: Hydrodemolition Preparation for Dense Concrete Bridge Overlays

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: May 1990 to June 1992

Research Board Funding: \$22,000

Funding Source: 100 percent State--Primary funds

Objective: To evaluate hydrodemolition preparation of an Iowa bridge deck.

Progress: Arrangements were made to add the research to a 1990 project by extra work order. The hydrodemolition equipment was committed to deck overlay preparation projects in Kansas City. This work took longer than expected and the hydrodemolition equipment was not available for Iowa work. The deck preparation was completed as scheduled by conventional methods.

Timing, scheduling and unexpected situations have prevented the trial with the hydrodemolition equipment. The hydrodemolition equipment has now left Des Moines. The owner of the hydrodemolition equipment also reports of problem getting permits from the Department of Natural Resources. There is not currently sufficient interest to accomplish the research. No research was conducted and the project was terminated.

Reports: None

Implementation: This research was an effort to evaluate new technology that may have improved bridge deck overlay quality.

Project Number: HR-330

Project Title: Evaluation of Recycled Rubber in Asphalt Concrete

Agency: University of Northern Iowa and Iowa Department of Transportation, Highway Division

Principal Investigators: Shahram Varzavand, Dr. Stephan Egger and Vernon Marks

Research Period: June 11, 1990 to December 31, 1995

Research Board Funding: \$98,956

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: To evaluate the use of asphalt-rubber binders and recycled rubber granules in Iowa asphalt concrete pavements.

Progress: Four experimental sections were constructed on Muscatine County project F-61-4(49)--20-70 on US 61 from Muscatine to Blue Grass. The asphalt concrete overlay will be two inches of surface over two inches of binder. A contract was executed with the University of Northern Iowa for laboratory evaluation of the asphalt-rubber binder. The construction project was completed in July 1991. There were no construction problems. Initial testing has been completed and annual testing and evaluation is being done. Performance of the asphalt rubber pavement test sections is currently similar to the conventional.

Reports: Construction Report, December 1991

Implementation: This research will provide information on whether an asphalt-rubber binder yields significantly improved performance and if it is cost-effective. It will provide information on the use of recycled rubber in asphalt concrete.

Project Number: HR-331

Project Title: Engineering Study: Skewed Tee Piers for Secondary Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald and Gary Harris

Research Period: June 26, 1991 to May 31, 1992

Research Board Funding: \$210,000

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

Objective: To develop standard designs which county engineers across Iowa can utilize on secondary bridges. This will avoid the duplication of costs and designs among the 99 counties.

Progress: Calhoun-Burns and Associates, Inc. is the consultant on this project. The work involves 15° and 30° skewed tee pier designs for the H30-87 bridge standards with lengths of 188'-10, 201'-4, 213'-10, 226'-4, and 243'-0. An additional span length of 174'-4 will be covered as well. This project is expected to be completed in October 1992.

Reports: None

Implementation: The design of standards will avoid duplication of effort in 99 counties. This will reduce maintenance and rehabilitation costs. Tee piers withstand ice, logs and debris better than pile bent piers.

Project Number: HR-332

Project Title: Design Methodology for Corrugated Metal Pipe Tiedowns

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber

Research Period: August 1, 1990 to January 31, 1993

Research Board Funding: \$165,900

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds, and 10 percent Street Research funds

Objective: a) Synthesize design standards from other state DOT's; b) determine longitudinal stiffness of corrugated metal pipe; and c) obtain experimental data on soil-pipe interaction.

Progress: The research is being conducted by Iowa State University to conduct the research. Research is in progress. Design standards have been synthesized from other state DOT's. Determination of longitudinal stiffness of corrugated metal pipe has been made. The experimental data on soil-pipe interaction is being documented. A field test of a 10 foot diameter corrugated metal pipe has been installed on the ISU campus. Weather has delayed application of the test load.

Reports: None

Implementation: Through the development of a rational methodology for the design of tiedowns and the provision of design standards of tiedowns for large corrugated metal pipe, the rate of pipe uplift failures can be reduced.

Project Number: HR-333

Project Title: Design Methodology for Post-Tensioning
Strengthening of Continuous Span Bridges

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber, Foud Fanous, and
Terry Wipf

Research Period: November 1, 1990 to October 31, 1992

Research Board Funding: \$247,850

Funding Source: 100 percent State--30 percent Primary funds,
40 percent Farm-to-Market funds, 30% Street
Research funds

Objective: 1) To develop a design methodology that practicing
engineers can use to design the post-tensioning
system required to strengthen various continuous
span bridges.
2) design and field test a strengthening system

Progress: An analysis of over 600 bridges with the ANSYS general
purpose finite-element program has been done. Seven
variables which significantly influence the
longitudinal and transverse distribution of moment and
force between the internal and external beams have
been identified. Presently, work is being done on a
simplified analysis technique that will provide
essentially the same answers as the finite element
method of analysis.

An Iowa DOT V12 series bridge has been selected for
strengthening in the field testing phase.

Reports: None

Implementation: The design methodology will make it possible for
the practicing engineer to determine the
post-tensioning system required through use of
graphs, nomographs, personal computer software,
etc., rather than having to use complex
analytical techniques.

Project Number: HR-334

Project Title: Field Measurement of Plow Loads During Ice Removal Operations

Agency: University of Iowa

Principal Investigator: Wilfred A. Nixon

Research Period: December 1, 1990 to April 30, 1993

Research Board Funding: \$137,921

Funding Source: 100 percent State--50 percent Primary funds, 25 percent Farm-to-Market funds and 25 percent Street Research funds

Objective: To determine the optimum plow blade loading through instrumentation of the hydraulic system of a conventional truck.

Progress: The research is being conducted by The University of Iowa. Testing was done during the 1990-1991 winter season and data was collected. The data is currently being analyzed. A series of tests using three different blades was conducted in the winter of 1991-1992. Good measurements were obtained of horizontal and vertical loads to scrape ice off the pavement. Mild weather during the latter part of the winter of 1991-1992 prevented completion of the testing. To allow for this testing, the project was extended through the winter of 1992-93.

Reports: Progress Report, January 1992

Implementation: Improvements of the ice blade or equipment will allow the removal of ice using fewer chemicals and less damage to roadway surfaces.

Project Number: HR-335

Project Title: Driver Behavior at Railroad Grade Crossings:
Before and After Safety Campaign

Agency: Iowa State University

Principal Investigator: Kenneth Brewer

Research Period: January 1, 1991 to March 31, 1992

Research Board Funding: \$49,500

Funding Source: 100 percent State--30 percent Primary funds,
35 percent Farm-to-Market funds, and 35 percent
Street Research funds

Objective: To compare driver behavior at selected railroad
crossings before and after "Operation Lifesaver."

Progress: An Operation Lifesaver public awareness campaign was
initiated in April 1991 in Mason City. This research
was conducted to evaluate the effectiveness. A data
collection method was used to obtain before and after
campaign data. Driver behavior and traffic
characteristics have been recorded at 16 of the 24
crossings. The research shows that Operation
Lifesaver, as conducted in Iowa in April 1991, did
alter drivers' behavior.

Reports: Final Report, March 1992

Implementation: Data collection at the railroad crossings should
enable you to see the effect the safety campaign
has on railroad crossing related accidents.

Project Number: HR-336

Project Title: Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability

Agency: Iowa Department of Transportation

Principal Investigator: Wendell Dubberke

Research Period: March 1, 1991 to March 31, 1993

Research Board Funding: \$40,000

Funding Source: 100 percent State--40 percent Primary funds, 30 percent Farm-to-Market funds and 30 percent Street Research funds

Objective: The objective of the research is to determine if thermogravimetric (TGA) analysis will differentiate between durable and nondurable carbonate aggregate for portland cement concrete.

Progress: Samples from selected crushed carbonate coarse aggregate for portland cement concrete have been obtained. Thermogravimetric testing of more than 200 samples has been conducted on Iowa State University equipment. An improved software program allows relatively quick testing without loss of resolution. Both limestones and dolomites have been tested. Efforts have been made to relate the slope of the weight loss or the temperature when the carbon dioxide is burned off to durability of the aggregate. The TGA equipment is capable of rapid, accurate and repeatable analysis of carbonate aggregate. The TGA slopes prior to the calcite and dolomite transitions yield a good correlation with field performance of carbonate aggregate.

Reports: Progress Report, December 1991

Implementation: Improved evaluation of coarse aggregate for concrete will yield economic benefits by allowing the use of all durable sources and preventing the use of nondurable aggregate that would result in decreased pavement life.

Project Number: HR-337

Project Title: Investigation of Rapid Thermal Analysis
Procedures for Prediction of the Service Life of
Portland Cement Concrete Pavement Carbonate
Coarse Aggregate

Agency: Iowa State University

Principal Investigators: Scott Schlorholtz and
Kenneth L. Bergeson

Research Period: May 1, 1991 to April 30, 1993

Research Board Funding: \$157,020

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and 30 percent
Street Research funds

Objective: To evaluate thermogravimetric (TGA) analysis as a
potential test of the durability of aggregate and to
analyze the chemical changes that result.

Progress: Iowa DOT personnel have obtained samples for the
research from 19 crushed carbonate sources (quarries).
Most of the samples selected for the research had ASTM
C666, Method B freeze and the durability results from
previous testing. There was also a wide range of
field performance of the 19 samples. Data from the
first year of testing showed that premature weight
loss in TGA testing related to decomposition
temperature of the various calcite sources. The
decomposition temperature also seems to relate to
crystallite size. Testing is continuing.

Reports: Phase I Progress Report, April 1992

Implementation: Improved evaluation of coarse aggregate for
concrete will yield economic benefits by
allowing the use of all durable source and
preventing the use of nondurable aggregate that
would result in decreased pavement life.

Project Number: HR-338

Project Title: The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool

Agency: Iowa State University

Principal Investigator: Kathleen M. Waggoner

Research Period: May 1, 1991 to April 30, 1993

Research Board Funding: \$116,527

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

Objective: The first goal of the project is to examine the responsibilities, goals, and effectiveness of persons in charge of secondary roads in eight participating states. The second goal is to develop a program by which bright and motivated high school students as well as university students majoring in civil engineering can be encouraging to consider county engineer positions as career choices.

Progress: A review of applicable state statutes has been completed regarding the obligations of registered professional engineers in the state of Iowa. An expert advisory group comprised of five county engineers has been set up in each of the eight participating states in this study. Visits to several state engineering conferences have been made as well as a questionnaire drafted to solicit comments from engineers and supervisors across the eight participating states.

Reports: Progress Report, October 1991

Implementation: Working carefully with the panel of experts, proposed solutions and new strategies will be identified and explored. Moreover, workshops and seminars will be held in order to provide counties with insights and proposed solutions to the "supply problem" presented by retirements and the difficulty of attracting replacements to county engineer positions.

Project Number: HR-339

Project Title: Multi-Project Scheduling Procedure for Transportation Projects

Agency: Iowa State University

Principal Investigator: Dr. James E. Rowings

Research Period: August 19, 1991 to January 31, 1993

Research Board Funding: \$90,730

Funding Source: 100 percent State--80 percent Primary funds,
10% Secondary funds and 10 percent Street funds

Objective: The objective of this research is to develop an overall system to schedule and control individual and multiple transportation construction projects.

Progress: A survey of DOTs and a literature review of scheduling methods has been completed. Typical transportation projects and scheduling approaches were compared. Draft scheduling specifications for bar charts and Critical Path Method (CPM) scheduling have been developed and are ready for field trial and evaluation on Iowa DOT projects. A recommended methodology for using linear scheduling has been developed.

Reports: Interim report, April 30, 1992

Implementation: This study will evaluate the procedure for establishing contract duration, allow more accurate project updating and forecasts, and produce a methodology for evaluation of the impact of scope changes and extra work and provide a means of multi-project coordination and scheduling

Project Number: HR-341

Project Title: Bond Enhancement Techniques for PCC Whitetopping

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

Principal Investigator: Brad Skinner, Jim Grove, and
Gary Harris

Research Period: June 20, 1991 to June 1996

Research Board Funding: \$25,000

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

Objective: To determine what techniques can be used to ensure the bond between the old asphalt concrete and the new portland cement concrete overlay.

Progress: Construction was completed in late June 1991 on 13 different test sections on R16 south of Dallas Center as part of a 4-mile project. Surface preparation techniques such as milling, planing, power brooming, and use of a tack coat and PCC grout were incorporated. All test sections are performing well. Preliminary testing indicates that all sections have adequate bond regardless of surface preparation technique used. Testing and evaluation are continuing. A construction report will be done in October 1992.

Reports: None

Implementation: The bond between the two surfaces is the key to determining what procedure should be used to properly design the thickness of the PCC overlay. If sufficient bond strength can be established, the pavement could be designed as a bonded overlay, thereby taking into account the structure of existing pavement.

Project Number: HR-342

Project Title: Use of Global Positioning System (GPS) for
Photogrammetry

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: June 1, 1991 to November 30, 1992

Research Board Funding: \$102,755

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: Determine the efficiency of using GPS, the advantages and disadvantages of flying one versus two flight strips on a project, the optimum flying height for a specific accuracy for control points, the XYZ coordinate of the aerial camera at the instant a photo was taken, the rotational orientation of the camera in addition to the XY and Z coordinates, the efficiency of available software used in aerotriangulation computations.

Progress: The research is being conducted by Iowa State University. Photo coordinates and observations have been processed on the computer using Albany software. Observations are being made using GPS camera locations. Ground control points have been established on a survey test area between Nevada and Colo in Story County. GPS receivers were installed on an airplane. Data has been collected during a flight over the test area. The data is encouraging in that it appears that satisfactory accuracy may be achievable.

Reports: Progress Report, March 1992

Implementation: GPS can establish the XY and Z coordinate of any point without the need to traverse or level from any other point. This could provide for possible cost savings while still providing the required accuracy.

Project Number: HR-343

Project Title: Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavements

Agency: Iowa State University

Principal Investigator: Max L. Porter

Research Period: October 1, 1991 to November 30, 1992

Research Board Funding: \$149,955

Funding Source: 100 percent State--50 percent Primary funds,
40 percent Farm-to-Market funds and
10 percent Street Research funds

Objective:

- 1) Conduct a laboratory study of resistance of the fibercomposite bars to highway load transfer type fatigue, and
- 2) Field install and evaluate center tie steel and load transfer dowels in a portland cement concrete paving project.

Progress: Testing and design of load transfer baskets and centerline tie bars has been done. Two load transfer baskets with 1 3/4" diameter x 18" dowels on 8" centers and 6 centerline tie bars were installed in a US 30 paving project in Story County just east of Ames on May 1, 1992. The retrofitted supporting baskets were not rigid enough and allowed some misalignment of the dowels. Other than this, there were no problems. The experimental dowels will be monitored.

Reports: None

Implementation: Fibercomposite reinforcing in concrete structures will not be subject to deterioration by corrosion. Information obtained through this research will help determine if fibercomposite reinforcing can be used in portland cement concrete in place of steel.

Project Number: HR-344

Project Title: Scour Susceptibility at Bridges in the State of Iowa

Agency: Geological Survey, U.S. Dept. of Interior

Principal Investigator: Ed Fischer

Research Period: October 1, 1991 to September 30, 1994

Research Board Funding: \$156,272

Funding Source: 100 percent State--40 percent Primary funds, 40 percent Farm-to-Market funds, and 20 percent Street Research funds

Objective: To evaluate the scour susceptibility of selected bridges and if possible, develop a regional methodology for use by engineers to determine the scour susceptibility of other bridges.

Progress: Research by the Geological Survey, U.S. Dept. of Interior is under way. The initial evaluation of around 130 bridges has been completed. The second phase, involving a more detailed evaluation, is in progress.

Reports: None

Implementation: Failure of bridges over water are often caused by scour and channel instability. Information and understanding of scour at bridge sites throughout Iowa will be analyzed to make the scour analyses.

Project Number: HR-345

Project Title: Electronic Bulletin Board System

Agency: Iowa Transportation Center and Iowa State University

Principal Investigator: Tom Maze

Research Period: December 6, 1991 to December 31, 1994

Research Board Funding: \$100,753

Funding Source: 100 Percent State--10 percent Primary funds
80 percent Farm-to-Market funds and
10 percent Street Research funds

Objective: To assist county engineers and their staffs in obtaining information, communicating between themselves, obtaining the latest Iowa DOT messages, and developing other information files at the request of interested users.

Progress: The first year of work has involved the purchase of the hardware, software and telephone lines as well as the installation and initial operation of the entire system. A computer committee made up of several county engineers has been in charge of developing system policies, identifying data to be exchanged through the bulletin board system, and working with the bulletin board users group to facilitate exchange. Much of the direction of work is being handled by Steve DeVries, Jackson County Engineer and Dr. Tom Maze, Iowa State University.

Reports: None

Implementation: This bulletin board system will help county offices to more easily and quickly transfer information between themselves, between the Iowa DOT and themselves, and between a central file server. A problem and solutions area would serve as a dialogue zone for discussing engineering and maintenance issues, with the results gradually accumulating into a database of practical information and solutions to real problems.

Project Number: HR-346

Project Title: Image Analysis for the Characterization of Materials for Highway Construction

Agency: Iowa State University

Principal Investigators: Glen Oren and Floyd G. Manwiller

Research Period: January 7, 1992 to December 31, 1992

Research Board Funding: \$67,085

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and
30 percent Street Research funds

Objective: To determine if image analysis of scanning electron microscope (SEM) images can accurately determine the air void system in portland cement and asphalt concrete.

Progress: Early efforts were directed at developing the image analysis test method and evaluating various SEM to obtain the best image. Many of the current SEM draw high vacuum on the sample and impart cracking and distortion of the samples. Environmental SEM provide an image without the high vacuum. It would also be desirable to be able to operate in the 5X magnification range. Most current SEM will not operate at that low of magnification. Twenty test sample slices of portland cement concrete that had void determination by linear traverse were obtained. Air void by image analysis has been determined for some of these. The initial results compared fairly well.

Reports: None

Implementation: The image analysis system would provide rapid and accurate air void analysis which would improve the evaluation of pavement problems. In asphalt pavement, it has the potential of reducing the use of toxic chemicals and the cost of disposal.

Project Number: HR-347

Project Title: Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections

Agency: Iowa State University

Principal Investigator: Tom Maze, Mohammad Elahi

Research Period: March 1, 1992 to March 31, 1993

Research Board Funding: \$61,414

Funding Source: 100 percent State--30 percent Primary funds, 20 percent Farm-to-Market funds and 50 percent Street Research funds

Objective: To quantify the relationship between intersection and traffic characteristics and the accident reduction potential of modified left-turn treatment

Progress: A literature review on left turn treatments has been completed. Data on 50 intersections have been obtained through a questionnaire. The data has been coded into a computer program. More intersection data is being obtained.

Reports: None

Implementation: Information related to safety considerations involving the treatment of left-turning traffic will help the engineer decide whether a left-turn bay is necessary.

Project Number: HR-348

Project Title: Recruiting and Retaining Women/Minorities for
Public Sector Engineering Positions

Agency: Iowa State University

Principal Investigator: Dr. Kathleen M. Waggoner
Dr. Lowell F. Greimann

Research Period: April 1, 1992 to April 30, 1994

Research Board Funding: \$138,932

Funding Source: 100 State--70 percent Primary funds, 20 percent
Farm-to-Market funds and 10 percent Street
Research funds

Objective: To evaluate and identify practices used by state highway agencies focused on attracting women and minorities into transportation engineering careers and to use the conclusions drawn from this study to develop new strategies that can be used by the Iowa DOT in meeting its goal of diversity in the workplace. Another objective is to focus on programs and plans used by high schools and universities to prepare and attract women and minority students into careers in transportation engineering.

Progress: A contract was signed with Iowa State University. Data from State agencies is being collected. Findings from a national study will be used to recommend appropriate courses of action for Iowa.

Reports: None

Implementation: Research indicates there is a need to focus on attracting more women and minorities into the field of transportation engineering.

Project Number: HR-349

Project Title: Recycled Paper Erosion Control Mats

Agency: Iowa Department of Transportation

Principal Investigator: Ole Skaar and Mark Masteller

Research Period: March 15, 1992 to December 31, 1993

Research Board Funding: \$20,000

Funding Source: 100 percent State--40 percent Primary funds,
40 percent Farm-to-Market funds and
20 percent Street Research funds

Objective: To determine whether recycled paper erosion control mats will successfully prevent erosion in ditch bottoms and on steep slopes

Progress: Earth-Gard, a recycled paper erosion control mat produced by Research Products Corporation of Madison, Wisconsin, was obtained from the Iowa distributor. It has been installed adjacent to conventional Excelsior mats on three primary locations and on local roads in three counties. Two cities are planning on installing the Earth-Gard mats.

The 1992 installations have been monitored and photographed. Some installations are performing well while there is some damage on others. The Earth-Gard does not seem to be as hardy and durable as the conventional excelsior mats.

Reports: None

Implementation: Use of recycled paper erosion control mats would reduce the volume to landfills and conserve natural resources.

Project Number: HR-350

Project Title: Channel and Flood Plain Aggradation in the Iowa River Basin

Agency: United State Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1992 to March 31, 1995

Research Board Funding: \$76,550

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market and 10 percent Street Research funds

Objective: The objective of this research is to quantify the rate of aggradation on the Iowa River and Skunk River. The overall objective is to understand the effects of land use changes and geomorphic processes on channel aggradation.

Progress: A staff action authorizing the conduct of this research has been signed.

Reports: None

Implementation: Knowledge of the sediment deposition process and rates of stream aggradation for Iowa streams would be beneficial to planners and engineers in the design of bridges, culverts and other water-related structures.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: March 5, 1980 to present

Research Board Funding: \$45,000.00/yr. (covers salary and state share of costs for FICA, IPERS, health insurance, vehicle costs and expenses)

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: Gary Harris has visited with many county engineers to discuss problems being encountered by the secondary road departments and to discuss present research projects during the year. At present, there are 10 active research projects that involve experimental construction by counties and three engineering studies. 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.

ANNUAL REPORT OF HIGHWAY DIVISION HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

Highway Division
Office of Materials
September 1993



**Iowa Department
of Transportation**

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ANNUAL REPORT
OF HIGHWAY DIVISION
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1993

OFFICE OF MATERIALS
(515) 239-1447

HIGHWAY DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

SEPTEMBER 1993

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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; second, to identify and implement improved engineering and management practices.

This report entitled, "Highway Division Highway Research and Development in Iowa", is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which direct the submission of a report of the Secondary Road Research Fund and the Street Research Fund respectively. It is a report of the status of research and development projects which were in progress on June 30, 1993; it is also a report on projects completed during the fiscal year beginning July 1, 1992, and ending June 30, 1993. 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 and 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 and now that denoted by 312.3A.

The Research Board consists of 13 regular members; six county engineers, three Iowa 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, 1993 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1992 to June 30, 1993. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

Table I

1993 IOWA HIGHWAY RESEARCH BOARD

<u>Member</u>	<u>Term Expires</u>	<u>Alternate</u>
Bernard C. Brown State Materials Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1452	12-31-93	E. Thomas Cackler State Construction Engineer Iowa DOT - Highway Division Ames, Iowa 50010 (515) 239-1503
Jim Christensen Page County Engineer P.O. Box 234 Clarinda, IA 51632 (712) 542-2510 SS#-073	12-31-93	J. Brian Morrissey Madison County Engineer P.O. Box 152 Winterset, IA 50273 (515) 462-1136 SS#-061
Steve DeVries Jackson County Engineer Courthouse Maquoketa, IA 52060 (319) 652-4782 SS#-049	12-31-94	Mark Nahra Cedar County Engineer Courthouse Tipton, IA 52772 (319) 886-6102 SS#-016
Royce J. Fichtner Marshall County Engineer Courthouse Marshalltown, IA 50158 (515) 754-6343 SS#-064	12-31-96	Gary Mauer Grundy County Engineer 706 G Avenue Grundy Center, IA 50638 319-824-6912 SS#-038
David Kao, Dean College of Engineering Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-5933	12-31-95	Wallace Sanders, Jr. Dept of Civil & Const. Engr. Iowa State University 394 Town Engineering Bld. Ames, IA 50011 (515) 294-6048 in AM 294-6344 in PM
Lyle Laartz Chickasaw County Engineer P.O. Box 316 New Hampton, IA 50659 (515) 394-2321 SS#-019	12-31-95	Randall J. Will Franklin County Engineer P.O. Box 118 Hampton, Iowa 50441 (515) 456-4671 SS#-035
Kenneth M. Meeks District 1 Engineer Iowa DOT - Highway Division 1020 S. Fourth Street Ames, IA, 50010 515) 239-1635	12-31-95	Maurice Burr District 6 Engineer Iowa DOT - Highway Division P.O. Box 3150 430 76th Ave. SW Cedar Rapids, IA 52406-3150 319-364-0235
A. Jacob Odgaard Associate Dean of Engr. University of Iowa Iowa City, IA 52242 (319) 335-5213	12-31-95	Wilfrid A. Nixon IA Inst of Hydraulic Res University of Iowa 300 S Riverside Drive Iowa City, IA 52242 (319) 335-5166
George F. Sisson Deputy Director, Development Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1461	12-31-94	Donald East Road Design Engineer Iowa DOT - Highway Division Ames, IA 50010 (515) 239-1470
Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072	12-31-94	Keith White Ida/Sac County Engineer 1703 W. 6th, RR 1 Ida Grove, IA 51445 (712) 364-2920 SS#-047
Larry Stevens City Engineer 804 South D Street Oskaloosa, IA 52577-3770 (515) 673-7472	12-31-94	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000
E. D. Tice Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004	12-31-95	Gary Bishop Jefferson County Engineer P.O. Box 827 Fairfield, IA 52556 515-472-6528 SS#-051
Paul Wiegand Director of Public Works 515 Clark Avenue Ames, IA 50010 (515) 239-5162	12-31-93	Neil Guess City Engineer 1700 N. 4th Avenue W. Newton, IA 50208 (515) 792-6622

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, Farm-to-Market Road Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in 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, 1993. Total expenditure was \$1,466,291.45.

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 for in-house projects are relatively small. 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 Sciences.

The purpose of NCHRP is to provide the funds and direction for research in highway matters of national concern.

The program is funded annually by all 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 1993 as part of the Annual Traffic Count Program. This activity consisted of 10 eight-hour manual counts, 420 portable recorder classification counts and 5,850 portable recorder volume 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1993 financial summary is:

Beginning Balance 7-1-92		\$1,294,630
Receipts		
State Road Use Tax Fund (1 1/2% of receipts)...	\$714,769	
Federal Aid Secondary (1 1/2% of receipts)...	170,210	
Research Income	55,315	
	=====	
Sub-Total		940,294
		=====
Total Funds Available		\$2,234,924
Obligation for Expenditures		
Obligated for		
Contract Research...	1,374,176	
Non-Contract		
Engineering Studies...	60,947	
	=====	
Total Expenditures		\$1,435,123
		=====
BALANCE 6-30-93		\$ 799,801

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year two hundred thousand dollars are set aside from the street construction fund solely for the purpose of financing engineering studies and research projects, which have as their objective the more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1992 financial summary is:

Beginning Balance (7-1-92)		\$221,625
Obligated for Expenditure		
HR-140	\$10,947	
HR-333	4,800	
HR-355	13,787	
HR-358	24,027	
HR-339	4,899	
HR-359	16,635	
HR-361	47,379	
HR-362	23,934	
HR-364	11,769	
HR-366	22,237	
	=====	
Total Obligated for Expenditure	180,414	
Ending Unobligated Balance 6-30-93		\$ 41,211

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved such as contracted research and project specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. 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 FY93 was \$585,712.70 and the Estimate for FY94 is \$750,000.

PROJECTS INITIATED DURING FY 1993

The new projects initiated during FY 1993 were:

- HR-351, "Bentonite Treatment for Economical Dust Reduction on Limestone Surfaced Secondary Roads"
- HR-352, "Stream Stabilization in Western Iowa"
- HR-353, "Epoxy-Coated Strands in Composite Precast Prestressed Concrete Panels"
- HR-354, "An Engineering Study to Design Triple Box Culvert Standards"
- HR-355, "The Role of Magnesium in Concrete Deterioration"
- HR-356, "Economical Production of Calcium Magnesium Acetate"
- HR-357, "An Expert System for Forecasting Fog on US 30 in Cedar Rapids"
- HR-358, "Evaluation of Microcracking and Chemical Deterioration in Concrete Pavements"
- HR-359, "Airborne GPS"
- HR-360, "Field Evaluation of Various Engineering Fabrics - Audubon Co."
- HR-361, "Development of a Model for the Ice Scraping Process"
- HR-362, "Design Methodology for Corrugated Metal Pipe Tiedowns: Phase II"
- HR-363, "Clarifying the Quadrennial Needs Study Process"

13 projects

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1992 to June 30, 1993
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
140	105,745/yr.	Collection and Analysis of Stream Flow Data	47,585.00	45,850.00	10,382.00	103,817.00
198	125,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way				
220	8,000	Protection of Structural Concrete Substructures				
246	118,000	Engineering Study - Reducing Sign Vandalism		850.00		850.00
277	92,210	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflection Cracking				
279	76,175	Cracking and Sealing PCC Pavement Prior to Resurfacing to Retard Reflective Cracking --Fremont County				
293	75,000	Pavement Instrumentation				
294	80,175	Ammonium Phosphate/Fly Ash Road Base Construction				
296	92,806/yr	ISU Technology Transfer	12,886.79	57,994.36	57,994.21	128,875.36
299	192,390	Control of Concrete Deterioration Due to Trace Compounds in Deicers	3,128.35	6,220.93		9,349.28
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete				
309	78,760	An Investigation of Emulsion Stabilized Limestone Screenings				
311	25,000	Creep and Resilient Modulus Testing of Asphalt Mixtures				
312	93,913	Low Cost Techniques of Base Stabilization - Dubuque Co.				
313	28,900	Air Formed Arch Culvert Construction - Washington Co.				
314	16,500	Air Formed Arch Culvert Construction - Crawford Co.				
315	98,529	Iowa Development of Rubblized Concrete - Mills Co.				
318	20,800	Evaluation of Preformed Neoprene Joint Seals	660.00			660.00
319	146,860	Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges	7,320.92	7,365.05		14,685.97
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria	5,312.58		3,922.82	9,235.40
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics	3,294.00	3,296.00	1,278.00	7,868.00
323	172,548	Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges		18,943.14	1,619.70	20,562.84
325	97,500	Thermoset Composite Concrete Reinforcement	1,172.69		8,577.33	9,750.02
327	110,000	Evaluation of Chemical Durability of Iowa Fly Ash Concretes	2,743.57	5,952.25	2,304.20	11,000.02
330	98,956	Evaluation of Recycled Rubber in Asphalt Concrete	4,955.96	3,558.46	2,302.78	10,817.20
331	210,000	Engineering Study - Skewed Tee Piers for Secondary Bridges		16,839.07		16,839.07
332	165,900	Design Methodology for Corrugated Metal Pipe Tiedowns: Phase I	2,280.73	49,251.73	15,262.91	66,795.37
333	263,850	Design Methodology for Post-Tensioning Strengthening of Continuous Span Bridges	46,342.49	46,908.90	59,210.86	152,462.25
334	137,921	Field Measurements of Flow Loads During Ice Removal Operations	13,138.11	10,118.15	24,834.38	48,090.64
335	49,500	Driver Behavior at Railroad Grade Crossings: Before and After Safety Campaign	2,398.36	1,569.03		3,967.39
336	40,000	Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability	40.00	2,820.00	6,540.00	9,400.00
337	157,020	Investigation of Rapid Thermal Analysis Procedures for Prediction of the Service Life of PCCP Carbonate Coarse Aggregate	31,527.71	29,125.96	37,983.69	98,637.36
338	116,527	The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool		46,244.28		46,244.28

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
339	139,720	Multi-Project Scheduling Procedure for Transportation Projects	39,391.56	1,477.25	140.24	41,009.05
341	25,000	Bond Enhancement Techniques for PCC Whitetopping				
342	102,755	Use of GPS for Photogrammetry	37,132.18	8,405.94	10,275.00	55,813.12
343	149,955	Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavement Slabs	39,265.79	25,121.98	3,113.65	67,501.42
344	156,272	Scour Susceptibility at Bridges in the State of Iowa	22,975.00	32,200.00		55,175.00
345	100,753	Electronic Bulletin Board System	5,400.38	12,077.42	1,267.31	18,745.11
346	116,345	Image Analysis for the Characterization of Materials for Highway Construction	30,444.62	13,236.15	15,688.55	59,369.32
347	61,414	Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections	14,711.84	6,332.30	12,908.70	33,952.84
348	138,932	Recruiting and Retaining Women/Minorities for Public Sector Engineering Positions	21,797.29	1,675.47	883.38	24,356.14
349	20,000	Recycled Paper Erosion Control Mats	1,598.40	534.20	2,370.40	4,503.00
350	76,550	Channel & Flood Plain Aggradation in the	19,025.00			19,025.00
351	129,495	Bentonite Treatment for Economical Dust Reduction on Limestone Surfaced Secondary Roads		41,496.01		41,496.01
352	188,000	Stream Stabilization in Western Iowa	7,943.00	38,787.53		46,730.53
353	193,900	Epoxy-Coated Stands in Composite Precast Prestressed Concrete Panels	31,850.67	12,146.47		43,997.14
354	180,000	An Engineering Study to Design Triple Box Culvert Standards				
355	137,873	The Role of Magnesium in Concrete Deterioration	37,525.66			37,525.66
356	10,000	Economical Production of Calcium Magnesium Acetate	318.25			318.25
357	145,245	An Expert System for Forecasting Fog on US 30 in Cedar Rapids	10,860.07			10,860.07
358	160,180	Evaluation of Microcracking and Chemical Deterioration in Concrete Pavements	63,000.00			63,000.00
359	166,355	Airborne GPS	14,481.18			14,481.18
360	30,290	Field Evaluation of Various Engineering Fabrics - Audubon Co.				
361	236,895	Development of a Model for the Ice Scraping Process				
362	239,340	Design Methodology for Corrugated Metal Pipe Tiedowns: Phase II	2,308.08			2,308.08
363	45,160	Clarifying the Quadrennial Needs Study Process	896.47			896.47
1027	40,000/yr.	Secondary Road Research Coordinator		55,320.61		55,320.61
Contract Research Sub-Total			585,712.70	601,718.64	278,860.11	1,466,291.45
HPR-2 (126)		Pooled fund project - Integrated Drainage Design Computer System (Phase II)		58.32		58.32
HPR-2 (134)		Pooled fund project - Test and Evaluation of Bridge Rails and Transitions		220.72		220.72
HPR-2 (144)		Pooled fund project - Testing of Small and Large Sign Supports		266.63		266.63
HPR-2 (147)		Pooled fund project - Disposal of Wastes from Highway Materials Testing Laboratories		308.64		308.64
HPR-2 (148)		Pooled fund project - Arterial Analysis Package - Signal Timing Update & Support		54.58		54.58
HPR-2 (151)		Pooled fund project - National Geotechnical Experimentation Sites		271.02		271.02
HPR-2 (153)		Pooled fund project - Gradation Testing of Asphalt Mixes		696.91		696.91
HPR-4 (189)		NCHRP FY89 General Project Funding		1,711.94		1,711.94
HPR-4 (190)		NCHRP FY90 General Project Funding		6,426.11		6,426.11
Noncontract Engineering Studies Sub-Total				10,014.87		10,014.87
Grand Total of Expenditures			585,712.70	611,733.51	278,860.11	1,476,306.32

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: Nick Melcher, U.S.G.S.

Research Period: Project continued to September 30, 1993

Research Board Funding: \$105,745 per year (matched by \$105,745
from the Department of the Interior)

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds and
10 percent Street Research funds

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

Objective: 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 1992-1993 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. Special reports on the Raccoon River and Clear Creek were distributed in 1992.

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

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: State Archaeologist

Research Period: July 1, 1977 to June 30, 1993

Research Board Funding: \$125,000

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 examinations.

Progress: The Iowa Department of Transportation contracts with the State Archaeologist to perform the needed preliminary investigations and to 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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

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 December 31, 1992

Research Board 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. The finding that the distance from the roadway is a major factor in the rate of chloride-ion intrusion makes the research successful. This did, however, require a longer research period. A final report was completed in December 1992 showing that intrusion of chloride-ions does occur in column piers that are subject to splash from adjacent roadway traffic. The sealants did not prevent the penetration of chloride-ion but did retard it.

Reports: Progress Report, December 1984, Final Report, December 1992

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-246

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: June 14, 1982 to June 25, 1992

Research Board 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 was established. Posters, tri-fold leaflets and bumper stickers were developed and distributed to schools, county offices, and driver licensing stations throughout the state. New material was developed to reflect a change made by the 1991 Iowa Legislature to stiffen the penalty for possession of a stolen sign. It is now considered a serious misdemeanor instead of a simple misdemeanor. However, attorneys and judges are very lenient with those convicted of sign vandalism. This does not convey the proper seriousness of sign vandalism.

Reports: Final Report, June 1992

Implementation: It was estimated that more than \$1.5 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. This information should motivate attorneys and judges to assess penalties to the full extent set forth by the Code of Iowa.

Project Number: HR-277

Project Title: Cracking and Seating to Retard Reflective Cracking - Hamilton County

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

Principal Investigators: Wes Smith, Richard Mumm and Gary Harris

Research Period: June 1, 1985 to March 31, 1993

Research Board Funding: \$92,210

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

Objective: To evaluate the effect of cracking PC pavement to various sized pieces and seating prior to resurfacing and its influence on reflective cracking and structural rating.

Progress: This 1986 project demonstrated that a 2 ft. x 3 ft. cracking pattern was optimal to retard reflective cracking in an asphalt overlay. The minimum ACC overlay thickness to be considered for good performance should be no less than 3 inches. Structural ratings determined from the Road Rater™ indicated little difference between each crack and seat section with varying ACC thicknesses and crack spacings. Although reflection cracking is reduced in the early years after construction, the effectiveness of the crack and seat method diminishes over time.

Reports: Final report, March 1993

Implementation: Cracking and seating is an alternative method of rehabilitation to be considered on a case by case basis.

Project Number: HR-279

Project Title: Cracking and Seating to Retard Reflective Cracking - Fremont County

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

Principal Investigators: Charles Marker, Glenn Miller and Gary Harris

Research Period: June 1, 1985 to January 31, 1993

Research Board Funding: \$76,175

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

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

Progress: This 1986 project was constructed on Fremont County road J46, two miles south of Farragut between county roads M16 and M18. There were six test sections of which four were cracked and seated (C & S) prior to being overlaid. Fremont County decided to utilize only a 3 ft. cracking pattern based on a 100 ft. trial test section. Pavement cracking appeared to be effective in reducing primarily longitudinal reflective cracking, but only marginally successful in the reduction of transverse reflective cracking.

Reports: Final report, January 1993

Implementation: Cracking and seating is an alternative method of rehabilitation to be considered on a case by case basis.

Project Number: HR-293

Project Title: Pavement Instrumentation

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

Principal Investigator: Marlee Walton

Research Period: May 1, 1986 to October 31, 1992

Research Board Funding: \$75,000

Funding Source: 100 percent State--Primary funds (Matched by
\$113,000 FHWA funds)

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

Progress: Much of the research was conducted by Iowa State University. Five conduits were placed in the subbase crossing the westbound lane of I-80 at the test site to get recordings of nuclear moisture and density of the subbase. Some 120 instruments were installed in a 40 ft. segment of reconstructed pavement. A weigh-in-motion and classification system was installed and is integrated with strain gage and deflection gage data collection equipment. Software was installed to gather data. Limited test data was collected due to problems with the project design and the equipment selected. A time extension was granted. In spite of design and equipment limitations and inaccessibility of instruments in concrete, the project successfully demonstrated that data can be gathered at a remote site and transferred to a central location for analysis.

Reports: Final Report, September 1992

Implementation: Even though proper instrumentation for this research was lacking, it has provided information for improved instrumentation on future projects.

Project Number: HR-294

Project Title: Ammonium Phosphate/Fly Ash Road Base Construction

Agency: Story County and Iowa State University

Principal Investigators: Del Jespersen and John Pitt

Research Period: May 1986 to June 30, 1993

Research Board Funding: \$80,175

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

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

Progress: A 1.8 mile section of R63 north of its intersection with E29 in Story County was selected for the project. This 1986 project demonstrated that in all cases the control sections utilizing a Type B base experienced dramatically less cracking in the surface than the APFA treated base sections. The cost per mix and subsequent surface maintenance costs for the APFA base sections, especially those having a substantial amount of limestone, were higher than the Type B base control sections. The type B base exhibited better performance than the APFA treated base on this project.

Reports: Final Report, June 1993

Implementation: The research has not shown substantial benefit of the addition of ammonium phosphate. This type of construction may prove to be economical only when petroleum product costs escalate.

Project Number: HR-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: October 1, 1987 to December 31, 1993

Research Board Funding: \$92,806

Funding Source: 100 percent State--10 percent Primary funds,
45 percent Farm-to-Market funds, 45 percent
Street Research funds

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
5. present transportation safety information to
rural communities by employing a Transportation
Safety Circuit Rider

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-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, 1992

Research Board Funding: \$192,390

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

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
4. Establish a correlation between an efficient laboratory test and field performance of concrete.

Progress: Laboratory testing of concrete and mortar specimens in salt brine with varying concentrations of sulfates has been completed. Phase II concluded that 15% fly ash replacement significantly improved the freeze-thaw resistance of mortar in sulfate-tainted brines. Evaluation of concrete beams with various aggregates in brine solutions was conducted as Phase III. A model to predict pavement life was developed but other research shows that life is more dependent on materials.

Reports: Final Report, May 1992

Implementation: This research demonstrated the additional deterioration that results from trace minerals in sodium chloride deicing salt.

Project Number: HR-303

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

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

Principal Investigators: Robert Gumbert, Richard Mumm and Gary Harris

Research Period: June 1, 1989 to October 31, 1993

Research Board Funding: \$100,000

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

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

Progress: The project was constructed on a 4.5 mile portion of Tama County road E66 (formerly IA 212, formerly US 30). Construction started in the middle of June 1989. Some problems were encountered with the compaction of the material in the widening trench. This was most likely due to the trenchers inability to keep pace with the milling machine. The finished surface is carrying traffic well, but there are some areas causing concern due to movement and evidence of marginal stability, and these areas have been rehabilitated. A final report is expected to be completed in October 1993.

Reports: Construction Report, December 1990

Implementation: A successful cold in-place recycling method will provide a cost effective method of rehabilitating older resurfaced roadways. This will also provide improved safety. Attention must be given to adequate compaction of the material in the widening trench before overlaying.

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover and
Gary Harris

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

Research Board Funding: \$78,760

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

Objective: The objective of project HR-309 was to construct and evaluate an experimental base using several variations of a by-product limestone screening/emulsion mix.

Progress: Construction of the 1.27 mile research project was completed in August 1988. Residual asphalt contents of 2.5%, 3.5% and 4.5% were used on test sections of 4 inch and 6 inch compacted thickness. A control section of 6 inches of untreated limestone screenings was included for comparative purposes. There was some potholing and edge cracking which required surface patching. Evaluation is continuing. A final report will be submitted in January 1994.

Reports: Construction Report, February 1989

Implementation: Finding useful ways of incorporating by-product aggregate into construction of lower traffic volume roads will ease the burden of disposal for contractors and reduce the cost of construction for counties.

Project Number: HR-311

Project Title: Creep and Resilient Modulus Testing of Asphalt Mixtures

Agency: Iowa Department of Transportation

Principal Investigator: Vernon J. Marks

Research Period: June 15, 1988 to May 31, 1993

Research Board Funding: \$25,000

Funding Source: 100 percent State--Primary funds (Federal Highway Administration funds have been received for testing and evaluation)

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

Progress: A Retsina Mark VI resilient modulus apparatus was obtained and a creep test unit was built. The creep and resilient modulus testing is in three parts. The first part was "The Effects of Crushed Particles in Asphalt Mixtures". Hot mix asphalt mixtures were made with 0, 30, 60, 85 and 100% crushed gravel, crushed limestone and crushed quartzite combined with uncrushed sand and gravel. These aggregate combinations were used with 4%, 5% and 6% asphalt cement. A creep resistance factor (CRF) developed during the research related very well to the amount of crushed particles and the perceived resistance to rutting.

Part II was creep and resilient modulus testing of 2 1/2 inch thick slices of four and six inch diameter drilled cores. These cores were taken from pavements with varying amounts of rutting and pavements of an improved design to resist rutting. An effort was made to relate creep and resilient modulus to rutting per million equivalent single axle loadings. There was a very poor correlation.

Part III data was used to compare creep and resilient modulus testing of 1) laboratory mixed and compacted specimens; 2) project mixed, laboratory compacted; and 3) drilled cores on five projects ranging from a low volume road to an interstate. No good correlations were obtained.

Reports: Final Report, Part I, January 1990
Final Report, Part II, January 1991
Final Report, Part III, May 1993

Implementation: The research has demonstrated the value of crushed particles in reducing the potential for rutting of high volume roadways.

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen, Roger Boulet and Gary Harris

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

Research Board Funding: \$93,913

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

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

Progress: The project is a 2.8 mile section of the Horseshoe Road in Dubuque County between Balltown and Richardsville. Construction of the project was completed in October 1988. Overall, the project went well. It is recommended these materials be used to construct roadways during the summer because of the better drying weather. The days were cool and this may have hindered efforts to achieve adequate compaction. The Consolid and BIO-CAT test sections have not performed well, and they have since been reconstructed similar to the macadam stone control section. A final report will be completed in November 1993.

Reports: Construction Report, March 1989

Implementation: The research has demonstrated the superior performance of the macadam section. The chemical soil stabilizations were unsuccessful.

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction - Washington County

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

Principal Investigators: R. G. Huber, Sam Moussalli and Gary Harris

Research Period: August 15, 1988 to December 31, 1993

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the air form method of arched culvert construction and to evaluate the performance.

Progress: The arch culvert was constructed in Washington County in October 1988. Post construction inspection of the air formed arch culvert showed the Air-O-Form method can be used to construct a structurally sound arch culvert. The arch culvert has been performing well. Trees and brush pass through and cleaning is not required. Evaluation of performance is in progress.

Reports: Construction Report, February 1989

Implementation: The arch design reduces cleaning and maintenance costs but construction must become more economical if it is to compete with box culvert construction for county and state culvert projects.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction - Crawford County

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

Principal Investigators: H. Dale Wight, Clyde Leonard and Gary Harris

Research Period: September 15, 1988 to December 31, 1994

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability of the Air-O-Form method of arch culvert construction and to evaluate the performance.

Progress: The project was constructed one mile north of IA 141 and one-half mile east of county road M55 in Nishnabotna Township. Construction was delayed until October of 1990 so that the county could find ways to make this project more affordable. The Air-O-Form method still has higher costs when compared to other types of culvert construction. This is probably due to the fact that very few contractors are qualified to use this method. Trees and brush pass through and cleaning is not required. The arch culvert has been performing well. Evaluation of performance is in progress.

Reports: Construction Report, May 1991

Implementation: The air formed method of arch culvert construction can be less time consuming, use less steel and concrete, and result in a stronger structure compared to conventional box culvert construction. Such a structure can also be hydraulically more efficient and aesthetically more pleasing than a box culvert. However, this method has not proven to be very economical in Iowa as yet.

Project Number: HR-315

Project Title: Iowa Development of Rubblized Concrete - Mills County

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

Principal Investigators: James Ebmeier, Glen Miller and Gary Harris

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

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

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: The project was constructed in 1989 on Mills County road L63 from its intersection with county road H40, north and east approximately 1.9 miles to the south corporate limits of Malvern. It is comprised of eight rubblized and nonrubblized test sections varying in ACC thickness from 3 inches to 5 inches. While there are some areas where the rideability is not the most desirable, only a few cracks have developed in the surface. As expected, the five inch sections are performing the best.

Reports: Construction Report, March 1990

Implementation: Through the development and success of this rehabilitation procedure, we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene Joint Seals

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to April 30, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants.

Progress: Four new paving projects with a wide range of average daily traffic were selected for sealant research for 1989. Three sites were added in 1990, one site in 1991 (which included Soff-cut joint sawing) and two more sites in 1992. Sections of neoprene, silicone, urethane and hot pour types of sealing materials were installed. Some joint seals have failed while others are performing well. The neoprene seals are performing well. The development of the Iowa Vacuum Joint Seal Tester (IA-VAC) is being done under this project. The vacuum joint tester has identified poor quality workmanship that has resulted in joint seal failure. Due to this testing, the quality of joint sawing and sealing by the contractor has improved. Evaluation of sealant performance is in progress.

Reports: Progress Report, January 1993

Implementation: Results from the evaluation will help to determine which joint sealants should be selected as cost effective or best for long term performance in future projects. This will increase the performance and longevity of portland cement concrete pavement.

Project Number: HR-319

Project Title: Lateral Load Resistance of Diaphragms in Prestressed Concrete Girder Bridges

Agency: Iowa State University

Principal Investigators: Robert E. Abendroth, F. Wayne Klaiber

Research Period: July 1, 1989 to December 31, 1991

Research Board Funding: \$146,860

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

Objective: To investigate the effectiveness of reinforced concrete and steel intermediate diaphragms to lateral load and to determine whether steel diaphragms of any conventional configuration can provide adequate protection to minimize the damage to prestressed concrete girders caused by lateral impact.

Progress: The research began with an extensive literature search. A survey questionnaire was distributed to define the state-of-the-art. A full scale simple span, prestressed concrete girder bridge model containing three beams was constructed in the laboratory. Several types of intermediate diaphragms were tested in this model. The research indicated that replacement of concrete diaphragms with properly designed steel diaphragms is possible.

Reports: Final Report, December 1991

Implementation: Steel diaphragms could provide the same protection to the prestressed concrete girders as the reinforced concrete diaphragms that are currently being used by the Iowa DOT. Use of steel diaphragms would reduce bridge construction costs.

Project Number: HR-321

Project Title: Production of Acetic Acid by Fermentation With Propionibacteria

Agency: Iowa State University

Principal Investigators: Earl Hammond, Bonita Glatz and Charles Glatz

Research Period: November 2, 1989 to June 30, 1995

Research Board Funding: \$97,850

Funding Source: 100 percent State--90 percent Primary funds,
10 percent Street Research funds

Objective: To find an economically favorable route to the production of acetic acid by fermentation with propionibacteria.

Progress: A bench-scale fermenter was purchased for use with fermentation studies. An ultrafiltration apparatus was purchased and attempts were made to adapt this into an ultrafiltration apparatus for removing acetic and propionic acids from the fermentation mixtures. Some improved methods of removing the acetic acid from the fermenter have been identified. Most of the FY92 research efforts were directed at improving fermentation conditions. A new system that employs cells imobilized in solid beads of calcium alginate is being developed. Hopefully, this will increase the acetic acid production rate. An improved hollow fiber acid recovery system was built. Fermentation experiments are continuing. The intent was to produce less expensive acetic acid for use in producing less expensive calcium magnesium acetate (CMA) deicer. An extension was granted in March 1993 to allow research to continue until June 30, 1995.

Reports: Progress Reports, January 1991; January 1992; Final Report, February 1993

Implementation: Reduced costs of acetic acid will allow the use of CMA deicer at selected locations to prevent corrosion.

Project Number: HR-322

Project Title: Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics

Agency: Water Resources Division of the United States Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1989 to December 31, 1993

Research Board Funding: \$91,471

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market funds, 10 percent Street Research funds

Objective: To develop a single set of equations for Iowa that relate measurable basin and channel characteristics to flood peaks of 5, 10, 25, 50 and 100 year frequencies

Progress: The research was conducted by the with Water Resources Division of the United States Geological Survey (USGS). An automated procedure for quantifying basin characteristics using a GIS has been developed. All data has been collected and the analysis has been completed. The final report has been written and is in the USGS review process.

Reports: None

Implementation: More reliable estimates of design flood discharges will allow selection of the required size of bridges and culverts which will reduce the cost by avoiding overdesign.

Project Number: HR-323

Project Title: Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges

Agency: Iowa State University

Principal Investigators: F. Wayne Klaiber and Terry J. Wipf

Research Period: December 1, 1989 to February 28, 1993

Research Board Funding: \$172,548

Funding Source: 100 percent State--20 percent Street Research funds, 80 percent Farm-to-Market funds

Objective: To develop a design manual for evaluating, rehabilitating and/or strengthening low volume bridges.

Progress: Phase I involving data collection and Phase II dealing with what types of bridges have the most problems and what those problems entail are now being conducted. Methods of rehabilitating low volume road bridges are being developed. Computer software has been developed. The final report published in February 1993 contains an evaluation and design manual for strengthening and replacing low volume steel stringer and timber stringer bridges.

Reports: Progress Report, August 1991; Final Report, February 1993

Implementation: There are over 24,000 rural bridges in Iowa. One-half of these are structurally deficient or obsolete. These bridges are generally on low volume roads and are low priority for expenditures for rehabilitation. A design manual for engineers to use will help address this problem of rehabilitating and/or strengthening of secondary bridges.

Project Number: HR-325

Project Title: Thermoset Composite Concrete Reinforcement

Agency: Iowa State University

Principal Investigator: Max Porter

Research Period: January 1, 1990 to October 31, 1992

Research Board Funding: \$97,500

Funding Source: 100 percent State--35 percent Primary funds
30 percent Farm-to-Market funds and 35 percent
Street Research funds

Objective: To determine shear behavior and strength on dowel
Fibercomposite (FC) bars with and without aging, and
to determine the potential aging effects on bond of
FC reinforcing bars.

Progress: Testing and evaluation of composite reinforcing has
been completed. The composite reinforcing has not
shown any adverse chemical problems. The chemical
aging at elevated temperatures caused loss of strength
of some concrete beams. Due to this, some specimens
were remade and retested. The fibercomposite dowels
were found to provide strengths and behavioral
characteristics that appear promising as a potential
substitute for steel dowels. The E-glass fibers
encapsulated in a vinyl ester resin matrix proved to
be very resistant to accelerated chemical aging.

Reports: Final Report - Part I, May 1992, Final Report - Part 2,
October 1992

Implementation: FC reinforcing bars in structures such as bridge
decks can offer a valuable alternative against
failures from corrosion. Results from tests on
long term exposure and aging of FC reinforcing
bars will influence the scope of their use.

Project Number: HR-327

Project Title: Evaluation of Chemical Durability of Iowa Fly Ash Concretes

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: April 1, 1990 to March 31, 1993

Research Board Funding: \$110,000

Funding Source: 100 percent State--40 percent Primary funds
40 percent Farm-to-Market funds and 20 percent
Street Research funds

Objective: To evaluate the chemical durability (sulfate/alkali) of Iowa Class C fly ash concretes at varying fly ash replacement levels ranging from 0 percent to 50 percent.

Progress: The research was conducted by Iowa State University. The specimens were aged in sulfate solutions. Testing has been completed. Data comparisons were conducted with the Iowa DOT. Curing studies and deicing salt solution studies were conducted. The research was directed at the chemical constituents of Iowa fly ashes and their effect on performance of portland cement concrete. No adverse effects were identified with most of the fly ashes evaluated.

Reports: Final Report, March 1993

Implementation: The determination of maximum percentage of low cost Iowa fly ash which can be used to produce quality concrete for Iowa highways will optimize savings for Iowa taxpayers as well as promote use of a waste material.

Project Number: HR-330

Project Title: Evaluation of Recycled Rubber in Asphalt Concrete

Agency: University of Northern Iowa and Iowa Department of Transportation, Highway Division

Principal Investigators: Shahram Varzavand, Dr. Stephan Egger and Vernon Marks

Research Period: June 11, 1990 to December 31, 1995

Research Board Funding: \$98,956

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: To evaluate the use of asphalt-rubber binders and recycled rubber granules in Iowa asphalt concrete pavements.

Progress: Four experimental sections were constructed on Muscatine County project F-61-4(49)--20-70 on US 61 from Muscatine to Blue Grass. The asphalt concrete overlay was two inches of surface over two inches of binder. A contract was executed with the University of Northern Iowa for laboratory evaluation of the asphalt-rubber binder. The construction project was completed in July 1991. There were no construction problems. Initial testing has been completed and annual testing and evaluation is being done. Performance of the asphalt rubber pavement test sections is currently similar to the conventional.

Reports: Construction Report, December 1991

Implementation: This research will provide information on whether an asphalt-rubber binder yields significantly improved performance and if it is cost-effective. It will provide information on the use of recycled rubber in asphalt concrete.

Project Number: HR-331

Project Title: Engineering Study: Skewed Tee Piers for
Secondary Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Norm McDonald and Gary Harris

Research Period: June 26, 1991 to October 31, 1993

Research Board Funding: \$210,000

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

Objective: To develop standard designs which county engineers across Iowa can utilize on secondary bridges. This will avoid the duplication of costs and designs among the 99 counties.

Progress: Calhoun-Burns and Associates, Inc. is the consultant on this project. The work involves 15° and 30° skewed tee pier designs for the H30-87 bridge standards with lengths of 188'-10, 201'-4, 213'-10, 226'-4, and 243'-0. An additional span length of 174'-4 will be covered as well. This project is expected to be completed and reviewed by October 1993.

Reports: None

Implementation: The design of standards will avoid duplication of effort in 99 counties. This will reduce maintenance and rehabilitation costs. Tee piers withstand ice, logs and debris better than pile bent piers.

Project Number: HR-332

Project Title: Design Methodology for Corrugated Metal Pipe
Tiedowns

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber

Research Period: August 1, 1990 to February 28, 1993

Research Board Funding: \$165,900

Funding Source: 100 percent State--10 percent Primary funds,
80 percent Farm-to-Market funds, and 10 percent
Street Research funds

Objective: a) Synthesize design standards from other state
DOT's; b) determine longitudinal stiffness of
corrugated metal pipe; and c) obtain experimental
data on soil-pipe interaction.

Progress: The research was conducted by Iowa State University.
Design standards were synthesized from other state
DOT's. Longitudinal stiffness of corrugated metal
pipe was determined. The experimental data on soil-
pipe interaction was documented. A field test of a 10
foot diameter corrugated metal pipe was installed on
the ISU campus. The test was conducted with 2 feet of
soil cover and a foreslope of 2:1. This test
indicated that the soil cover significantly increased
the stiffness of the pipe. Future plans include
development of a finite element analysis to better
describe the soil structure interaction.

Reports: Final Report, February 1993

Implementation: Through the development of a rational
methodology for the design of tiedowns and the
provision of design standards of tiedowns for
large corrugated metal pipe, the rate of pipe
uplift failures can be reduced.

Project Number: HR-333

Project Title: Design Methodology for Post-Tensioning
Strengthening of Continuous Span Bridges

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber, Foud Fanous, and
Terry Wipf

Research Period: November 1, 1990 to September 15, 1993

Research Board Funding: \$263,850

Funding Source: 100 percent State--30 percent Primary funds,
40 percent Farm-to-Market funds, 30% Street
Research funds

Objective: 1) To develop a design methodology that practicing
engineers can use to design the post-tensioning
system required to strengthen various continuous
span bridges.
2) design and field test a strengthening system

Progress: An analysis of over 600 bridges with the ANSYS general
purpose finite-element program were completed. Seven
variables which significantly influence the
longitudinal and transverse distribution of moment and
force between the internal and external beams were
identified. Work is being done on a simplified
analysis technique that will provide essentially the
same answers as the finite element method of analysis.

An Iowa DOT V12 series bridge near Mason City was
selected for strengthening in the field testing phase.
Strengthening is being done through post tensioning and
superimposed trusses. Extensive instrumentation has
been installed to record test load response.

Reports: Progress Report, September 1992

Implementation: The design methodology will make it possible for
the practicing engineer to determine the
post-tensioning system required through use of
graphs, nomographs, personal computer software,
etc., rather than having to use complex
analytical techniques.

Project Number: HR-334

Project Title: Field Measurement of Plow Loads During Ice Removal Operations

Agency: University of Iowa

Principal Investigator: Wilfred A. Nixon

Research Period: December 1, 1990 to October 31, 1993

Research Board Funding: \$137,921

Funding Source: 100 percent State--50 percent Primary funds, 25 percent Farm-to-Market funds and 25 percent Street Research funds

Objective: To determine the optimum plow blade loading through instrumentation of the hydraulic system of a conventional truck.

Progress: The research is being conducted by The University of Iowa. Testing was done during the 1990-1991 winter season and data was collected. The data is currently being analyzed. A series of tests using three different blades was conducted in the winter of 1991-1992. Good measurements were obtained of horizontal and vertical loads to scrape ice off the pavement. Mild weather during the latter part of the winter of 1991-1992 prevented completion of the testing. To allow for this testing, the project was extended through the winter of 1992-93. Final test objectives were achieved in the winter of '92-93. The final report is being prepared for release in October 1993.

Reports: Progress Report, January 1992

Implementation: Improvements of the ice blade or equipment will allow the removal of ice using fewer chemicals and less damage to roadway surfaces.

Project Number: HR-335

Project Title: Driver Behavior at Railroad Grade Crossings:
Before and After Safety Campaign

Agency: Iowa State University

Principal Investigator: Kenneth Brewer

Research Period: January 1, 1991 to March 31, 1992

Research Board Funding: \$49,500

Funding Source: 100 percent State--30 percent Primary funds,
35 percent Farm-to-Market funds, and 35 percent
Street Research funds

Objective: To compare driver behavior at selected railroad
crossings before and after "Operation Lifesaver."

Progress: An Operation Lifesaver public awareness campaign was
initiated in April 1991 in Mason City. This research
was conducted to evaluate the effectiveness. A data
collection method was used to obtain before and after
campaign data. Driver behavior and traffic
characteristics were recorded at 16 of the 24
crossings. The research shows that Operation
Lifesaver, as conducted in Iowa in April 1991, did
alter drivers' behavior.

Reports: Final Report, March 1992

Implementation: Data collection at the railroad crossings should
enable evaluation of the effect the safety
campaign has on railroad crossing related
accidents.

Project Number: HR-336

Project Title: Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability

Agency: Iowa Department of Transportation

Principal Investigator: Wendell Dubberke

Research Period: March 1, 1991 to October 31, 1993

Research Board Funding: \$40,000

Funding Source: 100 percent State--40 percent Primary funds, 30 percent Farm-to-Market funds and 30 percent Street Research funds

Objective: The objective of the research is to determine if thermogravimetric (TGA) analysis will differentiate between durable and nondurable carbonate aggregate for portland cement concrete.

Progress: Samples from selected crushed carbonate coarse aggregate for portland cement concrete were obtained. Thermogravimetric testing of more than 200 samples was conducted with Iowa State University equipment. An improved software program allows relatively quick testing without loss of resolution. Both limestones and dolomites have been tested. Efforts have been made to relate the slope of the weight loss or the temperature when the carbon dioxide is driven off to durability of the aggregate. The TGA equipment is capable of rapid, accurate and repeatable analysis of carbonate aggregate. The TGA slopes prior to the calcite and dolomite transitions yield a good correlation with field performance of carbonate aggregate.

Reports: Progress Report, December 1991

Implementation: Improved evaluation of coarse aggregate for concrete will yield economic benefits by allowing the use of all durable sources and preventing the use of nondurable aggregate that would result in decreased pavement life.

Project Number: HR-337

Project Title: Investigation of Rapid Thermal Analysis
Procedures for Prediction of the Service Life of
Portland Cement Concrete Pavement Carbonate
Coarse Aggregate

Agency: Iowa State University

Principal Investigators: Scott Schlorholtz and
Kenneth L. Bergeson

Research Period: May 1, 1991 to September 30, 1993

Research Board Funding: \$157,020

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and 30 percent
Street Research funds

Objective: To evaluate thermogravimetric (TGA) analysis as a
potential test of the durability of aggregate and to
analyze the chemical changes that result.

Progress: Iowa DOT personnel have obtained samples for the
research from 19 crushed carbonate sources (quarries).
Most of the samples selected for the research had ASTM
C666, Method B freeze and the durability results from
previous testing. There was also a wide range of
field performance of the 19 samples. Data from the
first year of testing showed that premature weight
loss in TGA testing related to decomposition
temperature of the various calcite sources. The
decomposition temperature also seems to relate to
crystallite size. The final report will be submitted
by September 15, 1993.

Reports: Phase I Progress Report, April 1992

Implementation: Improved evaluation of coarse aggregate for
concrete will yield economic benefits by
allowing the use of all durable source and
preventing the use of nondurable aggregate that
would result in decreased pavement life.

Project Number: HR-338

Project Title: The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool

Agency: Iowa State University

Principal Investigator: Kathleen M. Waggoner

Research Period: May 1, 1991 to September 15, 1993

Research Board Funding: \$116,527

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

Objective: The first goal of the project is to examine the responsibilities, goals, and effectiveness of persons in charge of secondary roads in eight participating states. The second goal is to develop a program by which bright and motivated high school students as well as university students majoring in civil engineering can be encouraging to consider county engineer positions as career choices.

Progress: A review of applicable state statutes has been completed regarding the obligations of registered professional engineers in the state of Iowa. An expert advisory group comprised of five county engineers was set up in each of the eight participating states in this study. Visits to several state engineering conferences were made as well as a questionnaire drafted to solicit comments from engineers and supervisors across the eight participating states. The questionnaire response rate was 60 percent. Information from Phase I was used in Phase II to develop a method to attract precollege and university engineering students into the county engineering profession. The final report is being prepared for release September 1993.

Reports: Interim Report - Phase I, September 1992

Implementation: Working carefully with the panel of experts, proposed solutions and new strategies will be identified and explored. Moreover, workshops and seminars will be held in order to provide counties with insights and proposed solutions to the "supply problem" presented by retirements and the difficulty of attracting replacements to county engineer positions.

Project Number: HR-339

Project Title: Multi-Project Scheduling Procedure for
Transportation Projects

Agency: Iowa State University

Principal Investigator: Dr. James E. Rowings

Research Period: August 19, 1991 to September 30, 1993

Research Board Funding: \$139,720

Funding Source: 100 percent State--80 percent Primary funds,
10% Secondary funds and 10 percent Street funds

Objective: The objective of this research is to develop an overall system to schedule and control individual and multiple transportation construction projects.

Progress: A survey of DOTs and a literature review of scheduling methods was completed. Typical transportation projects and scheduling approaches were compared. Draft scheduling specifications for bar charts and Critical Path Method (CPM) scheduling have been developed and are ready for field trial and evaluation on Iowa DOT projects. A recommended methodology for using linear scheduling has been developed. The original project on which the linear scheduling method was applied was useful in demonstrating what a linear schedule might look like as far as what types of information would be included and how it would be displayed. Since the research team was not involved in the planning phase of the project and only one project was tested, the research has been expanded.

Reports: Interim report, April 30, 1992; Final Report Part I, April 1993

Implementation: This study will evaluate the procedure for establishing contract duration, allow more accurate project updating and forecasts, and produce a methodology for evaluation of the impact of scope changes and extra work and provide a means of multi-project coordination and scheduling. In Phase II the technique will be applied to a group of diverse projects, from the early planning stages through completion of the projects.

Project Number: HR-341

Project Title: Bond Enhancement Techniques for PCC Whitetopping

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

Principal Investigator: Brad Skinner, Jim Grove, and
Gary Harris

Research Period: June 20, 1991 to June 1996

Research Board Funding: \$25,000

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

Objective: To determine what techniques can be used to ensure the bond between the old asphalt concrete and the new portland cement concrete overlay.

Progress: Construction was completed in late June 1991 on 13 different test sections on R16 south of Dallas Center as part of a 4-mile project. Surface preparation techniques such as milling, planing, power brooming, and use of a tack coat and PCC grout were incorporated. All test sections are performing well. Preliminary testing indicates that all sections have adequate bond regardless of surface preparation technique used. Testing and evaluation are continuing.

Reports: Construction report, January 1993

Implementation: The bond between the two surfaces is the key to determining what procedure should be used to properly design the thickness of the PCC overlay. If sufficient bond strength can be established, the pavement could be designed as a composite pavement, thereby taking into account the structure of existing asphalt pavement.

Project Number: HR-342

Project Title: Use of Global Positioning System (GPS) for
Photogrammetry

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: June 1, 1991 to January 31, 1993

Research Board Funding: \$102,755

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: Determine the efficiency of using GPS, the advantages and disadvantages of flying one versus two flight strips on a project, the optimum flying height for a specific accuracy for control points, the XYZ coordinate of the aerial camera at the instant a photo was taken, the rotational orientation of the camera in addition to the XY and Z coordinates, the efficiency of available software used in aerotriangulation computations.

Progress: The research was conducted by Iowa State University. Photo coordinates and observations were processed on the computer using Albany software. Observations were made using GPS camera locations. Ground control points were established on a survey test area between Nevada and Colo in Story County. GPS receivers were installed on an airplane. Five test flights were conducted to study the use of GPS in photogrammetry, three in Iowa and one each in California and Texas. The 1:3000 scale photography showed that the absolute accuracy of the camera location by GPS is better than 5 centimeters. The data is encouraging in that it appears that satisfactory accuracy may be achievable.

Reports: Final Report, January 1993

Implementation: GPS can establish the XY and Z coordinate of any point without the need to traverse or level from any other point. This could provide for possible cost savings while still providing the required accuracy.

Project Number: HR-343

Project Title: Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavements

Agency: Iowa State University

Principal Investigator: Max L. Porter

Research Period: October 1, 1991 to November 30, 1993

Research Board Funding: \$149,955

Funding Source: 100 percent State--50 percent Primary funds,
40 percent Farm-to-Market funds and
10 percent Street Research funds

Objective:

- 1) Conduct a laboratory study of resistance of the fibercomposite bars to highway load transfer type fatigue, and
- 2) Field install and evaluate center tie steel and load transfer dowels in a portland cement concrete paving project.

Progress: Testing and design of load transfer baskets and centerline tie bars was completed. Two load transfer baskets with 1 3/4" diameter x 18" dowels on 8" centers and 6 centerline tie bars were installed in a US 30 paving project in Story County just east of Ames on May 1, 1992. The retrofitted supporting baskets were not rigid enough and allowed some misalignment of the dowels. Other than this, there were no problems. Iowa State University performed static-load applications in the spring of 1993. The Iowa DOT did Road Rater testing at the same time.

Reports: Progress Report, January 1993

Implementation: Fibercomposite reinforcing in concrete structures will not be subject to deterioration by corrosion. Information obtained through this research will help determine if fibercomposite reinforcing can be used in portland cement concrete in place of steel.

Project Number: HR-344

Project Title: Scour Susceptibility at Bridges in the State of Iowa

Agency: Geological Survey, U.S. Dept. of Interior

Principal Investigator: Ed Fischer

Research Period: October 1, 1991 to September 30, 1994

Research Board Funding: \$156,272

Funding Source: 100 percent State--40 percent Primary funds, 40 percent Farm-to-Market funds, and 20 percent Street Research funds

Objective: To evaluate the scour susceptibility of selected bridges and if possible, develop a regional methodology for use by engineers to determine the scour susceptibility of other bridges.

Progress: Research by the Geological Survey, U.S. Dept. of Interior is under way. The initial evaluation of around 130 bridges has been completed. The second phase, involving a more detailed evaluation, is in progress. The third part of the project is the collection of actual scour measurements during floods where possible. Some of this was completed after the flooding in south central Iowa in 1992.

Reports: Progress Report, April 1993

Implementation: Failure of bridges over water are often caused by scour and channel instability. Information and understanding of scour at bridge sites throughout Iowa will be analyzed to make the scour analyses.

Project Number: HR-345

Project Title: Electronic Bulletin Board System

Agency: Iowa Transportation Center and Iowa State University

Principal Investigator: Tom Maze

Research Period: December 6, 1991 to December 31, 1994

Research Board Funding: \$100,753

Funding Source: 100 Percent State--10 percent Primary funds
80 percent Farm-to-Market funds and
10 percent Street Research funds

Objective: To assist county engineers and their staffs in obtaining information, communicating between themselves, obtaining the latest Iowa DOT messages, and developing other information files at the request of interested users.

Progress: A computer committee made up of several county engineers is in charge of developing system policies, identifying data to be exchanged through the bulletin board system, and working with the bulletin board users group to facilitate exchange. The system continues to be fine-tuned and upgraded to bring more new users on-line. Much of the direction of work is being handled by Steve DeVries, Jackson County Engineer and Dr. Tom Maze, Iowa State University. The system appears to have benefit.

Reports: Progress report, January 1993

Implementation: This bulletin board system will help county offices to more easily and quickly transfer information between themselves, between the Iowa DOT and themselves, and between a central file server. A problem and solutions area would serve as a dialogue zone for discussing engineering and maintenance issues, with the results gradually accumulating into a database of practical information and solutions to real problems.

Project Number: HR-346

Project Title: Image Analysis for the Characterization of Materials for Highway Construction

Agency: Iowa State University

Principal Investigators: Glen Oren and Floyd G. Manwiller

Research Period: January 7, 1992 to December 31, 1993

Research Board Funding: \$116,345

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and
30 percent Street Research funds

Objective: To determine if image analysis of scanning electron microscope (SEM) images can accurately determine the air void system in portland cement and asphalt concrete.

Progress: Early efforts were directed at developing the image analysis test method and evaluating various SEM to obtain the best image. Many of the current SEM draw high vacuum on the sample and impart cracking and distortion of the samples. It would also be desirable to be able to operate in the 5X magnification range. Most current SEM will not operate at that low of magnification. A low vacuum SEM with low magnification capabilities will soon be available. Twenty test sample slices of portland cement concrete that had void determination by linear traverse were obtained. Air void by image analysis has been determined for these. The initial results compared well.

Reports: Progress report, July 1992

Implementation: The image analysis system would provide rapid and accurate air void analysis which would improve the evaluation of pavement problems. In asphalt pavement, it has the potential of reducing the use of toxic chemicals and the cost of disposal.

Project Number: HR-347

Project Title: Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections

Agency: Iowa State University

Principal Investigator: Tom Maze, Joseph Henderson

Research Period: March 1, 1992 to October 31, 1993

Research Board Funding: \$61,414

Funding Source: 100 percent State--30 percent Primary funds, 20 percent Farm-to-Market funds and 50 percent Street Research funds

Objective: To quantify the relationship between intersection and traffic characteristics and the accident reduction potential of modified left-turn treatment

Progress: A literature review on left turn treatments has been completed. There has been data collected on 100 intersections throughout the state of Iowa. Data has been coded into a computer program. Analysis has been conducted on the preliminary database with positive results. A no-cost time extension was granted on the project.

Reports: Progress Report, April 1993

Implementation: Information related to safety considerations involving the treatment of left-turning traffic will help the engineer decide whether a left-turn bay is necessary.

Project Number: HR-348

Project Title: Recruiting and Retaining Women/Minorities for
Public Sector Engineering Positions

Agency: Iowa State University

Principal Investigator: Dr. Kathleen M. Waggoner
Dr. Lowell F. Greimann

Research Period: April 1, 1992 to April 30, 1994

Research Board Funding: \$138,932

Funding Source: 100 State--70 percent Primary funds, 20 percent
Farm-to-Market funds and 10 percent Street
Research funds

Objective: The primary objective of Phase I of this research has been to identify and evaluate the potential benefits and obstacles facing Iowa DOT administrators in charge of factoring racial and gender diversity into the DOT's future agenda. Another objective is to focus on programs and plans used by high schools and universities to prepare and attract women and minority students into careers in transportation engineering.

Progress: The research is being conducted by Iowa State University. Data expected available for use in this project from a similar 1990 AASHTO study was not released. Data from State agencies is being collected. A questionnaire was sent out to 274 DOT engineers and 325 secretaries and technicians. The response rate was 59.2%. A preliminary analysis of the data has been completed, but a more detailed analysis will be completed later.

Reports: Interim Report, May 31, 1993

Implementation: Research indicates there is a need to focus on attracting more women and minorities into the field of transportation engineering.

Project Number: HR-349

Project Title: Recycled Paper Erosion Control Mats

Agency: Iowa Department of Transportation

Principal Investigator: Ole Skaar and Mark Masteller

Research Period: March 15, 1992 to December 31, 1993

Research Board Funding: \$20,000

Funding Source: 100 percent State--40 percent Primary funds,
40 percent Farm-to-Market funds and
20 percent Street Research funds

Objective: To determine whether recycled paper erosion control mats will successfully prevent erosion in ditch bottoms and on steep slopes

Progress: Earth-Gard, a recycled paper erosion control mat produced by Research Products Corporation of Madison, Wisconsin, was obtained from an Iowa distributor. It has been installed adjacent to conventional Excelsior mats on three primary locations and on local roads in three counties. Two cities are planning on installing the Earth-Gard mats.

The 1992 installations have been monitored and photographed. Some installations are performing well while there is some damage on others. The Earth-Gard does not seem to be as hardy and durable as the conventional excelsior mats. The Earth-Gard disintegrates and is no longer functional after one year, whereas, the excelsior continues to function after the first year.

Reports: None

Implementation: Use of recycled paper erosion control mats would reduce the volume to landfills and conserve natural resources.

Project Number: HR-350

Project Title: Channel and Flood Plain Aggradation in the Iowa River Basin

Agency: United State Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1992 to March 31, 1995

Research Board Funding: \$76,550

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market and 10 percent Street Research funds

Objective: The objective of this research is to quantify the rate of aggradation on the Iowa River and Skunk River. The overall objective is to understand the effects of land use changes and geomorphic processes on channel aggradation.

Progress: Field work gathering stream profiles and elevations is in progress. There was substantial flooding of both the Iowa and Skunk Rivers during 1993. Data collection is continuing.

Reports: None

Implementation: Knowledge of the sediment deposition process and rates of stream aggradation for Iowa streams would be beneficial to planners and engineers in the design of bridges, culverts and other water-related structures.

Project Number: HR-351

Project Title: Bentonite Treatment for Economical Dust Reduction on Limestone Surfaced Secondary Roads

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: July 28, 1992 to December 31, 1994

Research Board Funding: \$129,495

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

Objective: To optimize the amount of Bentonite treatment on limestone surfaced roads to reduce dust generation and to examine the cost effectiveness of such treatment.

Progress: A one mile test road was constructed in Tama County in August of 1992 with Bentonite treatment levels of 3, 5, 7 and 9 percent. The 3 percent treatment appeared to reduce dust by about 45 percent. As treatment level increased, dust generation appeared to decrease. The 9 percent treatment appeared to exhibit about a 70 percent reduction compared to the control section. Crust development was rated somewhat better than the control for the 3 percent treatment and roughly two times better for the other treatment levels. There was no evident difference in any of the test sections with respect to braking distance and brake handling characteristics under wet surface conditions. Phase I of this project was approved for \$21,170 and as a result of the preliminary findings, funding of Phase II was recommended for \$108,325.

Reports: Phase I Progress report, January 1993

Implementation: Fugitive dust on secondary roads continues to be what many Iowa county engineers consider to be one of their high priority problems. Most dust treatments are relatively expensive and tend to create maintenance problems and increase maintenance costs. A low cost, effective dust palliative that does not create a maintenance problem is needed.

Project Number: HR-352

Project Title: Stream Stabilization in Western Iowa

Agency: Golden Hill Resource Conservation and Development

Principal Investigator: Marty Adkins

Research Period: August 20, 1992 to June 30, 1994

Research Board Funding: \$188,000

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

- Objective:**
- A. Development of a system that integrates information on stream conditions, associated geology, transportation facilities, potential economic impacts, and likely stabilization costs.
 - B. Development of technical guidelines for preliminary planning and cost forecasting on stream degradation control projects.
 - C. Development of administrative procedures for the allocation of technical and financial resources on stream degradation control projects.

Progress: Information on conditions at the streams in the 22 county deep loess soils region has been collected. A stream data base that includes 350 streams has been developed. Thirty streams were videotaped from a helicopter to inventory the areas of active degradation. Stream sediments were mapped in the tributaries of Walnut Creek. A data base has been developed containing bridge and culvert repair and replacement. Implementation of a GIS has begun.

Reports: Progress Report, June 1993

Implementation: Improved stream degradation information will allow more timely maintenance of stream crossing structures. It will also yield criteria that will assist in selection of the most cost effective structure.

Project Number: HR-353

Project Title: Epoxy-Coated Strands in Composite Precast
Prestressed Concrete Panels

Agency: Iowa State University

Principal Investigator: Robert Abendroth

Research Period: August 12, 1992 to August 31, 1994

Research Board Funding: \$193,900

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

Objective: The main objective of the research is to evaluate the static load strength performance of composite precast prestressed concrete panel slabs that are constructed with panels that contain grit-embedded, epoxy-coated strands and epoxy-coated welded wire fabric and a reinforced concrete (R/C) topping slab that contains epoxy-coated reinforcing bars.

Progress: The research is being conducted by Iowa State University. A literature review has been completed. A survey questionnaire was prepared and sent out to all states plus some other agencies. A bed for testing prestressed castings was constructed. Five castings have been prepared for testing.

Reports: None

Implementation: Field reviews done on some bridges with prestressed panel subdecks have reported discoloration and indications of metal corrosion in line with the prestressing steel strands. Results from this study will determine design specifications required for the substitution of noncorroding epoxy coated strands for the currently used noncoated steel strands.

Project Number: HR-354

Project Title: An Engineering Study to Design Triple Box Culvert Standards

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: September 1993 to January 1995

Research Board Funding: \$180,000

Funding Source: 100 percent State--30 percent Primary funds and 70 percent Farm-to-Market funds

Objective: To contract with a consultant to develop standard designs for triple reinforced concrete box culverts.

Progress: A consultant selection committee will select a qualified engineering firm in September of 1993 to perform the work. The study will involve developing details and quantities for 336 different box culverts. Several culvert sizes with 12 different fill heights and 4 different headwall skews will be considered.

Reports: None

Implementation: The design of standards will avoid duplication of effort among 99 counties. This will benefit city, county, and state professionals who prefer to utilize these designs instead of a bridge structure for certain area projects.

Project Number: HR-355

Project Title: The Role of Magnesium in Concrete Deterioration

Agency: Iowa State University

Principal Investigator: Robert Cody, Paul Spry, and Anita Cody

Research Period: November 1, 1992 to October 31, 1994

Research Board Funding: \$137,873

Funding Source: 100 percent State--70 percent Primary funds,
20 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: To investigate the role of magnesium in the
deterioration of Iowa highway concrete using a
scanning electron microscope (SEM) microprobe.

Progress: Laboratory testing of selected portland cement
concrete (PCC) pavement samples with the SEM
microprobe is in progress. A progress report will be
submitted in October 1993.

Reports: None

Implementation: This research will improve the identification of
the cause of PCC pavement deterioration. This
will support changes that will improve pavement
longevity.

Project Number: HR-356

Project Title: Economical Production of Calcium Magnesium Acetate

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Wallace Rippie

Research Period: November 18, 1992 to December 31, 1993

Research Board Funding: \$10,000

Funding Source: 100 percent State--Primary funds

Objective: To determine if calcium magnesium acetate (CMA) can be produced at a substantially reduced cost using a synthetic zeolite catalyst.

Progress: An extensive literature search has identified promising chemical reaction processes for production of acetic acid. Some chemicals have been obtained and additional chemicals are to be purchased. The research to oxidize alcohol as received from biomass fermentation at a 10% aqueous concentration has focused upon high temperature oxidation catalysts based on silica with titanium and vanadium ions added to the framework.

The current research literature reveals nickel and cobalt complexes being used at low temperatures and oxygen pressures to perform mild oxidations in contrast to alcohol oxidation. Unfortunately, these catalysts function in water free reactions. The current efforts on the project are to determine how to blend these two concepts to oxidize alcohol with low energy inputs in a short time with air.

Reports: None

Implementation: An inexpensive, non-corrosive deicer would reduce the deterioration of highways, structures and vehicles. This would result in increased longevity which would be a substantial cost savings.

Project Number: HR-357

Project Title: An Expert System for Forecasting Fog on US 30 in Cedar Rapids

Agency: Iowa State University

Principal Investigator: Eugene Takle

Research Period: November 23, 1992 to November 30, 1994

Research Board Funding: \$145,245

Funding Source: 100 percent State--Primary funds

Objective: The objective of this research is to consolidate all available information on the behavior of the cooling tower fog plume, and develop a computerized expert system to improve prediction of poor visibility from the tower fog plume on US 30 near Cedar Rapids.

Progress: The research is being conducted by Iowa State University. Data is being gathered from airport surface observations from DOT records and from a local video photographer. An expert system is being developed using a plume model from Electric Power Research Institute (EPRI).

Reports: None

Implementation: A computerized expert system will be developed to improve the prediction of the development of fog and poor visibility from the tower fog plume on US 30 near Cedar Rapids. The improved accuracy will increase driver safety, and reduce the cost of man-hours and equipment for traffic control and maintenance.

Project Number: HR-358

Project Title: Evaluation of Microcracking and Chemical Deterioration in Concrete Pavements

Agency: Iowa State University

Principal Investigator: Scott Schlorholtz

Research Period: March 1, 1993 to August 31, 1995

Research Board Funding: \$160,180

Funding Source: 100 percent State--45 percent Primary funds, 40 percent Farm-to-Market funds and 15 percent Street Research funds

Objective: To initiate an improved method of evaluating and identifying the initiating cause of early portland cement concrete (PCC) pavement deterioration.

Progress: A low vacuum scanning electron microscope has been ordered and will arrive in August.

Reports: None

Implementation: An improved method of identifying the initiating cause of PCC deterioration will allow changes to prevent deterioration and improve pavement longevity.

Project Number: HR-359

Project Title: Airborne GPS

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: April 12, 1993 to April 30, 1995

Research Board Funding: \$166,355

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: The objective of this research is to develop
orientation data using the multiantenna concept and
to use aerial photographs for direct stereo plotting.

Progress: A contract has been signed with Iowa State University
to conduct the research.

Reports: None

Implementation: This research will aid in updating the
Geographic Information System (GIS) using aerial
photographs. When using stereo pairs of
photographs for mapping, the elevation must be
known of a ground control or the tip of the
camera. Using the multiantenna concept will
allow determination of the location of camera
lense elevation with great accuracy. This
information will be used for navigation for
taking aerial photographs and to save time and
money in earthwork computations.

Project Number: HR-360

Project Title: Field Evaluation of Various Engineering Fabrics - Audubon Co.

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

Principal Investigator: George Parris, Gary Harris and Bill Cook

Research Period: May 1993 to September 30, 1998

Research Board Funding: \$30,290

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

Objective: To evaluate the Pro-Guard and Paveprep engineering fabrics and the fiber mesh glasgrid as reflective crack retarders when used in conjunction with an ACC overlay on a low volume secondary road.

Progress: Construction is scheduled to begin in August 1993 on county road F16 from the town of Gray east 2.6 miles to US 71 in Audubon County. There will be 8 test and control sections using three different engineering fabrics to be placed over both transverse and longitudinal cracks. A construction report will be submitted in February of 1994.

Reports: None

Implementation: Reflective cracking in ACC overlays usually open allowing water to enter the unsealed crack which causes stripping of the base material and accelerated deterioration of the overlay. Engineering fabrics may prove to impede reflective cracking and thus reduce maintenance costs.

Project Number: HR-361

Project Title: Development of a Model for the Ice Scraping Process

Agency: University of Iowa

Principal Investigator: Wilfrid Nixon

Research Period: May 1, 1993 to April 30, 1996

Research Board Funding: \$236,895

Funding Source: 100 percent State--60 percent Primary funds,
20 percent Farm-to-Market funds and 20 percent
Street Research funds

Objective: To develop two improved cutting edge designs for the removal of ice.

Progress: A literature research and product review are underway. Upgrading testing equipment to use with the new design is in progress also.

Reports: None

Implementation: This research project will include performing a series of experiments to confirm the model discussed in the proposal and developing this model. The aim is to use the new developed ice scraping model to aid in the development of new cutting edges which can be used on existing plowing equipment and to improve the efficiency of this equipment at scraping ice from the roadway.

Project Number: HR-362

Project Title: Design Methodology for Corrugated Metal Pipe
Tiedowns: Phase II

Agency: Iowa State University

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

Research Period: June 10, 1993 to June 30, 1995

Research Board Funding: \$239,340

Funding Source: 100 percent State--10 percent Primary funds,
80 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: To develop a design methodology that will prevent
uplift failures of corrugated metal pipes.

Progress: An advisory committee has been established to address
research aspects of the project such as the type and
size of pipes to be tested, and also the scope and
format for the tiedown standards. Actual tests are
scheduled to begin in late 1993.

Reports: Phase I, February 1993

Implementation: This design method will make it possible for
practicing engineers to determine, for a
particular situation, the required hold down
force through use of nomographs, computer
spreadsheets, etc., rather than having to use
complex analytical techniques such as finite
element analyses.

Project Number: HR-363

Project Title: Clarifying the Quadrennial Needs Study Process

Agency: Iowa State University

Principal Investigator: James Cable

Research Period: June 10, 1993 to January 31, 1994

Research Board Funding: \$45,160

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

Objective:

1. To identify sample counties and a control county from 1990 study year for detailed needs analysis.
2. Analyze the relative needs of the sample and control counties to determine the sensitivity of selected input variables on the study results.
3. Identify the possible reasons for shifts in the relative needs between counties in a given "Quadrennial Needs Study" and make recommendations on ways to improve the study process conducted by the Iowa DOT.

Progress: A contract has been signed with Iowa State University

Reports: None

Implementation: This study will be used to assist the counties in understanding the factors that affect the outcome of the Quadrennial Needs Study.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Gary Harris

Research Period: March 5, 1980 to present

Research Board Funding: \$47,000.00/yr. (covers salary and state share of costs for FICA, IPERS, health insurance, vehicle costs and expenses)

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: Gary Harris has visited with many county engineers to discuss problems being encountered by the secondary road departments and to discuss present research projects during the year. At present, there are 10 active research projects that involve experimental construction by counties and three engineering studies. 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.

**ANNUAL REPORT OF
PROJECT DEVELOPMENT DIVISION
HIGHWAY RESEARCH
AND DEVELOPMENT
IN IOWA**

Project Development Division
Office of Materials
September 1994



**Iowa Department
of Transportation**

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ANNUAL REPORT
OF
PROJECT DEVELOPMENT DIVISION
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE
FISCAL YEAR ENDING JUNE 30, 1994

OFFICE OF MATERIALS
(515) 239-1447

PROJECT DEVELOPMENT DIVISION
IOWA DEPARTMENT OF TRANSPORTATION
AMES, IOWA 50010

SEPTEMBER 1994

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RESEARCH AND DEVELOPMENT

The Project Development 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; second, to identify and implement improved engineering and management practices.

This report entitled, "Project Development Division Highway Research and Development in Iowa", is submitted in compliance with Sections 310.36 and 312.3A, Code of Iowa, which direct the submission of a report of the Secondary Road Research Fund and the Street Research Fund respectively. It is a report of the status of research and development projects which were in progress on June 30, 1994; it is also a report on projects completed during the fiscal year beginning July 1, 1993, and ending June 30, 1994. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials, Project Development Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing and coordinated program of research and development, the Project Development 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 and now that denoted by 312.3A.

The Research Board consists of 13 regular members; six county engineers, three Iowa DOT engineers, one representative from Iowa State University, one from the University of Iowa, and two engineers employed by Iowa municipalities. Each regular member may have an alternate who will serve at the request of the regular member. The regular members and their alternates are appointed by the Iowa Department of Transportation Project Development Division Director for a three-year term. The membership of the Research Board as of June 30, 1994 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1993 to June 30, 1994. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

2
TABLE I

1994 IOWA HIGHWAY RESEARCH BOARD		
<u>Member</u>	<u>Term Expires</u>	<u>Alternate</u>
Bernard C. Brown State Materials Engineer Iowa DOT - Project Development Division Ames, IA 50010 (515) 239-1452	12-31-96	John Smythe State Construction Engineer Iowa DOT - Project Development Division Ames, Iowa 50010 (515) 239-1503
Steve DeVries Mills County Engineer 418 Sharp Street Glenwood, IA 51534 (712) 527-4873 SS#-065	12-31-96	J. Brian Morrissey Madison County Engineer P.O. Box 152 Winterset, IA 50273 (515) 462-1136 SS#-061
Royce J. Fichtner Marshall County Engineer Courthouse Marshalltown, IA 50158 (515) 754-6343 SS#-064	12-31-96	Gary Mauer Grundy County Engineer 706 G Avenue Grundy Center, IA 50638 319-824-6912 SS#-038
Lyle Laartz Chickasaw County Engineer P.O. Box 316 New Hampton, IA 50659 (515) 394-2321 SS#-019	12-31-95	Randall J. Will Franklin County Engineer P.O. Box 118 Hampton, IA 50441 (515) 456-4671 SS#-035
Kenneth M. Meeks Transp. Center Develop. Engr. Iowa DOT - Project Development Division 1020 S. Fourth Street Ames, IA, 50010 515) 239-1635	12-31-95	Maurice Burr Transp. Center Develop. Engr. Iowa DOT - Project Development Division P.O. Box 3150 430 76th Ave. SW Cedar Rapids, IA 52406-3150 319-364-0235
Mark Nahra Cedar County Engineer Courthouse Tipton, IA 52772 (319) 886-6102 SS#-016	12-31-97	Dan Waid Jones County Engineer P.O. Box 368 Anamosa, IA 52205 (319) 462-3785 SS#-053
A. Jacob Odgaard Associate Dean of Engr. University of Iowa Iowa City, IA 52242 (319) 335-5213	12-31-95	Wilfrid A. Nixon IA Inst of Hydraulic Res University of Iowa 300 S Riverside Drive Iowa City, IA 52242 (319) 335-5166
Wallace Sanders, Jr. Dept of Civil & Const. Engr. Iowa State University 394 Town Engineering Bld. Ames, IA 50011 (515) 294-6048	12-31-96	Lowell F. Greimann Dept of Civil & Const. Engr. Iowa State University 390 Town Engineering Bld. Ames, IA 50011 (515) 294-5586
George F. Sisson Deputy Director, Engineering Iowa DOT - Engineering Division Ames, IA 50010 (515) 239-1461	12-31-94	Donald East Design Engineer Iowa DOT - Project Development Division Ames, IA 50010 (515) 239-1470
Tom Snyder Osceola County Engineer Courthouse Sibley, IA 51249 (712) 754-2303 SS#-072	12-31-94	Keith White Ida/Sac County Engineer 1703 W. 6th, RR 1 Ida Grove, IA 51445 (712) 364-2920 SS#-047
Larry Stevens City Engineer 804 South D Street Oskaloosa, IA 52577-3770 (515) 673-7472	12-31-94	Randall Krauel Director of Public Works 112 East 5th Carroll, IA 51401 (712) 792-1000
E. D. Tice Appanoose County Engineer Courthouse Centerville, IA 52544 (515) 856-6193 SS#-004	12-31-95	Gary Bishop Jefferson County Engineer P.O. Box 827 Fairfield, IA 52556 515-472-6528 SS#-051
Paul Wiegand Director of Public Works 515 Clark Avenue Ames, IA 50010 (515) 239-5162	12-31-96	Neil Guess City Engineer 1700 N. 4th Avenue W. Newton, IA 50208 (515) 792-6622

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 Project Development 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, Farm-to-Market Road Fund or the Street Research Fund, depending on which road system will benefit from the project. If more than one jurisdiction's roads share in 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, 1994. Total expenditure was \$1,596,711.03.

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Iowa DOT personnel are termed "in-house" projects. These projects may involve other departmental and field personnel, in addition to personnel from the Office of 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 for in-house projects are relatively small. The Office of Materials, Research Section, wishes to express its appreciation to other offices for their assistance.

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 1994 as part of the Annual Traffic Count Program. This activity consisted of 10 eight-hour manual counts, 380 portable recorder classification counts and 5,100 portable recorder volume 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. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1994 financial summary is:

Beginning Balance 7-1-93		\$ 799,801
Receipts		
State Road Use Tax Fund (1 1/2% of receipts)...	\$764,843	
Federal Aid Secondary (1 1/2% of receipts)...	182,143	
Research Income	64,054	
	=====	
Sub-Total		1,011,040
		=====
Total Funds Available		\$1,810,841
Obligation for Expenditures		
Obligated for		
Contract Research...	844,240	
Non-Contract		
Engineering Studies...	20,305	
	=====	
Total Expenditures		\$ 864,545
		=====
BALANCE 6-30-94		\$ 946,296

STREET RESEARCH FUND

The Street Research Fund was established in 1989 under Section 312.3A of the Iowa Code. Each year two hundred thousand dollars are set aside from the street construction fund solely for the purpose of financing engineering studies and research projects, which have as their objective the more efficient use of funds and materials available for construction and maintenance of city streets. The Iowa Department of Transportation accounting procedure for the Street Research Fund is based on obligations for expenditures on research projects and not the actual expenditures. The Fiscal Year 1993 financial summary is:

Beginning Balance (7-1-93)	\$ 41,211
FY94 Street Research Funding	<u>200,000</u>
Total Funds Available for Street Research	\$241,211

Obligated for Expenditure

HR-234A	\$ 1,525
HR-280A	40,000
HR-296	46,155
HR-324A	4,672
HR-339A	7,499
HR-367	250
HR-372	26,928
HR-373	38,094
	=====

Total Obligated for Expenditure	165,123
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Ending Unobligated Balance 6-30-94	\$ 76,088
------------------------------------	-----------

PRIMARY ROAD RESEARCH FUND

The Primary Road Research Fund is from non-obligated funds of the Primary Road Fund. These funds can only be expended on Iowa DOT projects for which the funds were reserved such as contracted research and project specific research supplies or equipment. An estimate of Primary Road Research Fund expenditures is made prior to the beginning of each fiscal year. 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 FY94 was \$611,639.97 and the Estimate for FY95 is \$750,000.

PROJECTS INITIATED DURING FY 1994

The new projects initiated during FY 1994 were:

- HR-234A, "An Engineering Study to Update the Iowa Transportation Laws Annotated"
- HR-263A, "An Engineering Study for Metrication of Secondary Bridge Standards"
- HR-280A, "Metrication of Single & Double Box Culvert Standards"
- HR-324A, "Metrication of the Self Taught Math & Plan Reading Course Materials"
- HR-339A, "Micro-Computer Based Linear Scheduling Applications for Highway Construction Project Control"
- HR-364, "Automated Recording of Bridge Inspection Data in the Pontis Format"
- HR-365, "Evaluation of Bridge Replacement Alternatives for the County Bridge System"
- HR-366, "Field Data Acquisition Technologies for Iowa Transportation Agencies"
- HR-367, "Solar Powered Highway Delineator System"
- HR-368, "Construction Automation Using Pen-Based Computers"
- HR-369, "Bond Development in Concrete Overlays"
- HR-370, "Pipe Rehabilitation With Polyethylene Piper Liners"
- HR-371, "Development of a County Condemnation Policy & Procedure Manual"
- HR-372, "Full Scale Field Measurements of Ice Scraping Loads"
- HR-373, "Investigation of Plastic Pipe for Highway Applications"

15 projects

TABLE II
FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECT EXPENDITURES
July 1, 1993 to June 30, 1994
(Active projects with no current fiscal year expenditures are included)

Project	Total Funds Committed	Project Title	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Street Research Fund Expenditures	Total Expenditures
140	109,470/yr.	Collection and Analysis of Stream Flow Data	49,262.00	47,585.00	10,761.00	107,608.00
198	125,000	Preliminary Archaeological Investigation Along Proposed Highway Right-of-Way				
234A	15,250	An Engineering Study to Update the Iowa Transportation Laws Annotated				
263A	400,000	An Engineering Study for Metrication of Secondary Bridge Standards				
280A	200,000	Metrication of Single & Double Box Culvert Standards		33,090.20		33,090.20
296	102,568/yr	ISU Technology Transfer	11,001.93	49,511.00	49,510.75	110,023.68
303	100,000	Field Evaluation of Cold In-Place Recycling of Asphalt Concrete				
309	78,760	An Investigation of Emulsion Stabilized Limestone Screenings				
312	93,913	Low Cost Techniques of Base Stabilization - Dubuque Co.		49,006.29		49,006.29
313	28,900	Air Formed Arch Culvert Construction - Washington Co.				
314	16,500	Air Formed Arch Culvert Construction - Crawford Co.				
315	98,529	Iowa Development of Rubblized Concrete - Mills Co.				
318	20,800	Evaluation of Preformed Neoprene Joint Seals				
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria				
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics				
324A	23,360	Metrication of the Selft Taught Math & Plan Reading Course Materials	2,334.63			2,334.63
330	98,956	Evaluation of Recycled Rubber in Asphalt Concrete		17.97	2,383.31	2,401.28
331	210,000	Engineering Study - Skewed Tee Piers for Secondary Bridges		7,787.34		7,787.34
333	263,850	Design Methodology for Post-Tensioning Strengthening of Continuous Span Bridges		22,550.17	7,133.06	29,683.23
334	137,921	Field Measurements of Plow Loads During Ice Removal Operations	7,547.71	12,634.08	459.59	20,641.38
336	40,000	Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability				
337	157,020	Investigation of Rapid Thermal Analysis Procedures for Prediction of the Service Life of PCCP Carbonate Coarse Aggregate	1,121.23	11,597.97	2,956.60	15,675.80
338	116,527	The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool		14,601.28		14,601.28
339	139,720	Multi-Project Scheduling Procedure for Transportation Projects	49,562.78	7,595.75	8,932.76	66,091.29
339A	74,984	Micro-Computer Based Linear Scheduling Applications for Highway Construction Project Control				
341	25,000	Bond Enhancement Techniques for PCC Whitetopping				
343	149,955	Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavement Slabs	10,992.46	30,802.75	10,976.85	52,772.06
344	156,272	Scour Susceptibility at Bridges in the State of Iowa	7,334.00	15,591.00	22,975.00	45,900.00
345	100,753	Electronic Bulletin Board System		12,409.18	3,390.77	15,799.95
346	116,345	Image Analysis for the Characterization of Materials for Highway Construction	5,153.45	16,957.55	14,182.51	36,293.51
347	61,414	Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections		5,721.03	11,376.35	17,097.38
348	138,932	Recruiting and Retaining Women/Minorities for Public Sector Engineering Positions	60,603.78	17,056.16	6,718.69	84,378.63
349	20,000	Recycled Paper Erosion Control Mats				

<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>Street Research Fund Expenditures</u>	<u>Total Expenditures</u>
350	76,550	Channel & Flood Plain Aggradation in the	15,423.00	19,025.00	27.00	34,475.00
351	129,495	Bentonite Treatment for Economical Dust Reduction on Limestone Surfaced Secondary Roads		38,143.29		38,143.29
352	188,000	Stream Stabilization in Western Iowa	41,452.24	47,119.23		88,571.47
353	193,900	Epoxy-Coated Stands in Composite Precast Prestressed Concrete Panels	18,704.89	37,117.89		55,822.78
354	180,000	An Engineering Study to Design Triple Box Culvert Standards	45,424.11	76,988.04		122,412.15
355	137,873	The Role of Magnesium in Concrete Deterioration	32,818.99	18,163.98	4,404.11	55,387.08
356	10,000	Economical Production of Calcium Magnesium Acetate	406.72			406.72
357	145,245	An Expert System for Forecasting Fog on US 30 in Cedar Rapids	49,111.51			49,111.51
358	160,180	Evaluation of Microcracking and Chemical Deterioration in Concrete Pavements	2,171.10	3,190.99	1,366.84	6,728.93
359	166,355	Airborne GPS	50,101.01	9,521.34	10,338.16	69,960.51
360	30,290	Field Evaluation of Various Engineering Fabrics - Audubon Co.				
361	236,895	Development of a Model for the Ice Scraping Process	80,331.84			80,331.84
362	239,340	Design Methodology for Corrugated Metal Pipe Tiedowns: Phase II	14,959.83	54,393.12	10,907.28	80,260.23
363	45,160	Clarifying the Quadrennial Needs Study Process	3,427.78	25,223.45		28,651.23
364	117,695	Automated Recording of Bridge Inspection Data in the Pontis Format	26,448.98	910.44		27,359.42
365	57,050	Evaluation of Bridge Replacement Alter- natives for the County Bridge System		46,448.29		46,448.29
366	74,125	Field Data Acquisition Technologies for Iowa Transportation Agencies	25,944.00	9,963.04	16,807.35	52,714.39
367	1,000	Solar Powered Highway Delineator System				
368	33,000	Construction Automation Using Pen-Based Computers				
370	10,000	Pipe Rehabilitation With Polyethylene Pipe Liners				
371	14,000	Development of a County Condemnation Policy & Procedure Manual				
372	179,519	Full Scale Field Measurements of Ice Scraping Loads				
373	126,980	Investigation of Plastic Pipe for Highway Applications				
1027.	47,000/yr.	Secondary Road Research Coordinator		48,740.26		48,740.26
Total			611,639.97	789,463.08	195,607.98	1,596,711.03

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: Nick Melcher, U.S.G.S.

Research Period: Project continued to September 30, 1994

Research Board Funding: \$109,470 per year (matched by \$109,470
from the Department of the Interior)

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds and
10 percent Street Research funds

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

Objective: 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 1993-1994 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. A special report on Clear Creek was distributed in 1994.

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

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: State Archaeologist

Research Period: July 1, 1977 to June 30, 1994

Research Board Funding: \$125,000

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 examinations.

Progress: The Iowa Department of Transportation contracts with the State Archaeologist to perform the needed preliminary investigations and to 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 is beneficial because counties know what projects should be reviewed and the reviews can be conducted in a more timely manner.

Project Number: HR-234A

Project Title: Compilation of Iowa Highway Laws

Agency: State of Iowa, Office of the Attorney General

Principal Investigator: Shane Tymkowicz

Research Period: May 1, 1994 to September 30, 1994

Research Board Funding: \$15,250

Funding Source: 100 percent State--10 percent Primary funds,
80 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: The objective of the engineering study is to update
the "Iowa Transportation Laws (Annotated)" and
provide the revisions to manual holders.

Progress: The Office of the Attorney General has hired a summer
law clerk to update the "Iowa Transportation Laws
(Annotated)." The revision is in progress and appears
to be on schedule.

Reports: None

Implementation: The updated manual will allow county engineers
and others to quickly find the sections of code
to consult on everyday minor legal matters,
thereby saving time.

Project Number: HR-263A

Project Title: An Engineering Study for Metrication of Secondary Bridge Standards

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: Gordon Port

Research Period: November 30, 1994 to November 30, 1995

Research Board Funding: \$400,000

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

Objective: The objective of this study is to convert the secondary bridge standards to SI (metric) units.

Progress: A consultant selection team has been appointed. Six proposals were received from qualified engineering firms. The consultant selection team is evaluating each of the respondents. The intent is to select a qualified consultant by mid-July of 1994. It is hoped that a contract can be offered to the selected firm by November 1994.

Reports: None

Implementation: This change is necessary to avoid losing federal funds. After September 30, 1996, federal funds can not be used for design or construction of any project that does not use metric units.

Project Number: HR-280A

Project Title: Metrication of Single and Double Box Culvert Standards

Agency: Iowa Department of Transportation, Project Development Division and Stanley Consultants, Inc.

Principal Investigator: Gordon Port

Research Period: January 24, 1994 to January 23, 1995

Research Board Funding: \$200,000

Funding Source: 100 percent State--30 percent Primary funds, 50 percent Farm-to-Market funds, and 20 percent Street funds

Objective: The objective of this engineering study is to engage a consulting firm to convert to metric (SI) units all the current single and double box culvert standards. The work will be done in accordance with ASTM E-380 (Standard of Metric Practice), the latest AASHTO design criteria and the Iowa DOT Office of Bridge Design Metric Policy.

Progress: A contract has been negotiated with Stanley Consultants, Inc. to perform this project. The metrication work is approximately 40% completed.

Reports: None

Implementation: By completion of this project, the single and double box culvert standards will be available in metric (SI) units for state, county and city use. This will help these agencies to meet the U.S. mandate for metrication deadline of September 30, 1996.

Project Number: HR-296

Project Title: Iowa State University Technology Transfer Center

Agency: Iowa State University

Principal Investigator: Tom Maze

Research Period: January 1, 1994 to December 31, 1994

Research Board Funding: \$102,568

Funding Source: 100 percent State--10 percent Primary funds,
45 percent Farm-to-Market funds, 45 percent
Street Research funds

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
5. present transportation safety information to
rural communities by employing a Transportation
Safety Circuit Rider

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-303

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

Agency: Tama County and the Iowa Department of Transportation, Project Development Division

Principal Investigators: Robert Gumbert, Richard Mumm, Gary Harris and Shane Tymkowicz

Research Period: June 1, 1989 to December 31, 1993

Research Board Funding: \$100,000

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

Objective: To identify an effective and affordable technique, based on cold in-place recycling of ACC pavement to widen an existing road of 5.4 m (18 ft. in width) to 7.2 m (24 ft.) and have a finished surface capable of carrying traffic satisfactorily.

Progress: The project was constructed on a 7.2 km (4.5 mi.) portion of Tama County road E66 (formerly IA 212, formerly US 30). Construction started in June of 1989. The project utilized cold in-place recycling of the existing ACC surface to provide material for a widening strip 0.9 m (3 ft.) wide to be placed along each side of the existing roadway. The roadway was then divided into test sections which received one of the following surface treatments: fog seal coat, bituminous seal coat, slurry seal coat, 50 mm (2 in.) of new hot mix ACC, 75 mm (3 in.) of cold in-place recycled ACC with a fog seal coat, 75 mm (3 in.) of cold in-place recycled ACC with a bituminous seal coat, 75 mm (3 in.) of cold in-place recycled ACC with a slurry seal coat, and 75 mm (3 in.) of cold in-place recycled ACC with a 50 mm (2 in.) surface coarse of new hot mix ACC. The test section with 75 mm (3 in.) of cold in-place recycled ACC with a 50 mm (2 in.) surface coarse of new hot mix ACC provided the best resistance to cracking. The test sections with only a fog, bituminous, or slurry seal coat quickly deteriorated and were resurfaced. This deterioration may have been due to the poor condition of the original ACC roadway.

Reports: Final Report, December 1993

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

Project Number: HR-309

Project Title: An Investigation of Emulsion Stabilized Limestone Screenings

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

Principal Investigators: Jerry Nelson, James M. Hoover and
Shane Tymkowicz

Research Period: May 20, 1988 to February 28, 1994

Research Board Funding: \$78,760

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

Objective: The objective of project HR-309 was to construct and evaluate an experimental base using several variations of a by-product limestone screening/emulsion mix.

Progress: Construction of the 2.04 km (1.27 mi.) research project was completed in August 1988. Residual asphalt contents of 2.5%, 3.5% and 4.5% were used on test sections of 100 mm (4 in.) and 150 mm (6 in.) compacted thickness. A control section of 150 mm (6 in.) of untreated limestone screenings was included for comparative purposes. There was some potholing and edge cracking which required surface patching. A low cost maintenance roadway was produced using a seal coat surface on 150 mm (6 in.) of stabilized limestone screenings with 4.5% asphalt cement. The remaining test sections did not produce a low cost maintenance roadway; therefore, a 50 mm (2 in.) asphalt concrete surface would be necessary on many roads to provide a low maintenance roadway using emulsion stabilized limestone screenings.

Reports: Final Report, February 1994

Implementation: Finding useful ways of incorporating by-product aggregate into construction of lower traffic volume roads will ease the burden of disposal for stone producers and reduce the cost of construction for counties.

Project Number: HR-312

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

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

Principal Investigators: Mark C. Jobgen, Roger Boulet,
Gary Harris and Shane Tymkowicz

Research Period: August 22, 1988 to January 31, 1994

Research Board Funding: \$93,913

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

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

Progress: The project is a 4.5 km (2.8 mi.) section of the
Horseshoe Road in Dubuque County between Balltown and
Richardsville. Construction of the project was
completed in October 1988. The Consolid and BIO-CAT
test sections did not perform well, and they have
since been reconstructed with a Macadam base that was
similar to the other two test sections. The Macadam
base test sections had the best overall performance.

Reports: Final Report, January 1994

Implementation: The research has demonstrated the superior
performance of the Macadam section. The
chemical soil stabilizations were unsuccessful.

Project Number: HR-313

Project Title: Air Formed Arch Culvert Construction - Washington County

Agency: Washington County and the Iowa Department of Transportation, Project Development Division

Principal Investigators: R. G. Huber, Mark Callahan and Shane Tymkowicz

Research Period: August 15, 1988 to February 28, 1994

Research Board Funding: \$28,900

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

Objective: To demonstrate the applicability of the air form method of arched culvert construction and to evaluate the performance.

Progress: The arch culvert was constructed in Washington County in October 1988. Post construction inspection of the air formed arch culvert showed the Air-O-Form method can be used to construct a structurally sound arch culvert. The arch culvert has been performing well. Trees and brush pass through and cleaning is not required. Continued monitoring will be conducted in order to evaluate the long term performance of the arch culvert.

Reports: Final Report, February 1994

Implementation: The arch design reduces cleaning and maintenance costs but construction must become more economical if it is to compete with box culvert construction for county and state culvert projects.

Project Number: HR-314

Project Title: Air Formed Arch Culvert Construction - Crawford County

Agency: Crawford County and the Iowa Department of Transportation, Project Development Division

Principal Investigators: H. Dale Wight, Clyde Leonard and Shane Tymkowicz

Research Period: September 15, 1988 to December 31, 1995

Research Board Funding: \$16,500

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

Objective: To demonstrate and evaluate the applicability of the Air-O-Form method of arch culvert construction and to evaluate the performance.

Progress: The project was constructed 1.6 km (1 mi.) north of IA 141 and 0.8 km (0.5 mi.) east of county road M55 in Nishnabotna Township. Construction was delayed until October of 1990 so that the county could find ways to make this project more affordable. The Air-O-Form method still has higher costs when compared to other types of culvert construction. This is probably due to the fact that very few contractors are qualified to use this method. Trees and brush pass through and cleaning is not required. The arch culvert has been performing well. Evaluation of performance is in progress.

Reports: Construction Report, May 1991

Implementation: The air formed method of arch culvert construction can be less time consuming, use less steel and concrete, and result in a stronger structure compared to conventional box culvert construction. Such a structure can also be hydraulically more efficient and aesthetically more pleasing than a box culvert. However, this method has not proven to be very economical in Iowa as yet.

Project Number: HR-315

Project Title: Iowa Development of Rubblized Concrete - Mills County

Agency: Mills County and the Iowa Department of Transportation,
Project Development Division

Principal Investigators: Steve DeVries and Shane Tymkowicz

Research Period: March 1, 1989 to December 31, 1994

Research Board Funding: \$98,529

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

Objective: To develop a rehabilitation procedure for severely deteriorated pavements. The proposed procedure is to rubblize the existing deteriorated pavement to create a crushed stone type of base in preparation for an asphalt overlay.

Progress: The project was constructed in 1989 on Mills County road L63 from its intersection with county road H40, north and east approximately 3.0 km (1.9 mi.) to the south corporate limits of Malvern. It is comprised of eight rubblized and nonrubblized test sections varying in ACC thickness from 75 mm (3 in.) to 125 mm (5 in.). While there are some areas where the rideability is not the most desirable, only a few cracks have developed in the surface. As expected, the five inch sections are performing the best. A final report will be completed in December 1994.

Reports: Construction Report, March 1990

Implementation: Through the development and success of this rehabilitation procedure, we could obtain a well drained, economical subbase through a recycling of existing materials. Maintenance of the overlay would be reduced due to prevention of reflection cracking.

Project Number: HR-318

Project Title: Evaluation of Preformed Neoprene Joint Seals

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: Robert Steffes

Research Period: May 15, 1989 to October 31, 1994

Research Board Funding: \$20,800

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

Objective: To install and evaluate neoprene preformed joint seals and to compare their long term performance and cost effectiveness with other hot poured or cold applied sealants.

Progress: Four new paving projects with a wide range of average daily traffic were selected for sealant research for 1989. Three sites were added in 1990, one site in 1991 (which included Soff-cut joint sawing) and two more sites in 1992. Sections of neoprene, silicone, urethane and hot pour types of sealing materials were installed. Some joint seals have failed and were resealed, while others are performing well. The neoprene seals are performing well. The Iowa Vacuum Joint Seal Tester (IA-VAC) was developed under this project. The vacuum joint tester has identified poor quality workmanship and helped to point out the need for contractor improvements in sawing and sealing operations.

Reports: Progress Report, January 1993

Implementation: Results from the evaluation will help to determine which joint sealants should be selected as cost effective or best for long term performance in future projects. This will increase the performance and longevity of portland cement concrete pavement.

Project Number: HR-321

Project Title: Production of Acetic Acid by Fermentation With Propionibacteria

Agency: Iowa State University

Principal Investigators: Earl Hammond, Bonita Glatz and Charles Glatz

Research Period: November 2, 1989 to June 30, 1995

Research Board Funding: \$97,850

Funding Source: 100 percent State--90 percent Primary funds,
10 percent Street Research funds

Objective: To find an economically favorable route to the production of acetic acid by fermentation with propionibacteria.

Progress: A bench-scale fermenter was purchased for use with fermentation studies. An ultrafiltration apparatus was purchased and attempts were made to adapt this into an ultrafiltration apparatus for removing acetic and propionic acids from the fermentation mixtures. Some improved methods of removing the acetic acid from the fermenter have been identified. Most of the FY92 research efforts were directed at improving fermentation conditions. A new system that employs cells immobilized in solid beads of calcium alginate is being developed. Hopefully, this will increase the acetic acid production rate. An improved hollow fiber acid recovery system was built. Fermentation experiments are continuing. The intent was to produce less expensive acetic acid for use in producing less expensive calcium magnesium acetate (CMA) deicer. An extension was granted in March 1993 to allow research to continue until June 30, 1995 using the project equipment. No additional Iowa DOT funds will be used. A final report, Part 2 will be submitted in June 1995.

Reports: Progress Reports, January 1991; January 1992; Final Report, February 1993

Implementation: Reduced costs of acetic acid will allow the use of CMA deicer at selected locations to prevent corrosion.

Project Number: HR-322

Project Title: Estimating Design Flood Discharge for Iowa Using
Drainage Basin and Channel Geometry
Characteristics

Agency: Water Resources Division of the United States Geological
Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1989 to December 31, 1993

Research Board Funding: \$91,471

Funding Source: 100 percent State--45 percent Primary funds,
45 percent Farm-to-Market funds, 10 percent
Street Research funds

Objective: To develop a single set of equations for Iowa that
relate measurable basin and channel characteristics
to flood peaks of 5, 10, 25, 50 and 100 year
frequencies

Progress: The research was conducted by the with Water Resources
Division of the United States Geological Survey
(USGS). An automated procedure for quantifying basin
characteristics using a GIS has been developed. All
data has been collected and the analysis has been
completed. This additional method of determining
flood discharge will improve the determination of the
required sizes of bridges and culverts.

Reports: Final Report, December 1993

Implementation: More reliable estimates of design flood
discharges will allow selection of the required
size of bridges and culverts which will reduce
the cost by avoiding overdesign.

Project Number: HR-324A

Project Title: Metrication of the Self-Taught Math and Plan Reading Course Materials

Agency: Iowa State University

Principal Investigator: James K. Cable

Research Period: April 25, 1994 to December 31, 1995

Research Board Funding: \$23,360

Funding Source: 100 percent State--45 percent Primary funds, 35 percent Farm-to-Market funds, 20 percent Street Research funds

Objective: The objective of this engineering study is to modify the current math and plan reading courses to use metric units.

Progress: A contract has been executed with Iowa State University. An advisory committee has been selected. The first draft of the math course materials has been distributed to the Advisory Committee for review and comments. Metric plans will not be available from the Iowa DOT until 1995, so modification of the plan reading course will not begin until 1995.

Reports: None

Implementation: Metrication of the Iowa DOT math and plan reading course materials will enable the training of new and current personnel in metric units to meet new FHWA requirements by 1996.

Project Number: HR-330

Project Title: Evaluation of Recycled Rubber in Asphalt Concrete

Agency: University of Northern Iowa and Iowa Department of Transportation, Project Development Division

Principal Investigators: Shahram Varzavand, Dr. Stephan Egger and Vernon Marks

Research Period: June 11, 1990 to December 31, 1995

Research Board Funding: \$98,956

Funding Source: 100 percent State--80 percent Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: To evaluate the use of asphalt-rubber binders and recycled rubber granules in Iowa asphalt concrete pavements.

Progress: Four experimental sections were constructed on Muscatine County project F-61-4(49)--20-70 on US 61 from Muscatine to Blue Grass. The asphalt concrete overlay was two inches of surface over two inches of binder. A contract was executed with the University of Northern Iowa for laboratory evaluation of the asphalt-rubber binder. The construction project was completed in July 1991. There were no construction problems. Initial testing has been completed and annual testing and evaluation is being done. Performance of the asphalt rubber pavement test sections is currently similar to the conventional.

Reports: Construction Report, December 1991; Interim Report, December 1993

Implementation: This research will provide information on whether an asphalt-rubber binder yields significantly improved performance and if it is cost-effective. It will provide information on the use of recycled rubber in asphalt concrete.

Project Number: HR-331

Project Title: Engineering Study: Skewed Tee Piers for
Secondary Bridges

Agency: Iowa Department of Transportation, Project Development
Division

Principal Investigator: Norm McDonald and Shane Tymkowicz

Research Period: June 26, 1991 to October 31, 1994

Research Board Funding: \$210,000

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

Objective: To develop standard designs which county engineers across Iowa can utilize on secondary bridges. This will avoid the duplication of costs and designs among the 99 counties.

Progress: Calhoun-Burns and Associates, Inc. is the consultant on this project. The work involves 15° and 30° skewed tee pier designs for the H30-87 bridge standards with lengths of 188'-10, 201'-4, 213'-10, 226'-4, and 243'-0. An additional span length of 174'-4 was added to the project. The work has been completed, but negotiation is continuing on billing and payment.

Reports: A set of tee pier standards

Implementation: The design of standards will avoid duplication of effort in 99 counties. This will reduce maintenance and rehabilitation costs. Tee piers withstand ice, logs and debris better than pile bent piers. The project will be converted to metric standards under HR-263.

Project Number: HR-333

Project Title: Design Methodology for Post-Tensioning
Strengthening of Continuous Span Bridges

Agency: Iowa State University

Principal Investigator: F. Wayne Klaiber, Fouad Fanous, and
Terry Wipf

Research Period: November 1, 1990 to September 15, 1993

Research Board Funding: \$263,850

Funding Source: 100 percent State--30 percent Primary funds,
40 percent Farm-to-Market funds, 30% Street
Research funds

Objective: 1) To develop a design methodology that practicing
engineers can use to design the post-tensioning
system required to strengthen various continuous
span bridges.
2) design and field test a strengthening system

Progress: An analysis of over 600 bridges with the ANSYS general
purpose finite-element program were completed. Seven
variables which significantly influence the
longitudinal and transverse distribution of moment and
force between the internal and external beams were
identified.

An Iowa DOT V12 series bridge near Mason City was
selected for field testing of the strengthening.
Strengthening was done through post tensioning and
superimposed trusses. Extensive instrumentation was
installed to record test load response. Field tests,
using heavily loaded trucks, were performed to evaluate
the structural behavior of the strengthened bridge when
subjected to the strengthening forces as well as live
loads. A design manual has been prepared which
explains the strengthening methodology.

Reports: Final Report, September 1993

Implementation: The design methodology will make it possible for
the practicing engineer to determine the
post-tensioning system required through use of
graphs, nomographs, personal computer software,
etc., rather than having to use complex
analytical techniques.

Project Number: HR-334

Project Title: Field Measurement of Plow Loads During Ice Removal Operations

Agency: University of Iowa

Principal Investigator: Wilfred A. Nixon

Research Period: December 1, 1990 to November 30, 1993

Research Board Funding: \$137,921

Funding Source: 100 percent State--50 percent Primary funds, 25 percent Farm-to-Market funds and 25 percent Street Research funds

Objective: To determine the optimum plow blade loading through instrumentation of the hydraulic system of a conventional truck.

Progress: The research was conducted by The University of Iowa. Initial testing and data collection was done during the '90-'91 and '91-'92 winter seasons. A series of tests using three different blades was conducted. Good measurements were obtained of horizontal and vertical loads to scrape ice off the pavement. Final test objectives were achieved in the winter of '92-93. A test technique has now been developed which can measure and record forces on a cutting edge while scraping ice. All three blades tested performed best at angles close to 0°F with high downloads. With advances in computers and feedback control systems, it should now be possible to develop an automatic control system to adjust the blade angle and download for the best and safest scraping performance.

Reports: Final Report, November 1993

Implementation: Improvements of the ice blade or equipment will allow the removal of ice using fewer chemicals and less damage to roadway surfaces.

Project Number: HR-336

Project Title: Thermogravimetric Analysis of Carbonate Aggregate to Predict Concrete Durability

Agency: Iowa Department of Transportation

Principal Investigator: Wendell Dubberke

Research Period: March 1, 1991 to February 28, 1994

Research Board Funding: \$40,000

Funding Source: 100 percent State--40 percent Primary funds, 30 percent Farm-to-Market funds and 30 percent Street Research funds

Objective: The objective of the research is to determine if thermogravimetric (TGA) analysis will differentiate between durable and nondurable carbonate aggregate for portland cement concrete.

Progress: Samples from selected crushed carbonate coarse aggregate for portland cement concrete were obtained. Thermogravimetric testing of more than 200 samples was conducted with Iowa State University equipment. An improved software program allows relatively quick testing without loss of resolution. Both limestones and dolomites have been tested. Efforts have been made to relate the slope of the weight loss or the temperature when the carbon dioxide is driven off to durability of the aggregate. The TGA equipment is capable of rapid, accurate and repeatable analysis of carbonate aggregate. The TGA slopes prior to the calcite and dolomite transitions yield a good correlation with field performance of carbonate aggregate.

Reports: Final Report, February 1994

Implementation: Improved evaluation of coarse aggregate for concrete will yield economic benefits by allowing the use of all durable sources and preventing the use of nondurable aggregate that would result in decreased pavement life.

Project Number: HR-337

Project Title: Investigation of Rapid Thermal Analysis
Procedures for Prediction of the Service Life of
Portland Cement Concrete Pavement Carbonate
Coarse Aggregate

Agency: Iowa State University

Principal Investigators: Scott Schlorholtz and
Kenneth L. Bergeson

Research Period: May 1, 1991 to September 30, 1993

Research Board Funding: \$157,020

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and 30 percent
Street Research funds

Objective: To evaluate thermogravimetric (TGA) analysis as a
potential test of the durability of aggregate and to
analyze the chemical changes that result.

Progress: Iowa DOT personnel have obtained samples for the
research from 19 crushed carbonate sources (quarries).
Most of the samples selected for the research had ASTM
C666, Method B freeze and the durability results from
previous testing. There was also a wide range of
field performance of the 19 samples. Data from the
first year of testing showed that premature weight
loss in TGA testing related to decomposition
temperature of the various calcite sources. The
decomposition temperature also seems to relate to
crystallite size. This data can be used along with
other data to predict the durability of carbonate
aggregate in portland cement concrete pavement.

Reports: Final Report, June 1993

Implementation: Improved evaluation of coarse aggregate for
concrete will yield economic benefits by
allowing the use of all durable source and
preventing the use of nondurable aggregate that
would result in decreased pavement life.

Project Number: HR-338

Project Title: The Value of the County Engineer: Strategies for Expanding the Shrinking Employment Pool

Agency: Iowa State University

Principal Investigator: Kathleen M. Waggoner

Research Period: May 1, 1991 to September 15, 1993

Research Board Funding: \$116,527

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

Objective: The first goal of the project is to examine the responsibilities, goals, and effectiveness of persons in charge of secondary roads in eight participating states. The second goal is to develop a program by which bright and motivated high school students as well as university students majoring in civil engineering can be encouraging to consider county engineer positions as career choices.

Progress: A review of applicable state statutes has been completed regarding the obligations of registered professional engineers in the state of Iowa. An expert advisory group comprised of five county engineers was set up in each of the eight participating states in this study. Visits to several state engineering conferences were made as well as a questionnaire drafted to solicit comments from engineers and supervisors across the eight participating states. The questionnaire response rate was 60 percent. Information from Phase I was used in Phase II to develop a method to attract precollege and university engineering students into the county engineering profession.

Reports: Final Report, September 1993

Implementation: Working carefully with the panel of experts, proposed solutions and new strategies were identified and explored. Moreover, workshops and seminars will be held in order to provide counties with insights and proposed solutions to the "supply problem" presented by retirements and the difficulty of attracting replacements to county engineer positions.

Project Number: HR-339

Project Title: Multi-Project Scheduling Procedure for
Transportation Projects

Agency: Iowa State University

Principal Investigator: Dr. James E. Rowings

Research Period: August 19, 1991 to March 31, 1994

Research Board Funding: \$139,720

Funding Source: 100 percent State--80 percent Primary funds,
10% Secondary funds and 10 percent Street funds

Objective: The objective of this research was to develop an overall system to schedule and control individual and multiple transportation construction projects.

Progress: A survey of DOTs and a literature review of scheduling methods was completed. Typical transportation projects and scheduling approaches were compared. Draft scheduling specifications for bar charts and Critical Path Method (CPM) scheduling have been developed and are ready for field trial and evaluation on Iowa DOT projects. A recommended methodology for using the linear scheduling method (LSM) has been developed. The original project on which the linear scheduling method was applied was useful in demonstrating what a linear schedule might look like as far as what types of information would be included and how it would be displayed. The research strongly suggests that the linear scheduling technique has great potential as a project management tool for both contractors and Iowa DOT personnel. However, before this technique can become a viable weapon in the project management arsenal, a software application needs to be developed.

Reports: Final Report Part I, April 1993 and Final Report Part II, March 1994

Implementation: The linear scheduling method will improve project planning, project coordination and will yield more efficient use of inspection personnel.

Project Number: HR-339A

Project Title: Micro-Computer Based Linear Scheduling
Applications for Highway Construction Project
Control

Agency: Iowa State University

Principal Investigator: James E. Rowings

Research Period: June 10, 1994 to March 31, 1995

Research Board Funding: \$74,984

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds and 10 percent
Street funds

Objective: The objective of this research is to develop a
computer software program for Linear Scheduling
Applications (LSM) to be available to contractors on
Iowa highway construction projects.

Progress: A contract has been signed with Iowa State University
to conduct the research.

Reports: None

Implementation: A previous research project (HR-339) identified
the LSM as a more effective procedure for
scheduling construction than the currently used
Critical Path Method (CPM). The development of
a computer program for the LSM would make it a
cost effective project management tool for use
by Iowa DOT contractors.

Project Number: HR-341

Project Title: Bond Enhancement Techniques for PCC Whitetopping

Agency: Dallas County and the Iowa Department of Transportation,
Project Development Division

Principal Investigator: Brad Skinner, Jim Grove, and
Shane Tymkowicz

Research Period: June 20, 1991 to June 1996

Research Board Funding: \$25,000

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

Objective: To determine what techniques can be used to ensure the bond between the old asphalt concrete and the new portland cement concrete overlay.

Progress: Construction was completed in late June 1991 on 13 different test sections on R16 south of Dallas Center as part of a 6.4 km (4 mi.) project. Surface preparation techniques such as milling, planing, power brooming, and use of a tack coat and PCC grout were incorporated. All test sections are performing well. Cores drilled in the test sections have shown that the ability of the portland cement concrete overlay to bond with the old asphalt concrete is affected by the surface preparation.

Reports: Construction report, January 1993

Implementation: The bond between the two surfaces is the key to determining what procedure should be used to properly design the thickness of the PCC overlay. If sufficient bond strength can be established, the pavement could be designed as a composite pavement, thereby taking into account the structure of existing asphalt pavement.

Project Number: HR-343

Project Title: Non-Corrosive Tie Reinforcing and Dowel Bars for Highway Pavements

Agency: Iowa State University

Principal Investigator: Max L. Porter

Research Period: October 1, 1991 to November 30, 1993

Research Board Funding: \$149,955

Funding Source: 100 percent State--50 percent Primary funds,
40 percent Farm-to-Market funds and
10 percent Street Research funds

Objective:

- 1) Conduct a laboratory study of resistance of the fibercomposite bars to highway load transfer type fatigue, and
- 2) Field install and evaluate center tie steel and load transfer dowels in a portland cement concrete paving project.

Progress: Testing and design of load transfer baskets and centerline tie bars was completed. Two load transfer baskets with 1 3/4" diameter x 18" dowels on 8" centers and 6 centerline tie bars were installed in a US 30 paving project in Story County just east of Ames on May 1, 1992. The retrofitted supporting baskets were not rigid enough and allowed some misalignment of the dowels. Other than this, there were no problems. Iowa State University performed static-load applications in the spring of 1993. The Iowa DOT did Road Rater testing at the same time. Test results show that the fiber composite bars are performing in a manner very similar to the steel bars in adjacent joints.

Reports: Final Report, November 1993

Implementation: Fibercomposite reinforcing in concrete structures will not be subject to deterioration by corrosion. Information obtained through this research will help determine if fibercomposite reinforcing can be used in portland cement concrete in place of steel.

Project Number: HR-344

Project Title: Scour Susceptibility at Bridges in the State of Iowa

Agency: Geological Survey, U.S. Dept. of Interior

Principal Investigator: Ed Fischer

Research Period: October 1, 1991 to September 30, 1994

Research Board Funding: \$156,272

Funding Source: 100 percent State--40 percent Primary funds, 40 percent Farm-to-Market funds, and 20 percent Street Research funds

Objective: To evaluate the scour susceptibility of selected bridges and if possible, develop a regional methodology for use by engineers to determine the scour susceptibility of other bridges.

Progress: Research by the Geological Survey, U.S. Dept. of Interior is under way. The initial evaluation of around 130 bridges has been completed. The second phase, involving a more detailed evaluation has been completed. Ten sites were surveyed and theoretical scour depths calculated using the scour equations in HEC-18, "Evaluating Scour at Bridges." Scour measurements (part 3 of the project) were obtained at several sites during the floods of 1993. Work on the final report has begun.

Reports: Progress Report, April 1993

Implementation: An improved method of determining scour depths will reduce the potential of catastrophic bridge failure.

Project Number: HR-345

Project Title: Electronic Bulletin Board System

Agency: Iowa Transportation Center and Iowa State University

Principal Investigator: Tom Maze

Research Period: December 6, 1991 to June 30, 1995

Research Board Funding: \$100,753

Funding Source: 100 Percent State--10 percent Primary funds
80 percent Farm-to-Market funds and
10 percent Street Research funds

Objective: To assist county engineers and their staffs in obtaining information, communicating between themselves, obtaining the latest Iowa DOT messages, and developing other information files at the request of interested users.

Progress: A computer committee made up of several county engineers is in charge of developing system policies, identifying data to be exchanged through the bulletin board system, and working with the bulletin board users group to facilitate exchange. The system continues to be fine-tuned and upgraded to bring more new users on-line. Much of the direction of work is being handled by Steve DeVries, Mills County Engineer and Dr. Tom Maze, Iowa State University. The system appears to have benefit.

Reports: Progress report, March 1994

Implementation: This bulletin board system will help county offices to more easily and quickly transfer information between themselves, between the Iowa DOT and themselves, and between a central file server. A problem and solutions area would serve as a dialogue zone for discussing engineering and maintenance issues, with the results gradually accumulating into a database of practical information and solutions to real problems.

Project Number: HR-346

Project Title: Image Analysis for the Characterization of Materials for Highway Construction

Agency: Iowa State University

Principal Investigators: Glen Oren and Floyd G. Manwiller

Research Period: January 7, 1992 to January 31, 1994

Research Board Funding: \$116,345

Funding Source: 100 percent State--40 percent Primary funds,
30 percent Farm-to-Market funds and
30 percent Street Research funds

Objective: To determine if image analysis of scanning electron microscope (SEM) images can accurately determine the air void system in portland cement and asphalt concrete.

Progress: Early efforts were directed at developing the image analysis test method and evaluating various SEM to obtain the best image. Many of the current SEM draw high vacuum on the sample and impart cracking and distortion of the samples. It would also be desirable to be able to operate in the 5X magnification range. Most current SEM will not operate at that low of magnification. A low vacuum SEM with low magnification capabilities was obtained. Twenty test sample slices of portland cement concrete that had void determination by linear traverse were obtained. Air void by image analysis has been determined for these. The results compared well with the standard linear traverse.

Reports: Final Report, January 1994

Implementation: The image analysis system would provide rapid and accurate air void analysis which would improve the evaluation of pavement problems. In asphalt pavement, it has the potential of reducing the use of toxic chemicals and the cost of disposal.

Project Number: HR-347

Project Title: Impacts on Safety of Left Turn Treatment at High Speed Signalized Intersections

Agency: Iowa State University

Principal Investigator: Tom Maze, Joseph Henderson

Research Period: March 1, 1992 to January 31, 1994

Research Board Funding: \$61,414

Funding Source: 100 percent State--30 percent Primary funds, 20 percent Farm-to-Market funds and 50 percent Street Research funds

Objective: To quantify the relationship between intersection and traffic characteristics and the accident reduction potential of modified left-turn treatment

Progress: A literature review on left turn treatments has been completed. Data has been collected on 100 intersections throughout the state of Iowa. The data has been divided into sets and coded into a computer program. Analysis has been conducted on the preliminary database with positive results. Each data set contained information regarding accidents, intersection geometry and traffic volumes from intersections with left-turns. The results show that there are relationships between left-turn accident rates, traffic characteristics and left-turn treatments. Protected phasing with a left-turn lane results in the lowest number of accidents.

Reports: Final Report, January 1994

Implementation: Information related to safety considerations involving the treatment of left-turning traffic will help the engineer decide whether a left-turn bay is necessary and what traffic light controls to use.

Project Number: HR-348

Project Title: Recruiting and Retaining Women/Minorities for
Public Sector Engineering Positions

Agency: Iowa State University

Principal Investigator: Dr. Kathleen M. Waggoner
Dr. Lowell F. Greimann

Research Period: April 1, 1992 to October 31, 1994

Research Board Funding: \$138,932

Funding Source: 100 State--70 percent Primary funds, 20 percent
Farm-to-Market funds and 10 percent Street
Research funds

Objective: The primary objective of Phase I of this research is to identify and evaluate the potential benefits and obstacles facing Iowa DOT administrators in charge of factoring racial and gender diversity into the DOT's future agenda. Another objective is to focus on programs and plans used by high schools and universities to prepare and attract women and minority students into careers in transportation engineering.

Progress: The research is being conducted by Iowa State University. Data expected available for use in this project from a similar 1990 AASHTO study was not released. Data from State agencies is being collected. A questionnaire was sent out to 274 DOT engineers and 325 secretaries and technicians. The response rate was 59.2%. A preliminary analysis of the data has been completed, but a more detailed analysis will be completed later.

Reports: Interim Report, May 31, 1993

Implementation: Research indicates there is a need to focus on attracting more women and minorities into the field of transportation engineering.

Project Number: HR-349

Project Title: Recycled Paper Erosion Control Mats

Agency: Iowa Department of Transportation

Principal Investigator: Ole Skaar and Mark Masteller

Research Period: March 15, 1992 to February 28, 1994

Research Board Funding: \$20,000

Funding Source: 100 percent State--40 percent Primary funds,
40 percent Farm-to-Market funds and
20 percent Street Research funds

Objective: To determine whether recycled paper erosion control mats will successfully prevent erosion in ditch bottoms and on steep slopes

Progress: Earth-Gard, a recycled paper erosion control mat produced by Research Products Corporation of Madison, Wisconsin, was obtained from an Iowa distributor. It has been installed adjacent to conventional Excelsior mats on three primary locations and on local roads in three counties. Two cities are evaluating the Earth-Gard mats.

The 1992 installations have been monitored and photographed. Some installations are performing well while there is some damage on others. The Earth-Gard does not seem to be as hardy and durable as the conventional excelsior mats. The Earth-Gard disintegrates and is no longer functional after one year, whereas, the excelsior continues to function after the first year.

Reports: Final Report, February 1994

Implementation: Use of recycled paper erosion control mats would reduce the volume to landfills and conserve natural resources.

Project Number: HR-350

Project Title: Channel and Flood Plain Aggradation in the Iowa River Basin

Agency: United State Geological Survey

Principal Investigator: Nick Melcher

Research Period: October 1, 1992 to March 31, 1995

Research Board Funding: \$76,550

Funding Source: 100 percent State--45 percent Primary funds, 45 percent Farm-to-Market and 10 percent Street Research funds

Objective: The objective of this research is to quantify the rate of aggradation on the Iowa River and Skunk River. The overall objective is to understand the effects of land use changes and geomorphic processes on channel aggradation.

Progress: Field work gathering stream profiles and elevations is in progress. There was substantial flooding of both the Iowa and Skunk Rivers during 1993. Long-term aggradation data were collected for the 12 bridge sites using a tree-coring method and a channel cross-sectional comparison method. Long-term aggradation data were collected at the six gaged sites using a stage-discharge rating curve comparison method. Short-term aggradation data for the 1993 flood were collected at three of the sites in the Marshalltown area using sediment collection pads. Data collection is continuing.

Reports: Progress Report, January 1994

Implementation: Knowledge of the sediment deposition process and rates of stream aggradation for Iowa streams will be beneficial to planners and engineers in the design of bridges, culverts and other water-related structures.

Project Number: HR-351

Project Title: Bentonite Treatment for Economical Dust Reduction on Limestone Surfaced Secondary Roads

Agency: Iowa State University

Principal Investigator: Kenneth Bergeson

Research Period: July 28, 1992 to December 31, 1994

Research Board Funding: \$129,495

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

Objective: To optimize the amount of bentonite treatment on limestone surfaced roads to reduce dust generation and to examine the cost effectiveness of such treatment.

Progress: A one mile test road was constructed in Tama County in August of 1992 with bentonite treatment levels of 3, 5, 7 and 9 percent. The 3 percent treatment appeared to reduce dust by about 45 percent. As treatment level increased, dust generation appeared to decrease. The 9 percent treatment appeared to exhibit about a 70 percent reduction compared to the control section. Crust development was rated somewhat better than the control for the 3 percent treatment and roughly two times better for the other treatment levels. There was no evident difference in any of the test sections with respect to braking distance and brake handling characteristics under wet surface conditions. Phase I of this project was approved for \$21,170 and as a result of the preliminary findings, funding of Phase II was approved for \$108,325.

A test road was constructed in Appanoose County in June 1993 with bentonite and calcium chloride test sections. The bentonite had treatment levels of 6, 8, 10 and 12 percent. The test road is being evaluated for dust generation, braking characteristics, crust development, surfacing material, and roughness. Field evaluation is scheduled to be completed by September 1994. A final report will be submitted in December 1994.

Reports: Phase I Progress report, January 1993

Implementation: Fugitive dust on secondary roads continues to be what many Iowa county engineers consider to be one of their high priority problems. Most dust treatments are relatively expensive and tend to create maintenance problems and increase maintenance costs. A low cost, effective dust palliative that does not create a maintenance problem is needed.

Project Number: HR-352

Project Title: Stream Stabilization in Western Iowa

Agency: Golden Hill Resource Conservation and Development

Principal Investigator: Marty Adkins

Research Period: August 20, 1992 to December 31, 1994

Research Board Funding: \$188,000

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

- Objective:
- A. Development of a system that integrates information on stream conditions, associated geology, transportation facilities, potential economic impacts, and likely stabilization costs.
 - B. Development of technical guidelines for preliminary planning and cost forecasting on stream degradation control projects.
 - C. Development of administrative procedures for the allocation of technical and financial resources on stream degradation control projects.

Progress: Information on conditions at the streams in the 22 county deep loess soils region has been collected. A stream data base that includes 350 streams has been developed. Thirty streams were videotaped from a helicopter to inventory the areas of active degradation. Stream sediments were mapped in the tributaries of Walnut Creek. A data base has been developed containing bridge and culvert repair and replacement. Implementation of a GIS has begun. A final report is expected to be completed in December 1994.

Reports: Progress Report, June 1993

Implementation: Improved stream degradation information will allow more timely maintenance of stream crossing structures. It will also yield criteria that will assist in selection of the most cost effective structure.

Project Number: HR-353

Project Title: Epoxy-Coated Strands in Composite Precast
Prestressed Concrete Panels

Agency: Iowa State University

Principal Investigator: Robert Abendroth

Research Period: August 12, 1992 to November 30, 1994

Research Board Funding: \$193,900

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

Objective: The main objective of the research is to evaluate the static load strength performance of composite precast prestressed concrete panel slabs that are constructed with panels that contain grit-embedded, epoxy-coated strands and epoxy-coated welded wire fabric and a reinforced concrete (R/C) topping slab that contains epoxy-coated reinforcing bars.

Progress: The research is being conducted by Iowa State University. A literature review has been completed. A survey questionnaire was prepared and sent out to all states plus some other agencies. A bed for testing prestressed castings was constructed. Ten castings have been prepared for testing. Five castings were used to establish a preliminary minimum thickness for R/C panels. The remaining 5 castings were used for confirmations, other measurements and observations. Information is being obtained on recommended thickness for R/C panels and on tentative development lengths for multiple and grit impregnated epoxy-coated strands. Basic testing has been nearly completed and preparations for the final report are underway.

Reports: Interim Report, February 1994

Implementation: Results from this study will determine design specifications required for the substitution of noncorroding epoxy coated strands for the currently used noncoated steel strands.

Project Number: HR-354

Project Title: An Engineering Study to Design Triple Box Culvert Standards

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: Shane Tymkowicz

Research Period: September 1993 to January 1995

Research Board Funding: \$180,000

Funding Source: 100 percent State--30 percent Primary funds and 70 percent Farm-to-Market funds

Objective: To contract with a consultant to develop standard designs for triple reinforced concrete box culverts.

Progress: A consultant selection committee has selected Shuck-Britson, Inc. as the qualified engineering firm in September of 1993 to perform the work. The study will involve developing details and quantities for 336 different box culverts. Several culvert sizes with 12 different fill heights and 4 different headwall skews will be considered. The project is approximately 80% completed and on schedule.

Reports: None

Implementation: The design of standards will avoid duplication of effort among 99 counties. This will benefit city, county, and state professionals who prefer to utilize these designs instead of a bridge structure for certain area projects.

Project Number: HR-355

Project Title: The Role of Magnesium in Concrete Deterioration

Agency: Iowa State University

Principal Investigator: Robert Cody, Paul Spry, and Anita Cody

Research Period: November 1, 1992 to October 31, 1994

Research Board Funding: \$137,873

Funding Source: 100 percent State--70 percent Primary funds,
20 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: To investigate the role of magnesium in the
deterioration of Iowa highway concrete using a
scanning electron microscope (SEM) microprobe.

Progress: Laboratory testing of selected portland cement
concrete (PCC) pavement samples with the Electron
microprobe is in progress. Tests show that service
life of the concrete is related to the degree of
chemical reactions between dolomite coarse aggregates
and the cement paste. Magnesium released by these
reactions, together with small volume changes at the
aggregate--cement paste rim weakens bonding between
the coarse aggregate particles and the cement paste,
and results in decreased service life.

Reports: Progress Report, December 1993

Implementation: This research will improve the identification of
the cause of PCC pavement deterioration. This
will support changes that will improve pavement
longevity.

Project Number: HR-356

Project Title: Economical Production of Calcium Magnesium Acetate

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: Wallace Rippie

Research Period: November 18, 1992 to June 30, 1995

Research Board Funding: \$10,000

Funding Source: 100 percent State--Primary funds

Objective: To determine if calcium magnesium acetate (CMA) can be produced at a substantially reduced cost using a synthetic zeolite catalyst.

Progress: An extensive literature search has identified promising chemical reaction processes for production of acetic acid. Some chemicals have been obtained and additional chemicals are to be purchased. The research to oxidize alcohol as received from biomass fermentation at a 10% aqueous concentration has focused upon high temperature oxidation catalysts based on silica with titanium and vanadium ions added to the framework.

The current research literature reveals nickel and cobalt complexes being used at low temperatures and oxygen pressures to perform mild oxidations in contrast to alcohol oxidation. Unfortunately, these catalysts function in water free reactions. The current efforts on the project are to determine how to blend these two concepts to oxidize alcohol with low energy inputs in a short time with air.

The metallic catalysts necessary for efficient alcohol oxidation to acetate in an aqueous media must be complexed in a matrix to avoid solubility losses. Extensive literature review has produced such a promising metallorganic polymer which can easily be synthesized.

Reports: None

Implementation: An inexpensive, non-corrosive deicer would reduce the deterioration of highways, structures and vehicles. This would result in increased longevity which would be a substantial cost savings.

Project Number: HR-357

Project Title: An Expert System for Forecasting Fog on US 30 in Cedar Rapids

Agency: Iowa State University

Principal Investigator: Eugene Takle

Research Period: November 23, 1992 to November 30, 1995

Research Board Funding: \$145,245

Funding Source: 100 percent State--Primary funds

Objective: The objective of this research is to consolidate all available information on the behavior of the cooling tower fog plume, and develop a computerized expert system to improve prediction of poor visibility from the tower fog plume on US 30 near Cedar Rapids.

Progress: The research is being conducted by Iowa State University. Data is being gathered from airport surface observations from DOT records and from a local video photographer. An expert system is being developed using a plume model from Electric Power Research Institute (EPRI). Changes in operations at the ADM plant during the '93-'94 season is causing some revision of project goals. Additional data is now available from near-plant SSI sensors and from nearby National Weather Service offices.

Reports: Progress Report, April 1994

Implementation: A computerized expert system will be developed to improve the prediction of the development of fog and poor visibility from the tower fog plume on US 30 near Cedar Rapids. The improved accuracy will increase driver safety, and reduce the cost of man-hours and equipment for traffic control and maintenance.

Project Number: HR-358

Project Title: Evaluation of Microcracking and Chemical Deterioration in Concrete Pavements

Agency: Iowa State University

Principal Investigator: Scott Schlorholtz

Research Period: March 1, 1993 to August 31, 1995

Research Board Funding: \$160,180

Funding Source: 100 percent State--45 percent Primary funds, 40 percent Farm-to-Market funds and 15 percent Street Research funds

Objective: To initiate an improved method of evaluating and identifying the initiating cause of early portland cement concrete (PCC) pavement deterioration.

Progress: The intent of this project is to determine the initial cause of premature PCC pavement deterioration. Fifty-nine cores were drilled from nine different PCC projects with varying degrees of deterioration and of varying ages. These have been prepared and polished and are ready for analyses. A low vacuum scanning electron microscope was purchased, but required modification to comply with purchase specification. This delayed analyses of the specimens. Testing and analysis is now proceeding.

Reports: Phase I Progress Report, February 1994

Implementation: An improved method of identifying the initiating cause of PCC deterioration will allow changes to prevent deterioration and improve pavement longevity.

Project Number: HR-359

Project Title: Airborne GPS

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: April 12, 1993 to April 30, 1995

Research Board Funding: \$166,355

Funding Source: 100 percent State--80 percent Primary funds,
10 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: The objective of this research is to develop
orientation data using the multiantenna concept and
to use aerial photographs for direct stereo plotting.

Progress: Three test flights have been made and data was
analyzed. The test flights evaluated multiantenna
concepts, use of GPS for pinpoint navigation, the
three DF GPS receiver and the antenna locations.
These tests have indicated that use of this concept
would yield useable survey data with reduced time and
labor.

Reports: Progress Report, June 1994

Implementation: This research will aid in updating the
Geographic Information System (GIS) using aerial
photographs. When using stereo pairs of
photographs for mapping, the elevation must be
known of a ground control or the tip of the
camera. Using the multiantenna concept will
allow determination of the location of camera
lense elevation with great accuracy. This
information will be used for navigation for
taking aerial photographs and to save time and
money in earthwork computations.

Project Number: HR-360

Project Title: Field Evaluation of Various Engineering Fabrics - Audubon Co.

Agency: Audubon County and Iowa Department of Transportation,
Project Development Division

Principal Investigator: George Parris and Shane Tymkowicz

Research Period: May 1993 to December 31, 1998

Research Board Funding: \$30,290

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

Objective: To evaluate the Pro-Guard and Paveprep engineering fabrics as reflective crack retarders when used in conjunction with an ACC overlay on a low volume secondary road.

Progress: The project is located in Audubon County on F16 from the town of Gray east 4.2 km (2.6 mi.) to US 71. The project was constructed in August 1993. There are 8 test sections using two different engineering fabrics. The fabric was placed over both transverse and longitudinal cracks.

Reports: Construction Report, April 1994

Implementation: Reflective cracking in ACC overlays usually open allowing water to enter the unsealed crack which causes stripping of the base material and accelerated deterioration of the overlay. Engineering fabrics may prove to impede reflective cracking and thus reduce maintenance costs.

Project Number: HR-361

Project Title: Development of a Model for the Ice Scraping Process

Agency: University of Iowa

Principal Investigator: Wilfrid Nixon

Research Period: May 1, 1993 to April 30, 1996

Research Board Funding: \$236,895

Funding Source: 100 percent State--60 percent Primary funds, 20 percent Farm-to-Market funds and 20 percent Street Research funds

Objective: To develop two improved cutting edge designs for the removal of ice.

Progress: A literature research and product review are underway. Upgrading testing equipment to use with the new design is in progress also. A number of different blade geometries have been evaluated. A nonuniform blade shape shows significant promise for ice removal.

Reports: None

Implementation: This research project will include performing a series of experiments to confirm the model discussed in the proposal and developing this model. The aim is to use the new developed ice scraping model to aid in the development of new cutting edges which can be used on existing plowing equipment and to improve the efficiency of this equipment at scraping ice from the roadway.

Project Number: HR-362

Project Title: Design Methodology for Corrugated Metal Pipe
Tiedowns: Phase II

Agency: Iowa State University

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

Research Period: June 10, 1993 to June 30, 1995

Research Board Funding: \$239,340

Funding Source: 100 percent State--10 percent Primary funds,
80 percent Farm-to-Market funds and 10 percent
Street Research funds

Objective: To develop a design methodology that will prevent
uplift failures of corrugated metal pipes.

Progress: An advisory committee has been established to address
research aspects of the project. Tests will be
conducted on full scale 3.0 m (120 in.) and 2.4 m
(96 in.) CMP. The results of the tests will be used
to create a numerical model with finite element
analyses. The analytical work and finite element
analysis of the soil-pipe interaction are being
conducted concurrently with field work.

Reports: Phase I, February 1993

Implementation: This design method will make it possible for
practicing engineers to determine, for a
particular situation, the required hold down
force through use of nomographs, computer
spreadsheets, etc., rather than having to use
complex analytical techniques such as finite
element analyses.

Project Number: HR-363

Project Title: Clarifying the Quadrennial Needs Study Process

Agency: Iowa State University

Principal Investigator: James Cable

Research Period: June 10, 1993 to January 31, 1994

Research Board Funding: \$45,160

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

Objective:

1. To identify sample counties and a control county from 1990 study year for detailed needs analysis.
2. Analyze the relative needs of the sample and control counties to determine the sensitivity of selected input variables on the study results.
3. Identify the possible reasons for shifts in the relative needs between counties in a given "Quadrennial Needs Study" and make recommendations on ways to improve the study process conducted by the Iowa DOT.

Progress: The study identified program inputs that can result in major shifts in needs, either up or down from minor changes in the input values. Eight counties exhibiting large shifts (greater than 30%) in needs were used to test the sensitivity of variables. A ninth county was used as the base line for the study. The report recommended improvements in the process of data collection in the areas of road and structure condition rating, traffic and in the assignment of construction cost areas.

Reports: Final Report, December 1993

Implementation: This study will be used to assist the counties in understanding the factors that affect the outcome of the Quadrennial Needs Study.

Project Number: HR-364

Project Title: Automated Recording of Bridge Inspection Data in the Pontis Format

Agency: Iowa State University

Principal Investigator: Fouad Fanous

Research Period: July 15, 1993 to January 31, 1995

Research Board Funding: \$117,695

Funding Source: 100 percent State--80% Primary funds, 10 percent Farm-to-Market funds and 10 percent Street funds

Objective: The objective of the research is to develop an automated computerized methodology for an integrated data base that includes the Pontis Bridge rating management system.

Progress: To date, a review of the current state-of-the-art technologies in computer software that can be used to capture data was conducted. In addition, a study of the PONTIS BMS program was performed to determine the input procedures, file construction and the format used by the program. The results of this study and with the suggestion received from the project advisory committee, the outlines and the construction of the proposed software were laid out. A preliminary version of the software was demonstrated to the advisory committee and their suggestions are being incorporated. Inspection data will be stored in files compatible with the PONTIS format and inspection reported can also be generated.

Reports: None

Implementation: There are over 26,000 bridges in Iowa and there have been significant bridge failures across the U.S. This prompted federal legislation in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) requiring a bridge management system (BMS). An Iowa DOT task force has reviewed the BMS currently available and identified the PONTIS BMS system as the most desirable to be developed for use in Iowa. The results of this work will help bridge inspectors and will expedite transferring inspection data to the PONTIS software.

Project Number: HR-365

Project Title: Evaluation of Bridge Replacement Alternatives for the County Bridge System

Agency: Iowa State University

Principal Investigator: F. W. Klaiber and Terry Wipf

Research Period: July 15, 1993 to August 31, 1994

Research Board Funding: \$57,050

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

Objective: The objective of the study is to identify, review, and evaluate replacement bridges currently being used by various counties in Iowa and surrounding states. Depending upon the findings of this review, improvements to these bridges may be proposed or a new system may be proposed.

Progress: A project advisory committee was established to assist the research team. A questionnaire was sent to the counties to collect information and data on existing replacement bridge structures. A second questionnaire was sent to manufacturers and producers of bridge replacement systems. The various replacement systems identified by the questionnaires are being evaluated and rated with the assistance of the project advisory committee. A final report is expected by August 1994.

Reports: None

Implementation: Improvements may be proposed to existing systems depending on the results of the evaluation of the bridge replacement alternatives. The improvements recommended and the report will serve as a resource for county engineers so they may select the most effective bridge replacement alternative.

Project Number: HR-366

Project Title: Field Data Acquisition Technologies for Iowa
Transportation Agencies

Agency: Iowa State University

Principal Investigator: Ed Jaselskis

Research Period: July 15, 1993 to August 31, 1994

Research Board Funding: \$74,125

Funding Source: 100 percent State--35 percent Primary funding,
35 percent Farm-to-Market funding and 30 percent
Street funding

Objective: The objective of the research is to investigate and
evaluate technologies for field data collection,
manipulation and reporting.

Progress: A greater emphasis is being placed on improved
pavement and bridge management systems through the
1991 Intermodal Surface Transportation Efficiency Act
(ISTEA). In recent years, a number of computerized
data gathering instruments have become available which
would be adaptable to management systems. Information
has been obtained on the current methods of data
collection and the hardware and software being used.
The interest level in using advanced field data
collection technologies was also evaluated.

Reports: Interim Report, May 1994

Implementation: This research will evaluate the data gathering
equipment and programs available and adaptable
to the highway industry. A recommended system
will be presented for state transportation
agency interest or selection.

Project Number: HR-367

Project Title: Solar Powered Highway Delineator System

Agency: University of Iowa mechanical engineering students

Principal Investigator: Todd Collis and Chris Lamar

Research Period: October 1, 1993 to December 31, 1993

Research Board Funding: \$1,000

Funding Source: 100 percent State--50 percent Primary funds,
25 percent Farm-to-Market funds, 25 percent
Street Research funds

Objective: The objective of this research is to study the
feasibility of use and to build a prototype of a
solar powered highway delineator.

Progress: A parts list for the solar powered delineator was
developed. A working prototype was constructed and
submitted to the University of Iowa instructor. The
student team made recommendations to the Iowa DOT for
its potential use.

Reports: Final report, December 1993

Implementation: Solar powered delineators could be used at
special locations where headlights do not
adequately light reflecting delineators

Project Number: HR-368

Project Title: Construction Automation Using Pen-Based Computers

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: John Smythe and Donna Buchwald

Research Period: April 25, 1994 to December 2, 1994

Research Board Funding: \$33,000

Funding Source: 100 percent State--Primary funds

Objective: The objective of the research is to determine if pen-based computers would provide a cost-effective benefit to the Iowa Department of Transportation

Progress: There have been substantial delays in obtaining the required Iowa DOT authorizations to purchase the pen-based computers. This will hinder the field evaluation as they were not available at the start of most sizeable, complex projects.

Reports: None

Implementation: The pen-based computers will improve the record keeping by project inspectors and reduce the time required for documentation which will be very much needed due to reduction in field inspection staffing.

Project Number: HR-370

Project Title: Pipe Rehabilitation With Polyethylene Pipe Liners

Agency: Dallas County, Jefferson County, Jones County, Mahaska County, Taylor County, and the Iowa Department of Transportation, Project Development Division

Principal Investigator: Brad Skinner, Gary Bishop, Dan Waid, Raymond Blessum, James Delozier and Shane Tymkowicz

Research Period: June 1, 1994 to December 31, 1999

Research Board Funding: \$10,000

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

Objective: The objective of the research is to demonstrate and evaluate the applicability of pipe rehabilitation with polyethylene pipe liners.

Progress: Six locations have been selected for the installation of polyethylene liners. The locations include corrugated metal pipe, concrete roadway pipe, and a wooden box culvert. The polyethylene liners to be used for this research are "Culvert-Renew" and "Snap-Tite." The installations should be completed by October 1994. The research will also evaluate any additional pipes that are rehabilitated with polyethylene liners.

Reports: Construction report, March 1995

Implementation: If the use of polyethylene liners is successful, it will give engineers an economical alternative to the removal and replacement of deteriorated culverts.

Project Number: HR-371

Project Title: Development of a County Condemnation Policy and Procedure Manual

Agency: Graham Land Acquisition Associates

Principal Investigator: James Graham

Research Period: June 22, 1994 to April 30, 1996

Research Board Funding: \$14,000

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

Objective: The objective of this engineering study is to develop a simplified county condemnation policy and procedure manual to guide county engineers.

Progress: The contract has been executed. An outline for the manual has been completed and distributed to selected individuals for review and comment.

Reports: None

Implementation: The manual will provide guidance to county engineers that will save time and avoid costly mistakes.

Project Number: HR-372

Project Title: Full Scale Field Measurements of Ice Scraping Loads

Agency: The University of Iowa

Principal Investigator: Wilfrid Nixon

Research Period: September 1, 1994 to July 31, 1996

Research Board Funding: \$179,519

Funding Source: 100 percent State--70 percent Primary funds, 15 percent Farm-to-Market funds and 15 percent Street funds

Objective: The objective of this research is to equip two Iowa DOT trucks with ice scraping blades and to develop automated controls for the most effective and safe ice scraping through the use of instrumentation and computers.

Progress: A Staff Action has approved the conduct of the research.

Reports: None

Implementation: Two Iowa DOT trucks are to be used in actual field operations. Research values obtained from HR-334 will be used as a basis for development of this research. The development of automated controls for ice scraping will help truck operators do their work in a more efficient, effective and safe manner.

Project Number: HR-373

Project Title: Investigation of Plastic Pipe for Highway Applications

Agency: Iowa State University

Principal Investigator: F. W. Klaiber, Richard Lohnes and Terry Wipf

Research Period: July 15, 1994 to October 14, 1995

Research Board Funding: \$126,980

Funding Source: 100 percent State--35 percent Primary funds
35 percent Farm-to-Market funds and
30 percent Street Research funds

Objective: The objective of this study is to review and evaluate the use of polyethylene pipe (PE pipe) in roadway applications. Structural performance, soil-structure interaction and the sensitivity of PE pipe to installation will be reviewed. The investigation will be limited to PE pipe 1.2 m (48 in.) or less in diameter.

Progress: A Staff Action has been approved for the conduct of this research.

Reports: None

Implementation: It appears that there are several applications in which using "plastic pipe" would be a favorable economic alternative. However, the newness of "plastic pipe" in the market requires the evaluation of its performance, integrity, and durability.

Project Number: HR-1027

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Project Development Division

Principal Investigator: Shane Tymkowicz

Research Period: March 5, 1980 to present

Research Board Funding: \$47,000.00/yr. (covers salary and state share of costs for FICA, IPERS, health insurance, vehicle costs and expenses)

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: Shane Tymkowicz 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 5 active research projects that involve experimental construction by counties and five engineering studies. 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.

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