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# Annual Report of Highway Research and Development in Iowa

Highway Division  
Office of Materials  
December 1990



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ANNUAL REPORT  
OF  
HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE  
FISCAL YEAR ENDING JUNE 30, 1990

OFFICE OF MATERIALS  
(515) 239-1447

HIGHWAY DIVISION  
IOWA DEPARTMENT OF TRANSPORTATION  
AMES, IOWA 50010

DECEMBER 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.



<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 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	15,962.59
321	97,850	Production of Acetic Acid by Fermentation With Propionibacteria	29,724.15		29,724.15
322	91,471	Estimating Design Flood Discharge for Iowa Using Drainage Basin and Channel Geometry Characteristics	20,490.00		20,490.00
323	172,548	Development of Evaluation, Rehabilitation and Strengthening Concepts for Low Volume Bridges		13,170.41	13,170.41
324	41,579	Construction Plan Reading Course Update	362.16		362.16
325	97,500	Thermoset Composite Concrete Reinforcement	9,529.15		9,529.15
327	110,000	Evaluation of Chemical Durability of Iowa Fly Ash Concretes	4,814.37		4,814.37
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	17,952.32
		Contract Research Sub-Total	386,965.31	440,905.42	832,744.25
HPR-PR-PL-1(26)		FY 1990 Planning & Research Program (Transportation Inventory Engineering Studies)		288,722.00	288,722.00
		Noncontract Engineering Studies Sub-Total		288,722.00	288,722.00
		Grand Total of Expenditures	386,965.71	729,627.42	1,121,466.25



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 spend 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 inter-state.

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 construction.

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 apparatus  
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 per-  
cent.

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

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 detrails 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.