Annual Report of Highway Division Highway Research and Development in Iowa

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

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.

Table I

1991 HIGHWAY RESEARCH ADVISORY 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 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 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. Incomplete 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 structures.

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, 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: 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 transverse joints. A final report will be submitted in October 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 Administration

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 completed.

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 construction 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 conventional 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: 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.

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 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.

Reports: Progress Report, January 1991

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 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 frequencies

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

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 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: A contract has been executed with Iowa State University. 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.

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 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: 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 retrofitting 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 initial aim of retrofitting 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 experience in control of equipment the operation was postponed, 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 corrugated 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 Research funds

Objective: To develop a design methodology that practicing engineers can use to design the post-tensioning system 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 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, 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 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 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 established. 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 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 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 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.

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 Center as part of a 4-mile project. Testing and evaluation 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 established, 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.

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: $36,000.00/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 12 active research projects that involve experimental construction by counties and six 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.