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HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

For the Fiscal Year Ending June 30, 1975

Prepared for Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

Prepared by Stephen E. Roberts Office of Operations Research Highway Division Iowa Department of Transportation October 15, 1975

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Annual Report

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

For the Fiscal Year Ending June 30, 1975

Prepared for Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

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[Materials]

Prepared by Stephen E. Roberts Office of Operations Research Highway Division Iowa Department of Transportation October 15, 1975

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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, it seeks to find workable solutions to the many problems that require more than ordinary, routine investigation. Second, it believes that a specific effort must be made to search out and to make use of improved engineering and management practices.

This is a report on the status of research and development projects which were in progress on June 30, 1975; it is also a report on projects completed during the fiscal year beginning July 1, 1974 and ending June 30, 1975. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Operations Research, Highway Division, Iowa Department of Transportation.

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IOWA HIGHWAY RESEARCH BOARD

In developing a continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established by the Highway Commission in 1949.

The Research Board contains thirteen regular members --six County Engineers, three Highway Division Engineers, one representative from Iowa State University and 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 membership of the Research Board as of June 30, 1975, is listed in Table I.

The Research Board held five regular meetings during the period July 1, 1974, to June 30, 1975. Suggestions for research and development were reviewed at these meetings, and recommendations were made by the Board.



Table I IOWA HIGHWAY RESEARCH BOARD June 30, 1975

Member

R. I. Bortle, District 4 Engr. Iowa Department of Transportation Highway Division Atlantic, Iowa 50022

D. R. Boylan, Dean College of Engineering Iowa State University Ames, Iowa 50010

D. Canney Mayor Cedar Rapids, Iowa 52401

V. L. Clark Decatur County Engineer Leon, Iowa 50144

R. H. Given, Deputy Chief Engr. of Development Iowa Department of Transportation Highway Division Ames, Iowa 50010

Alternate

W. L. Morris, District 3 Engr. Iowa Department of Transportation Highway Division Sioux City, Iowa 51100

P. W. Peterson Associate Dean of Research Iowa State University Ames, Iowa 50010

E. Niebuhr Director of Public Works Clinton, Iowa 52732

R. F. Sears Monroe County Engineer Albia, Iowa 52531

F. O. Bloomfield, Maintenance Engineer Iowa Department of Transportation Highway Division Ames, Iowa 50010

M. O. Hansen Poweshiek County Engineer Montezuma, Iowa 50171

R. G. Hering Dean of Engineering University of Iowa Iowa City, Iowa 52240

R. L. Haylock Butler County Engineer Allison, Iowa 50602

D. E. McLean, Deputy Chief Engr. of Operations Iowa Department of Transportation Highway Division Ames, Iowa 50010 C. Cabalka, Jr. Jasper County Engineer Newton, Iowa 50208

Kwan Rim Associate Dean for Research University of Iowa Iowa City, Iowa 52240

W. A. Groskurth Mitchell County Engineer Osage, Iowa 50461

T. E. McElherne, Specifications Engineer Iowa Department of Transportation Highway Division Ames, Iowa 50010

Member

R. Murdock Buchanan County Engineer Independence, Iowa 50644

R. Reinhart Pocahontas County Engineer Pocahontas, Iowa 50574

W. L. Schultz Guthrie County Engineer Guthrie Center, Iowa 50115

J. White City Engineer Dubuque, Iowa 52001

Alternate

D. L. Smith Delaware County Engineer Manchester, Iowa 52057

H. D. Wight Crawford County Engineer Denison, Iowa 51442

J. C. Calhoun Madison County Engineer Winterset, Iowa 50273

W. Amundson City Engineer Sioux City, Iowa 51100

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RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division or the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farm to Market Road Fund, depending upon which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1975. Total expenditure was \$280,567.28, including support of the National Cooperative Highway Research Program (see page 6).

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Highway Division personnel are termed "in-house" projects. All such projects involve other departmental and district personnel in addition to personnel from the Office of Operations Research. 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; they cannot be used for salary nor personal expenses of the participating personnel. Consequently, the contract amounts shown for inhouse projects are relatively small and the Office of Operations Research is indebted to other offices and the districts for their assistance.

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials. 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 to NCHRP averages about \$45,000 per year. Actual expenditures for individual fiscal years may be greater or less than this amount due to billing practices.

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Division personnel are brind "in-house" protects. All such projects involve other departmental and district personnol in enditates no personnel trans the office of Operations Research. In the principal invest operation of the offices are designated to principal investigators, which means that they have a major role in the planning, percordance, and analysis of the research.

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Table II

RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1974 to June 30, 1975

Project	Primary	Farm to Market	Total
120	23 700 00	A LADRID TO STREET AD	23,700.00
140	22,000.00	11,000.00	33,000.00
1/9	46.75	to provide the bas dater	46.75
163	438.15	warmon it is the statements	438.15
164	3.739.99	526.02	4,266.01
166	787.63	1954 700 200 30, 1975	787.63
160		43,306.76	43,306.76
170	90.000.00	Chemister 5 -+ 400 bickets	90,000.00
170	576.72		576.72
172	21 753 00	the former 7 Income Fr	21,753.00
172	21,750.00	9,312.35	9,312.35
1005	452.02		452.02
Sub-Total	163,494.26	64,145.13	227,639.39
NCHRP	44,027.79	6,319.66	50,347.45
HPR-2(113)	2,257.17	323.27	2,580.44
Total	\$209,779.22	\$70,788.06	\$280,567.28
		-7-	

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report contains brief descriptions of research projects for which open files were maintained in the Office of Operations Research during all or part of fiscal year 1975. An open file for each project is maintained from the project's inception to completion; the latter is signified by acceptance of the final report and the making of the final payment.

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RESEARCH PROJECT SUMMARY

Project Number: HR-121

Project Title: Skid Resistance of Highway Pavements

Research Agency: Office of Operations Research, I.D.O.T. Office of Materials, I.D.O.T.

Principal Investigator: Vernon J. Marks, Materials

Contract Period: July 1, 1969, to June 30, 1975

Contract Amount: \$32,800 current; \$50,400 previous

<u>Funding</u>: 100 percent state funds; 75 percent Primary and 25 percent Farm-to-Market

Research Objective: The Office of Materials is engaged in a regular program for measuring the skid resistance of highway pavements. The measuring device was developed jointly by the Offices of Materials and Operations Research under the original contract for Research Project HR-121. The objectives of the current project are (1) to investigate operating procedures that affect the test results and (2) to develop an improved equipment calibration system and an automatic system for recording the test results.

Project Activities: The major effort to date has been on the development of an automatic system for recording test results. The recording system has been installed and additional modification equipment has been installed for more efficient operation.

Progress: This project has been completed.

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Reports: None

<u>Implementation</u>: Automatic recording of the test results will furnish the operator of the skid test device with a printed record of the test immediately upon completion of a test. The automatic recording system will eliminate about 70 percent of the office work now required for data reduction and reporting.

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realistered of highly pavernate. The manufine device was developed jointin by the offices of Katerials and Device the headered and a the our pinel contract for Resource Frequeries and the digercizes of the our cash provide the test readilit and (2) to making proveduces that the test of the test readilit and (2) to making system for reconstinct the test readilit and (2) to

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RESEARCH PROJECT SUMMARY

HR-140 Project Number:

Collection and Analysis of Stream Flow Data Project Title:

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

Principal Investigator: S. W. Wiitala, U.S.G.S.

- Project continued to June 30, 1976 by Com-Contract Period: mission action June 3, 1975
- \$44,000 per year (matched by \$44,000 from Contract Amount: the Department of the Interior)
- 100 percent state funds; 50 percent Primary and Funding: 50 percent Farm-to-Market

Mark F. Looschen, Bridge Design ISHC Project Control: S. E. Roberts, Operations Research

The objectives of Project HR-140 are Research Objectives: 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.

Project Activities: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and analyzed to form the basis for predictions of future streamflow.

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Progress: The progress during 1974-75 was in accordance with schedules established by the Water Resources Division and the particular needs of the Department of Transportation.

Reports: Flood of August 2, 1972, in The Little Maquoketa River Basin, Dubuque County, Iowa, September 1973. Floods in The Rock River Basin, Iowa, October 1973.

<u>Implementation</u>: The information obtained from Project HR-140 is used daily by D.O.T. Personnel in the design of bridges and culverts.

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RESEARCH PROJECT SUMMARY

Project Number: HR-148

Project Title: Investigation of Pavement Wear in Relation to Studded Tire Use

Research Agency: Office of Operations Research, I.D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: August 20, 1969, to completion

Contract Amount: \$1,130 Operations Research, I.D.O.T.

Funding: 100 percent state funds, 75 percent Primary and 25 percent Farm-to-Market

Research Objective: The objective of this project is to measure pavement wear caused by studded tires and to estimate the extent of future wear if studded tires continue to be legal in Iowa.

Project Activities: The two principal activities carried on by the Office of Operations Research are (1) the measurement of pavement wear and (2) the estimation of studded tire usage in Iowa.

Progress: Pavement wear measurements have been made in Iowa for the winter period 1974-75.

Reports: The Office of Operations Research has prepared reports on studded tire usage in Iowa for the winter periods 1969 through 1975.

Implementation: The findings from Research Project HR-148 are being used to support recommendations adopted by the Iowa Department of Transportation concerning the banning of studded tires in Iowa.

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RESEARCH PROJECT SUMMARY

Project Number: HR-156

<u>Project Title</u>: Detection of Steel Corrosion in Bridge Decks and Reinforced Concrete Pavement

Research Agency: Office of Operations Research, I.D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: October 8, 1970, to completion

Contract Amount: \$2,500

Funding: 100 percent state, Primary Funds

Research Objective: The measurement of electrical potential between steel and its surroundings is a standard technique for detection of conditions conducive to corrosion of the steel. While the measurement technique is relatively simple, interpretation of the results is both difficult and highly subject to error.

The objectives of Project HR-156 are (1) to establish proper test procedures and data interpretation necessary for locating steel corrosion, and (2) to employ the test in assessing the effectiveness of overlays, waterproofing membranes and repair methods used on bridge decks.

Project Activities: The Office of Operations Research originally assembled two sets of corrosion detection equipment. One set is used by the Office of Operations Research in a testing program designed to reveal the overall reliability of the test and to identify and evaluate test variables that influence the accuracy of the results. The second set of equipment has now been supplemented by additional sets purchased by the Office of Materials so as to provide corrosion detection equipment for each district office. Progress: Corrosion readings have been made on various bridges and on continuously reinforced concrete pavement in nearly all parts of the state. All data compiled has been summarized and filed for future reference.

Reports: None

Implementation: The electrical potential method of determining probable corrosion of the steel in bridge decks is being used by maintenance personnel in all districts to aid in the evaluation of bridge decks proposed for repair or resurfacing.

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exter in the underlying paramet. Various many have been tried, with little or no moreas, to prevent the formetion of cheso inflection cracks. Project HR-168 prevides for the expectednicit institution and subrequent extination of tires synthetic fiber materials that and subrequent extitution of tires proventing such cracks.

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RESEARCH PROJECT SUMMARY

Project Number: HR-158

Project Title: Prevention of Reflection Cracking in Asphalt Overlays

Research Agency: Office of Operations Research, I.D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: May 1, 1971, to completion*

* Experimental construction 1971 observation of results 3 to 5 years

Contract Amount: \$2,700

Funding: 100 percent state, Primary funds

Research Objective: Cracks almost always develop in asphalt overlays at the same location as they exist in the underlying pavement. Various means have been tried, with little or no success, to prevent the formation of these reflection cracks. Project HR-158 provides for the experimental installation and subsequent evaluation of three synthetic fiber materials that are supposedly effective in preventing such cracks.

Project Activities: Sheets of three different synthetic fiber materials were placed between the existing portland cement concrete pavement and a three-inch asphalt overlay on a section of Iowa 89 in Dallas County. The effectiveness of each fiber material is being determined by comparison of reflection cracking in the treated and untreated (control) sections over a period of three to five years. The fiber materials are:

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Petromat - Phillips Petroleum Co. Structofors - American ENKA Corp. Cerex - Monsanto Chemical Co.

<u>Progress</u>: Installations of all three materials has been completed and crack surveys have been made at different intervals.

Reports: None

Implementation: Engineers have been most concerned about the reflection cracks which appear above the widening joints on pavements widened from 18 or 20 feet to 24 feet. It appears that use of the fiber material over these widening joints may become accepted practice provided the test application is successful.

RESEARCH PROJECT SUMMARY

Project Number: HR-159

Project Title: A Study of Roadside Vegetation Control

Research Agency: Cornell College, Mt. Vernon, Iowa Linn County

<u>Principal Investigators</u>: Dr. Paul A. Christiansen, Cornell Dr. David L. Lyon, Cornell W. G. Harrington, Linn Co. Engr.

Contract Period: May 15, 1971, to May 14, 1974

Contract Amount: \$23,700, Cornell College \$ 5,100, Linn County

Funding: 100 percent state, Farm-to-Market funds

<u>ISHC Project Control</u>: H. D. Dolling, Road Design S. E. Roberts, Operations Research

Research Objective:

The broadcast spraying of chemicals for control of roadside weeds and brush has

been an accepted practice for several years. It is now regarded as dangerous and unacceptable by ecologists and others who are concerned about man-made changes in the environment. Research Project HR-159 has helped to demonstrate the value of spot spraying, limited mowing, and the use of native grasses and other native species as an alternative management program for control of roadside vegetation.

<u>Project Activities</u>: Linn County agreed to follow the recommendations of Dr. Christiansen and Dr. Lyon in the management of roadside vegetation on 59 miles of secondary roads in Franklin Township. This area contains a wide variety of terrain conditions, soils, and roadside geometrics. Specific practices and the overall management program will be evaluated. Progress: Research was conducted on various plots from 1971 to 1973 to determine the response of roadside vegetation to limited herbicide treatments. Roadside vegetation released from annual mass spraying showed several definite trends with some species being affected more than others. Vegetation and numbers of species per plot increased in the majority of cases.

Reports: Progress Report -- Research Project HR-159

Implementation: This project received strong support from the county engineer members of the Iowa Highway Research Board. If the proposed program of roadside vegetation management is successfully demonstrated in Linn County, it will probably be adopted by many Iowa counties.

Note: The final report for Project HR-159 was delayed due to problems encountered by the principal investigators at Cornell College. A draft of the final report has now been received and is being reviewed for final publication. Final payment for the project will not be made until after acceptance of the final report.

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RESEARCH PROJECT SUMMARY

Project Number: HR-163

<u>Project Title</u>: HELP -- Highway Emergency Long-Distance Phone

Research Agency: Office of Operations Research, I.D.O.T. Iowa Highway Patrol

Principal Investigator: Stephen E. Roberts, Operations Research

Contract Period: July 1, 1972, to June 30, 1974

Contract Amount: \$30,200

Funding: 100 percent state, Primary funds

<u>Research Objective</u>: To analyze the various types of emergency situations that are incurred by motorists

in Iowa and to provide an organized means of assisting these motorists.

<u>Project Activities</u>: The Iowa Highway Patrol operates the HELP program. Under this program, any motorist in the state who requires assistance on the road may call (or have another motorist call for him) 800-362-2200 toll free, The call will be received by the Patrol in Des Moines. The Patrol will then contact its own field offices, local law enforcement agencies, local garages or service stations requesting aid for the motorist.

<u>Progress</u>: The system has been in operation for more than two years. A summary of all calls received during the first two years of operation has been completed.

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Reports: The final report has been accepted.

Implementation: Public acceptance of the HELP system has been quite favorable. After July 1, 1974, it will be continued under the supervision of the Iowa Highway Patrol and will also be funded by the Patrol.

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RESEARCH PROJECT SUMMARY

Project Number: HR-164

<u>Project Title</u>: A Computer Application Study Directed to Development of an Improved Hydrologic Design Method for Culverts

Research Agency: Iowa State University

Principal Investigators: Merwin D. Dougal, I.S.U. Ronald L. Rossmiller, I.S.U.

Contract Period: September 1, 1972, to February 28, 1974

Contract Amount: \$17,300

Funding: 100 percent State funds; 60 percent Primary and 40 percent Farm-to-Market

Research Objective: To study all phases of the hydrologic design of culverts and to develop an updated or improved design method complete with the necessary computer program.

<u>Project Activities</u>: Preliminary hydrologic design data has been obtained. A basic computer program has been developed and is being tested.

Reports: The final report has been accepted.

Implementation: The design study which is to make maximum use of computer techniques, may provide an improved and economical method for routine culvert design.

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RESEARCH PROJECT SUMMARY

Project Number: HR-165

- Experimental Steel Fiber Reinforced Concrete Project Title: Overlay
- Iowa Dept. of Transportation, Highway Division Research Agency: Greene County

Principal Investigators: Ronald Betterton, Greene County S. E. Roberts, Operations Research

December 20, 1972, to completion Contract Period:

\$60,000 Contract Amount:

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To determine the feasibility of mixing, placing, and finishing various fibrous concrete overlays and to evaluate the overall performance, longevity and maintenance characteristics of the overlays.

Project Activities: A fibrous portland cement concrete overlay has been placed on 3.03 miles of Greene County Road E-53 (Old U.S. 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length, and fiber content.

The fibrous concrete overlay and various control Progress: sections were placed in FY 1974. Performance is being observed.

Fibrous Concrete Resurfacing, Survey No. 1, April, Reports: 1974.

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Implementation: It is hoped that the project will demonstrate the feasibility of using thin fibrous concrete overlays for pavement resurfacing. Future use of the fibrous concrete will then depend primarily on its cost in comparision with other resurfacing techniques.

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RESEARCH PROJECT SUMMARY

Project Number: HR-166

Project Title: Freeway Operations Analysis of I-80, I-29 Interchange

Research Agency: Iowa State University

Principal Investigator: Kenneth A. Brewer, I.S.U.

Contract Period: July 1, 1973, to January 31, 1974

Contract Amount: \$8,700

Funding: 100 percent state, Primary funds

Research Objective: To demonstrate the applicability of video-tape technique to traffic operations analysis and to recommend an optimal solution to the traffic operations conflict associated with the I-80, I-29 interchange.

<u>Project Activities</u>: Video-tape recordings were made at various times over a period of several days during the summer of 1973. These tapes were then reviewed by trained observers who noted and categorized all erratic traffic movements.

Progress: The project has been completed.

Reports: An edited copy of the video-tape recording has been received together with a final report.

Implementation: Suggestions for improving the operation of the I-80, I-29 interchange are being reviewed.

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RESEARCH PROJECT SUMMARY

Project Number: HR-168

Project Title: Skid Resistance of Concrete Pavements

Research Agency: Iowa Dept. of Transportation, Highway Division Greene County

Principal Investigators: Ronald Betterton, Greene County B. C. Brown, Materials

Contract Period: June 18, 1973, to completion.

Contract Amount: \$3,800

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To investigate the possible effect of cement content on the skid resistance

of portland cement concrete pavement.

<u>Project Activities</u>: An agreement was made with Greene County to use three different cement contents in paving to be built in Greene County. The skid testing and evaluation of the results will be done by personnel from the Office of Materials.

Progress: Construction of the test sections was completed in 1973. Skid tests will continue to be made at intervals on each of the test sections for a period of three years.

Reports: None.

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RESEARCH PROJECT SUMMARY

Project Number: HR-169

Project Title: Ultimate Load Behavior of Full-Scale High-Way Truss Bridges

Research Agency: Iowa State University

Principal Investigators: W. W. Sanders, Jr., I.S.U.

Contract Period: April 1, 1974, to September 30, 1975

Contract Amount: \$78,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To relate specification criteria to actual bridge behavior as determined from tests on available truss bridges and to determine the life expectancy and the behavior of timber bridge decks.

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Project Activities: Field tests were conducted on the Hubby Bridge in Boone County. The work consisted of bridge inspection and rating, service load tests, and ultimate load tests of the deck and trusses. Additional service load tests were conducted on the Chestnut Ford Bridge in Dallas County. Laboratory fatigue tests on tension members taken from various bridges in the Saylorville Dam area were conducted at Iowa State University.

<u>Progress</u>: All field work, including surface load tests and ultimate load tests have been completed. Laboratory tests on tension members are nearing completion in the laboratory at Iowa State University.

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<u>Reports</u>: A report covering Phase I, Load Tests on the Hubby Bridge, has been accepted.

<u>Implementation</u>: It is expected that the results of the bridge tests will be of value to county engineers and others in estimating the load ratings of secondary road bridges of similar design.

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RESEARCH PROJECT SUMMARY

Project Number: HR-170

Project Title: Maintenance of Pavement Skid Resistance

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: B. H. Ortgies, Materials

Contract Period: May 1, 1974, to completion

Contract Amount: \$90,000

<u>Funding</u>: 88.9 percent state, Primary funds 11.1 percent Federal Aid Funds*

Research Objective: To investigate the skid resistance of plant mix seals, to develop design procedures for plant mix seals, and to construct several sections using various materials and mix designs.

Project Activities: A construction project using plant mix seals has been completed on U.S. 69 in Story County north of Ames.

Progress: Several tests sections have been constructed and skid tests were completed at two different intervals.

Reports: None

Implementation: The performance of the plant mix seals on U.S. 69 will to a large extent determine their future design and use in Iowa.

* R & D Demonstration Projects Division negotiated contract for \$10,000, April 3, 1974.

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RESEARCH PROJECT SUMMARY

Project Number: HR-171

<u>Project Title</u>: Evaluation of Crushed Limestone Rock for Soil Stabilization and Pollution Control on Disturbed Areas of Iowa Highways

Research Agency: Iowa State University

Principal Investigator: W. D. Shrader, I.S.U.

Contract Period: July 29, 1974 to September 30, 1975

Contract Amount: \$2,750

Funding: 100 percent state, primary funds

<u>Research Objective</u>: To evaluate the effectiveness of a mulch of crushed limestone aggregate for con-

trolling erosion on steep disturbed areas on state and county right-of-ways during the period of seeding establishment.

<u>Project Activities</u>: Rock mulch applications are planned at 5 construction sites throughout the state.

Progress: The crushed limestone has been applied at three locations on each of two projects. Observations and measurements are continuing. Reports: None

<u>Implementation</u>: Future use of crushed limestone as a mulch will depend upon the results of the present investigation and on other factors such as location and economics.

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RESEARCH PROJECT SUMMARY

Project Number: HR-172

Project Title: Experimental Use of Thermoplastic Paint for Traffic Lane Marking

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: J. H. Moody, Maintenance

Contract Period: August 7, 1974 to Completion

Contract Amount: \$22,500

Funding: 100 percent state, primary funds

Research Objective: To test an experimental thermoplastic paint for traffic lane markings on high traffic multilane highways.

Project Activities: Installations using thermoplastic paint have been made on I-235, I-80 and other highways in the Des Moines area.

Progress: Observations were made at different intervals during the winter season to determine the effects of snow plowing and studded tire wear on the traffic lane markings.

Reports: The final report has been accepted.

<u>Implementation</u>: The performance of the thermoplastic paint did not meet expectations. Additional projects may be initiated in a further search for more durable traffic lane marking paint.

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RESEARCH PROJECT SUMMARY

Project Number: HR-173

Project Title: A Computer-Based Information System for County Equipment Cost Records

Research Agency: University of Iowa

Principal Investigators: J. D. Poyzer, S.U.I. J. M. Liittschwager, S.U.I.

Contract Period: November 1, 1974 to July 31, 1975

Contract Amount: \$23,699

Funding: 100 percent state, farm-to-market funds

<u>Research Objective</u>: To provide a uniform system in all counties for gathering, storing, and processing data and information on equipment costs.

<u>Project Activities</u>: Present methods of collecting equipment cost data are being analyzed and a new system of cost accounting will be proposed and implemented.

<u>Progress</u>: The initial design of the proposed record-keeping system has been completed. Development of computer programs and the implementation phase of the system is now underway.

<u>Reports</u>: Interim Report--A Computer-Based Information System for County Equipment Cost Records.

Implementation: It is anticipated that a computer-based system for county equipment cost records will provide a means of collecting direct costs, indirect costs, and depreciation charges for all county equipment.

-32-
RESEARCH PROJECT SUMMARY

Project Number: HR-174

Project Title: Visibility and Relative Motion of Iowa Department of Transportation Snow Plows

Research Agency: Iowa State University

Principal Investigator: D. H. Schuster, I.S.U.

Contract Period: January 8, 1975 to May 31, 1975

Contract Amount: \$1,530

Funding: 100 percent state, primary funds

Research Objective: To determine under various driving conditions, the visibility and relative target values of different rear end displays on snow plows and to assess a motorist's perception of a snow plow's relative motion.

Project Activities: Various approach and passing sequences to snow plows equipped with different types of signs and flashers will be recorded on film the reactions of 96 licensed drivers to these approach and passing sequences will be recorded and analyzed.

Progress: Testing of the subjects and analysis of the data has been completed.

Reports: The final report has been received.

Implementation: It is anticipated that in the future, snow plows will be equipped with signs or displays that prove to be the most visible and effective.

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RESEARCH PROJECT SUMMARY

Project Number: HR-175

Project Title: Experimental Macadam Stone Base

Research Agency: Iowa Dept. of Transportation, Highway Division Des Moines County

Principal Investigator: C. K. Paulson, Des Moines County

Contract Period: June 16, 1975 to completion

Contract Amount: \$100,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To develop standardized design procedures and specifications for a cheaper road base construction that will be applicable to all counties that utilize limestone as a road aggregate.

Project Activities: Plans and specifications have been completed and construction of the proposed project is planned for the 1975 construction season.

<u>Progress</u>: As of June 30, 1975, a contract had been let for the project with the expectation that construction of the experimental base will begin early in August, 1975.

Reports: None

<u>Implementation</u>: It is anticipated that the performance of the experimental Macadam stone base, if successful, will encourage other counties to use similar construction on county roads.

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RESEARCH PROJECT SUMMARY

Project Number: HR-176

Project Title: Recycled Asphalt Pavement

Iowa Dept. of Transportation, Highway Division Research Agency: Kossuth County

Principal Investigator: R. P. Henely, Kossuth County

Contract Period: May 1, 1975, to completion

Contract Amount: \$50,000

100 percent state, Farm-to-Market funds Funding:

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications have been completed.

Construction of the proposed project has been completed. Progress: Observations will be made for a period of several years.

Reports: None

Recycling of asphalt pavement is being Implementation: attempted in several states. Its use in Iowa will largely be determined by economics and by the performance observed on Project HR-176.

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RESEARCH PROJECT SUMMARY

Project Number: HR-177

Project Title: Concrete Bridge Deck Repairs Using Injected Epoxy Resin

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: E. O'Connor, Maintenance

Contract Period: May 6, 1975 to May, 1978

Contract Amount: \$3,000

Funding: 100 percent state, primary funds

Research Objective: To provide the special equipment necessary for use in injecting epoxy resin in delaminated areas in bridge decks and to determine if this material does prevent or delay the formation of spalls in bridge decks.

<u>Project Activities</u>: Personnel from the Office of Maintenance will be in charge of the equipment used in the epoxy injection method. The Offices of Materials and Operations Research will assist in the evaluation of the results over a three-year period.

<u>Progress</u>: The special equipment has been ordered from the manufacturer.

Reports: None

<u>Implementation</u>: Although this method of preventing deterioration in bridge decks is not regarded as being completely effective, it may provide additional time until major bridge deck repairs can be completed.

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RESEARCH PROJECT SUMMARY

Project Number: HR-1005

Project Title: Low Profile Markers for Wet-Night Visibility

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: F. W. Walker, Operations Research J. H. Moody, Maintenance

Contract Period: September 1, 1974 to September 1, 1976

Contract Amount: \$6,949.41

Funding: 100 percent Federal funds

Research Objective: To evaluate the effectiveness of low profile markers in providing wet-night visibility and to determine the possibilities for further use of the markers in conjunction with conventional striping for traffic lanes.

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Project Activities: Installation of the low profile markers was started in the fall of 1974. Fortyseven installations were completed and observed for one winter season. Additional markers are to be installed in 1975.

Progress: An inspection of the aluminized markers was completed in the spring of 1975. Damage and wear due to snow plowing and studded tires was evaluated.

Reports: Interim Report: Low Profile Markers for Wet-Night Visibility.

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Annual Report

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA For the Fiscal Year Ending June 30, 1976

> Prepared For Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

> > 1

Office of Materials Highway Division Iowa Department of Transportation

November 1976

Ames, Iowa 50010 (515) 296-1392

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Department of Transportation

STATE CAPITOL

DES MOINES, IOWA 50319

REF. NO. 436.1

Subject: Annual Report

December 14, 1976

Honorable Robert D. Ray Governor, State of Iowa Des Moines, IA 50309

Dear Governor Ray:

The enclosed report entitled "Highway Research and Development in Iowa" covers the period July 1, 1975, through June 30, 1976. The report complies with the provision of Section 310.36, Code of Iowa, directing submission of an annual report on secondary road research.

The report contains information about all research and development activities engaged in by the Highway Division, including brief descriptions of individual projects and a record of research expenditures.

Respectfully submitted,

Iowa Department of Transportation

Victor Preisser Director of Transportation

Howard E. Gunnerson Director of Highways

FWW:km Enclosure

COMMISSIONERS

ARBARA DUNN Des Moines DONALD K. GARDNER Cedar Rapids

NER STEPHEN GARST Coon Rapids WILLIAM F. McGRATH Meirose ROBERT R. RIGLER New Hampton L. STANLEY SCHOELERMAN Spencer ALLAN THOMS Dubuque Annual Report

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

For the Fiscal Year Ending June 30, 1976

Prepared For Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

Office of Materials Highway Division Iowa Department of Transportation

November 1976

Ames, Iowa 50010 (515) 296-1392

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Research Project Descriptions

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 search out and make use of improved engineering and management practices.

This is a report on the status of research and development projects which were in progress on June 30, 1976; it is also a report on projects completed during the fiscal year beginning July 1, 1975 and ending June 30, 1976. 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

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Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established by the Highway Commission in 1949.

The Research Board contains 13 regular members; six County Engineers, three 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 membership of the Research Board as of June 30, 1976, is listed in Table I.

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The Research Board held nine regular meetings during the period July 1, 1975, to June 30, 1976. Suggestions for research and development were reviewed at these meetings, and recommendations were made by the Board.

TABLE I IOWA HIGHWAY RESEARCH BOARD June 30, 1976

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Member

Alternate

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011

C. Cabalka, Jr. Jasper County Engineer Newton, IA 50208

J. C. Calhoun Madison County Engineer Winterset, IA 50273

D. Canney Mayor Cedar Rapids, IA 52401

V. L. Clark Decatur County Engineer P. W. Peterson Associate Dean of Research Iowa State University Ames, IA 50011

R. J. Fichtner Grundy County Engineer Grundy Center, IA 50638

E. Schornhorst Shelby County Engineer Harlan, IA 51537

E. Niebuhr Director of Public Works Clinton, IA 52732

L. G. Petersma Van Buren County Engineer

Leon, IA 50144

R. H. Given, Deputy Chief Engineer of Operations Iowa Department of Transportation Highway Division Ames, IA 50010

R. L. Haylock Butler County Engineer Allison, IA 50602

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52240 Keosauqua, IA 52565

F. O. Bloomfield, Maintenance Engineer Iowa Department of Transportation Highway Division Ames, IA 50010

W. A. Groskurth Mitchell County Engineer Osage, IA 50461

Kwan Rim Associate Dean for Research University of Iowa Iowa City, IA 52240

Member

D. E. McLean, Deputy Chief Engineer of Development Iowa Dept. of Transportation Highway Division Ames, IA 50010

W. L. Morris, District 3 Engineer Iowa Dept. of Transportation Highway Division Sioux City, IA 51100

R. Reinhart Pocahontas County Engineer Pocahontas, IA 50574

D. L. Smith Delaware County Engineer Manchester, IA 52057

J. White City Engineer Dubuque, IA 52001

Alternate

T. E. McElherne, Specifications Engineer Iowa Dept. of Transportation Highway Division Ames, IA 50010

D. Campbell, District 2 Engineer Iowa Dept. of Transportation Highway Division Mason City, IA 50401

H. D. Wight Crawford County Engineer Denison, IA 51442

W. D. Upmeyer Jackson County Engineer Maquoketa, IA 52060

W. Amundson City Engineer Sioux City, IA 51100



RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division or the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farm-to-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1976. Total expenditure was \$234,241.94 including support of the National Cooperative Highway Research Program (See page 6.).

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Highway Division personnel are termed "in-house" projects. All such projects involve other departmental and district personnel in addition to personnel from the Office of Operations Research. 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; they cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Operations Research is indebted to other offices and the districts for their assistance.

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials. 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 to NCHRP averages about \$45,000 per year. Actual expenditures for individual fiscal years may be greater than or less than this amount, due to billing practices.

Table II

RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1975 to June 30, 1976

Project	Primary	Farm to Market	Total
140 148	22,000.00 17.00	33,000.00	55,000.00 17.00
159		7,194.60	7,194.60
169		34,373.09	34,373.09
171	972.94	sality and the	972.94
173		12,357.39	12,357.39
174	1,432.86		1,432.86
176		45,913.83	45,913.83
177	3,950.00		3,950.00
179	7,477.23		7,477.23
182	15.000.00		15,000.00
1005	415.65		415.65
Sub-Total	51,265.68	132,838.91	184,104.59

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Total	\$94,098.79	\$140,143.15	\$234,241.94
HPR-2(110)	5,616.11	928.24	6,544.35
NCHRP	37,217.00	6,376.00	43,593.00

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RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Operations Research during all or part of fiscal year 1976. An open file for each project is maintained from the project's inception to completion; completion is signified by the acceptance of the final report and the making of the final payment.



RESEARCH PROJECT SUMMARY

Project Number: HR-140

- <u>Project Title</u>: Collection and Analysis of Stream Flow Data
- <u>Research Agency</u>: Iowa City Office, Water Resources Division United States Geological Survey, Department of the Interior

Principal Investigator: S. W. Wiitala, U.S.G.S.

- <u>Contract Period</u>: Project continued to June 30, 1977 by approval of the Director-Chief Engineer, Highway Division
- <u>Contract Amount</u>: \$44,000 per year (matched by \$44,000 from the Department of the Interior)

Funding: 100 percent state funds; 50 percent Primary

and 50 percent Farm-to-Market

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

Project Activites: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and analyzed to form the basis for predictions of future streamflow.

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<u>Progess</u>: The progress during 1975-76 was in accordance with schedules established by the Water Resources Division.

Implementation: The information obtained from Project HR-140 is used daily by D.O.T. Personnel in the design of bridges and culverts.

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RESEARCH PROJECT SUMMARY

Project Number: HR-148

Project Title: Investigation of Pavement Wear in Relation to Studded Tire Use

Research Agency: Office of Operations Research, Iowa D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: August 20, 1969 to completion

Contract Amount: \$1,130 Operations Research Iowa D.O.T.

<u>Funding</u>: 100 percent state funds, 75 percent Primary and 25 percent Farm-to-Market

Research Objective: The objective of this project is to measure pavement wear caused by studded tires and to estimate the extent of future wear if studded tires remain legal in Iowa.

Project Activites: The two principal activities carried on by the Office of Operations Research are (1) the measurement of pavement wear and (2) the estimation of studded tire usage in Iowa.

Progress: Pavement wear measurements have been made in Iowa for the winter period 1975-76.

<u>Reports</u>: The Office of Operations Research has prepared reports on studded tire usage in Iowa for the winter periods 1969 through 1976.

<u>Implementation</u>: The findings from Research Project HR-148 are being used to support recommendations adopted by the Iowa Department of Transportation concerning the banning of studded tires in Iowa.

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RESEARCH PROJECT SUMMARY

Project Number: HR-156

<u>Project Title</u>: Detection of Steel Corrosion in Bridge Decks and Reinforced Concrete Pavement

Research Agency: Office of Operations Research, Iowa D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: October 8, 1970, to completion

Contract Amount: \$2,500

Funding: 100 percent state, Primary Funds

Research Objective: The measurement of electrical potential between steel and its surroundings is standard for detection of conditions conducive to steel corrosion. While the measurement technique is relatively simple, interpretation of the results is difficult and highly subject to error.

The objectives of Project HR-156 are (1) to establish proper test procedures and data interpretation necessary for locating steel corrosion, and (2) to employ the test in assessing the effectiveness of overlays, waterproofing membranes, and repair methods used on bridge decks.

Project Activities: The Office of Operations Research originally assembled two sets of corrosion detection equipment. One set is used by the Office of Operations Research in a testing program designed to reveal the overall reliability of the test and to identify and evaluate test variables that influence the accuracy of the results. The second set of equipment has now been supplemented by additional sets purchased by the Office of Materials so as to provide corrosion detection equipment for each district office.

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Progress: The original intent of this project was to learn how to use the corrosion detection equipment and be able to interpret results obtained through that use. It is believed that these objectives are fairly well established. The Office of Materials has acquired 18 sets of detection equipment, and training sessions have been held in all six districts. The equipment is almost totally an operational matter now. There will be some follow-up in training in the months ahead; after which, it is anticipated this project will be terminated. The evaluation of experimental bridge decks is being carried out under another project.

Reports: None

Implementation: The electrical potential method of determining probable corrosion of the steel in bridge decks is being used by maintenance personnel in all districts to aid in the evaluation of bridge decks proposed for repair or resurfacing.

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RESEARCH PROJECT SUMMARY

Project Number: HR-158

Project Title: Prevention of Reflection Cracking in Asphalt Overlays

Research Agency: Office of Operations Research, Iowa D.O.T.

Principal Investigator: F. W. Walker, Operations Research

Contract Period: May 1, 1971, to completion*

*Experimental construction 1971 observation of results 3 to 5 years

Contract Amount: \$2,700

Funding: 100 percent state, Primary funds

Research Objective: Cracks almost always develop in asphalt overlays at the same location as they exist in the underlying pavement. Various means have been tried, with little or no success, to prevent the formation of these reflection cracks. Project HR-158 provides for the experimental installation and subsequent evaluation of three synthetic fiber materials that are supposedly effective in preventing such cracks.

<u>Project Activities</u>: Sheets of three different synthetic fiber materials were placed between

the existing portland cement concrete pavement and a three-inch asphalt overlay on a section of Iowa 89 in Dallas County. The effectiveness of each fiber material is being determined by comparison of reflection cracking in the treated and untreated (control) sections over a period of three to five years. The fiber materials are: Petromat - Phillips Petroleum Co. Structofors - American ENKA Corp. Cerex - Monsanto Chemical Co.

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Progress: Installations of all three materials has been completed and crack surveys have been made at different intervals.

Reports: None

Implementation: Engineers have been most concerned about the reflection cracks which appear above the widening joints on pavements widened from 18 or 20 feet to 24 feet. It appears that use of the fiber material over these widening joints may become accepted practice provided the test application is successful.

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RESEARCH PROJECT SUMMARY

Project Number: HR-159

Project Title: A Study of Roadside Vegetation Control

Cornell College, Mt. Vernon, Iowa Research Agency: Linn County

Principal Investigators: Dr. Paul A. Christiansen, Cornell Dr. David L. Lyon, Cornell W. G. Harrington, Linn Co. Engr.

May 15, 1971, to May 14, 1974 Contract Period:

\$23,700, Cornell College Contract Amount: \$ 5,100, Linn County

Funding: 100 percent state, Farm-to-Market funds

H.D. Dolling, Road Design Iowa DOT Project Control: Fred W. Walker, Operations Research

Research Objective: The broadcast spraying of chemicals for control of roadside weeds and brush has been an accepted practice for several years. It is now regarded as dangerous and unacceptable by ecologists and others who are concerned about man-made changes in the environment. Research Project HR-159 has helped to demonstrate the value of spot spraying, limited mowing, and the use of native grasses and other native species as an alternative management program for control of roadside vegetation.

Project Activities: Linn County agreed to follow the recommendations of Dr. Christiansen

and Dr. Lyon in the management of roadside vegetation on 59 miles of secondary roads in Franklin Township. This area contains a wide variety of terrain conditions, soils, and roadside geometrics. Specific practices and the overall management program will be evaluated.

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Progress: This project has been completed.

Reports: The final report has been accepted.

Implementation: This project received strong support from the county engineer members of the Iowa Highway Research Board. If the proposed program of roadside vegetation management is successfully demonstrated in Linn County, it will probably be adopted by many Iowa counties.

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RESEARCH PROJECT SUMMARY

Project Number: HR-165

Project Title: Experimental Steel Fiber Reinforced Concrete Overlay

Research Agency: Iowa Department of Transportation, Highway Division, Greene County

<u>Principal Investigators</u>: Ronald Betterton, Greene County Fred W. Walker, Operations Research

Contract Period: December 20, 1972 to completion

Contract Amount: \$60,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To determine the feasibility of mixing, placing, and finishing various fibrous concrete overlays and to evaluate the

overall performance, longevity and maintenance characteristics of the overlays.

Project Activities: A fibrous portland cement concrete overlay has been placed on 3.03

miles of Greene County Road E-53 (Old U.S. 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length, and fiber content.

Progress: The fibrous concrete overlay and various control sections were placed in FY 1974. Performance is being observed.

<u>Reports</u>: Fibrous Concrete Resurfacing, Survey No. 1, April, 1974.

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Implementation: It is hoped that the project will demonstrate the feasibility of using thin fibrous concrete overlays for pavement resurfacing. Future use of the fibrous concrete will then depend primarily on its cost in comparison with other resurfacing techniques.

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RESEARCH PROJECT SUMMARY

Project Number: HR-168

Project Title: Skid Resistance of Concrete Pavements

Research Agency: Iowa Department of Transportation Highway Division Greene County

Principal Investigators: Ronald Betterton, Greene County B. C. Brown, Materials

Contract Period: June 18, 1973, to completion

Contract Amount: \$3,800

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To investigate the possible effect of cement concrete on the skid resistance of portland cement concrete pavement.

Project Activities: An agreement was made with Greene County to use three different cement contents in paving to be built in Greene County. The skid testing and evaluation of the results will be done by personnel from the Office of Materials.

<u>Progress</u>: Construction of the test sections was completed in 1973. Skid tests will continue to be made at one year intervals on each of the test sections.

Reports: None

Implementation: If skid test results continue to show that a higher cement content does result in improved skid resistance, these factors will be taken into consideration in future construction projects or additional experimental projects may be planned.

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RESEARCH PROJECT SUMMARY

Project Number: HR-169

Project Title: Ultimate Load Behavior of Full-Scale Highway Truss Bridges

Research Agency: Iowa State University

Principal Investigators: W. W. Sanders, Jr., I.S.U.

Contract Period: April 1, 1974, to September 30, 1975

Contract Amount: \$78,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To relate specification criteria to actual bridge behavior as determined from tests on available truss bridges and to determine the life expectancy and the behavior of

timber bridge decks.

Project Activities: Field tests were conducted on the Hubby Bridge in Boone County. The work consisted of bridge inspection and rating, service load tests, and ultimate load tests of the deck and trusses. Additional service load tests were conducted on the Chestnut Ford Bridge in Dallas County. Laboratory fatigue tests on tension members taken from various bridges in the Saylorville Dam area were conducted at Iowa State University.

Progress: This project has been completed.

Reports: A final report has been accepted.

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Implementation: It is expected that the results of the bridge tests will be of value to county engineers and others in estimating the load ratings of secondary road bridges of similar design.

RESEARCH PROJECT SUMMARY

Project Number: HR-170

Project Title: Maintenance of Pavement Skid Resistance

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: B. H. Ortgies, Materials

Contract Period: May 1, 1974, to completion

Contract Amount: \$90,000

<u>Funding</u>: 88.9 percent state, Primary funds 11.1 percent Federal Aid Funds*

Research Objective: To investigate the skid resistance of plant mix seals, to develop design procedures for plant mix seals, and to construct

several sections using various materials and mix designs.

Project Activities: A construction project using plant mix seals has been completed on U.S. 69 in Story County north of Ames.

<u>Progress</u>: Several test sections have been constructed and skid tests have been completed at different intervals.

Reports: A progress report has been prepared.

<u>Implementation</u>: The performance of the plant mix seals on U.S. 69 will to a large extent, determine their future design and use in Iowa.

*R & D Demonstration Projects Division negotiated contract for \$10,000, April 3, 1974.

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RESEARCH PROJECT SUMMARY

Project Number: HR-171

<u>Project Title</u>: Evaluation of Crushed Limestone Rock for Soil Stabilization and Pollution Control on Disturbed Areas of Iowa Highways

Research Agency: Iowa State University

Principal Investigator: W. D. Shrader, I.S.U.

Contract Period: July 29, 1974, to September 30, 1975

Contract Amount: \$2,750

Funding: 100 percent state, primary funds

Research Objective: To evaluate the effectiveness of a mulch of crushed limestone aggregate for controlling erosion on steep disturbed areas on state and county right-of-ways during the period of

seeding establishment.

<u>Project Activities</u>: Limestone applications were made and test plots were established on two construction sites.

Progress: The project has been completed.

Reports: A final report has been accepted.

<u>Implementation</u>: Future use of crushed limestone as a mulch will depend upon the results of the present investigation and on other factors such as location and economics.

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RESEARCH PROJECT SUMMARY

Project Number: HR-173

Project Title: A Computer-Based Information System for County Equipment Cost Records

Research Agency: University of Iowa

Principal Investigators: J. D. Poyzer, S.U.I. J. M. Liittschwager, S.U.I.

Contract Period: November 1, 1974 to July 31, 1975

Contract Amount: \$23,699

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To provide a uniform system in all counties for gathering, storing, and processing data and information on equipment costs.

Project Activities: Present methods of collecting equipment cost data are being analyzed and a new system of cost accounting has been proposed.

Progress: The record-keeping system has been designed and completed and computer programs have been developed. The project is complete.

Reports: Final Report--A computer based information system for county equipment cost records.

Implementation: It is anticipated that a computerbased system for county equipment cost records will provide a means of collecting direct costs, indirect costs, and depreciation charges for all county equipment.

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RESEARCH PROJECT SUMMARY

Project Number: HR-174

<u>Project Title</u>: Visibility and Relative Motion of Iowa Department of Transportation Snow Plows

Research Agency: Iowa State University <u>Principal Investigator</u>: D. H. Schuster, I.S.U. <u>Contract Period</u>: January 8, 1975 to May 31, 1975 <u>Contract Amount</u>: \$1,530 <u>Funding</u>: 100 percent state, primary funds

Research Objective: To determine under various driving conditions, the visibility and relative target values of different rear end displays on snow plows and to assess a motorist's perception of a snow plow's relative motion.

Project Activities: Various approach and passing sequences to snow plows equipped with different types of signs and flashers were recorded on film. The reactions of 64 licensed drivers to these approach and passing sequences were recorded and analyzed.

Progress: Testing of the subjects and analysis of the data has been completed.

Reports: The final report has been accepted.

Implementation: It is anticipated that in the future, snow plows will be equipped with signs or displays that prove to be the most visible and effective.

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RESEARCH PROJECT SUMMARY

Project Number: HR-175

Project Title: Experimental Macadam Stone Base

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

Principal Investigator: C. K. Paulson, Des Moines County

Contract Period: June 16, 1975 to completion

Contract Amount: \$100,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To develop standardized design procedures and specifications for a cheaper road base construction that will be applicable to all counties that utilize limestone as a road aggregate.

Project Activities: Plans and specifications have been completed and construction of the proposed project is planned for the 1975 construction season.

<u>Progress</u>: Construction of the experimental road has been completed. Evaluation of the experimental features of the project will be continued for a minimum of five years following construction.

Reports: A progress report is being prepared.

Implementation: It is anticipated that the performance of the experimental Macadam stone base, if successful, will encourage other counties to use similar construction on county roads.

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RESEARCH PROJECT SUMMARY

Project Number: HR-176

Project Title: Recycled Asphalt Pavement

Research Agency: Iowa Department of Transportation, Highway Division Kossuth County

Principal Investigator: R. P. Henely, Kossuth County

Contract Period: May 1, 1975, to completion

Contract Amount: \$50,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications have been

completed.

<u>Progress</u>: Construction of the proposed project has been completed. Observations will be made for a period of several years.

Reports: A progress report has been prepared.

Implementation: Recycling of asphalt pavement is being attempted in several states. Its use in Iowa will largely be determined by economics and by the performance observed on Project HR-176.

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RESEARCH PROJECT SUMMARY

Project Number: HR-177

- Project Title: Concrete Bridge Deck Repairs Using Injected Epoxy Resin
- Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: E. O'Connor, Maintenance

Contract Period: May 6, 1975, to May, 1978

Contract Amount: \$3,000

Funding: 100 percent state, primary funds

Research Objective: To provide the special equipment necessary for use in injecting epoxy resin in delaminated areas in bridge decks and to determine if this material does prevent or delay

the formation of spalls in bridge decks.

Project Activities: Personnel from the Office of Maintenance will be in charge of the equipment used in the epoxy injection method. The Offices of Materials and Operations Research will assist in the evaluation of the results over a three-year period.

Progress: The equipment was delivered late in the summer of 1975, and has been put to use. Results will be evaluated over a three-year period.

Reports: None

Implementation: Although this method of preventing deterioration in bridge decks is not regarded as being completely effective, it may provide additional time until major bridge deck repairs can be completed.

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RESEARCH PROJECT SUMMARY

Project Number: HR-178

Project Title: Pavement Deflection Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. Marks

Contract Period: November 5, 1975 to March 1, 1978

Contract Amount: \$26,000

Funding: 100 percent state, primary funds

Research Objective: To determine if the test equipment can provide data of sufficient accuracy to be used effectively in pavement design and to determine the seasonal deflection variation of flexible pavements.

Project Activities: The Road Rater was delivered by the manufacturer early in the spring of 1976. A tentative work plan for conducting various pavement deflection studies has been completed.

Progress: A brief training session on operation and maintenance of the equipment was provided by the manufacturer. Testing is being done on various interstate, primary and secondary roads in all parts of the state.

Reports: None

Implementation: It is anticipated that the Road Rater will prove to be a useful and effective tool in the design and maintenance of flexible pavements.

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RESEARCH PROJECT SUMMARY

Project Number: HR-179

Project Title: Bridge Deck Delamination Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. Marks

Contract Period: November 5, 1975 to Completion

Contract Amount: \$7,700

Funding: 100 percent state, primary funds

Research Objective: To evaluate the effectiveness of

bridge deck resurfacing, bridge deck overlays, and bridge deck delamination repairs. A long range objective of this research is to reduce bridge deck repair costs.

Project Activities: The Delamtect equipment has been received from the manufacturer and is currently being used to evaluate the soundness of bridge deck resurfacing and overlays.

<u>Progress</u>: The Delamtect System is being used as one effective tool in a major bridge deck repair program.

Reports: None

Implementation: It is anticipated that the Delamtect system will be very useful as a rapid, accurate and highly effective tool for detecting bridge deck delamination.

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RESEARCH PROJECT SUMMARY

Project Number: HR-180

Project Title: An Evaluation of An Epoxy Pavement Marking System

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: J. H. Moody C. S. Carmean

Contract Period: April, 1976 to Completion

Contract Amount: \$4,925

Funding: 100 percent state, primary funds

Research Objective: To determine if epoxy paint is an

economical alternative to standard paint on high traffic multi-lane roadways and to determine if epoxy lane markings will last an entire winter season without replacement.

Project Activities: An experimental epoxy based paint developed by the H.B. Fuller Company and the Minnesota Department of Highways was applied on several lanes of Interstate 235 in Des Moines. Standard striping paint was also used in the vicinity to serve as comparison with the new striping material.

Progress: The sandblasting and painting with the experimental material was only partially completed due to equipment failure. All remaining lanes were painted with standard striping paint. Observations and comparisons will continue to be made.

Reports: None

<u>Implementation</u>: If the epoxy pavement markings do give satisfactory service, it is anticipated that additional applications will be made on a more widespread basis.

RESEARCH PROJECT SUMMARY

HR-181 Project Number:

The Evaluation of Macadam Stone Shoulders Project Title:

Iowa Department of Transportation, Research Agency: Highway Division

B. Ortgies Principal Investigators: T. Legvold

May 25, 1975 to Completion Contract Period:

\$8,143 Contract Amount:

Funding: 100 percent state, primary funds

Research Objective: To determine the feasibility of using a macadam stone shoulder in

place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of macadam stone shoulders, and to evaluate the performance of macadam stone shoulders.

Project Activities: This experimental type of shoulder construction will be incorporated

into a Dallas County project on U.S. 6. Construction operations will be observed to identify problems and record methods and procedures. Comparisons will be made between macadam shoulders and recently constructed stabilized and paved shoulders.

Plans call for this project to be completed Progress: during the 1976 construction season. A tentative work plan has been completed.

None Reports:

It is anticipated that if macadam shoulder Implementation: construction proves to be an economical alternative to standard earth or paved shoulders, additional projects will be planned.

RESEARCH PROJECT SUMMARY

Project Number: HR-182

<u>Project Title</u>: An Evaluation of Cover Aggregate Stripping Characteristics

Research Agency: Iowa Department of Transportation Highway Division

Principal Investigators: C. L. Huisman K. Isenberger R. C. Hagebock R. D. Smith

Contract Period: May 25, 1976 to Completion

Contract Amount: \$15,000

Funding: 100 percent state, primary funds

Research Objective: To identify the stripping susceptibility of various types of cover aggregates

used in Iowa.

<u>Project Activities</u>: This research project will be incorporated into the 1976 Iowa DOT Maintenance Contract Sealcoat Program as a division of a project on Iowa 210 between Interstate 35 and Maxwell, Iowa. Thiry different cover aggregates types will be tested and standard sealcoat specifications will be used.

<u>Progress</u>: The seal coat was constructed on Iowa 210, using aggregates from 29 sources. Samples were taken during spreading and samples were taken from the road 7 days after construction.

<u>Implementation</u>: It is expected that a design guide will be developed that will include a description of the performance characteristics of each cover aggregate with each binder bitumen.

RESEARCH PROJECT SUMMARY

Project Number: HR-183

Project Title: Fatigue Behavior of High Air Content Concrete

Research Agency: Iowa State University

Principal Investigators: D. Y. Lee, F. W. Klaiber

Contract Period: August 1, 1976 to July 31, 1977

Contract Amount: \$30,348

Funding: 100 percent state funds: 50 percent Primary and 50 percent Farm-to-Market

Research Objective: To evaluate the effects of air content on the fatigue behavior of most commonly used concrete mixes; to establish fatigue curves for air-entrained concrete and to establish correlations between fatigue life or fatigue strength and other concrete properties.

Project Activities: A one-year agreement has been made with Iowa State University for the completion of the first phase of the project. An evaluation will be made upon the completion of the first phase. Phase II will be dependent upon the results of Phase I.

Progress: A contract has been signed with Iowa State University.

Implementation: The proposed work will be completed in 12 months. It is anticipated that at the

end of this period, there will be sufficient data to determine if effects of high air content on fatigue behavior of concrete are significant enough to justify change in concrete pavement design, and if continued study is warranted in order to establish the change in concrete design.

RESEARCH PROJECT SUMMARY

Project Number: HR-184

Project Title: Determination of Rumble Strip Effectiveness

Research Agency: Iowa Department of Transportation Highway Division

Principal Investigators: G. L. Fox W. F. Flannery R. C. Hagebock F. W. Walker

Contract Period: August, 1976 to completion

Contract Amount: None

Funding: (Maintenance Operation)

Research Objective: To identify the effectiveness of

the rumble strip as a traffic safety device when used on a widespread basis in both rural and urban situations.

Project Activities: The rumble strips will be cut at approved, designated locations.

An accident study will be conducted by the Iowa DOT using study periods of two years before and two years after placement.

<u>Progress</u>: Agreements have been signed with each of the participating counties. The rumble strip program will proceed and the rumble strips will be cut as soon as work schedules permit.

Reports: None

Implementation: The two-year study to be conducted following placement will help highway engineers to determine the desirability and effectiveness of using rumble strips on a widespread basis.

RESEARCH PROJECT SUMMARY

Project Number: HR-1005

Project Title: Low Profile Markers for Wet-Night Visibility

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: F. W. Walker, Operations Research J. H. Moody, Maintenance

Contract Period: September 1, 1974, to September 1, 1976

Contract Amount: \$6,949

Funding: 100 percent Federal funds

Research Objective: To evaluate the effectiveness of low profile markers in providing wet-night visibility and to determine the possibilities for further use of the markers in conjunction with conventional striping for traffic lanes.

Project Activities: Installation of the low profile markers has been completed and periodic inspections to determine damage or wear due to snow plowing and studded tires are being made.

<u>Progress</u>: Installation of the aluminized markers has been completed on the Des Moines Freeway. Their performance will be evaluated for a two-year period.

<u>Reports</u>: Interim Report: Low Profile Markers for Wet-Night Visibility

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RESEARCH PROJECT SUMMARY

Project Number: HR-1006

<u>Project Title</u>: Film - Use of Low Slump Dense Concrete for Bridge Deck Protection

<u>Research Aqency</u>: Iowa Department of Transportation, Highway Division Iowa State University

Principal Investigator: B. L. Brakke, J. V. Bergren, F. W. Walker

Contract Period: April 23, 1976 to December 31, 1976

Contract Amount: \$7,120

Funding: 100 percent Federal funds

<u>Research Objective</u>: The objective of this project will be to prepare a narrated film showing

the use of low slump dense concrete in the reconstruction of a deteriorated bridge deck and in construction of a two course deck on a new bridge.

Project Activities: The film will show methods used in preparing a deteriorated deck for a concrete overlay and construction inspection of low-slump, dense concrete and density checks of fresh concrete will be described.

<u>Progress</u>: The filming of bridges under construction and repair is scheduled for completion during the 1976 construction season.

Reports: None

<u>Implementation</u>: This film will be made available to other State Highway Departments, counties and cities to familiarize them with these procedures. Annual Report

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

For the Fiscal Year Ending June 30, 1977

Prepared For Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

3

Office of Materials Highway Division Iowa Department of Transportation

December 1977

Ames, Iowa 50010 (515) 296-1447

17-**T**68M 1:H535 977



Department of Transportation

17- T68M 1: H 535

STATE CAPITOL

DES MOINES, IOWA 50319

December 19, 1977

REF. NO. 436.1

The Honorable Robert D. Ray Governor of Iowa State Capitol Building Des Moines, IA 50309

Dear Governor Ray:

The enclosed report entitled "Highway Research and Development in Iowa" covers the period July 1, 1976 through June 30, 1977. The report complies with the provision of Section 310.36, Code of Iowa, directing submission of an annual report on secondary road research.

The report contains summary information of all research and development activities in which the Highway Division is engaged, a brief description of individual projects and a summary of receipts and expenditures.

Very truly yours,

Raymond Kassel Deputy Director

RLK:bf enclosure

COMMISSIONERS

SIGUX City

BARBARA DUNN Des Moines

DONALD K GARDNER Gedar Rapids WILLIAM F McGRATH Metrose New Hampton

L STANLEY SCHOELERMAN Spencer ALLAN THOMS Dubuque Annual Report

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

For the Fiscal Year Ending June 30, 1977

Prepared For Honorable Robert D. Ray Governor of Iowa and the County Engineers of Iowa

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Research Project Descriptions

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 is a report on the status of research and development projects which were in progress on June 30, 1977; it is also a report on projects completed during the fiscal year beginning July 1, 1976 and ending June 30, 1977. 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.

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IOWA HIGHWAY RESEARCH BOARD

In developing a continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established by the Highway Commission in 1949.

The Research Board contains 13 regular members; six County Engineers, three 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 membership of the Research Board as of June 30, 1977 is listed in Table I.

The Research Board held ten regular meetings

during the period of July 1, 1976, to June 30, 1977. Suggestions for research and development were reviewed at these meetings, and recommendations were made by the Board.

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Table I IOWA HIGHWAY RESEARCH BOARD June 30, 1977

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MEMBER

W. Amundson City Engineer Sioux City, IA 51100

D. A. Anderson, District 1 Engineer Iowa D.O.T. Highway Division Ames, IA 50010

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011

C. Cabalka, Jr. Jasper County Engineer Newton, IA 50208

D. Canney Mayor Cedar Rapids, IA 52401

ALTERNATE

F. Moore Director of Public Works Cedar Falls, IA 50613

R. C. Henely, District 6 Engineer Iowa D.O.T. Highway Division Cedar Rapids, IA 52404

P. W. Peterson Associate Dean of Research Iowa State University Ames, IA 50011

R. J. Fichtner Grundy County Engineer Grundy Center, IA 50638

E. Niebuhr Director of Public Works Clinton, IA 52732

V. L. Clark Decatur County Engineer Leon, IA 50144

R. H. Given, Deputy Chief Engineer - Staff Iowa D.O.T. Highway Division Ames, IA 50010

R. L. Haylock Butler County Engineer Allison, IA 50602

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52240 L. G. Petersma Van Buren County Engineer Keosauqua, IA 52565

F. O. Bloomfield Maintenance Engineer Iowa D.O.T. Highway Division Ames, IA 50010

W. A. Groskurth Mitchell County Engineer Osage, IA 50461

Kwan Rim Associate Dean for Research University of Iowa Iowa City, IA 52240

MEMBER

D. E. McLean, Deputy Chief Engineer Development Iowa D.O.T. Highway Division Ames, IA 50010

E. Schornhorst Shelby County Engineer Harlan, IA 51537

D. R. Shaw Ida County Engineer Ida Grove, IA 51445

D. L. Smith Delaware County Engineer Manchester, IA 52057

ALTERNATE

T. E. McElherne, Specifications Engineer Iowa D.O.T. Highway Division Ames, IA 50010

D. J. Lynam Adair County Engineer Greenfield, IA 50849

D. D. Linnan Buena Vista County Engine Storm Lake, IA 50588

W. D. Upmeyer Jackson County Engineer Maquoketa, IA 52060

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division or the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farm-to-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1977. Total expenditure was \$175,174.20 including support of the National Cooperative Highway Research Program (See page 6).

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by

Highway Division personnel are termed "in-house" projects. All such projects 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; they cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section wishes to express their appreciation to other offices and the districts for their assistance.

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials. The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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Table II

RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1976 to June 30, 1977

Project	Primary	Farm to Market	Total
140	22 000 00	22 000 00	44 000 00
140	22,000.00	22,000.00	44,000.00
154A	70.00		70.00
178	25,980.14		25,980.14
180	3,300.60		3,300.60
183	7,624.71	4,102.84	11,727.55
185	6,767.70	9,248.73	16,016.43
186	2,489.77	-	2,489.77
187	1,940.11		1,940.11
1005	25.08		25.08
1006	8,579.43	-	8,579.43
Sub-Total	78,777.54	35,351.57	114,129.11
NCHRP	51,331.80	7,217.58	58,549.38
HPR-2(119)	2,185.52	310.19	2,495.71

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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 12 percent of the receipts in 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. It has been determined that a minimum of \$125,000 per year should be used for research with the balance available for engineering studies which during fiscal year 1977 were traffic counts and road inventories. The values shown in Table II on the previous page are actual research expenditures for fiscal year 1977. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based upon obligations for expenditures on research projects and not the actual expenditure. The fiscal year 1977 financial summary is:

Beginning balance 7-1-76 \$ 662,683. Adjustment to beginning balance 172,431.

Receipts

34.378.

Interest	54,570.	
Fed. Sec. Rd.		
(1% of receipts)	154,505.	
State RUTF (1% of r	eceipts)393,635.	
Su	b-Total	582,518.
Total	Funds Available	\$1,417.632.
bligation for Expenditur Obligated for	es	
Contract Research	144,676.	
Non-Contract		
Engineering Studies	266,439.	
Total Expendi	tures	411,115.
	BALANCE (6-30-77)	\$1,006,517.

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of fiscal year 1977. An open file for each project is maintained from the project's inception to completion; completion is signified by the acceptance of the final report and and the making of the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.

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RESEARCH PROJECT SUMMARY

- Project Number: HR-140
- <u>Project Title</u>: Collection and Analysis of Stream Flow Data
- <u>Research Agency</u>: Iowa City Office, Water Resources Division United States Geological Survey, Department of the Interior

Principal Investigator: S. W. Wiitala, U.S.G.S.

<u>Contract Period</u>: Project continued to September 30, 1978, by approval of the Director-Chief Engineer, Highway Division

<u>Contract Amount</u>: \$44,000 per year (matched by \$44,000 from the Department of the Interior)

<u>Funding</u>: 100 percent state funds; 50 percent Primary and 50 percent Farm-to-Market

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

Research Objectives: The objectives of Project HR-140 are to obtain information about the flow

of water in Iowa streams with particular emphasis on the magnitude and frequency of floods and to compile and analyze this information for use by highway engineers engaged in the design of bridges, culverts, and embankments.

Project Activities: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and analyzed to form the basis for predictions of future streamflow.

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The progress during 1976-1977 was in accordance Progress: with schedules established by the Water Resources Division.

The information obtained from Project Implementation: HR-140 is used daily by D.O.T. Personnel in the design of bridges and culverts.

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RESEARCH PROJECT SUMMARY

Project Number: HR-148

<u>Project Title</u>: Investigation of Pavement Wear in Relation to Studded Tire Use

Research Agency: Office of Materials, Research Section Iowa Department of Transportation

Principal Investigator: V. J. Marks, Materials Research Section

Contract Period: August 20, 1969 to completion

<u>Contract Amount</u>: \$1,130 Office of Materials, Research Section, Iowa D.O.T.

Funding: 100 percent state funds, 75 percent Primary and 25 percent Farm-to-Market

Research Objective: The objective of this project is to

measure pavement wear caused by studded tires and to estimate the extent of future wear if studded tires remain legal in Iowa.

<u>Project Activities</u>: The two principal activities carried on by the Office of Materials are (1) the measurement of pavement wear and (2) the estimation of studded tire usage in Iowa.

- Progress: Pavement wear measurements have been made in Iowa for the winter period 1976-77.
- <u>Reports</u>: The Office of Materials has prepared reports on studded tire usage in Iowa for the winter periods 1969 through 1977.

Implementation: The findings from Research Project HR-148 are being used to support recommendations adopted by the Iowa Department of Transportation concerning the banning of studded tires in Iowa.

RESEARCH PROJECT SUMMARY

Project Number: HR-154 & HR-154A

Project Title: Investigation of Highway Lighting

Research Agency: Office of Materials, Research Section, Iowa Department of Transportation

Principal Investigators: Floyd Christofferson, Design Dept. V. J. Marks, Materials Research Section

Contract Period: September 2, 1970, to completion

Contract Amount: \$4,500

Funding: 100 percent state, Primary funds

Research Objective: A highway lighting project having 150 foot towers has been constructed at the interchange of I-80, I-35, and I-235 west of Des Moines. This is the first tower lighting to be used on Iowa highways. The objectives of project HR-154A are (1) to compare the tower lighting with existing conventional highway lighting where the luminaires are located 30 to 40 feet above the roadway, and (2) to investigate installations with particular regard for the rate of reduction of light output as influenced by lamp replacement and luminaire cleaning.

<u>Project Activities</u>: Representative conventional lighting installations have been observed along with the tower installation. Measurements were made of the level and uniformity of illumination and of glare. Measurements were also made to relate light output to lamp replacement and luminaire cleaning. Maintenance and cost experience will be recorded.

Progress: Glare and brightness readings have been taken on Interstate 235 in Des Moines and on the tower lighting installation in West Des Moines. Readings have also been obtained at other locations for comparative purposes. Some maintenance problems were encountered at various other lighting installations. An addition to this project was proposed to consider all Iowa tower installations in order to gain needed information. The purpose of the addition is to summarize and analyze all maintenance problems and to recommend remedial design, construction or special features as solutions to the problems.

<u>Reports</u>: Investigation of Highway Lighting, Final Report, November, 1976.

Implementation: This research yielded conclusive evidence that tower lighting was more effective than conventional lighting when lighting a large area such as an interchange. The addition to the project will provide solutions to the problems experienced with tower lighting.

RESEARCH PROJECT SUMMARY

Project Number: HR-156

<u>Project Title</u>: Detection of Steel Corrosion in Bridge Decks and Reinforced Concrete Pavement

Research Agency: Office of Materials, Research Section, Iowa Department of Transportation

Principal Investigator: V. J. Marks, Office of Materials, Research Section

Contract Period: October 8, 1970 to June 24, 1977 (completion)

Contract Amount: \$2,500

Funding: 100 percent state, Primary Funds

Research Objective: The measurement of electrical potential between steel and its surroundings is standard for detection of conditions conducive to steel corrosion. While the measurement technique is relatively simple, interpretation of the results is difficult and highly subject to error.

The objectives of Project HR-156 are (1) to establish proper test procedures and data interpretation necessary for locating steel corrosion, and (2) to employ the test in assessing the effectiveness of overlays, waterproofing membranes, and repair methods used on bridge decks.

<u>Project Activities</u>: The Office of Materials, Reseach Section originally assembled two sets of

corrosion detection equipment. One set is used by the Office of Materials, Research Section in a testing program designed to reveal the overall reliability of the test and to identify and evaluate test variables that influence the accuracy of the results. The second set of equipment has now been supplemented by additional sets purchased by the Office of Materials, and Office of Maintenance so as to provide corrosion detection equipment for each district office. Progress: The original intent of this project was to learn how to use the corrosion detection equipment and be able to interpret results obtained through that use. It is believed that these objectives are accomplished. The Office of Materials has acquired 18 sets of detection equipment, and training sessions have been held in all six districts. The equipment is almost totally an operational matter now. There will be some continual training, but a final report has been accepted and the project has been terminated. The evaluation of experimental bridge decks is being carried out under another project.

Reports: The final report has been completed.

<u>Implementation</u>: The electrical potential method of determining probable corrosion of the steel in bridge decks is being used by maintenance personnel in all districts to aid in the evaluation of bridge decks proposed for repair or resurfacing.

RESEARCH PROJECT SUMMARY

Project Number: HR-158

Project Title: Prevention of Reflection Cracking In Asphalt Overlays

Research Agency: Office of Materials, Research Section, Iowa Department of Transportation

Principal Investigator: V. J. Marks, Materials, Research Section

Contract Period: May 1, 1971 to April 29, 1977 (Completion)

Contract Amount: \$2,700

Funding: 100 percent state, Primary funds

Research Objectives: Cracks almost always develop in asphalt overlays at the same location as they exist in the underlying pavement. Various means have been tried, with little or no success, to prevent the formation of these reflection cracks. Project HR-158 provides for the experimental installation and subsequent evaluation of three synthetic fiber materials that are supposedly effective in preventing such cracks.

<u>Project Activities</u>: Sheets of three different synthetic fiber materials were placed between the existing portland cement concrete pavement and a three-inch asphalt overlay on a section of Iowa 89 in Dallas County. The effectiveness of each fiber material is being determined by comparison of reflection cracking in the treated and untreated (control) sections over a period of three to five years. The fiber materials are: Petromat - Phillips Petroleum Co. Structofors - American ENKA Corp. Cerex - Monsanto Chemical Co.

<u>Progress</u>: The project has been completed and crack surveys were made at several different intervals.

Reports: The final report has been completed.

<u>Implementation</u>: Engineers have been most concerned about the reflection cracks which appear above the widening joints on pavements widened from 18 or 20 feet to 24 feet. The use of the fiber reinforcing material over these widening joints will provide a method of preventing cracks or reducing their adverse effects on resurfacing projects. Installation of fabric reinforcing material has been incorporated into an I-29 resurfacing project North of Council Bluffs based upon the performance of this project.

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RESEARCH PROJECT SUMMARY

Project Number: HR-165

<u>Project Title</u>: Experimental Steel Fiber Reinforced Concrete Overlay

Research Agency: Greene County & Iowa Department of Transportation, Highway Division

Principal Investigators: R. Betterton, Greene County V. J. Marks, Materials, Research

Contract Period: December 20, 1972 to completion

Contract Amount: \$60,000

Funding: 100 percent state, Farm-to-Market Funds

Research Objective: To determine the feasibility of mixing, placing, and finishing various fibrous concrete overlays and to evaluate the overall performance, longevity and maintenance characteristics of the overlays.

Project Activities: A fibrous portland cement concrete overlay has been placed on 3.03 miles of Greene County Road E-53 (Old U.S. 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length, and fiber content.

<u>Progress</u>: The fibrous concrete overlay and various control sections were placed in FY 1974. Performance is being observed. Crack survey reports have been distributed annually.

<u>Reports</u>: Fibrous Concrete Resurfacing, Crack Surveys of April, 1974, November 1974, October 1975 and October 1976. Implementation: The project will demonstrate the feasibility of using thin fibrous concrete overlays for pavement resurfacing. Future use of the fibrous concrete will then depend primarily on its cost in comparison with other resurfacing techniques.

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RESEARCH PROJECT SUMMARY

Project Number: HR-168

Project Title: Skid Resistance of Concrete Pavements

Research Agency: Greene County& Iowa Department of Transportation, Highway Division

Principal Investigators: R. Betterton, Greene County B. C. Brown, Materials

Contract Period: June 18, 1973, to completion

Contract Amount: \$3,800

Funding: 100 percent state, Farm-to-Market funds

<u>Research Objective</u>: To investigate the possible effect of cement content on the skid resistance of portland cement concrete pavement.

Project Activities: An agreement was made with Greene County to use three different cement contents in paving to be built in Greene County. The skid testing and evaluation of the results will be done by personnel from the Office of Materials.

<u>Progress</u>: Construction of the test sections was completed in 1973. Skid tests will continue to be made at one year intervals on each of the test sections.

Reports: None

Implementation: The skid resistance testing conducted on this project will determine if the friction characteristics of Portland Cement Concrete Pavements is affected by cement content. This conclusion will be one factor in selecting the mix proportion for paving projects.
RESEARCH PROJECT SUMMARY

Project Number: HR-170

Project Title: Maintenance of Pavement Skid Resistance

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: B. H. Ortgies, Materials

Contract Period: May 1, 1974, to completion

Contract Amount: \$90,000

<u>Funding</u>: 88.9 percent state, Primary funds 11.1 percent Federal Aid Funds*

Research Objective: To investigate the skid resistance of plant mix seals, to develop design procedures for plant mix seals, and to construct several sections using various materials and mix designs.

<u>Project Activities</u>: A construction project using plant mix seals has been completed on U.S. 69 in Story County north of Ames.

Progress: Several test sections have been constructed and skid tests have been completed at different intervals.

Reports: An April, 1976 progress report has been prepared.

Implementation: The performance of the plant mix seals on this project will provide a basis for aggregate selection and determine to what extent plant mix seals will be utilized in the future.

*R & D Demonstration Projects Division negotiated contract for \$10,000. April 3, 1974.

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RESEARCH PROJECT SUMMARY

Project Number: HR-175

Project Title: Experimental Macadam Stone Base

Research Agency: Des Moines County & Iowa Department of Transportation, Highway Division

Principal Investigator: C. K. Paulson, Des Moines County

Contract Period: June 16, 1975 to completion

Contract Amount: \$100,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To develop standardized design procedures and specifications for a less expensive road base construction that will be applicable to all counties that utilize limestone as a road aggregate.

<u>Project Activities</u>: Plans and specifications have been drawn up and construction of the project was completed during the 1975 construction season.

<u>Progress</u>: Construction of the experimental road has been completed. Evaluation of the experimental features of the project will be continued for a minimum of five years following construction.

Reports: A progress report is being prepared.

Implementation: This project will yield better construction practices and determine the cost effectiveness of Macadam Stone Base design for secondary roadways. These results will determine to what extent this design is utilized in future road construction.

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RESEARCH PROJECT SUMMARY

Project Number: HR-176

Project Title: Recycled Asphalt Pavement

Research Agency: Kossuth County & Iowa Department of Transportation, Highway Division

Principal Investigator: R. P. Henely, Kossuth County

Contract Period: May 1, 1975, to completion

Contract Amount: \$50,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications have been

completed.

<u>Progress</u>: Construction of the proposed project has been completed. Observations will be made for a period of several years.

Reports: A September 3, 1975 report has been prepared.

Implementation: This project proved that recycling of asphalt concrete is feasible and that additional research is needed to solve related problems. Research Project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977, research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials.

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RESEARCH PROJECT SUMMARY

Project Number: HR-177

- Project Title: Concrete Bridge Deck Repairs Using Injected Epoxy Resin
- Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: E. O'Connor, Maintenance

Contract Period: May 6, 1975, to May, 1978

Contract Amount: \$3,000

Funding: 100 percent state, Primary funds

Research Objective: To provide the special equipment necessary for use in injecting epoxy resin in delaminated areas in bridge decks and to determine if this material does prevent or delay the formation of spalls in bridge decks.

Project Activities: Personnel from the Office of Maintenance will be in charge of the equipment used in the epoxy injection method. The Offices of Materials will assist in the evaluation of the results over a three-year period.

Progress: The equipment was delivered late in the summer of 1975. Epoxy injections have been made on three different bridges. Some problems were encountered in drilling holes and in the injection of the epoxy resin, however, estimates indicate that 75 to 80 percent of the areas injected have remained bonded. Results will be evaluated over a three-year period.

Reports: A March 25, 1977 progress report has been submitted.

Implementation: This project has shown that this procedure is not completely effective in preventing deterioration but will provide additional time until major deck repairs can be initiated.

RESEARCH PROJECT SUMMARY

Project Number: HR-178

Project Title: Pavement Deflection Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: F. Walker, D. Heins, Materials

Contract Period: November 5, 1975 to March 1, 1978

Contract Amount: \$26,000

Funding: 100 percent state, Primary funds

Research Objective: To determine if the test equipment can provide data of sufficient accuracy to be used effectively in pavement design and to determine the seasonal deflection variation of flexible pavements.

<u>Project Activities</u>: The Road Rater was delivered by the manufacturer early in the spring of

1976. A tentative work plan for conducting various pavement deflection studies has been completed.

Progress: Testing is being conducted on various interstate primary and secondary roads in all parts of the state. Correlations with Benkelman Beam data and AASHTO structual numbers have been obtained. A seasonal variation study is in progress.

Reports: A May, 1977 progress report has been completed.

Implementation: This project has proven that the Road Rater is a useful and effective tool in the design and maintenance of flexible pavements.

RESEARCH PROJECT SUMMARY

Project Number: HR-179

Project Title: Bridge Deck Delamination Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: F. Walker, Materials

Contract Period: November 5, 1975 to completion

Contract Amount: \$7,700

Funding: 100 percent state, Primay funds

Research Objective: To evaluate the effectiveness of bridge deck resurfacing, bridge deck overlays, and bridge deck delamination repairs. A long range objective of this research is to reduce bridge deck repair costs.

Project Activities: The Delamtect equipment has been received from the manufacturer and is currently being used to evaluate the soundness of bridge deck resurfacing and overlays.

<u>Progress</u>: The Delamtect System is being used as one effective tool in a major bridge deck repair program. The System is also being used to verify bond on bonded thin-lift P.C. Concrete resurfacing projects.

Reports: None

Implementation: This project has shown that the delamtect is a rapid, effective tool for detecting bridge deck delamination. It is being used to determine the extent of needed repairs and to evaluate the performance of "Iowa Method" resurfacing.

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RESEARCH PROJECT SUMMARY

Project Number: HR-180

Project Title: An Evaluation of An Epoxy Pavement Marking System

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: J. H. Moody, C. S. Caream

Contract Period: April, 1976 to completion

Contract Amount: \$4,925

Funding: 100 percent state, Primary funds.

Research Objective: To determine if epoxy paint is an economical alternative to standard paint on high traffic multi-lane roadways and to determine if epoxy lane markings will last an entire winter

season without replacement.

Project Activities: An experimental epoxy based paint developed by the H.B. Fuller Company

and the Minnesota Department of Highways was applied on several lanes of Interstate 235 in Des Moines. Standard striping paint was also used in the vicinity for comparison purposes.

Progress: The sandblasting and painting was only partially completed due to equipment failure. Observations made following the application indicate some irregularities due to an improper mixture of the epoxy components. After one winter season, properly applied sections appear to be in relatively good condition indicating improved durability.

Reports: A written evaluation has been completed.

Implementation: This project has shown that an application of properly mixed epoxy paint will provide more durable traffic lane markings for use on multiple lane highways. Further research by the manufacturer is needed to eliminate or reduce application problems.

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RESEARCH PROJECT SUMMARY

Project Number: HR-181

Project Title: The Evaluation of Macadam Stone Shoulders

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: B. Ortgies

Contract Period: May 25, 1975 to completion

Contract Amount: \$8,143

Funding: 100 percent state, primary funds

Research Objective: To determine the feasibility of using a macadam stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the con-

struction and maintenance of macadam stone shoulders, and to evaluate the performance of macadam stone shoulders.

Project Activities: This experimental type of shoulder construction was incorporated into a Dallas County project on U.S. 6. Shoulder construction operations were observed and methods and procedures were recorded. Comparisons will be made between macadam shoulders and recently constructed stabilized and paved shoulders.

<u>Progress</u>: The shoulder construction work has been completed. A visual and structural evaluation program will be continued for the duration of the project.

<u>Reports</u>: A construction and performance report will be submitted one year after construction.

Implementation: This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

RESEARCH PROJECT SUMMARY

Project Number: HR-182

<u>Project Title</u>: An Evaluation of Cover Aggregate Stripping Characteristics

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: C. L. Huisman, K. Isenberger Bill Dunshee, R. D. Smith

Contract Period: May 25, 1976 to completion

Contract Amount: \$15,000

Funding: 100 percent state, Primary funds

<u>Research Objective</u>: To identify the stripping susceptibility of various types of cover aggregates

used in Iowa.

Project Activities: This research project was incorporated into the 1976 Iowa DOT Maintenance Contract Seal coat program as a division of a project on Iowa 210 between Interstate 35 and Maxwell, Iowa. Twentynine different cover aggregate types were tested and standard seal coat specifications were used.

<u>Progress:</u> Samples to determine the amount of aggregate retained on the surface are being taken at periodic intervals. Results of the tests are being evaluated.

Reports: A progress report was submitted in March, 1977.

Implementation: A design guide will be developed that will include a description of the performance characteristics of each cover aggregate with each binder bitumen.

RESEARCH PROJECT SUMMARY

Project Number: HR-183

Project Title: Fatigue Behavior of High Air Content Concrete

Research Agency: Iowa State University

Principal Investigators: D. Y. Lee, F. W. Klaiber

Contract Period: August 1, 1976 to July 31, 1977

Contract Amount: \$30,348

Funding: 100 percent state funds: 50 percent Primary, and 50 percent Farm-to-Market

Research Objective: To evaluate the effects of air content on the fatigue behavior of most commonly used concrete mixes; to establish fatigue curves for airentrained concrete and to establish correlations between fatigue life or fatigue strength and other concrete properties.

Project Activities: A one-year agreement has been made with Iowa State University for the completion of the first phase of the project. An evaluation will be made upon the completion of the first phase. Phase II will be dependent upon the results of Phase I.

Progress: Phase I has been completed.

Reports: A final report is being prepared.

Implementation: Fatigue curves obtained from this study will provide a basis for an improved rigid pavement design for pavements in which air-entrained concrete is used.

RESEARCH SUMMARY PROJECT

Project Number: HR-184

Project Title: Determination of Rumble Strip Effectiveness

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: G. L. Fox, V. J. Marks, Bill Dunshee

Contract Period: August, 1976 to completion

Contract Amount: None

Funding: (Maintenance Operation)

Research Objective: To identify the effectiveness of the rumble strip as a traffic safety device when used on a widespread basis in both rural and urban situations.

Project Activities: The rumble strips were cut at approved, designated locations. An accident

study will be conducted by the Iowa DOT using study periods of two years before and two years after placement.

<u>Progress</u>: Agreements were signed with each of the participating counties. The rumble strips have been cut at all the proposed locations in each of the participating counties.

Reports: None

Implementation: The two-year accident study will determine the desirability and effectiveness of using rumble strips on a widespread basis.

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RESEARCH PROJECT SUMMARY

Project Number: HR-185

Project Title: Laboratory Study of Slurry Seal Coats

Research Agency: Iowa State University

Principal Investigator: D. Y. Lee

Contract Period: August 1, 1976 to May 31, 1977

Contract Amount: \$25,520

<u>Funding</u>: 100 percent State funds: 50 percent Primary and 50 percent Farm-to-Market

Research Objective: (1) To provide a comprehensive literature search and digest on material characteristics, design procedures and field experiences of slurry seals. (2) To conduct a laboratory study of slurry seal design procedures, testing and evaluation methods and

materials. (3) To determine the desirability of a field study.

Research Activities: Extensive laboratory tests involving some 400 slurry seals were conducted. Various aggregates, including many from Iowa sources, were tested. Slurry seal development, uses, characteristics, tests and design methods were reviewed in conjunction with the Iowa DOT's past experiences and through a literature search.

<u>Progress</u>: The literature search and laboratory work have been completed. Phase I of this project is complete. Phase II will be completed under HR-195, "Field Performance and Evaluation of Slurry Seals."

Reports: Final report-Laboratory Study of Slurry Seal Coats."

<u>Implementation</u>: This project provided information that will be used in a field research project. The field research will result in the development of the most effective slurry seal specifications.

RESEARCH PROJECT SUMMARY

Project Number: HR-186

<u>Project Title</u>: Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Construction.

Research Agency: Iowa State University

Principal Investigators: W. D. Shrader, S. J. Henning

Contract Period: January 1, 1977 to December 31, 1980

Contract Amount: \$172,085

Funding: 100 percent state funds: 75 percent Primary and 25 percent Farm-to-Market.

Research Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil to varying conditions and various tillage practices and to determine the effects of land surface elevation above drainage tile or perched water tables.

Project Activities: A four year contract has been signed with Iowa State University. Work is continuing on the selection of sites in several counties for borrow pits with desirable characteristics.

<u>Progress</u>: Three borrow pit sites have been selected for the research. Temporary easements or rental arrangements are being worked out. Available equipment and tillage practices are also being reviewed.

Reports: None

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared.

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RESEARCH PROJECT SUMMARY

Project Number: HR-187

<u>Project Title</u>: Development of a Minicomputer Controlled Frost, Ice and Snow Detector for Bridge Hazard Monitoring

Research Agency: Cytronics Incorporated

Principal Investigator: P. W. Poppe

Contract Period: January 13, 1977 to December 31, 1977

Contract Amount: \$19,500

<u>Funding</u>: 100 percent state funds: 75 percent Primary and 25 percent Farm-to-Market

Research Objective: To design, develop and deliver a microprocessor controlled frost, ice and snow detector with the capability to accurately detect frost, ice and snow in the presence of de-icing chemicals under normal conditions at bridge sites.

Project Activities: Laboratory testing, design and development work for Phase I of the project was essentially completed early in the spring of 1977.

<u>Progress</u>: Field testing of equipment could not be completed due to a lack of frost during the past winter season. Plans call for completion of the field tests later in the fall.

Reports: None

Implementation: The development of an effective frost, ice and snow detector will result in improved motorist safety, reduced tort liability and reduced annual expenditures for winter maintenance.

RESEARCH PROJECT SUMMARY

Project Number: HR-188

<u>Project Title</u>: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations

Research Agency: Kossuth County & Iowa Department of Transportation, Highway Division

Principal Investigator: R. P. Henely

Contract Period: April 11, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Project Activities: A work plan has been completed. The project was let on June 21, 1977.

Several contractors and equipment manufacturers have shown an interest in the project.

<u>Progress</u>: The project is progressing very well. Preliminary indications are that the contractor will be able to produce in excess of 300 tons per hour of 50 percent recycled mix while meeting all pollution requirements. Higher tonages and higher percentages of recycled vs. virgin aggregate will also be tried.

Reports: None

Implementation: In the interest of conserving energy and material, the elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. Achieving this goal will allow continuation of asphalt recycling.

RESEARCH PROJECT SUMMARY

Project Number: HR-189

Project Title: A Study of the Spergen Formation of Southeastern Iowa

Research Agency: Iowa Geological Survey

Principal Investigator: B. L. Milne

Contract Period: April 12, 1977 to August 31, 1978

Contract Amount: \$4,880

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Funding: 100 percent state funds: 50 percent Primary and 50 percent Farm-to-Market

Research Objective: To provide detailed geographic and stratigraphic information on the location of Spergen Formation in eight southeastern counties in Iowa. Efforts will be made to trace the depth and characteristics of the Spergen in order to find potentially viable areas for mining or quarrying.

Project Activities: The research is being carried out by the University of Iowa, Department of Geology. Attempts are being made to designate desirable locations for further exploration.

Progress: Stratigraphic data is being collected by the Iowa Geological Survey and field investigation are in progress.

Reports: None

Implementation: The potential for additional research on the Spergen Formation at the completion of the project is great. Coring of the rock and analysis by the Materials Testing Laboratory to determine the physical properties of recommended sites will be considered at the conclusion of this project.

RESEARCH PROJECT SUMMARY

Project Number: HR-190

Project Title: Portable School Stop Signs and Other Non-Uniform School Stop Control Devices.

Research Agency: Iowa State University

Principal Investigator: R. L. Carstens

Contract Period: May 1, 1977 to May 31, 1978

Contract Amount: \$42,950

Funding: 100 percent state funds: 70 percent Primary and 30 percent Farm-to-Market

Research Objective: To determine the advantages and disadvantages of the use of portable school stop signs and other non-uniform school stop control devices and to recommend the most appropriate controls for school

crossings.

Project Activities: A literature search on all related research previously completed has been made and is being evaluated.

Progress: Mail survey instruments for the purpose of gathering additional information on types of school stop signs presently being used have been mailed and returned.

Reports: The first progress report is due on September 1, 1977 ...

Implementation: Implementation of the findings and recommendations of this research will result in the development of the most effective and acceptable forms of school crossing control.

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RESEARCH PROJECT SUMMARY

Project Number: HR-191

- Project Title: Bonded, Thin-Lift Non-Reinforced Portland Cement Concrete Resurfacing
- Research Agency: Clayton County & Iowa Department of Transportation, Highway Division

Principal Investigator: M. L. Johnson

Contract Period: May 16, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: The research objectives are: 1. To establish methods and procedures for surface preparation for P.C. Concrete resurfacing. 2. To establish mixing procedures using super water reducing admixtures and to study the economics and performance of portland cement resurfacing. 3. To determine if this method of overlay can be considered as a viable alternative for concrete pavement restoration.

Project Activities: The project is scheduled for letting in July, 1977. Construction will be completed during the 1977 construction season.

Progress: A contract has been signed with Clayton County. Plans and specifications have been completed.

Reports: None

Implementation: This research will determine whether bonded, thin-lift non-reinforced Portland Cement resurfacing is a viable alternative for concrete pavement restoration and rehabilitation.

RESEARCH PROJECT SUMMARY

Project Number: HR-192

Project Title: An Evaluation of Dense Bridge Floor Concrete

Iowa Department of Transportation, Research Agency: Highway Division

Principal Investigators: R. W. Pratt, J. V. Bergren

Contract Period: May, 1977 to completion

Contract Amount: \$3,340

Funding: 100 percent state, Primary funds

Research Objective: To determine the feasibility of mixing, placing and finishing dense portland cement concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity and maintenance performance of dense portland cement concrete.

Project Activities: The project is located in the Town of Ackley on U.S. 20 in Hardin County.

The construction involves the redecking of a multiple span overhead crossing over a railroad. It is proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture.

Placement of the bridge deck will be completed Progress: during the 1977 construction season. Evaluation will continue for a five-year period.

A progress report will be submitted 6 months Reports: after construction.

Implementation: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if this admixture is a solution to the problem of corrosion of steel in bridge decks.

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RESEARCH PROJECT SUMMARY

Project Number: HR-1005

Project Title: Low Profile Markers for Wet-Night Visibility

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: F. W. Walker, Materials, Research Section J. H. Moody, Maintenance

Contract Period: September 1, 1974 to September 1, 1976

Contract Amount: \$6,949

Funding: 100 percent Federal funds

Research Objective: To evaluate the effectiveness of low profile markers in providing wet-night visibility and to determine the possibilities for further use of the markers in conjuction with conventional striping for traffic lanes.

Project Activities: Installation of the low profile markers has been completed. Periodic inspections to determine performance and damage or wear due to snow plowing and studded tires are being made.

<u>Progress</u>: Installation of the aluminized markers has been completed on the Des Moines Freeway. Their performance was evaluated for a two-year period.

Reports: Final report: Low Profile Markers for Wet-Night Visibility, April 1, 1977.

Implementation: Evaluation of these low profile markers showed that the angularity of reflection was very limited. Installation was also costly and difficult. It is not recommended that further trial and study of this type of marker be conducted until it can be improved.

RESEARCH PROJECT SUMMARY

Project Number: HR-1006

Project Title: Film - "Use of Low Slump Dense Concrete for Bridge Deck Protection"

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

Principal Investigators: B. L. Brakke, J. V. Bergren, V. J. Marks

Contract Period: April 23, 1976 to December 31, 1976

Contract Amount: \$7,120

Funding: 100 percent Federal funds

Research Ojbective: The objective of this project will be to prepare a narrated film showing the use of low slump dense concrete in the reconstruction of a

deteriorated bridge deck and in construction of a two course deck on a new bridge.

Project Activities: The film will show methods used in preparing a deteriorated deck for a concrete overlay including construction inspection of low-slump, dense concrete and density checks of fresh concrete.

<u>Progress</u>: The filming of bridges under various stages of construction and repair was completed during the 1976 construction season.

Reports: The film has been completed and delivered.

Implementation: This film will be made available to other State Highway Departments, counties and cities to familiarize them with these procedures.

RESEARCH PROJECT SUMMARY

Project Number: HR-1010

Project Title: Film - "Recycled Portland Cement Concrete Pavement"

Research Agency: Iowa State University & Iowa Department of Transportation, Highway Division

Principal Investigators: D. J. Brown, V. J. Marks, J. V. Bergren

Contract Period: June 16, 1977 to March 1, 1978

Contract Amount: \$14,000

Funding: 100 percent Federal funds

Research Objective: To prepare a high quality 16 mm color, sound film showing the reason for P.C.C.

recycling, preliminary investigation work, (trial mixes and designing), all phases of construction and benefits from P.C.C. recycled projects.

Project Activities: Filming of nearly all aspects of the recycling operation has been obtained from the I-680 project north of Council Bluffs and the Iowa 2 project in Taylor County.

Progress: Rough film footage is presently being obtained from two recycling projects in the state. Filming of other related projects needed for completion of the film will be obtained during the 1977 construction season.

Reports: None

Implementation: In an effort to help conserve natural resources, this film will describe an alternative for use in parts of Iowa and other states where aggregates of acceptable quality are not locally available.

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of HIGHWAY RESEARCH And DEVELOPMENT In IOWA



HIGHWAY DIVISION OFFICE OF MATERIALS

DECEMBER 1978

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Disclaimer

The contents of this report reflect the views of the author and do not necessarily reflect the official views or policy of the Iowa Department of Transportation or the research agency. This report does not constitute a standard, specification or regulation.



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ANNUAL REPORT

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE FISCAL YEAR ENDING JUNE 30, 1978

BY VERNON J. MARKS 3.3

RESEARCH ENGINEER OFFICE OF MATERIALS HIGHWAY DIVISION IOWA DEPARTMENT OF TRANSPORTATION (515)296-1447

DECEMBER 1978

AMES, IOWA 50010 (515) 296-1447

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Research Project Descriptions

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 oridinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report entitled, "Highway Research and Development in Iowa" is submitted in compliance with Section 310.36, Code of Iowa, directing submission of a report of the Secondary Road Research Fund. It is a report on the status of research and development projects which were in progress on June 30, 1978; it is also a report on projects completed during the Fiscal year beginning July 1, 1977 and ending June 30, 1978. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials - Highway Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

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

The Research Board consists of 13 regular members; six County Engineers, three 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 membership of the Research Board as of June 30, 1978 is listed in Table I.

The Research Board held nine regular meetings during the period of July 1, 1977 to June 30, 1978. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

TABLE I IOWA HIGHWAY RESEARCH BOARD JUNE 30, 1978

Member

W. W. Amundson City Engineer Sioux City, IA 51100

D. A. Anderson District 1 Engineer Iowa DOT - Highway Division Ames, IA 50010

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011

Alternate

F. Moore Director of Public Works Cedar Falls, IA 50613

R. C. Henely District 6 Engineer Iowa DOT - Highway Division Cedar Rapids, IA 52404

P. W. Peterson Associate Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011

TABLE I CONT. IOWA HIGHWAY RESEARCH BOARD

Member

C. Cabalka, Jr. Jasper County Engineer Newton, IA 50208

G. Calvert Deputy Director-Development Iowa DOT - Highway Division Ames, IA 50010

R. H. Given Deputy Director-Staff Iowa DOT - Highway Division Ames, IA 50010

W. A. Groskurth Mitchell County Engineer Osage, IA 50461

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52240

E. Niebuhr City Engineer Clinton, IA 52732

Alternate

R. J. Fichtner Marshall County Engineer Marshalltown, IA 50158

T. E. McElherne Specifications Engineer Iowa DOT - Highway Division Ames, IA 50010

F. O. Bloomfield Maintenance Engineer Iowa DOT - Highway Division Ames, IA 50010

W. A. Moellering Fayette County Engineer West Union, IA 52175

K. Rim Associate Dean for Research University of Iowa Iowa City, IA 52240

R. Kirchner City Engineer

L. G. Petersma Van Buren County Engineer Keosauqua, IA 52565

E. Schornhorst Shelby County Engineer Harlan, IA 51537

D. R. Shaw Ida County Engineer Ida Grove, IA 51445

D. L. Smith Delaware County Engineer Manchester, IA 52057 Fort Dodge, IA 50501

G. L. Gronvold Jefferson County Engineer Fairfield, IA 52556

D. J. Lynam Adair County Engineer Greenfield, IA 50849

D. D. Linnan Buena Vista County Engineer Storm Lake, IA 50588

L. Mattusch Clinton County Engineer Clinton, IA 52732

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RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division or the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farmto-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1978. Total expenditure was \$454,812.74 including support of the National Cooperative Highway Research Program (see page 6).

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; they cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section wishes to express their appreciation to other offices and the districts for their assistance.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials (now the American Association of State Highway and Transportation Officials -- AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the Federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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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 1½ percent of the receipts in the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund (designated "Farm-to-Market") is itemized in Table II.

The Office of Transportation Inventory conducted traffic counts and secondary road inventories in 25 counties during fiscal year 1978. The values shown in Table II on the previous page are actual research expenditures for fiscal year 1978. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based upon obligations for expenditures on research projects and not the actual expenditure. The Fiscal Year 1978 financial summary is:

Beginning balance 8-1-77

\$1,006,517

Receipts

Interest

35,989

Fed. Sec. Rd. (1½% of receipts) ... 148,855 State RUTF (1½% of Receipts) 387,306 Sub-Total Total Funds Available

572,150 \$1,578,667

Obligation for Expenditures Obligated for

Contract Research 318,	219
Non-Contract Engineering Studies 215.	383
Total Expenditures	533,602
BALANCE (6-30-78)	\$1,045,065

SECONDARY ROAD TRAFFIC COUNTY PROGRAM

During fiscal year 1978, the traffic count program conducted by the Office of Transportation Inventory on the Secondary Road System in 25 Counties required a total of 2,806 4-hour or 8-hour manual counts. The traffic data from these counts was used to develop motor vehicle traffic flow maps for each county showing the average annual daily traffic (ADT) on specific road sections in each county. This data provides the county engineer, highway engineer, planner, and administrator with essential information needed for the determination of design standards, systematic classification of highways, and the development of programs for improvement and maintenance of secondary roads.

This traffic data is also added to the Iowa Department of Transportation's Secondary Road Base Record. This record is utilized for the preparation of numerous reports and studies including the annual vehicle miles of travel, mileage summaries, need studies, special studies, accident analysis, etc.

TABLE II RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1977 to June 30, 1978

Project	Primary	Farm-to-Market	Total
140	22,000.00	22,000.00	44,000.00
175	stored - and second and the second	100,000.00	100,000.00
181	8,143.00	The storage water and the storage and	8,143.00
183	7,549.29	11,071.16	18,620.45
185	5,901.03	3,505.01	9,406.04
186	15,723.95	16,581.68	32.305.63
187	1,235.02	1,517.16	2,752.18
189	571.26	668.14	1,239.40
190	26,428.03	10,687.51	37,115.54
191		50,000.00	50,000.00
194		9,455.06	9,455.06
195	12,748.04		12,748.04
196		703.02	703.02

TOTAL	\$196,400.68	\$258,412.06	\$454,812.74
HPR-2(119)	6,669.77	946.65	7,616.42
HPR-2(118)	9,163.84	1,300.63	10,464.47
NCHRP	55,043.40	8,700.46	63,743.86
Sub Total	125,523.67	247,464.32	372,987.99
1011	11,227,23		11,227.23
1010	5,832.92	Anna Provi Province	5,832.92
198	a any state-weather	15,912.12	15,912.12
197	8,163.90	5,363.46	13,527.36

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of the Fiscal Year beginning July 1, 1977 and ending June 30, 1978. An open file for each project is maintained from the project's inception to completion; completion is signified by the acceptance of the final report and the making of the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.

7

Project Number: HR-140

Project Title: Collection and Analysis of Stream Flow Data

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

Principal Investigator: S. W. Wiitala, U.S.G.S.

- Contract Period: Project continued to September 30, 1979 by approval of the Director-Highway Division
- Contract Amount: \$44,000 per year (matched by \$44,000 from the Department of Interior)
- Funding: 100 percent State funds; 50 percent Primary and 50 percent Farmto-Market

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

Project Activities: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and analyzed to form the basis for predictions of future streamflow.

Progress: The progress during 1977-1978 was in accordance with schedules established by the Water Resources Division.

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

Project Number: HR-148

Project Title: Investigation of Pavement Wear in Relation to Studded Tire Use

Research Agency: Office of Materials, Research Section, Iowa Department of Transportation

Principal Investigator: V. J. Marks, Materials Research Section

Contract Period: August 20, 1969 to completion

Contract Amount: \$1,130

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

Research Objective: The objective of this project is to measure pavement wear caused by studded tires and to estimate the extent of future wear if studded tires remain legal in Iowa.

Project Activities: The two principal activities carried on by the Office of Materials are (1) the measurement of pavement wear and (2) the estimation of studded tire use in Iowa.

Progress: Pavement wear measurements have been made in Iowa for the winter period 1977-78.

Reports: The Office of Materials has prepared reports on studded tire usage in Iowa for the winter periods 1969-70 through 1977-78.

Implementation: The findings from Research Project HR-148 are being used to support recommendations adopted by the Iowa Department of Transportation concerning the banning of studded tires in Iowa. Project Number: HR-154 & HR-154A

Project Title: Investigation of Highway Lighting

Research Agency: Office of Materials, Research Section, Iowa DOT

Principal Investigators: Floyd Christofferson, Design Department and Vernon J. Marks, Research Section

Contract Period: September 2, 1970 to completion

Contract Amount: \$4,500

Funding: 100 percent State, Primary funds

Research Objective: A highway lighting project having 150 foot towers has been constructed at the interchange of I-80, I-35 and I-235 west of Des Moines. This is the first tower lighting to be used on Iowa highways. The objectives of project HR-154A are (1) to compare the tower lighting with existing conventional highway lighting where the luminaires are located 30 to 40 feet above the roadway, and (2) to investigate installations with particular regard for the rate of reduction of light output as influenced by lamp replacement and luminaire cleaning.

Project Activities: Representative conventional lighting installations have been observed along with the tower installation. Measurements were made of the level and uniformity of illumination and of glare. Measurements were also made to relate light output to lamp replacement and luminaire cleaning. Maintenance and cost experience will be recorded.

Progress: Glare and brightness readings have been taken on Interstate 235 in Des Moines and on the tower lighting installation in West Des Moines. Readings have also been obtained at other locations for comparitive purposes. Some maintenance problems were encountered at various other lighting installations. An addition to this project was proposed to consider all Iowa tower installations in order to gain needed information. The purpose of the addition is to summarize and analyze all maintenance problems and to recommend remedial design, construction or special features as solutions to the problems. The addition showed that maintenance problems at tower lighting installations are not considered excessive.

Reports: Investigation of Highway Lighting, Final Report, November, 1976. Addendum to Investigation of Highway Lighting, June, 1978.

Implementation: This research yielded conclusive evidence that tower lighting was more effective than conventional lighting when lighting a large area such as an interchange. New design concepts and improvements will be incorporated into future installations.

Project Number: HR-165

Project Title: Experimental Steel Fiber Reinforced Concrete Overlay

Research Agency: Greene County and Iowa Department of Transportation, Highway Division

Principal Investigators: R. Betterton, Greene County and Vernon J. Marks, Materials Research Section

Contract Period: December 20, 1972 to completion

Contract Amount: \$60,000

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

Research Objective: To determine the feasibility of mixing, placing and finishing various fibrous concrete overlays and to evaluate the overall performance, longevity and maintenance characteristics of the overlays.

Project Activities: A fibrous Portland Cement Concrete overlay has been placed on 3.03 miles of Greene County Road E-53 (old US 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length and fiber content.

Progress: The fibrous concrete overlay and various control sections were placed in FY 1974. Performance is being observed. Crack survey reports have been distributed annually. A final crack survey report will be completed late in 1978.

Reports: Fibrous Concrete Resurfacing, Crack Surveys of April, 1974, November, 1974, October, 1975, October, 1976 and October, 1977.

Implementation: The project will demonstrate the feasibility of using thin fibrous concrete overlays for pavement resurfacing. Future use of the fibrous concrete will then depend primarily on its cost in comparison with other resurfacing techniques.

11
Skid Resistance of Concrete Pavements Project Title:

Greene County and Iowa Department of Transportation, Research Agency: Highway Division

R. Betterton, Greene County and B. C. Brown, Principal Investigators: Materials

June 18, 1973 to completion Contract Period:

\$3,800 Contract Amount:

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

To investigate the possible effect of cement content on Research Objective: skid resistance of Portland Cement Concrete pavement.

An agreement was made with Greene County to use three Project Activities: different cement contents in paving to be built in Greene County. The skid testing and evaluation of the results will be done by personnel from the Office of Materials.

Construction of the test sections was completed in 1973. Skid tests Progress: will continue to be made at one year intervals on each of the test sections.

Reports: None

Implementation: The skid resistance testing conducted on this project will determine if the friction characteristics of Portland Cement Concrete pavements is affected by cement content. This conclusion will be one factor in selecting the mix proportion for paving projects.

Project Title: Maintenance of Pavement Skid Resistance

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. A. Shelquist, Materials

Contract Period: May 1, 1974 to completion

Contract Amount: \$90,000

Funding: 88.9 percent State, Primary funds, 11.1 percent Federal Aid Funds*

Research Objective: To investigate the skid resistance of plant mix seals, to develop design procedures for plant mix seals, and to construct several sections using various materials and mix designs.

Project Activities: A construction project using plant mix seals has been completed on US 69 in Story County north of Ames.

Progress: Ten test section of open graded asphalt friction course have been constructed and skid tests have been completed at different intervals.

Reports: An April, 1976 progress report has been prepared.

Implementation: The performance of the plant mix seals on this project will provide a basis for aggregate selection and determine to what extent plant mix seals will be utilized in the future.

*R & D Demonstration Projects Division negotiated contract for \$10,000. April 3, 1974.

Project Title: Experimental Macadam Stone Base

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

Principal Investigator: C. K. Paulson, Des Moines County

Contract Period: June 16, 1975 to completion

Contract Amount: \$100,000

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

Research Objective: To develop standardized design procedures and specifications for a less expensive road base construction that will be applicable to all counties that utilize limestone as a road aggregate.

Project Activities: Plans and specifications have been drawn up and construction of the project was completed during the 1975 construction season.

Progress: Construction of the experimental road has been completed. Evaluation of the experimental features of the project will be continued for a minimum of five years following construction.

Reports: A construction report has been completed, September, 1977.

Implementation: This project will yield better construction practices and determine the cost effectiveness of Macadam Stone Base design for secondary roadways. These results will help to determine to what extent this design is utilized in future road construction.

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Project Title: Concrete Bridge Deck Repairs Using Injected Epoxy Resin Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: E. O'Conner, Maintenance

Contract Period: May 6, 1975 to November, 1978

Contract Amount: \$3,000

Funding: 100 percent State, Primary funds

Research Objective: To provide the special equipment necessary for use in injecting epoxy resin in delaminated areas in bridge decks and to determine if this material does prevent or delay the formation of spalls in bridge decks.

Project Activities: Personnel from the Office of Maintenance will be in chage of the equipment used in the epoxy injection method. The Office of Materials will assist in the evaluation of the results over a three-year period.

Progress: The equipment was delivered late in the summer of 1975. Epoxy injections have been made on three different bridges. Some problems were encountered in drilling holes and in the injection of the epoxy resin. The equipment seems to be more applicable to large areas of delamination. An effort to use the unit to repair cracks in a prestress beam was unsuccessful. Results will be evaluated over a three-year period. Progress has been curtailed due to personnel limitations.

Reports: A March 25, 1977 progress report has been submitted.

Implementation: This project has shown that this procedure is not completely effective in preventing deterioration but will provide additional time until major deck repairs can be initiated.

Project Title: Recycled Asphalt Pavement

Research Agency: Kossuth County & Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely, Kossuth County

Contract Period: May 1, 1975 to completion

Contract Amount: \$50,000

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

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications have been completed.

Progress: Construction of the proposed project was completed during the summer of 1975. Observations will be made for a period of several years.

Reports: A September 3, 1975 report has been prepared.

Implementation: This project proved that recycling of asphalt concrete is feasible and that additional research is needed to solve related problems. Research Project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977, research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials. Kossuth County has not accepted recycled asphalt pavement as a standard reconstruction practice.

Pavement Deflection Study Project Title:

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigator: C. Potter, D. Heins, Materials

Contract Period: November 5, 1975 to March 1, 1979

\$26,000 Contract Amount:

Funding: 100 percent State, Primary funds

Research Objective: To determine if the test equipment can provide data of sufficient accuracy to be used effectively in pavement design and to determine the seasonal deflection variation of flexible pavements.

The Road Rater was delivered by the manufacturer early in Project Activities: the spring of 1976. A tentative work plan for conducting various pavement deflection studies has been completed.

Testing is being conducted on various interstate, primary and Progress: secondary roads in all parts of the state. Correlations with Benkelman Beam data and AASHTO structual numbers have been obtained. A final report and evaluation is due to be completed early in 1979.

Reports: A May, 1977 progress report has been completed.

Implementation:

This project has proven that the Road Rater is a useful and effective tool in the design and maintenance of flexible pavements.

Project Title: Bridge Deck Delamination Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. Marks, Research Section, Materials

Contract Period: November 5, 1975 to completion

Contract Amount: \$7,700

Funding: 100 percent State, Primary funds

Research Objective: To evaluate the effectiveness of bridge deck resurfacing, bridge deck overlays, and bridge deck delamination repairs. A long range objective of this research is to reduce bridge deck repair costs.

Project Activities: The Delamtect equipment has been received from the manufacturer and is currently being used to evaluate the soundness of bridge deck resurfacing and overlays.

Progress: The Delamtect System is being used as one effective tool in a major bridge deck repair program. The System is also being used to verify bond on bonded thin-lift P.C. Concrete resurfacing projects. The project has been completed.

Reports: A final report has been completed, April, 1978.

Implementation: This project has shown that the delamtect is a rapid, effective tool for detecting bridge deck delamination. It is being used to determine the extent of needed repairs and to evaluate the performance of "Iowa Method" resurfacing.

<u>Project Title</u>: An Evaluation of An Epoxy Pavement Marking System <u>Research Agency</u>: Iowa Department of Transportation, Highway Division <u>Principal Investigators</u>: J. H. Moody, C. S. Carmean, Maintenance Contract Period: April, 1976 to completion

Contract Amount: \$4,925

Funding: 100 percent State, Primary funds.

Research Objective: To determine if epoxy paint is an economical alternative to standard paint on high traffic multi-lane roadways and to determine if epoxy lane markings will last an entire winter season without replacement.

Project Activities: An experimental epoxy based paint developed by the H. B. Fuller Company and the Minnesota Department of Highways was applied on several lanes of Interstate 235 in Des Moines. Standard striping paint was also used in the vicinity for comparison purposes.

Progress: The sandblasting and painting was only partially completed due to equipment failure. Observations made following the application indicate some irregularities due to an improper mixture of the epoxy components. After one winter season, properly applied sections appear to be in relatively good condition indicating improved durability.

Reports: A written evaluation has been completed.

Implementation: This project has shown that an application of properly mixed epoxy paint will provide more durable traffic lane markings for use on multiple lane highways. Further research by the manufacturer is needed.

Project Title: The Evaluation of Macadam Stone Shoulders

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. A. Shelquist, Materials

Contract Period: May 25, 1975 to completion

Contract Amount: \$8,143

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of using a Macadam Stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of Macadam Stone shoulders, and to evaluate the performance of Macadam Stone shoulders.

Project Activities: This experimental type of shoulder construction was incorporated into a Dallas County project on US 6. Shoulder construction operations were observed and methods and procedures were recorded. Comparisons will be made between Macadam shoulders and recently constructed stabilized and paved shoulders.

Progress: The shoulder construction work has been completed. A recent visual observation showed that the shoulders with the asphalt concrete surface were performing well with no spots on the surface. The side with the cover aggregate seal has some damage and open surface. A visual and structural evaluation program will be continued for the duration of the project.

Reports: A construction report was distributed in November, 1977.

Implementation: This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

Project Title: An Evaluation of Cover Aggregate Stripping Characteristics

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: K. Isenberger, R. D. Smith, Materials and B. Dunshee, Maintenance

Contract Period: May 25, 1976 to completion

Contract Amount: \$15,000

Funding: 100 percent State, Primary funds

Research Objective: To identify the stripping susceptibility of various types of cover aggregates used in Iowa.

Project Activities: This research project was incorporated into the 1976 Iowa DOT Maintenance Contract seal coat program as a division of a project on Iowa 210 between Interstate 35 and Maxwell, Iowa. Twentynine different cover aggregate types were tested and standard seal coat specifications were used.

Progress: Samples to determine the amount of aggregate retained on the surface are being taken at periodic intervals. Results of the tests for aggregate retention are being evaluated.

Reports: A progress report was submitted in March, 1977.

Implementation: A design guide will be developed that will include a description of the performance characteristics of each cover aggregate with each binder bitumen.

Project Title: Fatigue Behavior of High Air Content Concrete

Research Agency: Iowa State University

Principal Investigators: D. Y. Lee, F. W. Klaiber, Iowa State University

Contract Period: August 1, 1976 to July 31, 1977

Contract Amount: \$30,348

Funding: 100 percent State funds: 50 percent Primary and 50 percent Farmto-Market

Research Objective: To evaluate the effects of air content on the fatigue behavior of most commonly used concrete mixes; to establish fatigue curves for air-entrained concrete and to establish correlations between fatigue life or fatigue strength and other concrete properties.

Project Activities: A one-year agreement has been made with Iowa State University for the completion of the first phase of the project. An evaluation will be made upon the completion of the first phase. Phase II will be dependent upon the results of Phase I.

Progress: Phase I has been completed.

Reports: A final report was submitted July, 1977.

Implementation: Fatigue curves obtained from this study will provide a basis for an improved rigid pavement design for pavements in which air-entrained concrete is used.

Project Title: Determination of Rumble Strip Effectiveness

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigators: G. L. Fox, V. J. Marks, B. Dunshee

August, 1976 to completion Contract Period:

Contract Amount: None

(Maintenance Operation) Funding:

Research Objective: To identify the effectiveness of the rumble strip as a traffic safety device when used on a widespread basis in both rural and urban situations.

The rumble strips were cut at approved, designated Project Activities: locations. An accident study will be conducted by the Iowa DOT using study periods of two years before and two years after placement.

Progress: Agreements were signed with each of the participating counties. The rumble strips have been cut at all the proposed locations in each of the participating counties. A written evaluation will be completed early in 1979.

Reports: None

Implementation:

The two-year accident study will determine the desirability and effectiveness of using rumble strips on a widespread basis.

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Project Title: Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Construction

Research Agency: Iowa State University

Principal Investigators: W. D. Shrader, S. J. Henning, Iowa State University

Contract Period: January 1, 1977 to December 31, 1980

Contract Amount: \$172,085

Funding: 100 percent State funds: 75 percent Primary and 25 percent Farmto-Market

Research Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil to varying conditions and various tillage practices and to determine the effects of land surface elevation above drainage tile or perched water tables.

Project Activities: A four-year contract has been signed with Iowa State University. Work is completed on the selection of sites in several counties for borrow pits with desirable characteristics.

Progress: Four borrow pit sites have been selected for the research. Temporary easements or rental arrangements have been worked out. Borrow pit shaping, top soil replacement and crop planting were completed at two of the site locations.

Reports: A progress report has been distributed.

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared.

HR-187 Project Number:

Development of a Minicomputer Controlled Frost, Ice and Snow Project Title: Detector for Bridge Hazard Monitoring

Cytronics Incorporated Research Agency:

Principal Investigator: P. W. Poppe

January 13, 1977 to December 31, 1978 Contract Period:

\$19,500 Contract Amount:

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

Research Objective: To design, develop and deliver a microprocessor controlled frost, ice and snow detector with the capability to accurately detect frost, ice and snow in the presence of de-icing chemicals under normal conditions at bridge sites.

Project Activities: Laboratory testing, design and development work for Phase I of the project have been completed.

Progress: Field testing of equipment could not be completed due to a lack of frost during the first winter season. An extension has been granted for this project to allow for modification of equipment and additional field testing in order to attain the desired reliability.

Reports: A progress report has been distributed.

The development of an effective frost, ice and snow detector Implementation: will result in improved motorist safety, reduced tort liability and reduced annual expenditures for winter maintenance.

- Project Title: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations
- Research Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely

Contract Period: April 11, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent state, Farm-to-Market funds

Research Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Project Activities: A work plan has been completed. The project was let on June 21, 1977. Several contractors and equipment manufacturers showed an interest in the project.

Progress: The project was considered to be very successful. Recycled asphalt proved to be good quality material at a savings of approximately 30 cents per ton over virgin material. Through modifications of equipment, all D.E.Q. requirements for air pollution were easily met and the project gained nationwide and world-wide recognition.

Reports: A progress report was distributed in December, 1977.

Implementation: In the interest of conserving energy and material, the elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. Achieving this goal will allow continuation of asphalt recycling.

Project Title: A Study of the Spergen Formation of Southeastern Iowa

Research Agency: Iowa Geological Survey

Principal Investigator: B. L. Milne

Contract Period: April 12, 1977 to December 31, 1978

Contract Amount: \$4,880

Funding: 100 percent State funds: 50 percent Primary and 50 percent Farmto-Market

Research Objective: To provide detailed geographic and stratigraphic information on the location of Spergen Formation in eight southeastern counties in Iowa. Efforts will be made to trace the depth and characteristics of the Spergen in order to find potentially viable areas for mining or quarrying.

Project Activities: The research is being carried out by the University of Iowa, Department of Geology. Attempts are being made to designate desirable locations for further exploration.

Progress: Stratigraphic data is being collected by the Iowa Geological Survey and field investigations have been completed Due to problems in computer programing and other complications, a four month extension has been granted for this project.

Reports: A final report is being prepared.

Implementation: The potential for additional research on the Spergren Formation at the completion of the project is great. Coring of the rock and analysis by the Materials Testing Laboratory to determine the physical properties of recommended sites will be considered at the conclusion of this project.

Project Title: Portable School Stop Signs and Other Non-Uniform School Stop Control Devices

Research Agency: Iowa State University

Principal Investigator: R. L. Carstens

Contract Period: May 1, 1977 to May 31, 1978

Contract Amount: \$42,950

Funding: 100 percent State funds: 70 percent Primary and 30 percent Farmto-Market

Research Objective: To determine the advantages and disadvantages of the use of portable school stop signs and other non-uniform school stop control devices and to recommend the most appropriate controls for school crossings.

Project Activities: A literature search on related research was completed. A mail survey was used to gather information on the types of school stop signs presently being used.

Progress: The project has been completed and the final report has been accepted. Results of the research, when considering accident frequency, did not show any advantages or disadvantages for portable school stop signs. Recommendations made as a result of the study are being reviewed. The development of a

School Crossing Manual has been proposed. Also, legislation to require more uniformity in school stop signs is being proposed.

Reports: A final report has been completed, May, 1978.

Implementation: Implementation of the findings and recommendations of this research will result in the development of the most effective and acceptable forms of school crossing control.

Project Title: Bonded, Thin-Lift Non-Reinforced Portland Cement Concrete Resurfacing

Research Agency: Clayton County and Iowa Department of Transportation, Highway Division

Principal Investigator: M. L. Johnson

Contract Period: May 16, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent State, Farm-to-Market

Research Objective: The research objectives are: 1. To establish methods and procedures for surface preparation for P. C. Concrete resurfacing. 2. To establish mixing procedures using super water reducing admixtures and to study the economics and performance of Portland Cement resurfacing. 3. To determine if this method of overlay can be considered as a viable alternative for concrete pavement restoration.

Project Activities: A contract was signed with Clayton County. The plans and specifications have been completed. The project was let in July, 1977.

Progress: A thin-bonded low slump Portland Cement Concrete overlay was placed on a 1.3 mile portion of a secondary Clayton County Road in September, 1977. No major problems were experienced in mixing and proportioning the concrete. An adequate bond was developed and the project is performing well. Evaluation will continue for a five year period.

Reports: A construction report has been completed, September, 1977

Implementation: This research will determine whether bonded, thin-lift nonreinforced Portland Cement resurfacing is a viable alternative for concrete pavement restoration and rehabilitation.

Project Title: An Evaluation of Dense Bridge Floor Concrete

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. W. Pratt, J. V. Bergren

Contract Period: May, 1977 to completion

Contract Amount: \$3,340

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of mixing, placing and finishing dense Portland Cement Concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity and maintenance performance of dense Portland Cement Concrete.

Project Activities: The project is located in the Town of Ackley on US20 in Hardin County. The construction involved the redecking of a multiple span overhead crossing over a railroad. It was proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture.

Progress: A portion of a full depth bridge deck using concrete with a high range water reducer was placed in August 1977. Problems were encountered in pumping the concrete and in controlling slump and air content. Further experimental construction using concrete with high range water reducer

admixtures is scheduled on a Cass County project.

Reports: A construction report has been completed, December, 1977.

Implementation: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if this admixture is a solution to the problem of corrosion of steel in bridge decks.

HR-194 Project Number:

Mission Oriented Dust Control and Surface Improvement Processes Project Title: for Unpaved Roads

Iowa State University Research Agency:

Principal Investigator: J. M. Hoover

July 1, 1977 to December 31, 1979 Contract Period:

\$99,860 Contract Amount:

100% Farm-to-Market funds Funding:

To identify current practices, products and specifica-Research Objective: tions of potentially economic dust control systems and to plan, design and construct a series of demonstration test sections in several regions in Iowa for the purpose of evaluating materials, construction costs and performance of various dust control methods.

Project Activities: A contract has been signed with Iowa State University and an Advisory Committee has been selected. Site selection, based on geographic/geologic regions in the State, has been underway for several months.

Progress: Site selection representing five regional areas in the state have been completed. Negotiating for participation with the counties involved have also been completed. Current dust control practices and specifications are being evaluated.

Semi-annual progress reports have been submitted. Reports:

The project will identify alternate practices and the most Implementation: economical methods of dust control.

HR-195 Project Number:

Project Title: Field Performance and Evaluation of Slurry Seal Coats

Iowa State University Research Agency:

Principal Investigator: D. Y. Lee

July 1, 1977 to August 31, 1980 Contract Period:

\$91,000 Contract Amount:

Funding: 100 percent state, Primary funds

To evaluate performance characteristics of materials Research Ojbective: native to Iowa and applicability of other materials in slurry seals, mix designs and to correlate laboratory tests with field performance.

Project Activities: This project is the second phase of a two part study. Construction on Phase II, a field performance evaluation of slurry seals was delayed due to inflated costs under a revised schedule. The project was let in April, 1978 and a time extension through August 31, 1980 was granted with an additional \$11,000 in research construction funding.

The slurry seal application will be made on a section of US 6 in Progress: Dallas County. Plans and specifications have been completed. Iowa DOT maintenance forces have been blading the surface to remove rutting.

Reports: None

The project will provide a basis for the development and Implementation: preparation of slurry seal, design methods, criteria, procedures and specifications for the successful application of slurry seal as an economic pavement maintenance alternative.

HR-196 Project Number:

Project Title: Dust Control Using Asphalt Emulsion

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigator: V. J. Marks

August 15, 1977 to March 15, 1978 Contract Period:

\$1,000 Contract Amount:

100% State, Farm-to-Market Funding:

To evaluate the application procedure and performance Research Objective: of the cationic asphalt emulsion dust control system and to attempt to find a cost effective method of meeting dust control regulations.

The experimental sections were layed out and appli-Project Activities: cation rates were determined. The asphalt emulsion was applied on two sections of roadway in Boone County.

Progress: In an effort to control fugitive dust, a cationic asphalt emulsion was blended with warm water and applied on the roadways in late July. The testing included various application procedures. The effectiveness lasted only a short time.

A final report has been distributed in November, 1977. Reports:

After visual observations, it was concluded that this Implementation: procedure, utilizing a dilute asphalt emulsion, was not an effective method of dust control.

Project Title: Fatigue Behavior of High Air Content Concrete--Phase II

Research Agency: Iowa State University

Principal Investigator: D. Y. Lee, F. W. Klaiber

Contract Period: October 1, 1977 to January 31, 1979

Contract Amount: \$49,425

Funding: 100 percent State funds: 50 percent Primary and 50 percent Farmto-Market

Research Objective: To study the effects of water-cement ratio and aggregate type on fatigue strength of Portland Cement Concrete. In conclusion, new design curves taking these variables into consideration will be developed.

Project Activities: Materials for the project have been purchased and the first batch of concrete was poured in January, 1978. Fatigue testing began in February, 1978.

Progress: A planning meeting was held in November, 1977. Aggregate sources were determined. Materials sources were determined and material combinations were modified in order to obtain better results. Total number of batches was also increased from nine to ten.

Reports: A progress report has been submitted, June 1978.

Implementation: The final report will combine results from both Phase I and Phase II and will provide recommendations and fatigue design curves for designing concrete pavements in which air entrainment is one parameter given consideration.

HR-198 Project Number:

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

State Archaeologist (University of Iowa) Research Agency:

Principal Investigator: M. McKusick

July 1, 1977 to June 30, 1979 Contract Period:

\$33,000 Contract Amount:

100 percent State, Farm-to-Market Funding:

Research Objective: 1. To determine well in advance of highway construction if proposed planning corridors contain known or probable sites of archaeological value. 2. To locate such sites and describe their limits as accurately as possible without resorting to excavation or other detailed examination.

Project Activities: The Iowa Department of Transportation had an ongoing contract with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary reports.

Progress: Secondary road construction sites with archaeological value are being examined in advance of construction. The project will be evaluated following the completion of one more year.

Reports: None

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

Project Title: Upgrading Asphalt Surface Friction by Aggregate Sprinkle Treatments

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

Contract Period: June 1, 1978 to December 31, 1983

Contract Amount: \$42,500

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixtures of local aggregates for 1" and 1¹/₂" thick surface courses followed by a surface sprinkle treatment of pre-coated hard, durable chips to produce a long lasting non-skid pavement surface.

Project Activities: Preconstruction plans and arrangements were completed. The contract was let on May 23, 1978. This experimental type of resurfacing was applied on old US 30 between Interstate 35 and the City of Nevada.

Progress: The paving and sprinkle treatments have been completed. Appearance is very good with the exception of some corregation which occurred during application. Texture depth testing by the silly putty method has

been completed for all test sections.

Reports: None

Implementation: This project will be utilized in the evaluation of paving materials and texturing. It will also assist in determining the effectiveness of maintenance practices to increase skid resistance

Project Title: Fly Ash In Portland Cement Concrete Pavement-Monona County

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

Principal Investigator: O. D. Ives

Contract Period: February 21, 1978 to completion

Contract Amount: \$16,300

Funding: 100 percent State: Farm-to-Market

Research Objective: 1. To evaluate problems related to shipping, storing, and placing fly ash. 2. To establish a procedure for batching, mixing and placing concrete with specified air content. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: Plans and specifications were completed and the project was let early in the spring of 1978. Samples of the fly ash were obtained from the source and a history of sample testing was compiled prior to construction.

Progress: Paving was completed in June, 1978. Minor modifications were made in the batching system, but no special problems were encountered in the paving operation using conventional equipment. General appearance and workmanship of the concrete appears to be satisfactory.

Reports: None

Implementation: Laboratory studies and limited field use has shown that the utilization of fly ash in concrete has resulted in a cost savings and material conservation along with the disposal of a waste product.

Project Title: Fly Ash in Portland Cement Concrete Pavement-Woodbury County

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

Principal Investigator: C. E. Leonard

Contract Period: March, 1978 to completion

Contract Amount: None (no additional cost)

Research Objective: 1. To determine the problems related to shipping, storing and batching fly ash. 2. To establish procedures for mixing, and placing uniform concrete using fly ash. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: The proposed research will be incorporated into two bridge replacement projects on Iowa 982. The project will involve construction of a grooved, textured approach section.

Progress: Construction on these two bridge replacement projects is scheduled for completion during the 1978 construction season. A construction report will be completed six months after completion of the paving.

Reports: None

Implementation: Laboratory studies and limited field use has shown that the

utilization of fly ash in concrete has resulted in a cost savings and material conservation along with the disposal of a waste product.

<u>Project Title</u>: Wind Tunnel Analysis to Determine the Effect of Adjustment in the Adjacent Topography on Drifting Snow at Highway Grade Separations.

Research Agency: Iowa State University

Principal Investigator: S. L. Ring

Contract Period: June 1, 1978 to June 1, 1979

Contract Amount: \$60,566

Funding: 100 percent State funds: 75 percent Primary and 25 percent Farmto-Market

Research Objective: 1. To reproduce blowing and drifting snow using scale models in a wind tunnel 2. To analyze effects of strategically placed vegetation, snow fences or structures in order to make recommendations for controlling drifting snow at highway grade separations.

Project Activities: A contract agreement has been negotiated. Model parameters based on highway design criteria will be established. Desired testing and analysis techniques will be utilized.

<u>Progress</u>: Preliminary work and planning of the first model overpass to scale is being completed. A literature search is underway. Field interviews to obtain information on drifting snow have been conducted.

Reports: Monthly progress reports are being submitted.

Implementation: The study will provide design features to reduce the economic costs of accidents, vehical removal, maintenance operations and travel delay caused by the problem of snow drifting at highway grade separations.

Project Title: Film - "Recycled Portland Cement Concrete Pavement"

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

Principal Investigators: D. J. Brown, V. J. Marks, J. V. Bergren

Contract Period: June 16, 1977 to March 1, 1978

Contract Amount: \$14,000

Funding: 100 percent Federal funds

Research Objective: To prepare a high quality 16 mm color, sound film showing the reason for P.C.C. recycling, preliminary investigation work, (trial mixes and designing), all phases of construction and benefits from P.C.C. recycled projects.

Project Activities: Filming of all aspects of the recycling operation have been obtained from the I-680 project north of Council Bluffs and the lowa 2 project in Taylor County. Editing, narration and technical work were completed.

Progress: The film has been completed and delivered to the Federal Highway Administration. The film has received very favorable acceptance and wide circulation among other governmental agencies as well as private organizations.

Reports: The film has been completed and delivered.

Implementation: In an effort to help conserve natural resources, this film describes an alternative for use in parts of Iowa and other states where aggregates of acceptable quality are not locally available.

Project Title: Recycling Cass County I-80 Asphalt Concrete

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

Contract Period: August, 1977 to completion

Contract Amount: \$12,000

Funding: 100 percent Federal funds

Research Objective: 1. To test handling and processing procedures. 2. To develop design criteria. 3. To evaluate performance of this recycled material which was damaged by moisture, temperature and traffic.

Project Activities: Approximately 40,000 tons of asphalt concrete were removed and piled for storage in Cass County. Laboratory tests indicate that the material has considerable value when upgraded with approximately 35% virgin material. A field trial is needed to verify laboratory findings.

Progress: Approximately 300 tons of this recycled material was placed on a test section of U.S. 169 south of Algona. The salvaged mix was blended with virgin aggregate and placed 1¹/₂ inches thick on old Portland Cement Concrete pavement.

Reports: A progress report has been completed.

Implementation: The information and test data obtained will be utilized to develop the necessary parameters for appropriate incorporation of this waste asphalt material in additional projects.

Project Title: Evaluation of asphalt sprinkle treatment to probate a non-skid surface.

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division.

Principal Investigator: D. D. Jordison

Contract Period: January 18, 1978 to January, 1981

Contract Amount: \$10,000

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixture of local aggregates for surface courses, followed by a sprinkle treatment of non-polishing aggregates to produce a durable, non-skid pavement surface.

Project Activities: During the 1977 construction season, several projects were initiated by the Highway Division of the Iowa DOT using sprinkle applications of high grade aggregate to achieve the desired non-skid surface. Several projects are also planned for 1978.

Progress: Eleven (11) different sprinkle treatment projects using various aggregates were completed during the 1978 construction season.

All projects are performing well, although some aggregate loss is evident on certain projects. Periodic field reviews will continue.

Reports: "Sprinkle Treatments", FHWA Interim Report-June, 1978.

Implementation: The sprinkle treatment procedure saves money by utilizing a limited amount of expensive aggregates, while providing a longer lasting pavement texture and improving the frictional coefficients of the pavement.

Project Title: Consolidation Monitoring Device

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division.

Principal Investigator: V. J. Marks

Contract Period: June 1, 1978 to December 1, 1978

Contract Amount: \$11,110

Funding: 100 percent Federal funds

Research Objective: To evaluate the usefulness, accuracy, precision and reproducibility of a device which continuously monitors the consolidation of plastic Portland Cement Concrete pavements under production conditions.

Project Activities: A license to use the CMD was obtained from the U.S. Nuclear Regulatory Commission. It was required that the device be under the direct supervision of a qualified person at all times. Laboratory evaluation and calibration was completed in the Materials Laboratory at the Iowa DOT.

Progress: The CMD was used during the months of June and July on Iowa 44 in Audubon and Guthrie Counties. Data was collected on over five miles of paving operation. Records on maintenance, operation and a safety log were

also maintained.

Reports: None

<u>Implementation</u>: This device, which automatically monitors and records density during pavement construction, may be utilized in allowing strength specifications to be met more easily.

Of HIGHWAY RESEARCH And DEVELOPMENT In IOWA



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HIGHWAY DIVISION OFFICE OF MATERIALS

DECEMBER 1979

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Disclaimer

The contents of this report reflect the views of the author and do not necessarily reflect the official views or policy of the Iowa Department of Transportation or the research agency. This report does not constitute a standard, specification or regulation.



7-T68M 1979

ANNUAL REPORT

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE FISCAL YEAR ENDING JUNE 30, 1979

By

VERNON J. MARKS RESEARCH ENGINEER OFFICE OF MATERIALS HIGHWAY DIVISION IOWA DEPARTMENT OF TRANSPORTATION

DECEMBER 1979

AMES, IOWA 50010 (515) 296-1447

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Research Project Descriptions
TABLE I CONT. IOWA HIGHWAY RESEARCH BOARD

Member

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011

G. Calvert Deputy Director, Development Iowa DOT-Highway Division Ames, IA 50010

R. H. Given Deputy Director, Staff Iowa DOT-Highway Division Ames, IA 50010

W. A. Groskurth Mitchell County Engineer Osage, IA 50461

R. C. Henely District 6 Engineer Iowa DOT-Highway Division Cedar Rapids, IA 52404

R. G. Hering Dean of Engineering

Alternate

P. W. Peterson Associate Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011

T. E. McElherne Specifications Engineer Iowa DOT-Highway Division Ames, IA 50010

F. O. Bloomfield Maintenance Engineer Iowa DOT-Highway Division Ames, IA 50010

W. A. Moellering Fayette County Engineer West Union, IA 52175

R. F. Percival District 5 Engineer Iowa DOT-Highway Division Fairfield, IA 52556

K. Rim Associate Dean for Research

University of Iowa Iowa City, IA 52240

E. Niebuhr City Engineer Clinton, IA 52732

L. G. Petersma Van Buren County Engineer Keosauqua, IA 52565

E. Schornhorst Shelby County Engineer Harlan, IA 51537

D. R. Shaw Ida County Engineer Ida Grove, IA 51445

D. L. Smith Delaware County Engineer Manchester, IA 52057 University of Iowa Iowa City, IA 52240

R. Kirchner City Engineer Fort Dodge, IA 50501

G. L. Gronvold Jefferson County Engineer Fairfield, IA 52556

D. J. Lynam Adair County Engineer Greenfield, IA 50849

D. D. Linnan Buena Vista County Engineer Storm Lake, IA 50588

L. Mattusch Clinton County Engineer Clinton, IA 52732

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division or the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farm-to-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1979. Total expenditure was \$439,962.74 including support of the National Cooperative Highway Research Program (see page 6).

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; they cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section wishes to express their 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 Officals --AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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 1½ percent of the receipts in the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund (designated "Farm-to-Market") is itemized in Table II.

The values shown in Table II are actual research expenditures for fiscal year 1979. The Office of Transportation Inventory engineering studies included traffic counts and secondary road inventories. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based upon obligations for expenditures on research projects and not the actual expenditure. The Fiscal Year 1979 financial summary is:

Beginning Balance 7-1-78

1,063,891

Receipts		
Interest	60,487	
Fed. Sec. Rd.		
(11% of receipts)	142,233	
State RUTF (12% of receipts)	430,460	
Sub-Total	The Parameter Street	633,180
Total Funds Available		1,697,071

Obligation for Expenditures

Obligated for		
Contract Research	461,587	
Non-Contract		
Engineering Studies	319,957	
Total Expenditures		781,544
BALANCE (6-30-79)		951,527

SECONDARY ROAD TRAFFIC COUNT PROGRAM

During fiscal year 1979, the traffic count program conducted by the Office of Transportation Inventory on the Secondary Road System in 26 Counties required a total of 2,601 4-hour or 8-hour manual counts. The traffic data from these counts was used to develop motor vehicle traffic flow maps for each county showing the average annual daily traffic (ADT) on specific road sections in each county. A secondary road inventory was completed in 8 counties and partially completed in 4 counties. This data provides the county engineer, highway engineer, planner, and administrator with essential information needed for the determination of design standards, systematic classfication of highways, and the development of programs for improvement and maintenance of secondary roads. This traffic data is also added to the Iowa Department of Transportation's Secondary Road Base Record. This record is utilized for the preparation of numerous reports and studies including the annual vehicle miles of travel, mileage summaries, need studies, special studies, accident analysis, etc.

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TABLE II RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1978 to June 30, 1979

Project	Primary	Farm-to-Market	Total
140	\$11,000.00	\$33,000.00	\$44,000.00
186	24,227.91	23,629.01	47,856.92
187	1,242.00	1,062.00	2,304.00
188	-	28,000.00	28,000.00
189	400.05	167.82	567.87
190	2,467.06	2,153.74	4,620.80
194		31,671.34	31,671.34
195	59,721.63		59,721.63
197	13,466.69	16,730.70	30,197.39
198		38,716.62	38,716.62
200		16,300.00	16,300.00
202	38,800.59	8,995.90	47,796.49

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203		6,303.54	6,303.54
204		17,750.23	17,750.23
1013	1,555.12		1,555.12
Sub-total	\$152,881.05	224,480.90	377,361.95
NCHRP	56,333.35	5,537.21	61,870.56
HPR-2(113)	(411.95)	(58.97)	(470.92)
HPR-2(119)	1,051.86	149.29	1,201.15
TOTAL	\$209,854.31	\$230,108.43	\$439,962.74

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of the fiscal year beginning July 1, 1978 and ending June 30, 1979. An open file for each project is maintained for the project's inception to completion; completion is signified by the acceptance of the final report and the making of the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.

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HR-140 Project Number:

Project Title: Collection and Analysis of Stream Flow Data

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

Principal Investigator: D. K. Leifeste, U.S.G.S.

Project continued to September 30, 1980 by approval Contract Period: of the Director -- Highway Division

\$44,000 per year (matched by \$44,000 from the Depart-Contract Amount: ment of Interior)

100 percent State funds; 50 percent Primary and 50 percent Funding: Farm-to-Market

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

The Water Resources Division employs a staff of Project Activities: engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and analyzed to form the basis for predictions of future streamflow.

The progress during 1978-1979 was in accordance with schedules Progress: established by the Water Resources Division.

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

Project Title: Investigation of Pavement Wear in Relation to Studded Tire Use

Office of Materials, Research Section, Iowa Depart-Research Agency: ment of Transportation

Principal Investigator: V. J. Marks, Materials Research Section

Contract Period: August 20, 1969 to completion

Contract Amount: \$1,130

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

Research Objective: The objective of this project is to measure pavement wear caused by studded tires and to estimate the extend of future wear if studded tires remain legal in Iowa.

Project Activities: Annual surveys of studded tire use were made by Iowa DOT personnel during the years 1969 through 1978. The surveys were made by observing tires on parked vehicles in parking lots and on streets. Moving vehicle counts and wear measurements were also made to determine studded tire use and wear.

Final analysis of the studded tire wear measurements and the Progress: additional safety hazards involved, resulted in a recommendation that studded tires be banned in Iowa. The project has been completed.

Reports: Final report, June 1979.

The findings from Research Project HR-148 are being used Implementation: to support recommendations adopted by the Iowa Department of Transportation concerning the banning of studded tires in Iowa.

Project Title: Experimental Steel Fiber Reinforced Concrete Overlay

Greene County and Iowa Department of Transportation, Research Agency: Highway Division

Principal Investigators: R. Betterton, Greene County and Vernon J. Marks Materials Research Section

December 20, 1972 to completion Contract Period:

\$60,000 Contract Amount:

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

To determine the feasibility of mixing, placing Research Objectives: and finishing various fibrous concrete overlays and to evaluate the overall performance, longevity and maintenance characteristics of the overlays.

Project Activities: A fibrous Portland Cement Concrete overlay was placed on 3.03 miles of Greene County Road E-53 (old US 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length and fiber content.

The fibrous concrete overlay and various control sections were Progress: placed in FY 1974. Performance was observed and crack survey reports were distributed annually. A final crack survey report was completed late in 1978. All experimental sections are serviceable and still in place, although some longitudinal cracking is evident.

Reports: Final report, December, 1978.

Future use of the fibrous concrete will then depend Implementation: primarily on its cost in comparison with other resurfacing techniques. Results from the project have shown that fibrous concrete can be used to produce thin, high performance highway pavement overlays. However, improvements in the cost-effectiveness of fibrous concrete are needed if this type of pavement resurfacing is going to be developed to any significant degree. Conventional concrete without fiber reinforcement was less expensive and yielded better performance.

Project Title: Recycled Asphalt Pavement

Research Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely, Kossuth County

Contract Period: May 1, 1975 to completion

Contract Amount: \$50,000

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

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications and cost estimates were completed early in 1975.

Progress: Construction of the proposed project was completed during the summer of 1975. Observations will be made for a period of several years.

Reports: A September 3, 1975 report has been prepared.

Implementation: This project proved that recycling of asphalt concrete is feasible and that additional research was needed to solve related problems. Research Project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977, research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials. Kossuth County has accepted recycled asphalt pavement as a standard reconstruction practice.

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Project Title: Concrete Bridge Deck Repairs Using Injected Epoxy Resin Research Agency: Iowa Department of Transportation, Highway Division Principal Investigator: E. O'Connor, Maintenance

Contract Period: May 6, 1975 to November, 1978

\$3,000 Contract Amount:

100 percent State, Primary funds Funding:

Research Objective: To provide the special equipment necessary for use in injecting epoxy resin in delaminated areas in bridge decks and to determine if this material does prevent or delay the formation of spalls in bridge decks.

Project Activities: In 1975, \$3,000 was authorized for acquisition of an epoxy injection machine from a manufacturer in Topeka, The equipment was delivered late in the summer of 1975. The Office Kansas. of Materials assisted in the evaluation of the results over a three-year period.

Progress: Epoxy injections were made on three different bridges. Some problems were encountered in drilling holes and in the injection of the epoxy resin. The equipment seems to be more applicable to large areas of delamination. An effort to use the unit to repair cracks in a prestress beam was unsuccessful. Continued observation and monitoring of repaired deck areas will be required to determine long term results.

Reports: Final report, January, 1979.

There has been only a limited opportunity to use the Implementation: epoxy injection process to rebond delaminated areas in bridge decks, however, results to date would indicate that there are instances this repair procedure can be used advantageously.

Project Title: Pavement Deflection Study

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: C. Potter, D. Heins, Materials

Contract Period: November 5, 1975 to March 1, 1979

Contract Amount: \$26,000

Funding: 100 percent State, Primary funds

Research Objective: To determine if the test equipment can provide data of sufficient accuracy to be used effectively in pavement design and to determine the seasonal deflection variation of flexible pavements.

The Road Rater was delivered by the manufacturer Project Activities: early in the spring of 1976. A tentative work plan for conducting a variety of pavement deflection studies was completed.

Correlations with Benkelman Beam data and AASHTO structural Progress: numbers have been obtained. There have been some equipment problems with the Road Rater, however, the unit has demonstrated its ability to increase the quantity of testing with the greater capacity for testing. An inventory program has been initiated.

Reports: Final report, February, 1979

This project has proven that the Road Rater is a useful Implementation: and effective tool in the design and maintenance of flexible pavements. A goal is to establish structural ratings for all primary flexible roadways in Iowa.

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Project Title: An Evaluation of an Epoxy Pavement Marking System

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: J. H. Moody, Maintenance

Contract Period: April, 1976 to completion

Contract Amount: \$4,925

Funding: 100 percent State, Primary funds.

Research Objective: To determine if epoxy paint is an economical alternative to standard paint on high traffic multi-lane roadways and to determine if epoxy lane markings will last an entire winter season without replacement.

Project Activities: An experimental epoxy based paint developed by the H. B. Fuller Company and the Minnesota Department of Highways was applied on several lanes of Interstate 235 in Des Moines. Standard striping paint was also used in the vicinity for comparison purposes.

Progress: The sandblasting and painting was only partially completed due to equipment failure. Observations made following the application indicated some irregularities due to an improper mixture of the epoxy components. In September, 1979, the Century Fence Company replaced some of the pavement markings which were previously improperly applied. No problems were encountered during the application of the paint. Nighttime observation of the newly applied traffic paint has shown reflectivity equal to or better than standard lane markings. Evaluation of this newly applied line will continue for a minimum of three years.

Reports: HR-180 Final report, November, 1978.

Implementation: This project has shown that an application of properly mixed epoxy paint will provide more durable traffic lane markings for use on multiple lane highways. Further research is recommended using updated equipment for surface cleaning and epoxy paint application.

Project Title: The Evaluation of Macadam Stone Shoulders

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist, Materials

Contract Period: May 25, 1975 to completion

Contract Amount: \$8,143

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of using a Macadam Stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of Macadam Stone shoulders, and to evaluate the performance of Macadam Stone Shoulders.

Project Activities: This experimental type of shoulder construction was incorporated into a Dallas County project on US 6. Shoulder construction operations were observed and methods and procedures were recorded. Structural number comparisons between Macadam shoulders and recently constructed stabilized and paved shoulders is continuing.

Progress: The shoulder construction work has been completed. A recent visual observation showed that the shoulders with the asphalt concrete surface were performing well with no spots on the surface. The side with the cover aggregate seal has some damage and open surface. A visual and structural evaluation program will be continued for the duration of the project. Long term effects from traffic and environmental factors will also have to be determined.

Reports: A construction report was distributed in November, 1977.

Implementation: This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

Project Title: An Evaluation of Cover Aggregate Stripping Characteristics

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: K. Isenberger, R. D. Smith, Materials and B. Dunshee, Maintenance

Contract Period: May 25, 1976 to completion

Contract Amount: \$15,000

Funding: 100 percent State, Primary funds

Research Objective: To identify the stripping susceptibility of various types of cover aggregates in Iowa.

Project Activities: This research project was incorporated into the 1976 Iowa DOT Maintenance Contract seal coat program as a division of a project on Iowa 210 between Interstate 35 and Maxwell, Iowa. Twenty-nine different cover aggregate types were tested and standard seal coat specifications were used.

Progress: Samples to determine the amount of aggregate retained on the surface were taken at periodic intervals and results of the tests for aggregate retention were evaluated. Due to the influence of unexpected variables upon field samples, laboratory data are reliable for only the most general observations. Conclusions indicate that gravels as a group appear to be retained better than carbonates and rainfall shortly after seal coat placement can affect aggregate retention. Field observations were summarized and an analysis of skid resistance data was completed.

Reports: Final report, February, 1979.

Implementation: The research was used to rate the various aggregates for use as cover aggregates. A performance summary listing was developed as a guide to be used in cover aggregate construction or maintenance.

Project Title: Determination of Rumble Strip Effectiveness

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: S. Basu, V. J. Marks, B. Dunshee

Contract Period: August, 1976 to completion

Contract Amount: None

Funding: (Maintenance Operation)

Research Objective: To identify the effectiveness of the rumble strip as a traffic safety device when used on a widespread basis in both rural and urban situations.

Project Activities: Written agreements were signed with each of the participating counties. The rumble strips were cut at approved, designated locations.

Progress: Total intersection related accident data was evaluated on a before and after basis. A saturation use of rumble strips was also studied. Results of this study indicate that the greatest benefit of this type of use can be derived from areas with low traffic volumes.

Reports: Final Report, January, 1979.

Implementation: The investigation of accidents at the various test sites showed that rumble strips were effective in reducing certain types of intersection accidents. No statistically significant effect of saturation use was found on total accidents, although there are indications that accidents may be reduced when used in low density or rural type areas.

Project Title: Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Construction

Research Agency: Iowa State University

Principal Investigators: W. D. Shrader, S. J. Henning, Iowa State University

Contract Period: January 1, 1977 to December 31, 1980

Contract Amount: \$172,085

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

Research Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil to varying conditions and various tillage practices and to determine the effects of land surface elevation above drainage tile or perched water tables.

Project Activities: A four-year contract has been signed with Iowa State University. Work is completed on the selection of sites in several counties for borrow pits with desirable characteristics.

Progress: Four borrow pit sites have been selected for the research. Temporary easements or rental arrangements have been worked out. Borrow pit shaping, top soil replacement and crop planting were completed at two of the site locations.

Reports: A second Annual Progress Report (1978) was completed and distributed.

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared. Crop yield reports for 1978 for the two sites were received and evaluated. The two remaining sites were completed in October and November, 1978. All four sites will be used for agricultural production in 1979.

Project Title: Development of a Minicomputer Controlled Frost, Ice and Snow Detector for Bridge Hazard Monitoring

Research Agency: Cytroncis Incorporated

Principal Investigator: P. W. Poppe

Contract Period: January 13, 1977 to May 1, 1979

Contract Amount: \$19,500

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

Research Objective: To design, develop and deliver a microprocessor controlled frost, ice and snow detector with the capability to accurately detect frost, ice and snow in the presence of de-icing chemicals under normal conditions at bridge sites.

Project Activities: Laboratory testing, design and development work for Phase I were completed early in the project. Several modifications were made in the original equipment in an attempt to improve reliability.

Progress: Field testing of equipment could not be completed due to a lack of frost during the first winter season. Several extensions were granted for this project to allow for modification of equipment and additional field testing in attempts to attain the desired reliability. It was concluded that some of the technical problems could be corrected with additional equipment and testing. However, sensor damage and installation difficulties related to winter maintenance will continue to be major problems. The project was terminated, but final evaluation of the unit will be done by Iowa DOT Maintenance personnel. The frost and ice detector equipment was turned over to the Iowa DOT in the spring of 1979. Problems with damage to bridge deck sensors caused by snow plows and traffic and heater circuit limitation have resulted in a considerable amount of down time. The experience of the past winters again point out the environmental difficulties related to the maintenance and operation of frost and ice detector installations.

Reports: A progress report has been distributed.

Implementation: Modifications have improved the effectiveness of the detector, but further evaluation is necessary. The development of an effective frost, ice and snow detector will result in improved motorist safety, reduced tort liability and reduced annual expenditures for winter maintenance.

Project Title: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations

Research Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely

Contract Period: April 11, 1977 to completion

Contract Amount: \$50,000

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

Research Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Project Activities: A work plan has been completed. The project was let on June 21, 1977. Several contractors and equipment manufacturers showed an interest in the project.

The project was considered to be very successful. Recycled Progress: asphalt proved to be good quality material at a savings of approximately 30 cents per ton over virgin material. Through modifications of equipment, all D.E.Q. requirements for air pollution were easily met and the project gained nationwide and world-wide recognition.

Reports: A progress report was distributed in December, 1977.

In the interest of conserving energy and material, the Implementation: elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. The "drum in a drum" asphalt plant modification will prevent pollution while allowing normal production utilizing recycled materials. The plant modification is commerically available and will promote recycling and in turn conservation of natural resources.

Project Title: A Study of the Spergen Formation of Southeastern Iowa

Research Agency: Iowa Geological Survey

Principal Investigator: B. L. Milne

Contract Period: April 12, 1977 to December 31, 1978

Contract Amount: \$4,880

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

Research Objective: To provide detailed geographic and stratigraphic information on the location of Spergen Formation in eight southeastern counties in Iowa. Efforts were made to trace the depth and characteristics of the Spergen in order to find potentially viable areas for mining or quarrying.

Project Activities: The research was carried out by the University of Iowa, Department of Geology. Attempts were made to designate desirable locations for further exploration.

Stratigraphic data was collected by the Iowa Geological Survey Progress: and field investigations were completed. Samples were collected at six localities and mapped in the subsurface in a seven county area. Well logs were selected from a computer printout, supplied by the Iowa Geological Survey.

Reports: Final Report, December, 1978.

Copies of the final report were forwarded to the Iowa Implementation: Limestone Producers Association for further distribution. The potential remains for additional research on the Spergen Formation of southeastern Iowa. Additional coring and rock analysis would be necessary to determine the physical properties of recommended sites.

Project Title: Bonded, Thin-Lift Non-Reinforced Portland Cement Concrete Resurfacing.

Research Agency: Clayton County and Iowa Department of Transportation, Highway Division

Principal Investigator: M. L. Johnson

Contract Period: May 16, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent State, Farm-to-Market

Research Objective: The research objectives are: 1. To establish methods and procedures for surface preparation for p.c. concrete resurfacing; 2. To establish mixing procedures using super water reducing admixtures and to study the economics and performance of portland cement resurfacing; 3. To determine if this method of overlay can be considered as a viable alternative for concrete pavement restoration.

Project Activities: A contract was signed with Clayton County. The plans and specifications have been completed. The project was let in July, 1977.

Progress: A thin-bonded low slump portland cement concrete overlay was placed on a 1.3 mile portion of a secondary Clayton County road in September, 1977. No major problems were experienced in mixing and proportioning the concrete. An adequate bond was developed and the project is performing well. Evaluation will continue for a five year period.

Reports: A construction report has been completed, September, 1977.

Implementation: This research will determine whether bonded, thin-lift non-reinforced portland cement resurfacing is a viable alternative for concrete pavement restoration and rehabilitation. Based upon the success of this project, a thin-bonded overlay rehabilitation was used on I-80 in Pottawattamie County.

Project Title: An Evaluation of Dense Bridge Floor Concrete

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. W. Pratt, J. V. Bergren

Contract Period: May, 1977 to completion

Contract Amount: \$3,340

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of mixing, placing and finishing dense portland cement concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity and maintenance performance of dense portland cement concrete.

Project Activities: The project is located in the Town of Ackley on US 20 in Hardin County. The construction involved the redecking of a multiple span overhead crossing over a railroad. It was proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture.

Progress: A portion of a full depth bridge deck using concrete with a high range water reducer was placed in August 1977. Problems were encountered in pumping the concrete and in controlling slump and air content. Cores from the deck yielded good air contents for both the Standard D-57 concrete and the high range water reducer (HRWR) concrete. The calculated one year strength for the D-57 concrete was 6650 psi and 8500 psi for the HRWR concrete. The chloride content was slightly higher in the D-57 concrete. The cores revealed good consolidation of both concretes, even though the bottom surface of the HRWR exhibited an open honeycomb appearance.

Reports: A construction report has been completed, December, 1977.

Implementation: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if this admixture is a solution to the problem of corrosion of steel in bridge decks.

Project Title: Mission Oriented Dust Control and Surface Improvement Processes for Unpaved Roads

Research Agency: Iowa State University

Principal Investigator: J. M. Hoover

Contract Period: July 1, 1977 to December 31, 1979

Contract Amount: \$99,860

Funding: 100% State, Farm-to-Market funds

Research Objective: To identify current practices, products and specifications of potentially economic dust control systems and to plan, design and construct a series of demonstration test sections in several regions in Iowa for the purpose of evaluating materials, construction costs and performance of various dust control methods.

Project Activities: A contract has been signed with Iowa State University and an Advisory Committee has been selected. Site selection, based on geographic/geologic regions in the State, has been completed. Additional sites were added in order to get adequate representation of soil aggregate characteristics of the various regions.

Progress: Current dust control practices and specifications are being evaluated. Dust collectors were established at all locations this spring and dust collection techniques will be continued until construction.Design testing and recommendations to individual counties for test section construction is nearly completed. Categories of products for use on individual test sections have been recommended to counties.

Reports: Semi-annual progress reports have been submitted.

Implementation: The project will identify alternate practices and the most economical methods of dust control.

Project Title: Field Performance and Evaluation of Slurry Seal Coats

Research Agency: Iowa State University

Principal Investigator: D. Y. Lee

Contract Period: July 1, 1977 to August 31, 1980

Contract Amount: \$91,000

Funding: 100 percent State, Primary funds

Research Objective: To evaluate performance characteristics of materials native to Iowa and applicability of other materials in slurry seals, mix designs and to correlate laboratory tests with field performance.

Project Activities: This project is the second phase of a two part study. Construction on Phase II, a field performance evaluation of slurry seals was delayed due to inflated costs. Under a revised schedule, the project was let in April, 1978 and a time extension through August 31, 1980 was granted with an additional \$11,000 in research construction funding.

Progress: Application of the slurry seal test sections and approximately half of the control sections were completed in September, 1978.
Problems were encountered in obtaining the optimum emulsion content. Some test sections failed and were replaced. Resurfacing of the remaining control sections was completed during the 1979 construction season. Evaluation of the test sections will be continued.

Reports: None

Implementation: The project will provide a basis for the development and preparation of slurry seal, design methods, criteria, procedures and specifications for the successful application of slurry seal as an economic pavement maintenance alternative.

Project Title: Fatigue Behavior of High Air Content Concrete--Phase II

Research Agency: Iowa State University

Principal Investigator: D. Y. Lee, F. W. Klaiber

Contract Period: October 1, 1977 to January 31, 1979

Contract Amount: \$49,425

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

Research Objective: To determine the effects of various air contents, various water-cement ratios, and different aggregate types on the flexural fatigue strength of plain concrete and to develop fatigue curves that incorporate these effects.

Project Activities: Materials for the project have been purchased and the first batch of concrete was poured in January, 1978. Fatigue testing began in February, 1978. Fifteen series of concrete were investigated in the study. Variables consisted of air-content, watercement ratios, coarse aggregate types and fine aggregate types.

<u>Progress</u>: A planning meeting was held in November, 1977. Aggregate and material sources were determined and material combinations were modified in order to obtain better results. Conclusions from the study indicate that the fatigue behavior of plain concrete in flexure is affected by the air content and by the water-cement ratio. The project has been completed.

Reports: Final Report, February, 1979.

Implementation: The fatigue curves developed in this study will be compared to those followed in the Iowa DOT pavement design procedures. Results from the study collaberate well with data from the Portland Cement Association.

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

Research Agency: State Archaeologist (University of Iowa)

Principal Investigator: M. McKusick

Contract Period: July 1, 1977 to June 30, 1979

Contract Amount: \$33,000

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

Research Objective: 1. To determine well in advance of highway construction if proposed planning corridors contain known or probable sites of archaeological value. 2. To locate such sites and describe their limits as accurately as possible without resorting to excavation or other detailed examination.

Project Activities: The Iowa Department of Transportation had an ongoing contract with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary reports.

Progress: Secondary road construction sites with archaeological value are being examined in advance of construction. Under a new Iowa DOT policy, a revolving fund will be established within the Secondary Road Research Fund to initially pay for the services of a survey contractor and to prepare billings to the counties and cities for their

proportionate share of costs incurred.

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

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

Project Title: Upgrading Asphalt Surface Friction by Aggregate Sprinkle Treatments

Research Agency: Iowa Department of Transportation, Highway Division

Principle Investigator: R. A. Shelquist

Contract Period: June 1, 1978 to December 31, 1983

Contract Amount: \$42,500

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixtures of local aggregates for 1" and 1'z" thick surface courses followed by a surface sprinkle treatment of pre-coated hard, durable chips to produce a long lasting non-skid pavement surface.

Project Activities: Preconstruction plans and arrangements were completed. The contract was let on May 23, 1978. This experimental type of resurfacing was applied on old US 30 between Interstate 35 and the City of Nevada.

Progress: The paving and sprinkle treatments have been completed. Appearance is very good with the exception of some corregation which occurred during application. Texture depth testing by the silly putty method has been completed for all test sections.

Reports: Progress Report, October, 1979.

Implementation: This project will be utilized in the evaluation of paving materials and texturing. It will also assist in determining the effectiveness of maintenance practices to increase skid resistance.

HR-200 Project Number:

Project Title: Fly Ash In Portland Cement Concrete Pavement-Monona County

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

Principal Investigator: O. D. Ives

Contract Period: February 21, 1978 to completion

Contract Amount: \$16,300

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

Research Objective: 1. To evaluate problems related to shipping, storing, and placing fly ash. 2. To establish a procedure for batching, mixing and placing concrete with specified air content. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: Plans and specifications were completed and the project was let early in the spring of 1978. Samples of the fly ash were obtained from the source and a history of sample testing was completed prior to construction.

Paving on Monona County Road E-54 was completed in June, 1978. Progress: Minor modifications were made in the batching system, but no special problems were encountered in the paving operation using conventional equipment. General appearance and workmanship of the concrete appears to be satisfactory. The concrete produced appears to date to be of a comparable quality to standard portland cement concrete.

Construction Report, December, 1978. Reports:

Implementation: Laboratory studies and limited field use has shown that the utilization of fly ash in concrete has resulted in a cost savings and material conservation along with the disposal of a waste product. Results of the use of fly ash in p.c. concrete in Monona County have been encouraging. It was recommended that specifications be developed for portland cement concrete using fly ash for paving and structural work.

Project Title: Fly Ash in Portland Cement Concrete Pavement-Woodbury County

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

Principal Investigator: C. E. Leonard

Contract Period: March, 1978 to completion

Contract Amount: None (no additional cost)

Research Objective: 1. To determine the problems related to shipping, storing and batching fly ash. 2. To establish procedure for mixing, and placing uniform concrete using fly ash. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: The proposed research was incorporated into two bridge replacement projects on Iowa 982. The project includes paving two bridge approach sections at two bridge construction sites.

Progress: Construction on these two bridge replacement projects was completed in October, 1978. No problems were observed in handling or in batching fly ash through a central ready mix plant. Little difference was noted in paving with fly ash mixes as compared to standard concrete mixes.

Reports: Construction Report, May, 1979

Implementation: Fly ash can be used successfully in paving mixes. Quality control test results show that specification air content, slump and flexural strength can be achieved with normal paving operations.

Project Title: Wind Tunnel Analysis to Determine the Effect of Adjustment in the Adjacent Topography on Drifting Snow at Highway Grade Separations.

Research Agency: Iowa State University

Principal Investigator: S. L. Ring

Contract Period: June 1, 1978 to July 13, 1979

Contract Amount: \$61,151

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

Research Objective: 1. To reproduce blowing and drifting snow using scale models in a wind tunnel. 2. To analyze effects of strategically placed vegetation, snow fences or structures in order to make recommendations for controlling drifting snow at highway grade separations.

Project Activities: A contract agreement was negotiated and model parameters based on highway design criteria were established. A literature search was completed and field interviews to obtain information on drifting snow were conducted.

Progress: Scale models were constructed and tested in the wind tunnel to reproduce snow drifting phenomenon. The model was modified to represent the introduction of plantings and changes in the physical configuration of the adjacent topography. The effects of snow drifting phenomenon were then observed and recommendations for field testing were made.

Reports: Final Report, June, 1979

Implementation: The study will provide design criteria to reduce the economic costs of accidents vehical removal, maintenance operations and travel delay caused by the problem of snow drifting at highway grade separations.

Project Title: Transverse Joint Sealing with Various Sealants

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

Principal Investigators: G. Hardy, V. J. Marks

Contract Period: July 25, 1978 to December 31, 1983

Contract Amount: \$51,000

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

Research Objective: To evaluate the performance of pcc pavement contraction joints utilizing a variety of sealants and joint preparations and to identify an effective joint sealant system.

Project Activities: These experimental pavement joints were incorporated into a Secondary Road paving project in Dallas County during the 1978 construction season. Joint sealing procedures, materials and specifications were determined prior to construction.

Progress: Six different sealant materials were used with three methods of joint cleaning. Other variables were introduced and some cost comparisons were made. Core samples for joint sealant analysis were taken in the spring of 1979. Visual observations are being made periodically.

Reports: Progress Report, July, 1979.

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

Project Title: Safer Construction and Maintenance Practices to Minimize Potential Liability by Counties from Highway Accidents

Research Agency: Iowa State University

Principal Investigator: R. L. Carstens

Contract Period: September 1, 1978 to September 30, 1979

Contract Amount: \$38,335

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

Research Objective: To give county engineers guidance in the selection and implementation of measures that will reduce the potential liability of counties for accidents resulting from alleged imperfections in highway facilities.

Project Activities: A literature search dealing with tort claims for counties has been completed. An analysis of tort claim experience derived from questionnaire responses from 85 counties was also completed. Studies to evaluate blading operations and methods of developing advisory speeds on curves on unsurfaced roads were also undertaken.

Progress: Analysis of data has been completed and a tenative list of recommendations has been circulated to advisory groups for evaluation. Additional suggestions are being solicited.

Reports: A final report is being completed.

Implementation: This study will assist county engineers in establishing guidelines relating to highway construction and maintenance practices, including the use of traffic control devices that will improve highway safety and reduce the potential liability by counties.

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

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Contract Period: December 14, 1978 to December 31, 1985

Contract Amount: \$3,150

Funding: 100 percent State, Primary funds

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

Project Activities: Approval was granted and specifications were approved for incorporating the special coarse aggregate into two bridge deck overlay projects on Interstate 35 near Ankeny, Iowa.

Progress: Resurfacing of the bridge decks was completed in the summer of 1979. The use of special aggregates resulted in a more consistent mix with improved workability and greater ease of finishing and texturing.

Reports: None

Implementation:

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

HR-206 Project Number:

Project Title: Cement Produced from Fly Ash and Lime

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigator: W. Rippie

Contract Period: April 1, 1979 to June 30, 1980

\$2,510 Contract Amount:

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

To determine if a fly ash-lime cement with desir-Research Objective: able characteristics can be produced and to determine the combination of ingredients necessary to attain this end.

The materials and supplies have been obtained from Project Activities: various sources and laboratory work is underway. Facilities at the Coal Research Laboratory at the University of West Virginia will be utilized to melt and process materials in the production of the new cement.

Initial laboratory work has been completed. A group of samples Progress: has been forwarded to the West Virginia Laboratory for processing.

None Reports:

In view of continued shortages of portland cement, utili-Implementation: zation of fly ash, a waste product, will conserve energy and increase cement supply for construction projects.

Project Title: Feasibility of Wind-Powered Aeration of Rest Area Lagoons

Research Agency: Iowa State University

Principal Investigator: J. L. Cleasby

Contract Period: June 1, 1979 to September 20, 1979

Contract Amount: \$8,870

Funding: 100 percent State, Primary funds

Research Objective: To evaluate the feasibility of using wind-powered equipment to aerate rest area lagoons to permit existing lagoons to accomodate higher seasonal BOD loadings than were intended in the original lagoon design.

Project Activities: Phase I will include an evaluation of load projections on rest area lagoons, lagoon design, seasonal aeration requirements and Iowa DEQ regulations. The design of the lagoons was studied and a survey of the interstate rest areas was conducted.

Progress: The project has been completed. Conclusions indicate certain disadvantages to wind-powered aeration of rest area lagoons, the greatest being the fact that wind speeds are lowest during the time when the need for aeration is the greatest. Also, equipment costs are higher for wind-powered aeration than for conventional equipment. Rest area lagoons will continue to be monitored, particularly those with apparent problems.

Reports: Final Report, September, 1979

Implementation: The results of this study will result in a substantial savings to the Iowa DOT. The savings arises from a change in environmental quality standards developed for municipalities due to the unique loading of rest area lagoons. The change will eliminate the need for some reconstruction.

Project Title: Alternative Methods of Stabilizing the Degrading Stream Channels in Western Iowa

Research Agency: Iowa State University

Principal Investigator: R. H. Lohnes

Contract Period: June 1, 1979 to September 30, 1980

Contract Amount: \$79,254

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

Research Objective: To develop and evaluate several alternative methods of stabilizing the degrading channels of the streams and gullies in the loess hills of western Iowa.

Project Activities: A comprehensive inventory of grade stabilization structures will be conducted early in the project. A selected number of successful and problem structures will be chosen for detailed documentation and analysis. Phase I will also consist of a review of related work already completed and the effects of freezethaw cycles will be studied.

Progress: An inventory of channel stabilization structures is being reviewed and cost data is being collected. Topographic maps, airphotos and plans of structures are being obtained. Collection of

soil samples and additional field testing and laboratory work is also underway.

Reports: None

Implementation: Bridge structures are expensive to construct and maintain. If more economical methods of grade stabilization can be developed, it will result in the savings of millions of dollars for counties in western Iowa.
Project Title: Pavement Surface on Macadam Base

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

Principal Investigator: D. J. Lynam

June 26, 1979 to December 31, 1983 Contract Period:

\$100,347 Contract Amount:

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

Research Objective: To determine the feasibility, economics and performance of placing pc concrete Macadam base while developing design criteria by varying the thickness of the pc concrete and to determine if the Macadam base is effective in reducing D-cracking and deterioration of concrete produced with limestone of poor durability characteristics.

Construction and evaluation will be completed on Project Activities: approximately two miles of Adair County Road G-61. Seven different roadway construction procedures will be utilized. A variation in shoulder construction will be incorporated into one section. One mile adjacent to the experimental construction will be included in the evaluation of the research.

Preconstruction activity has been completed. A photo file

Progress: record of the existing grade has been completed. Construction will be completed in the fall of 1979.

Reports: None

This study will result in the ability to construct a Implementation: pavement with improved performance in regard to Dcracing and subgrade failure, hopefully at a lower cost.

Project Title: The Effect of Deer Reflectors on Deer-Vehicle Accidents

Research Agency: Iowa Conservation Commission, Iowa Department of Transportation, Highway Division

Principal Investigator: L. Gladfelter, H. Dolling, G. Albansoder

Contract Period: June 15, 1979 to September 30, 1983

Contract Amount: \$30,072

Funding: 100 percent State, Primary funds

Research Objective: To evaluate the "Swareflex" reflector system in reducing deer-vehicle accidents, to determine a cost benefit ratio for the system and to identify deer crossing areas throughout the State for possible implementation of the system.

Project Activities: Equipment is being selected and purchased. Installation of traffic counting equipment at the designated sites is underway. Deer-vehicle accident records will be maintained for one year prior to the installation of the reflectors. The study areas selected are distributed around the State so as to reflect different driving conditions, traffic volume and deer densities.

Progress: Traffic counters have been installed in each of the designated areas to document changes in traffic volumes during the study period. Records are being maintained on deer-vehicle accidents at all

selected sites.

Reports: None

Implementation: An effective deer reflector will reduce deer-vehicle accidents and thereby result in savings to the motorist.

Project Title: Evaluation of Recycled Asphalt Concrete-Kossuth County

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division

Principal Investigator: R. P. Henely

Contract Period: June, 1976 to February, 1980.

Contract Amount: \$30,000

Funding: 100 percent Federal funds

Research Objective: To determine and evaluate the properties of the recycled asphalt, the load bearing capacity and performance of the completed pavement, pollution control capacity of the plant and appurtenances, operational aspects of scarification crushing and processing equipment and the economic viability of recycling asphalt pavements on a large scale.

Project Activities: The old asphalt material was ripped, salvaged and stockpiled for crushing. No serious problems were encountered in the mixing and paving operations. An energy savings was realized in using the recycled asphalt, however, an air pollution problem persisted at the mixing plant in spite of efforts to correct it.

<u>Progress</u>: Visual inspection indicated that the recycled asphalt concrete pavement is performing well. Air pollution requirements were not met on this project, but were achieved in a 1977 project.

Reports: Construction Report, September, 1977.

Implementation: An impressive savings in energy and in the conservation of resources was realized in the completion of this project. More consideration will be given to the recycling of old asphalt pavements in the future.

Project Title: Recycling Cass County I-80 Asphalt Concrete

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

Contract Period: August, 1977 to completion

Contract Amount: \$12,000

Funding: 100 percent Federal funds

Research Objective: 1. To test handling and processing procedures. 2. To develop design criteria. 3. To evaluate performance of this recycled material which was damaged by moisture, temperature and traffic.

Project Activities: Approximately 40,000 tons of asphalt concrete were removed and piled for storage in Cass County. Laboratory tests indicate that the material has considerable value when upgraded with approximately 35% virgin material. Field trial was necessary to verify laboratory findings.

Progress: Approximately 300 tons of this recycled material was placed on a test section of U.S. 169 south of Algona. The salvaged mix was blended with virgin aggregate and placed 1½ inches thick on old portland cement concrete pavement. An inspection was made following one full year of service. Although the surface does have a very dry and somewhat ravelled appearance which may be attributed to low asphalt content, there was no evidence of rutting or shoving from traffic.

Reports: Final Report, December, 1978.

Implementation: In light of test results after one year of experience, it may be concluded that it is feasible to recycle the salvaged asphalt concrete. Laboratory tests and field observation indicate that with certain limitations, a satisfactory and uniform mixture can be produced through recycling procedures.

Project Title: Evaluation of Asphalt Sprinkle Treatment to Provide a Non-Skid Surface.

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division

Principal Investigator: D. D. Jordison

Contract Period: January 18, 1978 to January, 1981

Contract Amount: \$10,000

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using a standard asphalt mixture of local aggregates for surface courses, followed by a sprinkle treatment of non-polishing aggregates to produce a durable, non-skid pavement surface.

Project Activities: During the 1977 construction season, several projects were initiated by the Highway Division of the Iowa DOT using sprinkle applications of high grade aggregate to achieve the desired non-skid surface.

Progress: Several different sprinkle treatment projects using various aggregates were completed during the 1977 construction season. All projects are performing well, although some aggregate loss is evident on certain projects. Periodic field reviews will continue.

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Reports: "Sprinkle Treatments", FHWA Interim Report-June, 1978.

Implementation: The sprinkle treatment procedure saves money by utilizing a limited amount of expensive aggregates, while providing a longer lasting pavement texture and improving the frictional coefficients of the pavement.

Project Title: Consolidation Monitoring Device

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Contract Period: June 1, 1978 to December 1, 1978

Contract Amount: \$11,110

Funding: 100 percent Federal funds

Research Objective: To evaluate the usefulness, accuracy, precision and reproducibility of a device which continuously monitors the consolidation of plastic portland cement concrete pavements under production conditions.

Project Activities: A license to use the CMD was obtained from the U.S. Nuclear Regulatory Commission. It was required that the device be under the direct supervision of a qualified person at all times. Laboratory evaluation and calibration was completed in the Materials Laboratory at the Iowa DOT. The CMD was used during the months of June and July on Iowa 44 in Audubon and Guthrie Counties. Data was collected on over five miles of paving operation. Records on maintenance, operation and a safety log were also maintained. The project has been completed.

Progress: Results of the evaluation testing indicated that in its present state, the CMD is not a reliable instrument. Under field conditions, the air gap is difficult to maintain. Any variation from the prescribed distance for the air gap causes the accuracy of the readings to suffer. Mounting and adjustment problems were also experienced in field testing.

Reports: Final Report, November, 1978.

Implementation: This device, which automatically monitors and records density during pavement construction, may be utilized in allowing strength specifications to be met more easily. However, some modification should be made to either measure the air gap between the sensor head and the concrete surface and compensate for the difference or automatically control the air gap. A modification of this type would improve the accuracy and operation of the CMD unit. or HIGHWAY RESEARCH And DEVELOPMENT In IOWA



HIGHWAY DIVISION OFFICE OF MATERIALS

DECEMBER 1980

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ANNUAL REPORT

HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE FISCAL YEAR ENDING JUNE 30, 1980

VERNON J. MARKS RESEARCH ENGINEER OFFICE OF MATERIALS HIGHWAY DIVISION IOWA DEPARTMENT JF TRANSPORTATION

DECEMBER 1980

AMES, IOWA 50010 (515) 296-1447

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RESEARCH AND DEVELOPMENT

The Highway Division of the Iowa Department of Transportation engages in research and development for two reasons: first, to find workable solutions to the many problems that require more than ordinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report entitled, "Highway Research and Development in Iowa" is submitted in compliance with Section 310.36, Code of Iowa, directing submission of a report of the Secondary Road Research Fund. It is a report on the status of research and development projects which were in progress on June 30, 1980; it is also a report on projects completed during the fiscal year beginning July 1, 1979 and ending June 30, 1980. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials-Highway Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established in 1949.

The Research Board consists of 13 regular members; six County Engineers, three 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 alter-

nate who will serve at the request of the regular member. The membership of the Research Board as of June 30, 1980 is listed in Table I.

The Research Board held ten regular meetings during the period of July 1, 1979 to June 30, 1980. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

> TABLE I IOWA HIGHWAY RESEARCH BOARD JUNE 30, 1980

Member

W. W. Amundson City Engineer Sioux City, IA 51100

R. Betterton Greene County Engineer Jefferson, IA 50129

F. O. Bloomfield Right-of-Way Director Iowa DOT-Highway Division Ames, IA 50010

Alternate

R. Holland City Engineer Bettendorf, IA 52722

P. Dvorak Grundy County Engineer Grundy Center, IA 50638

C. L. Huisman Materials Engineer Iowa DOT-Highway Division Ames, IA 50010 TABLE I CONT. IOWA HIGHWAY RESEARCH BOARD

Member

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011

G. Calvert Deputy Director, Development Iowa DOT-Highway Division Ames, IA 50010

W. A. Groskurth Mitchell County Engineer Osage, IA 50461

R. C. Henely District 6 Engineer Iowa DOT-Highway Division Cedar Rapids, IA 52404

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52240

D. D. Linnan Buena Vista County Engineer Storm Lake, IA 50588

Alternate

P. W. Peterson Associate Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011

T. E. McElherne Specifications Engineers Iowa DOT-Highway Division Ames, IA 50010

W. A. Moellering Fayette County Engineer West Union, IA 52175

R. F. Percival District 5 Engineer Iowa DOT-Highway Division Fairfield, IA 52556

H. Kane 1202 A Engr. Bldg. University of Iowa Iowa City, IA 52242

R. Michaelis Carroll County Engineer

L. Mattusch Clinton County Engineer Clinton, IA 52732

E. Niebuhr City Engineer Clinton, IA 52732

L. G. Petersma Van Buren County Engineer Keosauqua, IA 52565

E. Schornhorst Shelby County Engineer Harlan, IA 51537 Carroll, IA 51401

G. D. Petermeir Benton County Engineer Vinton, IA 52349

R. Kirchner City Engineer Fort Dodge, IA 50501

N. Konrady Lucas County Engineer Chariton, IA 50049

D. J. Lynam Adair County Engineer Greenfield, IA 50849

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division and the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farmto-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1980. Total expenditure was \$407,403.45 including support of the National Cooperative Highway Research Program (see pg 5).

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; they cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section wishes to express their 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 Officals -- AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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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 1¹/₂ percent of the receipts in the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund (designated "Farm-to-Market") is itemized in Table II.

The values shown in Table II are actual research expenditures for fiscal year 1980. The Office of Transportation Inventory engineering studies included traffic counts and secondary road inventories. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based upon obligations for expenditures on research projects and not the actural expenditure. The Fiscal Year 1980 financial summary is.

Beginning Balance 7-1-79

931,827

795,634

1,727,461

Receipts	
Interest	75,267
Fed. Sec. Rd	
(11% of receipts)	274,657
State RUTF (12% of receipts)	442,722
External Research Income	2,988
Sub-Total	A STREET MARK
Total Funds Available	

Obligation for Expenditures Obligated for

Contract Research	110,525	
Non-Contract Engineering Studies	421,730	
Total Expenditures		532,255
BALANCE 6-30-80		1,195,206

SECONDARY ROAD TRAFFIC COUNT PROGRAM

During fiscal year 1980, the traffic count program conducted by the Office of Transportation Inventory on the Secondary Road System in 26 Counties required a total of 3,846 4-hour and 75 8-hour manual counts. The traffic data from these counts was used to develop motor vehicle traffic flow maps for each county showing the average annual daily traffic (ADT) on specific road sections in each county. A secondary road inventory was completed in 9 counties. This data provides the county engineer, highway engineer, planner and administrator with essential information needed for the determination of design standard, systematic classification of highways and the development of programs for improvement and maintenance of secondary roads.

This traffic data is also added to the Iowa Department of Transportation's Secondary Road Base Record. This record is utilized for the preparation of numerous reports and studies including the annual vehicle miles of travel, mileage summaries, need studies, special studies, accident analysis, etc.

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TABLE II RESEARCH AND DEVELOPMENT EXPENDITURES July 1, 1979 to June 30, 1980

Project	Primary	Farm-to-Market	Total
140	\$22,825.00	11,825.00	34,650.00
165		50,586.46	50,586.46
186	42,122.23		42,122.23
187	641.79	720.00	1,361.79
188		2,987.58	2,987.58
194		37,907.78	37,907.78
195	1,707.22		1,707.22
197	3,079.91	2,618.34	5,698.25
198		67,164.30	67,164.30
202	7,208.91	6,143.52	13,352.43
204		17,240.31	17,240.31
206	431.31	325.94	757.25
207	8,708.57		8,708.57

208	14,574.71	23,937.13	38,511.84
210	4,263.73		4,263.73
211		23,962.12	23,962.12
212		13,428.89	13,428.89
213	37.00		37.00
220	340.36		340.36
1019	521.86		521.86
Sub-total	106,462.60	258,847.37	365,309.97
NCHRP	35,996.35	5,161.31	41,157.66
PR-2(118)	412.52	58.55	471.07
IPR-2(119) Total	406.99 143,278.46	57.76 264,124.99	464.75

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of the fiscal year beginning July 1, 1979 and ending June 30, 1980. An open file for each project is maintained for the project's inception to completion; completion is signified by the acceptance of the final report and making of the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.

Collection and Analysis of Stream Flow Data Project Title:

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

Principal Investigator: D. K. Leifeste, U.S.G.S.

Project continued to September 30, 1981 by approval Contract Period: of the Director -- Highway Division

\$47,300 per year (matched by \$47,300 from the Depart-Contract Amount: ment of Interior)

100 percent State funds; 50 percent Primary and 50 percent Funding: Farm-to-Market

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

The Water Resources Division employes a staff of Project Activities: engineers and technicians who monitor and maintain a network of water measuring stations on Iowa streams. These measurements, along with data from special studies of selected streams, are compiled and anlyzed to form the basis for predictions of future streamflow.

The progress during 1979-1980 was in accordance with schedules Progress: established by the Water Resources Division.

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

Project Title: Experimental Steel Fiber Reinforced Concrete Overlay

Research Agency: Greene County and Iowa Department of Transportation, Highway Division

Principal Investigators: R. Betterton, Greene County and Vernon J. Marks, Materials Research Section

Contract Period: December 20, 1972 to completion

Contract Amount: \$110,586

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

Research Objectives: To determine the feasibility of mixing, placing and finishing various fibrous concrete overlays and to evaluate the overall performance, longevity and maintenance characterisitcs of the roadway.

Project Activities: A fibrous Portland Cement Concrete overlay was placed on 3.03 miles of Greene County Road E-53 (old US 30). The 40 different test sections contain various combinations of depth, cement content, steel fiber length and fiber content.

Progress: The fibrous concrete overlay and various control sections were placed in FY 1974. Performance was observed and crack survey reports were distributed annually. A final crack survey report was completed late in 1978. All experimental sections are serviceable and still in place, although some longitudinal cracking is evident.

An additional amount of \$50,586 was spent on this project as the result of a law suit filed against the Iowa DOT by a former employee of Hallett Construction Company, contractor for the project.

Reports: Final report, December, 1978.

Implementation: Future use of the fibrous concrete will then depend primarily on its cost in comparison with other resurfacing techniques. Results from the project have shown that fibrous concrete can be used to produce thin, high performance highway pavement overlays. However, improvements in the cost-effectiveness of fibrous concrete are need if this type of pavement resurfacing is going to be developed to any significant degree. Conventional concrete without fiber reinforcement was less expensive and yielded better performance.

Project Title: Recycled Asphalt Pavement

Research Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely, Kossuth County

Contract Period: May 1, 1975 to completion

Contract Amount: \$50,000

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

Research Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Project Activities: Plans and specifications and cost estimates were completed early in 1975

Progress: Construction of the proposed project was completed during the summer of 1975. Road Rater testing and friction testing has been completed on the road annually.

Reports: A September 3, 1975 report has been prepared.

Implementation: This project proved that recycling of asphalt concrete is feasible and that additional research was needed to solve related problems. Research Project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977, research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials. Kossuth County has accepted recycled asphalt pavement as a standard reconstruction practice.

Road Rater testing and friction testing have been completed on the road annually. The evaluation phase of the project has been completed. Maintenance costs and procedures will be summarized.

Project Title: The Evaluation of Macadam Stone Shoulders

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist, Materials

Contract Period: May 25, 1975 to completion

Contract Amount: \$8,143

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of using a Macadam Stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of Macadam Stone shoulders, and to evaluate the performance of Macadam Stone Shoulders.

Project Activities: This experimental type of shoulder construction was incorporated into a Dallas County project on US 6. Shoulder construction operations were observed and methods and procedures were recorded. Structural number comparisons between Macadam shoulders and recently constructed stabilized and paved shoulders is continuing.

Progress: The shoulder construction work has been completed. A visual observation showed that the shoulders with the asphalt concrete surface were performing well with no spots on the surface. The side with the cover aggregate seal has some damage and open surface. A visual and structural evaluation program will be continued for the duration of the project. Long term effects from traffic and environmental factors will also have to be determined. A final report will be completed in the fall of 1981.

Reports: A construction report was distributed in November, 1977.

Implementation:

This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

Project Title: Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Construction

Research Agency: Iowa State University

Principal Investigators: W. D. Shrader, S. J. Henning, Iowa State University

Contract Period: January 1, 1977 to December 31, 1981

Contract Amount: \$172,085

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

Research Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil, to varying conditions and various tillage practices and to determine the effects of land surface elevation above drainage tile or perched water tables.

Project Activities: A four-year contract has been signed with Iowa State University. Work is completed on the selection of sites in several counties for borrow pits with desirable characteristics.

Progress: Four borrow pit sites have been cropped for the research. Temporary easements or rental arrangements have been established. The four locations selected are representative of a range of soil conditions present in Iowa. All four of the sites were used for agricultural production in 1979 and two sites were in their second year of production. Crop yield reports for 1979 for all four sites were received and evaluated.

Reports: A third Annual Progress Report (1979) was completed and distributed.

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared. The two remaining sites were completed in October and November, 1978.

Project Title: Development of a Minicomputer Controlled Frost, Ice and Snow Detector for Bridge Hazard Monitoring

Research Agency: Cytronics Incorporated

Principal Investigator: P. W. Poppe

Contract Period: January 13, 1977 to May 1, 1979

Contract Amount: \$19,500

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

Research Objective: To design, develop and deliver a microprocessor controlled frost, ice and snow detector with the capability to accurately detect frost, ice and snow in the presence of de-icing chemicals under normal conditions at bridge sites.

Project Activities: Laboratory testing, design and development work for Phase I were completed early in the project. Several modifications were made in the original equipment in an attempt to improve reliability.

Progress: Field testing of equipment could not be completed due to a lack of frost during the first winter season. Several extensions were granted for this project to allow for modification of equipment and additional field testing in attempts to attain the desired reliability. It was concluded that some of the technical problems could be corrected with additional equipment and testing. However, sensor damage and installation difficulties related to winter maintenance will continue to be major problems. The project was terminated, but final evaluation of the unit will be done by Iowa DOT Maintenance personnel. The frost and ice detector equipment was turned over to the Iowa DOT in the spring of 1979. Problems with damage to bridge deck sensors caused by snow plows and traffic and heater circuit limitation have resulted in a considerable amount of down time. The experience of the past winters again point out the environmental difficulties related to the maintenance and operation of frost and ice detector installations.

Reports: A progress report has been distributed.

Implementation: Modifications have improved the effectiveness of the detector, but further evaluation is necessary. The development of an effective frost, ice and snow detector will result in improved motorist safety, reduced tort liability and reduced annual expenditures for winter maintenance.

<u>Project Title</u>: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations

Research Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. C. Henely

Contract Period: April 11, 1977 to completion

Contract Amount: \$50,000

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

Research Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Project Activities: A work plan was completed and the project was let on June 21, 1977. Several contractors and equipment manufacturers showed an interest in the project.

Progress: The project was considered to be very successful. Recycled asphalt proved to be good quality material at a savings of approximately 30 cents per ton over virgin material. Through modifications of equipment, all D.E.Q. requirements for air pollution were easily met and the project gained nationwide and world-wide recognition.

Reports: A progress report was distributed in December, 1977.

Implementation: In the interest of conserving energy and material, the elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. The "drum in a drum" asphalt plant modification will prevent pollution while allowing normal production utilizing recycled materials. The plant modification is commerically available and will promote recycling and in turn conservation of natural resources.

Project Title: Bonded, Thin-Lift Non-Reinforced Portland Cement Concrete Resurfacing.

Research Agency: Clayton County and Iowa Department of Transportation, Highway Division

Principal Investigator: M. L. Johnson

Contract Period: May 16, 1977 to completion

Contract Amount: \$50,000

Funding: 100 percent State, Farm-to-Market

Research Objective: The research objectives are: 1. To establish methods and procedures for surface preparation for p.c. concrete resurfacing; 2. To establish mixing procedures using super water reducing admixtures and to study the economics and performance of portland cement resurfacing; 3. to determine if this method of overlay can be considered as a viable alternative for concrete pavement restoration.

Project Activities: A contract was signed with Clayton County. The plans and specifications have been completed. The project was let in July, 1977.

Progress: A thin-bonded low slump portland cement concrete overlay was placed on a 1.3 mile portion of a secondary Clayton County road in September, 1977. No major problems were experienced in mixing and proportioning the concrete. An adequate bond was developed and the project has performed well. Evaluation continued through April, 1980 and indicated that all three methods of preparation used, scarification, sandblasting, and waterblasting, provided adequate bond strenghth. Waterblast preparation would not remove traffic paint. Additional research is suggested to determine cost benefits and to aid in equipment development and preparation procedures.

Reports: A final report was completed, June, 1980.

Implementation: This research will determine whether bonded, thin-lift non-reinforced portland cement resurfacing is a viable alternative for concrete pavement restoration and rehabilitation. Based upon the success of this project, a thin-bonded overlay rehabilitation was used on I-80 in Pottawattamie County.

Project Title: An Evaluation of Dense Bridge Floor Concrete

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: J. V. Bergren, R. A. Britson

Contract Period: May, 1977 to completion

Contract Amount: \$3,340

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility of mixing, placing and finishing dense portland cement concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity and maintenance performance of dense portland cement concrete.

Project Activities: The project is located in the Town of Ackley on US 20 in Hardin County. The construction involved the redecking of a multiple span overhead crossing over a railroad. It was proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture.

Progress: A portion of a full depth bridge deck using concrete with a high range water reducer was placed in August 1977. Problems were encountered in pumping the concrete and in controlling slump and air content. Cores from the deck yielded good air contents for both the Standard D-57 concrete and the high range water reducer (HRWR) concrete. The calculated one year strength for the D-57 concrete was 6650 psi and 8500 psi for the HRWR concrete. The chloride content was slightly higher in the D-57 concrete. The cores revealed good consolidation of both concretes, even though the bottom surface of the HRWR exhibited an open honeycomb appearance.

Reports: A construction report has been completed, December, 1977.

Implementation: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if the admixture is a solution to the problem of corrosion of steel in bridge decks.

Project Title: Mission Oriented Dust Control and Surface Improvement Processes for Unpaved Roads

Research Agency: Iowa State University

Principal Investigator: J. M. Hoover

Contract Period: July 1, 1977 to March 31, 1981

Contract Amount: \$99,860

Funding: 100% State, Farm-to-Market funds

Research Objective: To identify current practices, products and specifications of potentially economic dust control systems and to plan, design and construct a series of demonstration test sections in several regions in Iowa for the purpose of evaluating materials, construction costs and performance of various dust control methods.

Project Activities: A contract was signed with Iowa State University and an Advisory Committee was selected. Site selection, based on geographic/geologic regions in the State, has been completed. Additional sites were added in order to get adequate representation of soil aggregate characteristics of the various regions.

Progress: Current dust control practices and specifications are being evaluated. Dust collectors were established at all locations and dust collection techniques were continued until construction. Design

testing recommendations and construction operations were begun on a number of test plots in several counties. Comparisons of laboratory and field test data are being made. Field testing and observation of the test sections will continue. A final report will be completed in March 1981. Categories of products for use on individual test sections have been recommended to counties.

Reports: Semi-annual progress reports have been submitted.

Implementation: The project will identify alternate practices and the most economical methods of dust control.

Project Title: Field Performance and Evaluation of Slurry Seal Coats

Research Agency: Iowa State University

Principal Investigator: D. Y. Lee

Contract Period: July 1, 1977 to November 26, 1980

Contract Amount: \$91,000

Funding: 100 percent State, Primary funds

Research Objective: To evaluate performance characteristics of materials native to Iowa and applicability of other materials in slurry seals, mix designs and to correlate laboratory tests with field performance.

Project Activities: This project is the second phase of a two part study. Construction on Phase II, a field performance evaluation of slurry seals was delayed due to inflated costs. Under a revised schedule, the project was let in April, 1978 and a time extension through November 26, 1980 was granted with an additional \$11,000 in research construction funding.

Progress: Application of the slurry seal test sections and approximately half of the control sections were completed in September, 1978, Problems were encountered in obtaining the optimum emulsion content. Some test sections failed and were replaced. Resurfacing of the remaining control sections was completed during the 1979 construction season. Evaluation of the test sections is continuing and the project is nearly completed.

Reports: A final report will be completed in November, 1980.

Implemenation: The project will provide a basis for the development and preparation of slurry seal, design methods, criteria, procedures and specifications for the successful application of slurry seal as an economic pavement maintenance alternative.

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

Research Agency: State Archaeologist (University of Iowa)

Principal Investigator: J. Hotopp

Contract Period: July 1, 1977 to June 30, 1980

Contract Amount: \$75,000

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

Research Objective: 1. To determine well in advance of highway construction if proposed planning corridors contain known or probable sites of archaeological value. 2. To locate such sites and describe their limits as accurately as possible without resorting to excavation or other detailed examination.

Project Activities: The Iowa Department of Transportation has an ongoing contract with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary reports.

Progress: Secondary road construction sites with archaeological value are being examined in advance of construction. Under a new Iowa DOT policy, a revolving fund has been established within the Secondary Road Research Fund to initially pay for the services of a survey contractor and to prepare billings to the counties and cities for their proportionate share of costs incurred. Additional funds were allocated to the revolving fund due to an unanticipated heavy load of Phase 2 testing activity. High potential sites, located through Phase 1 surface survey techniques, required additional subsurface examination in order to establish significance.

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

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

Project Title: Upgrading Asphalt Surface Friction by Aggregate Sprinkle Treatments

Research Agency: Iowa Department of Transportation, Highway Division

Principle Investigator: R. A. Shelquist

June 1, 1978 to December 31, 1983 Contract Period:

\$42,500 Contract Amount:

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixtures of local aggregates for 1" and 1'2" thick surface courses followed by a surface sprinkle treatment of pre-coated hard, durable chips to produce a long lasting non-skid pavement surface.

Project Activities: Preconstruction plans and arrangements were completed. The contract was let on May 23, 1978. This experimental type of resurfacing was applied on old US 30 between Interstate 35 and the City of Nevada.

The paving and sprinkle treatments have been completed. Appear-Progress: ance is very good with the exception of some corregation which occurred during application. Texture depth testing by the silly putty method has been completed for all test sections. Friction testing of the sections is also being conducted on a periodic basis.

Reports: Progress Report, October, 1979.

This project will be utilized in the evaluation of paving Implementation: materials and texturing. It will also assist in determining the effectiveness of sprinkle treatment in providing durable friction properties.

Project Title: Fly Ash in Portland Cement Concrete Pavement-Monona County

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

Principal Investigator: O. D. Ives

Contract Period: February 21, 1978 to completion

Contract Amount: \$16,300

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

Research Objective: 1. To evaluate problems related to shipping, storing, and placing fly ash. 2. To establish a procedure for batching, mixing and placing concrete with specified air content. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: Plans and specifications were completed and the project was let early in the spring of 1978. Samples of the fly ash were obtained from the source and a history of sample testing was completed prior to construction.

Progress: Paving on Monona County Road E-54 was completed in June, 1978. Minor modifications were made in the batching system, but no special problems were encountered in the paving operation using conventional equipment. General appearance and workmanship of the concrete is satisfactory. The concrete produced has shown to date that it is of a comparable quality to standard portland cement concrete.

Reports: Final Report, January, 1980.

Implementation: Laboratory studies and limited field use has shown that the utilization of fly ash in concrete has resulted in a cost savings and material conservation along with the disposal of a waste product. Results of the use of fly ash in p.c. concrete in Monona County have been encouraging. It was recommended that specifications be developed for portland cement concrete using fly ash for paving and structural work.

Project Title: Fly Ash in Portland Cement Concrete Pavement-Woodbury County

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: C. E. Leonard

Contract Period: March, 1978 to completion

Contract Amount: None (no additional cost)

Research Objective: 1. To determine the problems related to shipping, storing and batching fly ash. 2. To establish procedure for mixing, and placing uniform concrete using fly ash. 3. To demonstrate that concrete of comparable quality can be produced.

Project Activities: The proposed research was incorporated into two bridge replacement projects on Iowa 982. The project includes paving two bridge approach sections at two bridge construction sites.

Progress: Construction on these two bridge replacement projects was completed in October, 1978. No problems were observed in handling or in batching fly ash through a central ready mix plant. Objectives of the project were successfully met. This project helped to verify that paving specifications can be met with fly ash mixes without any serious problems.

Reports: Final Report, April, 1980

Implementation: Fly ash can be used successfully in paving mixes. Quality

control test results show that specification air content,

slump and flexural strength can be achieved with normal paving operations.

<u>Project Title</u>: Wind Tunnel Analysis to Determine the Effect of Adjustment in the Adjacent Topography on Drifting Snow at Highway Grade Separations.

Research Agency: Iowa State University

Principal Investigator: S. L. Ring

Contract Period: June 1, 1978 to July 13, 1979

Contract Amount: \$61,151

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

Research Objective: 1. To produce blowing and drifting snow using scale models in a wind tunnel. 2. To analyze effects of strategically placed vegetation, snow fences or structures in order to make recommendations for controlling drifting snow at highway grade separations.

Project Activities: A contract agreement was negotiated and model parameters based on highway design criteria were established. A literature search was completed and field interviews to obtain information on drifting snow were conducted.

<u>Progress</u>: Scale models were constructed and tested in the wind tunnel to reproduce snow drifting phenomenon. The model was modified to represent the introduction of plantings and changes in the physical config-

uration of the adjacent topography. The effects of snow drifting phenomenon were then observed and recommendations for field testing were made.

Reports: Final Report, June, 1979

Implementation: The study will provide design criteria to reduce the economic costs of accidents, vehicle removal, maintenance operations and travel delay caused by the problem of snow drifting at highway grade separations.

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Project Title: Transverse Joint Sealing with Various Sealants

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

Principal Investigators: G. Hardy, V. J. Marks

Contract Period: July 25, 1978 to December 31, 1983

Contract Amount: \$51,000

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

Research Objective: To evaluate the performance of pcc pavement contraction joints utilizing a variety of sealants and joint preparations and to identify an effective joint sealant system.

Project Activities: These experimental pavement joints were incorporated into a Secondary Road paving project in Dallas County during the 1978 construction season. Joint sealing procedures, materials and specifications were determined prior to construction.

Progress: Six different sealant materials were used with three methods of joint cleaning. Other variables were introduced and some cost comparisons were made. Core samples for joint sealant analysis were taken in 1979 and 1980. Visual observations are being made periodically. Evaluation of the various joint sealing procedures is continuing. Attempts to find an effective joint sealant system will continue.

Reports: Progress Report, July, 1979

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

Project Title: Safer Construction and Maintenance Practices to Minimize Potential Liability by Counties from Highway Accidents

Research Agency: Iowa State University

Principal Investigator: R. L. Carstens

Contract Period: September 1, 1978 to September 30, 1979

Contract Amount: \$38,335

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

Research Objective: To give county engineers guidance in the selection and implementation of measures that will reduce the potential liability of counties for accidents resulting from alleged imperfections in highway facilities.

Project Activities: A literature search dealing with tort claims for counties has been completed. An analysis of tort claim experience derived from questionnaire responses from 85 counties was also completed. Studies to evaluate blading operations and methods of developing advisory speeds on curves on unsurfaced roads were also undertaken.

Progress: Analysis of data has been completed. Conclusions from the study indicate that the most frequently recurring allegations against counties involve sign usage and traffic control. Recommendations set forth in the final report stress that importance of correct traffic

signing along with proper documentation of facts and data. A number of other detailed recommendations are included in the final report.

Reports: Final Report, September, 1979.

Implementation: This study will assist county engineers in establishing quidelines relating to highway construction and maintenance practices, including the use of traffic control devices that will improve highway safety and reduce the potential liability by counties.

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

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Contract Period: December 14, 1978 to December 31, 1985

Contract Amount: \$3,150

Funding: 100 percent State, Primary funds

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

Project Activities: Approval was granted and specifications were approved for incorporating the special coarse aggregate into two bridge deck overlay projects on Interstate 35 near Ankeny, Iowa.

Progress: Resurfacing of the bridge decks was completed in the summer of 1979. The use of special aggregates resulted in a more consistent mix with improved workability and greater ease of finishing and texturing. Friction testing is being conducted on the bridges on a regular basis.

Reports: None

Implementation:

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

Project Title: Cement Produced from Fly Ash and Lime

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigator: W. Rippie

Contract Period: April 1, 1979 to June 30, 1980

\$2,510 Contract Amount:

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

Research Objective: To determine if a fly ash-lime cement with desirable characteristics can be produced and to determine the combination of ingredients necessary to attain this end.

Project Activities: The materials and supplies have been obtained from various sources and laboratory work is underway. Facilities at the Coal Research Laboratory at the University of West Virginia will be utilized to melt and process materials in the production of the new cement.

A group of samples was forwarded to the West Virginia Laboratory Progress: for processing. Additional laboratory work is being completed.

Reports: None

In view of continued shortages of portland cement, utili-Implementation; zation of fly ash, a waste product, will conserve energy and increase cement supply for construction projects.
Project Title: Feasibility of Wind-Powered Aeration of Rest Area Lagoons

Research Agency: Iowa State University

Principal Investigator: J. L. Cleasby

Contract Period: June 1, 1979 to September 30, 1979

Contract Amount: \$8,870

Funding: 100 percent State, Primary funds

To evaluate the feasibility of using wind-powered Research Objective: equipment to aerate rest area lagoons to permit existing lagoons to accomodate higher seasonal BOD loadings than were intended in the original lagoon design.

Phase I will include an evaluation of load projec-Project Activities: tions on rest area lagoons, lagoon design, seasonal aeration requirements and Iowa DEQ regulations. The design of the lagoons was studied and a survey of the interstate rest areas was conducted.

The project has been completed. Conclusions indicate certain Progress: disadvantages to wind-powered aearation of rest area lagoons, the greatest being the fact that wind speeds are lowest during the time when the need for aeration is the greatest. Also, equipment costs are higher for wind-powered aeration than for conventional equipment. Rest area lagoons will continue to be monitored, particularly those with apparent problems.

Reports: Final Report, September, 1979

The results of this study will result in a substantial Implementation: savings to the Iowa DOT. The savings arises from a change in environmental quality standards developed for rest area lagoons due to the unique loading. The change will eliminate the need for some reconstruction.

Project Title: Alternative Methods of Stabilizing the Degrading Stream Channels in Western Iowa

Research Agency: Iowa State University

Principal Investigator: R. H. Lohnes

Contract Period: June 1, 1979 to November 30, 1980

Contract Amount: \$79,254

Funding: 100 per State: 25 percent Primary and 75 percent Farm-to-Market

Research Objective: To develop and evaluate several alternative methods of stabilizing the degrading channels of the streams and gullies in the loess hills of western Iowa.

Project Activities: A comprehensive inventory of grade stabilization structures was conducted early in the project. A selected number of successful and problem structures were chosen for detailed documentation and analysis. Phase I consisted of a review of related work already completed and the effects of freeze-thaw cycles on soil cement were studied.

Progress: An inventory and evaluation of grade stabilization structures was obtained in Phase I of the project. Computerized data on a 13 county area in western Iowa was obtained and problem areas were studied. More efficient methods of stabilizing the degrading streams of western Iowa are being studied. Multiple installations of check dams, use of sheet piling and sand-soil cement appear to have some potential. A final report for Phase I is being completed.

Reports: Progress Report, March 1, 1980

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

Project Title: Pavement Surface on Macadam Base

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

Principal Investigator: D. J. Lynam

Contract Period: June 26, 1979 to December 31, 1983

Contract Amount: \$100,347

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

Research Objective: To determine the feasibility, economics and performance of placing pc concrete on a macadam base while developing design criteria by varying the thickness of the pc concrete and to determine if the macadam base is effective in reducing D-cracking deterioration of concrete produced with limestone of poor durability characteristics.

Project Activities: Construction was completed on approximately two miles of Adair County Road G-61. Seven different roadway typical sections were utilized. A variation in shoulder construction will be incorporated into one section. One mile adjacent to the experimental construction was included in the evaluation of the research.

Progress: Actual construction work was completed on Adair County Road G-61 in the fall of 1979. Minor construction problems were encountered initially in placing the thin section of pcc on the stone base. Road

Rater evaluations of the pavement have been made. Some small areas of distress are visable, but the overall appearance of the pavement is good.

Reports; Construction Report, 1980.

Project Title: The Effect of Deer Reflectors on Deer-Vehicle Accidents

Iowa Conservation Commission, Iowa Department of Research Agency: Transportation, Highway Division

Principal Investigator: L. Gladfelter, H. Dolling, G. Albansoder

June 15, 1979 to September 30, 1983 Contract Period:

\$30,072 Contract Amount:

Funding: 100 percent State, Primary funds

Research Objective: To evaluate the "Swareflex" and Bosch reflector system in reducing deer-vehicle accidents, to determine a cost benefit ratio for the system and to identify deer crossing areas throughout the State for possible implementation of the system.

Project Activities: Equipment was selected and purchased. Traffic counting equipment has been installed at the designated sites. Deer-vehicle accident records were maintained for one year prior to the installation of the reflectors. The study areas selected are distributed around the State to include different driving conditions, traffic volume and deer densities.

Records are being maintained on deer-vehicle accidents at all Progress: selected sites. Equipment has been selected and installed on all five sites around the State. Silver reflectors purchased from the Robert Bosch Corporation were installed at one site for comparison purposes. A number of Swareflex reflectors had to be replaced due to a design problem.

Additional data will be needed to determine any meaningful results from the installation of the deer reflectors. However, results from the first installation, installed approximately one year ago, indicate a possible decrease in deer-vehicle accidents.

Annual progress reports will be completed. Reports:

An effective deer reflector will reduce deer-vehicle Implementation: accidents and thereby result in savings to the motorist.

Project Title: Performance of Randomly-Oriented Fiber-Reinforced Roadway Soils (A Laboratory and Field Investigation)

Research Agency: Iowa State University

Principal Investigator: J. M. Hoover

Contract Period: July 1, 1979 to June 30, 1982.

Contract Amount: \$143,207

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

Research Objective: To conduct a laboratory and field investigation into the potential of improving soil-aggregate surface and roadway subgrade materials and local base course materials by strengthening these materials through fibrous reinforcement.

Project Activities: Work accomplished during the early months of the project illustrates that fiber reinforcement has significant potential for improvement of engineering properties of soil. Preliminary screening tests were performed in soils taken from potential roadway sites. A screening and selection process is being continued on a variety of different fibers.

Progress: Field demonstration sections using a variety of fibers were constructed in Linn and Story Counties during the summer of 1980. One the Linn County project, three different types of three different percentages of fibers were used. The Story County project was constructed on an existing gravel road. Some difficulty was experienced in mixing the fibers into the roadbed due to equipment failure. Results of the use of the fibers to date appear favorable.

Reports: Semi-annual progress reports are being submitted.

Implementation: Due to economic restraints, new and cost effective methods are needed for the improvement of subgrade base course construction. This project will aid in the development of new and improved design procedures.

Suitability of Treating Iowa's Marginal Aggregates and Project Title: Soils by Foamix Process.

Research Agency: Iowa State University

Principal Investigators: D. Y. Lee

Contract Period: October 15, 1979 to May 31, 1980

Contract Amount: \$19,019

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

Research Objective: To investigate, in the laboratory, the suitability of Foamix in treating aggregates and soils locally available for use as cold mix base material and the potential of Foamix in cold mix asphalt pavement recycling.

Project Activities: Four representative local materials were obtained and evaluated, using a Mobil-Conoco Foaming Unit, in conjunction with an asphalt cement from a major asphalt supplier in Iowa.

Thirteen aggregates and aggregate blends plus two recycled pave-Progress: ment materials were evaluated in the Laboratory using a foamix process in the mix design. Results were good for the majority of the mixes. Field trials with several different aggregate-soil mixtures are recommended. These materials are considered to be of marginal quality and exhibit some potential for the foamix process.

Reports: Final Report, May 1980

Higher labor costs and an increasing shortage of materials Implementation: is forcing county engineers to explore alternate methods of road construction. Foamed asphalt offers some potential for energy conservation and the utilization of marginal, locally available aggregates.

<u>Project Title</u>: Improved Asphalt Surfaces and Asphalt Resurfacing Performance Through Crack Maintenance

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. Shelquist, E. O'Connor

Contract Period: November 12, 1979 to March 1, 1985

Contract Amount: \$13,550

Funding: 100 percent State, Primary funds

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

Project Activities: Originally the proposed research was going to be incorporated into three asphalt roadways each representing different conditions or desired results. However, some revisions in the original plans were necessary due to financial limitations placed on construction and maintenance with selected projects being removed from the program.

Progress: Evaluations were made and bids were taken for a mobile type high pressure industrial waterblaster. A Vanguard 2000 PSI Waterblaster purchased from a Des Moines distributor. This high pressure washer was used extensively for joint and crack maintenance on various primary and interstate highways.

Reports: none

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

HR-214 Project Number:

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

Research Agency: Iowa State University

Principal Investigators: F. W. Klaiber

Contract Period: March 12, 1980 to May 31, 1981

Contract Amount: \$58,895

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

The development of economical techniques to increase Research Objective: both the live load and dead load carrying capacity of existing single span steel beam, concrete deck bridges.

Project Activities: A comprehensive literature review was undertaken and is essentially completed. A field review of several different bridges was completed and a one half scale model of a 50' x 30' I beam bridge was constructed for laboratory testing purposes.

Strain gages are being attached to the concrete deck for measure-Progress: ment of concrete strains. Brackets have been designed and fabricated for attaching the prestressing rods to individual beams and a loading plan has been designed.

Reports: Progress Report, September 12, 1980

There are a number of old simple span steel beam concrete Implementation: bridges that are not in compliance with present bridge standards. This research is proposed as a feasibility study to strengthen these bridges in order to avoid posting load limits.

Project Title: Improvement of Longitudinal Joints in Asphalt Pavement

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator; R. A. Shelquist

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

Contract Amount: \$10,700

Funding: 100 percent State, Primary funds

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

Project Activities: The proposed research was incorporated into an asphalt widening and resurfacing project on Iowa 44 in Guthrie and Dallas Counties. Construction was tentatively scheduled for completion in July and August of 1980.

Progress: A preconstruction meeting was held on April 11, 1980. Asphalt widening and resurfacing was completed on Iowa 44 in August, 1980. Core samples were taken shortly after completion of the project. Evaluation will be an annual visual observation for deterioration of the longitudinal joint.

Reports: none

Implementation: Improved methods for construction of longitudinal joints
will result in increased life of asphalt resurfacing
resulting from reduced joint deterioration.

Project Title: Emulsion Treated Macadam Base

Research Agency: Dubuque County, Iowa Department of Transportation, Highway Division

Principal Investigator: C. L. Baule

Contract Period: April 28, 1980 to January 15, 1985

Contract Amount: \$156,048

Funding: 100 percent State, Fram-to-Market funds

Research Objective: To identify and construct a cost effect asphalt emulsion bound macadam section and to evaluate the performance of an asphalt bound macadam as compared to unbound macadam.

Project Activities: The proposed experiemtnal pavement was incorporated into a paving project on Dubuque County Road D-53. The seven different macadam sections were placed with standard paving equipment prior to construction. Additional funding was approved for the purchase of two engineering fabrics for use on the macadam sections in order to provide increased structural capacity.

Progress: Construction of the macadam sections was completed in September, 1980. The most serious problem encountered in the project was the inability to obtain complete coating of the emulsion treated materials. More favorable weather conditions and modified construction procedures helped to alleviate this problem. Riding quality and over all appearance of this experimental pavement is good. Evaluation will continue for a five year period.

Reports: A construction report will be submitted in January, 1981.

<u>Implementation</u>: Macadam base projects in the past have provided excellent drainage characteristics. The use of asphalt emulsion binder and engineering fabrics will result in energy savings and improved' stability while still providing a relatively low cost roadway base.

Project Title: Reducing the Adverse Effect of Transverse Cracking <u>Research Agency</u>: Iowa Department of Transportation, Highway Division <u>Principal Investigator</u>: V. J. Marks <u>Contract Period</u>: March 7, 1980 to January 31, 1984 <u>Contract Amount</u>: \$43,000 Funding: 100 percent State, Primary funds

Research Objective: To identify a method of reducing the adverse effect of transverse cracking and improving the performance of asphalt pavement.

Project Activities: The research was incorporated into a Jones County primary project on Iowa 64. Some of the variations from standard construction practices used in this project included the following: 1. Use of an asphalt that is partially blown and less susceptible to temperature variations; 2. Variation in mix designs; 3. The sawing and sealing of transverse joints.

Progress: The sawing and sealing of the experimental joints was completed early in September, 1980. No particular problems were experienced in this research. Density and gradation requirements were satisfactorily met. The performance of the asphalt surface will be evaluated annually

primarily by visual appearance.

Reports: A construction report will be completed in January, 1981.

Implementation: With the prevention of transverse cracking and subsequent crack deterioration asphalt surfaced roads will last longer and require less maintenance and less frequent resurfacing.

<u>Project Title</u>: Liability and Traffic Control Considerations for Low Level Stream Crossings

Research Agency: Iowa State University

Principal Investigators: R. L. Carstens

Contract Period: June 1, 1980 to April 30, 1981

Contract Amount: \$28,350

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

Research Objective: To assess the practicality of low level stream crossings, to evaluate the potential of tort liability associated with these crossings and to provide guidance for the selection of traffic control measures and devices to minimize the hazards involved.

Project Activities: A survey of agencies having experience with low level stream crossings was made. A total of 286 questionnaires were mailed out to various agencies in 25 states. Of these, 53.8 percent were completed and returned. Responses from persons having experience with low water crossings were widely varied. Very little similarity in liability and sign usage was reported.

Progress: A phased method of evaluating signing practices was adopted. An assignment of a general pattern of sign usage was made with a more discriminatory assessment of specific patterns that emerged as most favored. Further evaluation indicated a strong preference for a pattern of sign usage including two warning signs plus an advisory plate if needed and a regulatory sign. A formulation of recommendations will be made later in the project.

Reports: Quarterly progress reports have been submitted.

Implementation: The development of adequate signing and traffic control will allow the use of low water stream crossings which will reduce the fund expenditures for bridges.

Project Title: Settlement at Culverts and Bridges

Research Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W. E. Buss

Contract Period: May, 1980 to January 31, 1984

Contract Amount: \$11,200

Funding: 100 percent State, Primary funds

Research Objective: To identify cost effective construction methods that may prevent settlement at culverts and bridges.

Project Activities: This research was incorporated into a grade, culvert, pavement widening and resurfacing project on Iowa 44 in Dallas County. Various methods of backfilling and bedding will be evaluated.

Progress: The required backfilling procedures for bridges and culverts were completed by the contractor by extra work order. K-Krete, sand and Class A material with moisture control were used on the bridge approaches. K. Krete and Class A, B and C road stone were used in various combinations in the culvert replacement and backfill.

Reports: none

Implementation: The reduction in settlement will result in less maintenance and will provide the best method of backfill at a reasonable

cost.

Project Title: Protection of Structural Concrete Substructures

Iowa Department of Transportation, Highway Division Research Agency:

Principal Investigators: J. Risch, J. Whiting

Contract Period: May, 1980 to July 15, 1985

\$8,000 Contract Amount:

Funding: 100 percent State, Primary funds

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

Project Activities: Attempts will be made to determine the extent of the steel corrosion problem. A sufficient number of test applications of commercially available products will be made to permit various appreciation rates and varying degrees of preparation.

A considerable amount of core sampling of pier columns and chloride Progress: analysis will be done in bridge pier columns in the Des Moines and Cedar Rapids areas. Supplies and equipment have been purchased and core sampling has begun.

Reports: None

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 Title: Evaluation of Recycled Asphalt Concrete-Kossuth County

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division

Principal Investigator: R. P. Henely

Contract Period: June, 1976 to February, 1980

Contract Amount: \$30,000

Funding: 100 percent Federal funds

Research Objective: To determine and evaluate the properties of the recycled asphalt, the load bearing capacity and performance of the completed pavement, pollution control, capacity of the plant and appurtenances, operations aspects of scarification crushing and processing equipment and the economic viability of recycling asphalt pavements on a large scale.

Project Activities: The old asphalt material was ripped, salvaged and stockpiled for crushing. No serious problems were encountered in the mixing and paving operations. An energy savings was realized in using the recycled asphalt, however, an air pollution problem persisted at the mixing plant in spite of efforts to correct it.

Progress: Visual inspection indicated that the recycled asphalt concrete pavement is performing well. Air pollution requirements were not met on this project, but were achieved in a 1977 project.

Reports: Final report, February, 1980.

Implementation: An impressive savings in energy and in the conservation of resources was realized in the completion of this project.
More consideration will be given to the recycling of old asphalt pavements in the future.

Project Title: Evaluation of Asphalt Sprinkle Treatment to Provide a Non-Skid Surface

Research Agency: Federal Highway Administration, Iowa Department of Transportation, Highway Division

Principal Investigator: D. D. Jordison

Contract Period: January 18, 1978 to January, 1981

Contract Amount: \$10,000

Funding: 100 percent State, Primary funds

Research Objective: To determine the feasibility and cost effectiveness of using a standard asphalt mixture of local aggregates for surface courses, followed by a sprinkle treatment of non-polishing aggregates to produce a durable, non-skid pavement surface.

Project Activities: During the 1977 construction season, several projects were initiated by the Highway Division of the Iowa DOT using sprinkle applications of high quality aggregate to achieve the desired non-skid surface.

Progress: Several different sprinkle treatment projects using various aggregates were completed during the 1977 construction season. All projects are performing well, although some aggregate loss was evident soon after construction. Sprinkle treatments appear to be an effective means of providing pavements with higher quality frictional properties. Periodic field reviews will continue. A final report is being prepared.

Reports: "Sprinkle Treatments", FHWA Interim Report-June, 1978

Implementation: The sprinkle treatment procedure saves money by utilizing a limited amount of expensive aggregates, while providing pavement texture and improving the frictional coefficients of the pavement.

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HIGHWAY DIVISION IOWA DEPARTMENT OF TRANSPORTATION AMES, IOWA 50010

DECEMBER 1981

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RESEARCH AND DEVELOPMENT

The Highway Division of the Iowa Department of Transportation engages in research and development for two reasons: first, to find workable solutions to the many problems that require more than ordinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report entitled, "Highway Research and Development in Iowa" is submitted in compliance with Section 310.36, Code of Iowa, directing submission of a report of the Secondary Road Research Fund. It is a report on the status of research and development projects which were in progress on June 30, 1981; it is also a report on projects completed during the fiscal year beginning July 1, 1980 and ending June 30, 1981. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials-Highway Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing, coordinated program of research and development, the Highway Division is assisted by the Iowa Highway Research Board. This advisory group was established in 1949.

The Research Board consists of 13 regular members; six County Engineers, three 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 membership of the Research Board as of June 30, 1981 is listed in Table 1.

The Research Board held nine regular meetings during the period of July 1, 1980 to June 30, 1981. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

TABLE I

1982

IOWA HIGHWAY RESEARCH BOARD

Member

Term Expires

12-31-82

Alternate

Bettendorf, IA 52722

R. Holland

City Engineer

(319)359-0347

W. W. Amundson Director of Public Works Box 447 Sioux City, IA 51100 (712) 279-6111

F. O. Bloomfield Right-of-Way Director Iowa DOT-Highway Division Ames, IA 50010 (515)239 - 1149

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011 (515)294-5933

G. Calvert Deputy Director, Development Iowa DOT-Highway Division Ames, IA 50010 (515)239 - 1461

P. Dvorak Grundy County Engineer Grundy Center, IA 50638 (319)824-6912

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319) 353-6603

R. Kirchner City Engineer Fort Dodge, IA 50501 (515) 576-3601

12-31-82

12-31-82

12-31-82

C. L. Huisman Materials Engineer Iowa DOT-Highway Division Ames, IA 50010 (515)239 - 1452

P. W. Peterson Associate Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011 (515) 294-2336

T. E. McElherne Specifications Engineer Iowa DOT-Highway Division Ames, IA 50010 (515)239-1566

R. Gumbert Tama County Engineer Toledo, IA 52342 (515)484 - 3341

H. Kane, Chairman Civil & Env. Engr. Program University of Iowa Iowa City, IA 52242 (319) 353-4968

Muscatine County Engineer

Muscatine, IA 52761

W. J. Schreiner City Engineer Ankeny, IA 50021 (515)964-5500

12-31-83

12-31-84

12-31-84

N. Konrady Lucas County Engineer Chariton, IA 50049 (515)774 - 4013

D. D. Linnan Buena Vista County Engineer Storm Lake, IA 50588 (712)732 - 1519

D. J. Lynam Adair County Engineer Greenfield, IA 50849 (515)743-6111

18

L. Mattusch Clinton County Engineer Clinton, IA 52732 (319)243-6210

W. A. Moellering Fayette County Engineer West Union, IA 52175 (319)422 - 3342

R. F. Percival District 5 Engineer Iowa DOT-Highway Division Fairfield, IA 52556

12-31-83

12-31-82

12-31-84

12-31-82

12-31-83

12-31-84

R. Michaelis Carroll County Engineer Carroll, IA 51401 (712)792 - 3603

R. Simmering

(319)263-6351

C. Christensen Fremont County Engineer Sidney, IA 51652 (712)374 - 2613

> G. D. Petermeir Benton County Engineer Vinton, IA 52349 (319) 472-2211

N. Jorgensen Franklin County Engineer Hampton, IA 50441 (515) 466-4671

V. R. Snyder District 4 Engineer Iowa DOT-Highway Division Atlantic, IA 50022 (712)243-3355

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division and the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farmto-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are likewise shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1981. Total expenditure was \$761,115.60 including support of the National Cooperative Highway Research Program (see pg. 5).

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Highway Division personnel are termed "in-house" projects. These projects may involve other departmental and district personnel in addition to personnel from the Office of Materials, Research Section. In many instances, personnel from other offices are designated as principal investigators, which means that they have a major role in the planning, performance, and analysis of the research.

Contract research funds may be used for material and equipment costs for in-house research, but cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section wishes to express their appreciation to other offices and districts for their assistance.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials (now the American Association of State Highway and Transportation Officials -- AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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 11 percent of the receipts in the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund is itemized in Table II.

The values shown in Table II are actual research expenditures for fiscal year 1981. The Office of Transportation Inventory engineering studies include traffic counts and secondary road inventories. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based upon obligations for expenditures on research projects and not the actual expenditure. The Fiscal Year 1981 financial summary is.

Beginning Balance 7-1-80

Receipts	79,840	
Fed. Sec. Rd	007 100	
(11% of receipts)	227,162	
State RUTF (11% of receipts)	465,972	
External Research Income	137,785	910,759
Sub-Total	a maintain and a start of	2,105,965
Total Funds Available		

Obligation	for	Expenditures
Obligate	d fo	or

887,325

1,195,206

1,074,028

Contract Research ... Non-Contract 144,612 Engineering Studies ... 1,031,937 Total Expenditures

BALANCE 6-30-81

SECONDARY ROAD TRAFFIC COUNT PROGRAM

During fiscal year 1981, the traffic count program conducted by the Office of Transportation Inventory on the Secondary Road System in 25 counties required a total of 3,774 4-hour manual counts. The traffic data from these counts was used to develop motor vehicle traffic flow maps for each county showing the average annual daily traffic (ADT) on specific road sections in each county. A secondary road inventory was completed in 10 counties. This data provides the county engineer, highway engineer, planner and administrator with essential information needed for the determination of design standard, systematic classification of highways and the development of programs for improvement and maintenance of secondary roads.

This traffic data is also added to the Iowa Department of Transportation's Secondary Road Base Record. This record is utilized for the preparation of numerous reports and studies including the annual vehicle miles of travel, mileage summaries, need studies, special studies, accident analysis, etc.

Project	Total Funds Committed	Primary Road Research Fund Expenditures	Secondary Road Research Fund Expenditures	Total Expenditures
140	48,410/yr	23,927.50	23,927.50	47,855.00
143	6,000		5,805.15	5,805.15
176	50,000			
181	8,143			
186	172,085	27,462.14	796.38	28,258.52
188	50,000			
192	3,340			
194	100,135		20,825.82	20,825.82
195	91,902	13,510.33		13,510.33
198	75,000			
199	100,000			
203	51,000			
205	3,150			
206	2,510			
208	79,254	3,986.29	35,239.05	39,225.34
208A	137,725	1,463.80	20,625.46	22,089.26
209	100,347		100,346.85	100,346.85
210	30,072	7,641.46		7,641.46
211	149,114		53,224.83	53,224.83
213	13,550	204.60		204.60
214	58,895	25,041.76	25,921.30	50,963.06
215	10,700			
216	156,289		156,288.60	156,288.60
217	43.000			
218	28,350		25,558.77	25,558.77
219	11,200			
220	8,000	186.59		186.59
221	40,465	8,590.70	14,941.74	23,532.44
222	17,500			
223	2,400		2,400.00	2,400.00
224	8,000	528.00		528.00
225	89,660	11,122.36	9,719.41	20,841.77
226	44,000		9,240.72	9,240.72
227	34,855	2,178.17	2,086.70	4,264.87
228	48,540	8,872.80	2,007.93	10,880.73
229	130,000			
230	56,305		4,662.04	4,662.04
231	38,000			
232	4,105			
233	138,405			
234	5,000			
235	49,850			
		124 716 50	512 620 25	640 324 75
Sub T	otal	134, /16.50	515,618.25	040,334.75
HPR-1(87)	NCHRP	9,816.88	2,633.17	12,450.05
HPR-1(88)	NCHRP	2,806.52	1,954.73	4,761.25
HPR-1 (89)	NCHRP	6,282.57	1,817.86	8,100.43
HPR-2(118)	NCHRP		3.02	3.02
HPR-2(119)	NCHRP	ning f	(-101.90)	(-101.90)
HPR-PR-PL-	Research	Program	87,568.00	87,568.00
TOTAL		153,622.47	607,493,13	761,115.60

TABLE II FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECTS July 1, 1980 to June 30, 1981

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of the fiscal year beginning July 1, 1980 and ending June 30, 1981. An open file for each project is maintained from the project's inception to completion; completion is signified by the acceptance of the final report and making of the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.



Project Title: Collection and Analysis of Stream Flow Data

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

Principal Investigator: D. K. Leifeste, U.S.G.S.

Research Period: Project continued to September 30, 1982 by approval of the Director--Highway Division.

Research Funding: \$48,410 per year (matched by \$48,410 from the Department of Interior).

Funding Source: 100 percent State funds; 50 percent Primary and 50 percent Farm-to-Market.

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

Progress: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of stream 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 1980-1981 was in accordance with schedules established by the Water Resources Division.

Reports: Periodically, a summary report of magnitude and frequency of Iowa floods is prepared. 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-143

Project Title: Development of a Computer Program for Roadway Profile Adjustment

Agency: Iowa DOT

Principal Investigators: Lowell Richardson and John Nimmo.

Research Period: November 18, 1980 to January 1, 1981.

Research Funding: \$6,000

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

Objective: To modify the present profile adjustment program to accept a break in grade with a break in stationing and further to adapt the program for use on asphalt concrete roadways.

Progress: The program has been modified and tested to verify the capability of the program.

Reports: A printout of the data processing program is available.

Implementation: The modification will save substantial time in adjusting the profile of a roadway with a bridge or paved cross road.

Project Title: Recycled Asphalt Pavement

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

Principal Investigator: R. Schiek, Kossuth County

Research Period: May 1, 1975 to March 30, 1982

Research Funding: \$50,000

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

Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.

Progress: Construction of the proposed project was completed during the summer of 1975. Road Rater testing and friction testing has been completed on the road annually. A final report will be submitted by March 30, 1982.

Reports: Progress Report September 1975

Implementation: This project proved that recycling of asphalt concrete is feasible and that additional research was needed to solve related problems. Research Project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977, research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials. Kossuth County has accepted recycled asphalt pavement as a standard reconstruction practice.

Project Number: HR-181

Project Title: The Evaluation of Macadam Stone Shoulders

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist, Materials

Research Period: May 25, 1976 to September 30, 1981

Research Funding: \$8,143

Funding Source: 100 percent State, Primary funds

Objective: To determine the feasibility of using a macadam stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of macadam stone shoulders, and to evaluate the performance of macadam stone shoulders.

Progress: This experimental type of shoulder construction was incorporated into a Dallas County project on U.S. 6. Shoulder construction operations were observed and methods and procedures were recorded. The shoulder construction work was completed in 1977. Visual observations showed that the shoulders with the asphalt concrete surface were performing well with no apparent surface deterioration. The side with the cover aggregate seal has some damage and open surface. A visual and structural evaluation program will be continued for the duration of the project. Structural number comparisons between macadam shoulders and recently constructed stabilized and paved shoulders are continuing. Long term effects from traffic and environmental factors will also have to be determined. A final report will be completed in the fall of 1981.

Reports: Construction Report November 1977

Implementation: This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

Project Title: Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Construction

Agency: Iowa State University

Principal Investigator : S. J. Henning, Iowa State University

Research Period: January 1, 1977 to December 31, 1982

Research Funding: \$172,085

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

Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil, to varying conditions and various tillage practices and to determine the effects of land surface elevation above drainage tile or perched water tables.

Progress: Four borrow pit sites were obtained in Audubon, Buchanan, Hamilton, and Lee Counties. These four locations were representative of the range of soil conditions present in Iowa. Corn, soybeans, and alfalfa plots were planted with various top soil replacement and ground preparations. Crop yields resulting from the various conditions have been compared. Research on the Audubon site has been completed. Research on the Buchanan and Lee County sites will be completed after the 1981 crop season. Research on the Hamilton County site will continue at least through the 1982 crop season.

Reports: Progress Reports 1977, 1978, 1979, and 1980.

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared.

Project Title: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations Agency: Kossuth County and Iowa Department of Transportation, Highway Division

Principal Investigator: R. Schiek

Research Period: April 11, 1977 to December 31, 1982

Research Funding: \$50,000

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

Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Progress: The project was constructed in 1977 and all aspects were considered to be very successful. Recycled asphalt proved to be good quality material at a savings of approximately 30 cents per ton over virgin material. Through modifications of equipment, all D.E.Q. requirements for air pollution were easily met and the project gained nationwide and world-wide recognition. A final report will be submitted by December 31, 1982.

Reports: Progress Report December 1977

Implementation: In the interest of conserving energy and material, the elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. The "drum in a drum" asphalt plant modification will prevent pollution while allowing normal production utilizing recycled materials. The plant modification is commercially available and will promote recycling and in turn conservation of natural resources.

Project Title: An Evaluation of Dense Bridge Floor Concrete

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Britson

Research Period: May, 1977 to December 31, 1982

Research Funding: \$3,340

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Funding Source: 100 percent State, Primary funds

Objective: To determine the feasibility of mixing, placing, and finishing dense portland cement concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity, and maintenance performance of dense portland cement concrete.

Progress: The project is located in the Town of Ackley on U.S. 20 in Hardin County. The construction involved the redecking of a multiple span overhead crossing over a railroad. It was proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture. A portion of a full depth bridge deck using concrete with a high range water reducer was placed in August 1977. Problems were encountered in pumping the concrete and in controlling slump and air content. Cores from the deck yielded good air contents for both the Standard D-57 concrete and the high range water reducer (HRWR) concrete. The calculated one year strength for the D-57 concrete was 6650 psi and 8500 psi for the HRWR concrete. The chloride content was slightly higher in the D-57 concrete. The cores revealed good consolidation of both concretes, even though the bottom surface of the HRWR exhibited an open honeycomb appearance.

Reports: Construction Report December 1977

<u>Implementation</u>: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if the admixture is a solution to the problem of corrosion of steel in bridge decks.

Project Number: HR-194

Project Title: Mission Oriented Dust Control and Surface Improvement Processes for Unpaved Roads

Agency: Iowa State University

Principal Investigator: J. M. Hoover

Research Period: July 1, 1977 to March 31, 1981

Research Funding: \$99,860

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

Objective: To identify current practices, products, and specifications of potentially economic dust control systems and to plan, design, and construct a series of demonstration test sections in several regions in Iowa for the purpose of evaluating materials, construction costs, and performance of various dust control methods.

Progress: Sites were selected in various counties to represent the range of soils encountered in Iowa. Substantial laboratory testing was conducted on the soils from the selected sites to determine the potential materials and procedures. Promising products and procedures were used on various county roadways. Dust control on these sites has been evaluated.

Reports: Final Report May 1981

Implementation: The project will identify alternate practices and the most economical methods of dust control.

Project Title: Field Performance and Evaluation of Slurry Seal Coats

Agency: Iowa State University

Principal Investigator: D. Y. Lee

Research Period: July 1, 1977 to November 26, 1980

Research Funding: \$91,000

Funding Source: 100 percent State, Primary funds

To evaluate performance characteristics of materials native to Iowa and applicability Objective: of other materials in slurry seals, mix designs and to correlate laboratory tests with field performance.

Progress: This project is the second phase of a two-part study. Construction on Phase II, a field performance evaluation of slurry seals was delayed due to inflated costs. Under a revised schedule, the project was let in April, 1978 and a time extension through November 26, 1980 was granted with an additional \$11,000 in research construction funding. Application of the slurry seal test sections and approximately half of the control sections were completed in September, 1978. Problems were encountered in obtaining the optimum emulsion content. Some test sections failed and were replaced. Resurfacing of the remaining control sections was completed during the 1979 construction season. Evaluation of the test sections was based on friction testing and a visual observation of slurry seal performance.

Reports: Final Report December 1980.

Implementation: The project will provide a basis for the development and preparation of slurry seal design methods, criteria, procedures and specifications for the successful application of slurry seal as an economic pavement maintenance alternative.

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: D. Anderson

Research Period: July 1, 1977 to June 30, 1981

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

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

Objective: 1. To determine well in advance of highway construction if proposed planning corridors contain known or probable sites of archaeological value. 2. To locate such sites and describe their limits as accurately as possible without resorting to excavation or other detailed examination.

Progress: The Iowa Department of Transportation has an ongoing contract with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary Secondary road construction sites with archaeological value are being examined in advance reports. of construction. Under a new Iowa DOT policy, a revolving fund has been established within the Secondary Road Research Fund to initially pay for the services of a survey contractor. Billings are then made to the counties and cities for their proportionate share of costs incurred. Additional funds were allocated to the revolving fund due to an unanticipated heavy load of Phase 2 testing activity. High potential sites, located through Phase 1 surface survey techniques, required additional subsurface examination in order to establish significance.

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

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

Project Title: Upgrading Asphalt Surface Friction by Aggregate Sprinkle Treatments

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

Research Period: June 1, 1978 to December 31, 1983

Research Funding: \$42,500

Funding Source: 100 percent State, Primary funds

Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixtures of local aggregates for 1" and 1½" thick surface courses followed by a surface sprinkle treatment of precoated hard, durable chips to produce a long lasting non-skid pavement surface.

Progress: This experimental type of resurfacing was applied on old U.S. 30 between Interstate 35 and the City of Nevada in 1978. Appearance is very good with the exception of some corregation which occurred during application. Texture depth tests by the silly putty method and friction tests of the sections are being conducted on a periodic basis.

Reports: Progress Report, October 1979

<u>Implementation</u>: This project will be utilized in the evaluation of paving materials and texturing. It will also assist in determining the effectiveness of sprinkle treatment in providing durable friction properties.

Project Number: HR-203

Project Title: Transverse Joint Sealing with Various Sealants

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

Principal Investigators: G. Hardy, V. J. Marks

Research Period: July 25, 1978 to December 31, 1983

Research Funding: \$51,000

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

Objective: To evaluate the performance of pcc pavement contraction joints utilizing a variety of sealants and joint preparations and to identify an effective joint sealant system.

Progress: These experimental pavement joints were incorporated into a Secondary Road paving project in Dallas County during the 1978 construction season. Joint sealing procedures, materials, and specifications were determined prior to construction. Six different sealant materials were used with three methods of joint cleaning. Other variables were introduced and some cost comparisons were made. Core samples for joint sealant analysis were taken in 1979 and 1980. Visual observations are being made annually. Evaluation of the various joint sealing procedures is continuing. Attempts to find an effective joint sealant system will continue.

Reports: Progress Report, July 1979

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

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

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Research Period: December 14, 1978 to December 31, 1985

Research Funding: \$3,150

Funding Source: 100 percent State, Primary funds

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

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

Reports: None

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

Project Number: HR-20	6
Project Title: Cement	Produced from Fly Ash and Lime
Agency: Iowa Departme	ent of Transportation, Highway Division
Principal Investigator	: W. Rippie

Research Period: April 1, 1979 to January 31, 1982

Research Funding: \$2,510

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

Objective: To determine if a fly ash-lime cement with desirable characteristics can be produced and to determine the combination of ingredients necessary to attain this end.

Progress: Fine crushed limestone and fly ash were obtained, pulverized, and blended. The mixture was submitted to the Coal Research Laboratory of the University of West Virginia for fusion in an induction furnace. Some concrete strength specimens have been made and tested using the fused and crushed material as the cementateous ingredient.

Reports: None

ed ve Implementation: In view of continued shortages of portland cement, utilization of fly ash, a waste product, will conserve energy and increase cement supply for construction projects.

Project Title: Alternative Methods of Stabilizing the Degrading Stream Channels in Western Iowa

Agency: Iowa State University

Principal Investigator: R. A. Lohnes

Research Period: June 1, 1979 to November 30, 1980

Research Funding: \$79,254

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

Objective: To develop and evaluate several alternative methods of stabilizing the degrading channels of the streams and gullies in the loess hills of western Iowa.

Progress: An inventory and evaluation of grade stabilization structures in a 13-county area of western Iowa was obtained. A selected number of successful and problem structures were chosen for detailed documentation and analysis. Multiple installations of check dams, use of sheet piling and sand-soil cement appear to have some potential for stream control. The final report recommends design and construction of several experimental structures in western Iowa for evaluation.

Reports: Final Report September 1980

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

Project Number: HR-208A

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

Agency: Iowa State University

Principal Investigators: R. A. Lohnes, F. W. Klaiber, and M. D. Dougal

Research Period: December 1, 1980 to November 30, 1983

Research Funding: \$137,725

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

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

Progress: Six demonstration sites, three in Shelby County and three in Pottawattamie County, have been selected for initial field installation and operational studies. Preliminary designs for the control structures have been completed. The designs include three vertical sheetpile structures, two soil-cement structures, and one pre-cast concrete structure. Hydraulic and structural analysis of the proposed structures are in progress.

Reports: Progress Report May 1981

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

Project Title: Pavement Surface on Macadam Base

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

Principal Investigator: D. J. Lynam

Research Period: June 26, 1979 to December 31, 1983

Research Funding: \$100,347

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

Objective: To determine the feasibility, economics and performance of placing pc concrete on macadam base while developing design criteria by varying the thickness of the pc concrete and to determine if the macadam base is effective in reducing D-cracking deterioration of concrete produced with limestone of poor durability characteristics.

Progress: Construction was completed on approximately two miles of Adair County Road G-61 in 1979. Seven different roadway typical sections were utilized. A variation in shoulder construction with improved drainage was incorporated into one section. One mile adjacent to the experimental construction was included in the evaluation of the research. Minor construction problems were encountered initially in placing the thin section of pcc on the stone base. Road Rater evaluations of the pavement have been made. Some small areas of distress are visable, but the overall appearance of the pavement is good.

Reports: Construction Report 1980

Implementation: This study will result in the ability to construct a pavement with improved performance in regard to D-cracking and subgrade failure, hopefully at a lower cost.

Project Number: HR-210

Project Title: The Effect of Deer Reflectors on Deer-Vehicle Accidents

Agency: Iowa Conservation Commission, Iowa Department of Transportation, Highway Division

Principal Investigators: L. Gladfelter, H. Dolling

Research Period: June 15, 1979 to September 30, 1983

Research Funding: \$30,072

Funding Source: 100 percent State, Primary funds

Objective: To evaluate the "Swareflex" and Bosch reflector system in reducing deer-vehicle accidents, to determine a cost benefit ratio for the system and to identify deer crossing areas throughout the State for possible implementation of the system.

Progress: Traffic counting equipment was installed at the five designated sites. Deer-vehicle accident records were maintained for one year prior to the installation of the reflectors. The study areas selected are distributed around the State to include different driving conditions, traffic volume and deer densities. Red Swareflex reflectors were mounted at four sites. Silver reflectors purchased from the Robert Bosch Corporation were installed at one site for comparison purposes. A number of Swareflex reflectors had to be replaced due to a design problem. Additional data will be needed to determine any meaningful results from the installation of the deer reflectors. However, results from the first year of data indicates a possible decrease in deer-vehicle accidents.

Reports: Progress reports June 1980, June 1981

Implementation: An effective deer reflector will reduce deer-vehicle accidents and thereby result in savings to the motorist.

Project Title: Performance of Randomly-Oriented Fiber-Reinforced Roadway Soils (A Laboratory and Field Investigation)

Agency: Iowa State University

Principal Investigator: J. M. Hoover

Research Period: July 1, 1979 to June 30, 1982

Research Funding: \$143,207

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

Objective: To conduct a laboratory and field investigation into the potential for improving soil-aggregate surface and roadway subgrade materials and local base course materials by strengthening these materials through fibrous reinforcement.

Progress: Field demonstration sections using a variety of fibers were constructed in Linn and Story Counties during the summer of 1980. On the Linn County project, three different types and three different percentages of fibers were used. The Story County project was constructe on an existing gravel road. Some difficulty was experienced in mixing the fibers into the roadbed due to equipment failure. Results of the use of the fibers to date appear favorable.

Reports: Progress Report December 1980

Implementation: Due to economic restraints, new and cost-effective methods are needed for the improvement of subgrade base course construction. This project will aid in the development of new and improved design procedures.

Project Number: HR-213

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

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. R. Samuelson

Research Period: November 12, 1979 to March 1, 1985

Research Funding: \$13,550

Funding Source: 100 percent State, Primary funds

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

Progress: A Vanguard 2000 PSI Waterblaster was purchased from a Des Moines distributor. This high pressure washer was used extensively for joint and crack maintenance on various primary and interstate highways.

Reports: None

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

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

Agency: Iowa State University

Principal Investigator: F. W. Klaiber

Research Period: March 12, 1980 to May 31, 1981

Research Funding: \$58,895

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

Objective: The development of economical techniques to increase both the live load and dead load carrying capacity of existing single span steel beam concrete deck bridges.

Progress: The final report has been received. A one-half scale model of a 50' x 30' I-beam bridge was constructed for laboratory testing. Strain gauges were attached to the concrete deck to measure concrete strains. Post tensioning rods were attached to individual beams with bolted on brackets designed for that purpose. The bridge was loaded and strain measurements were made. It was determined that existing composite concrete deck, steel I-beam bridges can be strengthened by post tensioning.

Reports: Final Report June 1981

Implementation: There are a number of old single span steel beam concrete bridges that are not in compliance with present bridge standards. This research determined the feasibility of strengthening these bridges in order to avoid posting load limits. A field test will be proposed.

Project Number: HR-215

Project Title: Improvement of Longitudinal Joints in Asphalt Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

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

Research Funding: \$10,700

Funding Source: 100 percent State, Primary funds

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

Progress: Asphalt widening and resurfacing were completed on Iowa 44 in Guthrie and Dallas Counties in August 1980. Core samples to determine densities were taken that fall. Visual observations are made annually.

Reports: Construction Report, February 1981

Implementation: Improved methods for construction of longitudinal joints will result in increased life of asphalt resurfacing resulting from reduced joint deterioration.
Project Title: Emulsion Treated Macadam Base

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

Principal Investigator: C. L. Baule

Research Period: April 28, 1980 to January 15, 1985

Research Funding: \$156,048

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

Objective: To identify and construct a cost-effective asphalt emulsion bound macadam section and to evaluate the performance of an asphalt bound macadam as compared to unbound macadam.

Progress: Construction of the macadam sections was completed in September 1980. The most serious problem encountered in the project was the inability to obtain complete coating of the emulsion treated materials. More favorable weather conditions and modified construction procedures helped to alleviate this problem. Riding quality and overall appearance of this experimental pavement is good. Evaluation will continue for a five year period.

Reports: Construction Report, January 1981

Implementation: Macadam base projects in the past have provided excellent drainage characteristics. The use of asphalt emulsion binder and engineering fabrics will result in energy savings and improved stability while still providing a relatively low cost roadway base.

Project Number: HR-217

Project Title: Reducing the Adverse Effect of Transverse Cracking

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Research Period: March 7, 1980 to January 31, 1984

Research Funding: \$43,000

Funding Source: 100 percent State, Primary funds

Objective: To identify a method of reducing the adverse effect of transverse cracking and improving the performance of asphalt pavement.

Progress: The research was incorporated into a Jones County primary project on Iowa 64 which was completed in September 1980. Some of the variations from standard construction practices used in this project included the following: 1. Use of an asphalt that is partially blown and less susceptible to temperature variations; 2. Variation in mix designs; 3. The sawing and sealing of transverse joints. No particular problems were experienced in this research. Density and gradation requirements were satisfactorily met. No transverse cracking has been noted in any experimental section or standard construction through July 1981.

Reports: Construction Report, February 1981

Implementation: With the prevention of transverse cracking and subsequent crack deterioration, asphalt surfaced roads will last longer and require less maintenance and less frequent resurfacing.

Project Title: Liability and Traffic Control Considerations for Low Level Stream Crossings

Agency: Iowa State University

Principal Investigator: R. L. Carstens

Research Period: June 1, 1980 to April 30, 1981

Research Funding: \$28,350

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

Objective: To assess the practicality of low level stream crossings, to evaluate the potential . of tort liability associated with these crossings and to provide guidance for the selection of traffic control measures and devices to minimize the hazards involved.

Progress: A survey of agencies having experience with low level stream crossings was made. A total of 286 guestionnaires was mailed out to various agencies in 25 states. Of these, 53.8 percent were completed and returned. Responses from persons having experience with low water crossings were widely varied. Very little similarity in liability and sign usage was reported. A phased method of evaluating signing practices was adopted. An assignment of a general pattern of signs was made and different combinations of messages were shown to several test groups. Two warning signs with messages, "FLOOD AREA AHEAD" and "IMPASSABLE DURING HIGH WATER" were recommended along with a regulatory sign with the message, "DO NOT ENTER WHEN FLOODED". Some general recommendations are also given for low water stream crossing usage in Iowa.

Reports: Final Report, April 1981

The development of adequate signing and traffic control will allow the use of low Implementation: water stream crossings which will reduce the fund expenditures for bridges.

Project Number: HR-219

Project Title: Settlement at Culverts and Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W. E. Buss

Research Period: May 1980 to January 31, 1984

Research Funding: \$11,200

Funding Source: 100 percent State, Primary funds

Objective: To identify cost effective construction methods that may prevent settlement at culverts and bridges.

Progress: This research was incorporated into a grade, culvert, pavement widening and resurfacing project on Iowa 44 in Dallas County. Various methods of backfilling and bedding for bridges and culverts were completed by the contractor by extra work order. K-Krete, sand, and Class A material with moisture control were used on the bridge approaches. K-Krete and Class A, B, and C road stone were used in various combinations in the culvert replacement and backfill.

Reports: None

The reduction in settlement will result in less maintenance and will provide the Implementation: best method of backfill at a reasonable cost.

Project Title: Protection of Structural Concrete Substructures

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: J. Risch, J. Whiting

Research Period: May, 1980 to July 15, 1985

Research Funding: \$8,000

Funding Source: 100 percent State, Primary funds

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

Progress: A substantial number of cores was drilled from bridge pier columns on I-235 in Des Moines and I-380 in Cedar Rapids to determine the chloride contamination. A number of commercially available waterproofing products was used with varying application rates and surface preparation methods to determine their potential for preventing chloride intrusion. Cores will be taken annually to monitor chloride content of the pier column concrete.

Reports: Construction Report, February 1981

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-221

Construction and Maintenance Practices to Minimize the Potential Liability of Project Title: Counties for Roads in Rural Subdivisions

Agency: Iowa State University

Principal Investigator: R. L. Carstens

Research Period: July 1, 1980 to August 31, 1981

Research Funding: \$40,465

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

Objective: To identify specific street-related problems that have given rise to claims against municipalities and to determine corrective actions that have been shown to be effective as counter-measures in avoiding or mitigating situations that typically lead to street-related tort claims.

Reports: Progress Report, March 1981

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

Project Title: Retardation of Reflection Cracking Using Stabilizing Additive 5990

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Shelquist

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

Research Funding: \$17,500

Funding Source: 100 percent State, Primary funds

- Objective: To evaluate the use of Stabilizing Additive 5990 (a mixed polymer in granular form) as a method of reducing cracking in asphaltic concrete overlays.
- Progress: A crack survey was made of the existing portland cement concrete prior to construction and the asphaltic concrete resurfacing has been laid.

Reports: None

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

Project Number: HR-223

Project Title: Engineering Study for Maintenance of Iowa's Granular Surfaced Roads

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: S. L. Tritsch

Research Period: June, 1980 to January, 1981

Research Funding: \$2,400

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

Objective: To develop a training slide presentation which will visualize the procedures for the maintenance of secondary granular surfaced roads.

Progress: With the help of Boone, Grundy, Madison, and Story County Secondary Road Departments, slides were obtained of maintenance operations. The following areas were expanded: safety, dragging, cutting, intersections, superelevations, and reporting any discrepancies. A slide-tape presentation was developed and copies were made for distribution and sale.

Reports: Slide-tape presentation, January 1981

Implementation: The slide-tape presentation will result in more efficient and effective maintenance
of gravel roadways.

Project Title: Restoration of Frictional Characteristics on Older PCC Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V. J. Marks

Research Period: July 1, 1980 to December 31, 1983

Research Funding: \$8,000

Funding Source: 100 percent State, Primary funds

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

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

Reports: Construction Report, April 1981

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

Project Number: HR-225

Project Title: Characterization of Fly Ash for Use in Concrete

Agency: Iowa State University

Principal Investigator: Turgut Demirel

Research Period: August 1, 1980 to January 31, 1982

Research Funding: \$89,660

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

Objective: To determine the components or combinations of components of fly ash responsible for good or poor performance of concrete and to quantify fly ash variability.

Progress: Thirty-five fly ash samples were collected from seven power plants. Elemental analyses of all fly ash samples have been performed using x-ray fluorescence. Concrete mixes have been prepared and subjected to freeze-thaw testing and x-ray diffraction analysis.

Reports: Progress Report No. 1

Implementation: The research will establish criteria for predicting suitability of a given fly ash for use in highways in Iowa.

Project Title: Iowa Research with Chem-Crete Bitumen

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

Principal Investigators: D. Jespersen, K. Jones

Research Period: August 1980 to October 31, 1984

Research Funding: \$44,000

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

Objective: To determine if Chem-Crete bitumen will provide significantly improved performance of the mix designs used and to determine if a satisfactory asphalt concrete base can be made using a poorly graded sand.

Progress: Test sections of Chem-Crete resurfacing and standard asphalt resurfacing were constructed in September 1980 on Story County Roads E-57 and North Dakota Street Extension (Ames). Soon after construction, cracks in the Chem-Crete test sections appeared. The Chem-Crete Corporation is working with Story County to determine how to correct the problem. Evaluation will continue for a four-year period.

Reports: A construction report will be submitted in November 1981.

Implementation: Products which result in improved characteristics of low quality aggregate will allow the use of locally available aggregate thereby conserving resources and reducing cost.

Project Number: HR-227

Project Title: Piling Stresses in Bridges with Integral Abutments

Agency: Iowa State University

Principal Investigators: Lowell F. Greimann and Amde M. Wolde-Tinsae

Research Period: December 1, 1980 to August 31, 1982

Research Funding: \$34,855

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

Objective: To determine the maximum length to which bridges with integral abutments can be safely designed.

Progress: A questionnaire was sent to the fifty states, Puerto Rico, and the FHWA Region 15 Construction Office. The questions were directed at limitations in bridge length, type, and skew. A literature search on analytical models has been completed.

Reports: Progress Report, June 15, 1981

Implementation: Currently, bridges with integral abutments are limited to 265 feet in Iowa. If the maximum safe length of these bridges is determined to be longer, savings of highway dollars would be realized.

Project Title: Engineering Study - Automating Iowa's Speed Monitoring Program

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Shyamal Basu

Research Period: March 1, 1981 to October 30, 1982

Research Funding: \$48,540

Funding Source: 100 percent State funds: 78 percent Primary 22 percent Farm-to-Market

Objective: To develop and make operational a system with flexible capabilities of collecting accurate speed data on all road systems in Iowa.

Progress: Inductance loops will be installed in the pavement at 33 sites. Electrical power must be obtained for all sites. Six print/punch automatic speed monitoring devices will be obtained.

Reports: None

Implementation: The use of this automatic equipment will result in reduced cost of data collection while improving the quality thereof.

Project Number: HR-229

Project Title: Alternate Flexible Overlays

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

Principal Investigators: P. Schwarting, C. Leonard

Research Period: March 1981 to October 1987

Research Funding: \$130,000

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

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

Progress: The construction plans have been completed for Osceola County Roads A-34 and A-46 incorporating experimental asphalt resurfacing. The test sections planned consist of cold-laid bituminous concrete overlays using HFMS-2, CSS-1, MC-3000, and SC-800 asphalt cements.

Reports: A construction report will be submitted in 1982.

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

Project Title: An Investigation of Signing Needs at Uncontrolled Local Road Intersections

Agency: Iowa State University

Principal Investigators: K. A. Brewer, W. F. Woodman

Research Period: April 1, 1981 to March 31, 1982

Research Funding: \$56,305

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

Objective: 1. To investigate the variety of legend and symbol face combinations of sign designs to determine whether there are any other combinations which may better communicate with drivers approaching local uncontrolled intersections; 2. To identify the alternative courses of action available to any county encountering such a problem intersection on their local road system.

Progress: Questionnaires are being sent to the Iowa counties and to officials in the other forty-nine states in regard to local intersections. An Apple II computer is being prepared to drive a special video player recorder to present a view of selected intersection approaches from "over the driver's shoulder". An array of sign displays will be shown between each intersection tape. The driver simulated exercise will be shown at regional fairs to obtain participation by rural residents to identify desired driver communication needs.

Reports: Progress Report, June 30 1981

Implementation: The project will identify courses of action counties may consider for a problem intersection on their local road system to improve safety thus reducing accidents.

Project Number: HR-231

Project Title: Special Surface Preparation Prior to Bituminous Overlay

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

Principal Investigator: W. Davison

Research Period: May 1981 to April 1986

Research Funding: \$38,000

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

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

Progress: Four crack sealing methods are planned for Cerro Gordo County Road S-25. The crack filling materials will be standard emulsion sealer, rubberized asphalt sealer, pressure limestone-emulsion slurry and pressure fly ash and cement slurry. Each type of crack sealer will be overlaid with a 2" Type B asphalt cement concrete, 1½" Type B asphalt cement concrete and limestone-emulsion slurry. Evaluation will continue for a five year period.

Reports: None

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

Project Title: Reducing the Problem of Transverse Cracking

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: R. Merritt and V. Marks

Research Period: May 1, 1981 to March 1, 1985

Research Funding: \$4,105

Funding Source: 100 percent State, Primary funds

Objective: To identify a method of reducing the adverse effect of transverse cracking and improving the performance of asphalt pavement.

Progress: Engineering fabric will be used in full depth asphalt construction on a Jones County project. For two experimental sections, the fabric will be placed on grade beneath the asphalt treated base. The fabric will be placed between lifts of the asphalt treated base for two other sections. The project will be monitored periodically for occurence of transverse cracking.

Reports: None

Implementation: The prevention of transverse cracking and subsequent deterioration will increase the life of asphalt surfaced roads and require less maintenance and less frequent resurfacing.

Project Number: HR-233

Project Title: Field Demonstration and Evaluation of Foamed Asphalt

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

Principal Investigators: E. Schornhorst, D. Y. Lee

Research Period: May 1, 1981 to March 1, 1986

Research Funding: \$138,405

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

Objective: 1. To evaluate the performance of foamed asphalt as a stabilizing agent using existing soils and granular surfacing material; 2. To correlate field strength characteristics and performances of foamed mixes with laboratory strength characteristics and performances; 3. To develop specifications and evaluate construction procedures and inspection tests.

Progress: The planned project is a three mile section of Shelby County Road M-56. Eight test sections comprised of a base six inches deep using existing soil and granular surfacing material with AC-5 foamed asphalt cement as the binder material will be constructed. The eight test sections will include two levels of moisture content and four levels of surface treatments (no surface treatments, fog seal, single chip seal, and double chip seal).

Reports: None

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

Project Title: Compilation of Iowa Highway Laws

Agency: Iowa Department of Transportation, Office of General Counsel

Principal Investigator: R. Goodwin

Research Period: May 15, 1981 to September 1, 1981

Research Funding: \$5,000

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

Objective: To provide a current annotated Iowa Highway, Road and Street Law publication.

Progress: Two law clerks have been retained on a temporary basis to search out the laws and pertinent court cases and draft the publication for the Director of the Iowa DOT General Counsel Division.

Reports: None

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

Project Number: HR-235

Project Title: Warrants for Rumble Strips on Rural Highways

Agency: Iowa State University

Principal Investigator: R. L. Carstens

Research Period: June 16, 1981 to June 30, 1982

Research Funding: \$49,850

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

Objective: 1. To improve safety on rural highways by recommending guidelines or warrants for the use of rumble strips; 2. To reassess the conclusions regarding rumble strip installations that were studied in the research project HR-184, "Determination of Rumble Strip Effectiveness."

Progress: An inventory of rumble strips in use on highways in Iowa will be undertaken. Accident data will be analyzed for all rumble strip installations since 1977, all locations that were recorded in HR-184 as being installed before 1978, and a representative sample of other locations installed before 1978.

Reports: None

Implementation: A reduction of accidents would occur if rumble strips are installed where they are warranted but do not exist. Cost savings will arise if rumble strips are not installed where they are not warranted.

or HIGHWAY RESEARCH And DEVELOPMENT In IOWA



HIGHWAY DIVISION OFFICE OF MATERIALS DECEMBER 1982

ANNUAL REPORT OF HIGHWAY RESEARCH AND DEVELOPMENT IN IOWA

FOR THE FISCAL YEAR ENDING JUNE 30, 1982

OFFICE OF MATERIALS (515)239-1447

HIGHWAY DIVISION IOWA DEPARTMENT OF TRANSPORTATION AMES, IOWA 50010

DECEMBER 1982

PETERSON AND DEVICE PROPERTY.

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Research Project Descriptions

RESEARCH AND DEVELOPMENT

The Highway Division of the Iowa Department of Transportation engages in research and development for two reasons: first, to find workable solutions to the many problems that require more than ordinary, routine investigation; and second, to identify and implement improved engineering and management practices.

This report entitled, "Highway Research and Development in Iowa", is submitted in compliance with Section 310.36, Code of Iowa, which directs the submission of a report of the Secondary Road Research Fund. It is a report on the status of research and development projects which were in progress on June 30, 1982; it is also a report on projects completed during the fiscal year beginning July 1, 1981, and ending June 30, 1982. Detailed information on each of the research and development projects mentioned in this report is available in the Office of Materials, Highway Division, Iowa Department of Transportation.

IOWA HIGHWAY RESEARCH BOARD

In developing a progressive, continuing, coordinated program of research

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

The Research Board consists of 13 regular members; six county engineers, three DOT Highway Division engineers, one representative from Iowa State University, one from the University of Iowa, and two engineers employed by Iowa municipalities. Each regular member may have an alternate who will serve at the request of the regular member. The regular members and their alternates are appointed by the Iowa Department of Transportation Highway Division Director for a three-year term. The membership of the Research Board as of June 30, 1982, is listed in Table 1.

The Research Board held eight regular meetings during the period of July 1, 1981 to June 30, 1982. Suggestions for research and development were reviewed at these meetings and recommendations were made by the Board.

1982 IOWA HIGHWAY RESEARCH BOARD

MEMBER

TERM EXPIRES

ALTERNATE

W. W. Amundson Director of Public Works Box 447 Sioux City, IA 51100 (712)279-6111

F. O. Bloomfield Right-of-Way Director Iowa DOT-Highway Division Ames, IA 50010 (515)239-1149

D. R. Boylan, Dean College of Engineering Iowa State University Ames, IA 50011 (515)294-5933

G. Calvert Deputy Director, Development Iowa DOT-Highway Division Ames, IA 50010 (515)239-1461

P. Dvorak Grundy County Engineer Grundy Center, IA 50638 (319)824-6912

R. G. Hering Dean of Engineering University of Iowa Iowa City, IA 52242 (319)353-6603

R. Kirchner City Engineer

12-31-82

12-31-82

12-31-82

12-31-82

12-31-84

12-31-84

12-31-83

R. Holland City Engineer Bettendorf, IA 52722 (319)359-0347

C. L. Huisman Materials Engineer Iowa DOT-Highway Division Ames, IA 50010 (515)239-1452

P. W. Peterson Associate Dean of Research Iowa State University 104 Marston Hall Ames, IA 50011 (515)294-2336

T. E. McElherne Specifications Engineer Iowa DOT-Highway Division Ames, IA 50010 (515)239-1566

R. Gumbert Tama County Engineer Toledo, IA 52342 (515)484-3341

H. Kane, Chairman Civil & Env. Engr. Program University of Iowa Iowa City, IA 52242 (319)353-4968

W. J. Schreiner City Engineer Ankeny, IA 50021 (515)964-5500

Fort Dodge, IA 50501 (515)576-3601

N. Konrady Lucas County Engineer Chariton, IA 50049 (515)774-4013

12-31-83

12-31-82

D. D. Linnan Buena Vista County Engineer Storm Lake, IA 50588 (712)732-1519

D. J. Lynam Adair County Engineer Greenfield, IA 50849 (515)743-6111

L. Mattusch Clinton County Engineer Clinton, IA 52732 (319)243-6210

W. A. Moellering Fayette County Engineer West Union, IA 52175 (319)422-3342

R. F. Percival District 5 Engineer Iowa DOT-Highway Division Fairfield, IA 52556 (515)472-4171

12-31-84

12-31-82

12-31-83

12-31-84

R. Simmering Muscatine County Engineer Muscatine, IA 52761 (319)263-6351

R. Michaelis Carroll County Engineer Carroll, IA 51401 (712)792-3603

C. Christensen Fremont County Engineer Sidney, IA 51652 (712)374-2613

G. D. Petermeir Benton County Engineer Vinton, IA 52349 (319)472-2211

N. Jorgensen Franklin County Engineer Hampton, IA 50441 (515)466-4671

V. R. Snyder District 4 Engineer Iowa DOT-Highway Division Atlantic, IA 50022 (712)243-3355

RESEARCH AND DEVELOPMENT PROJECTS

Proposals for research and development are reviewed by the Iowa Highway Research Board, and its recommendations are transmitted to the Director of the Highway Division and the Director of the Department of Transportation. Expenditure of funds for research and development is then authorized on an individual project basis.

These expenditures may be charged to the Primary Road Fund or the Farmto-Market Road Fund, depending on which road system will benefit from the project. If both primary and secondary roads share in the benefits, then the costs are shared.

Table II is a record of expenditures for research and development made during the fiscal year ending June 30, 1982. Total expenditure was \$640,830.09, including support of the National Cooperative Highway Research Program (see page 5).

IN-HOUSE RESEARCH AND DEVELOPMENT

Research and development projects performed by Highway Division personnel are termed "in-house" projects. These projects may involve other departmental and district personnel, in addition to personnel from the Office of Materials, Research Section. In many instances, personnel from other offices are designated as principal investigators, which means that they have a major role in the planning, performance and analysis of the research.

Contract research funds may be used for material and equipment costs for in-house research, but cannot be used for salary or personal expenses of the participating personnel. Consequently, the contract amounts shown for in-house projects are relatively small and the Office of Materials, Research Section, wishes to express its appreciation to other offices and districts for their assistance.

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

The National Cooperative Highway Research Program (NCHRP) was organized by the American Association of State Highway Officials (now the American Association of State Highway and Transportation Officials -- AASHTO). The program is administered by the Transportation Research Board, a branch of the National Academy of Science.

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

The program is funded annually by all of the states in an amount equal to 0.0675 percent of the federal aid allocated to the states for highways. Iowa's obligation and actual expenditure for NCHRP varies and may be influenced by billing practices.

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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 1½ percent of the receipts in the Farm-to-Market Fund in a fund to be known as the Secondary Road Research Fund. This authorization was first made in 1949, it was repealed in 1963 and reinstated in 1965. When the fund was reinstated, the use was designated to finance engineering studies and research projects. A summary of research and development expenditures from the Secondary Road Research Fund is itemized in Table II.

The values shown in Table II are actual research expenditures for fiscal year 1981. The Office of Transportation Inventory engineering studies include traffic counts and secondary road inventories. The Iowa Department of Transportation accounting procedure for the Secondary Road Research Fund is based on obligations for expenditures on research projects and not the actual expenditure. The Fiscal Year 1981 financial summary is.

Beginning Balance 7-1-81

\$1,074,028

Receipts Interest Fed. Sec. Rd. (1½% of receipts) ... State RUTF (1½% of receipts) External Research Income Sub-Total Total Funds Available Obligation for Expenditures Obligated for

\$ 68,507 165,569 477,785 139,690

851,551 \$1,925,579

Contract Research ...751,999Non-Contract37,322Engineering Studies ...37,322Total Expenditures789,321

BALANCE 6-30-82

\$1,136,258

SECONDARY ROAD TRAFFIC COUNT PROGRAM

During fiscal year 1982 the traffic count program conducted by the Office of Transportation Inventory on the Secondary Road System in 25 counties required a total of 2,800 four-hour manual counts. The traffic data from these counts was used to develop motor vehicle traffic flow maps for each county showing the average annual daily traffic (ADT) on specific road sections in each county. A secondary road inventory was completed in 14 counties. This data provides the county engineer, highway engineer, planner and administrator with essential information needed to determine design standard, systematic classification of highways and the development of programs for improvement and maintenance of secondary roads.

This traffic data is also added to the Iowa Department of Transportation's Secondary Road Base Record. This record is utilized for the preparation of numerous reports and studies including the annual vehicle miles of travel, mileage summaries, need studies, special studies, accident analysis, etc.

FINANCIAL SUMMARY OF RESEARCH AND DEVELOPMENT PROJECTS

July 1, 1981 to June 30, 1982

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на на на на на на на 173 10,660 5,055,00 6,055,00 6,055,00 176 30,000 2,013,93 19,051,93 19,051,93 188 50,000 2,013,93 19,051,93 19,051,93 196 100,000 200 51,000 200 200,000 200 203 51,000 200 100,000 200 200,000 200 206 2,310 40,655,19 40,655,19 40,655,19 40,655,19 213 13,550 204,60 3,244,55 7,746,61 216 135,280 200 200 20,000 3,75 3,76 216 135,280 14,399,54 14,393,54 20,460 3,420,72 3,240,76 224 40,000 3,75 3,77 3,78 23,420,72 3,240,76 3,240,76 225 49,600 3,240,72 3,240,76 3,240,76 3,240,76 3,240,76 3,240,76	140	48,410	24,205,00	24,205,00	48,410.00
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102 3,30 193 75,000 193 75,000 193 10,000 205 3,100 206 2,510 207 3,0,072 208 10,0,3,47 201 30,0,072 211 14,50,51 204,60 213 13,550 204,60 214 58,695 4,314,06 3,434,55 215 10,700 206 226 14,000 3,75 3,75 227 43,000 3,75 3,75 228 3,000 3,75 3,77 229 14,04,655 9,60,71,11 23,692,69 224 40,005 3,75 3,77 225 34,655 9,60,131 13,627,11 23,640,72 228 44,658 20,07,33 4,677,61 229 13,0,000 32,017,3 4,677,61 229 13,0,001 32,017,64 3,024,03 231	199	50,000			
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203 \$1,000 226 2,550 2084 137,725 14,505,42 46,525,42 61,030,84 209 100,347 40,656,19 40,656,19 24,65 211 139,114 40,656,19 24,65 24,60 214 55,895 4,314,66 3,434,55 7,748,61 215 10,700	190	100.000			
005 3,150 006 2,510 007,725 14,505.42 46,525.42 61,030.64 003 00,347 204.60 204.60 211 144,114 40,666.19 204.60 213 13,550 204.60 34.43.55 7,748.61 214 56,905 4,314.05 3,434.55 7,748.61 215 10,700 20 6,000 20,740.72 20,460.72 211 40,465 14,939.54 14,939.54 14,939.54 217 43,000 3,75 3,77 3,78 213 40,465 9,260,72 9,240,72 9,240,72 214 40,465 9,260,73 20,407,72 9,240,72 225 44,000 9,261,31 15,67,11 22,460,72 9,240,72 226 30,000 20,97,93 20,97,74 20,97,74 20,97,74 229 130,000 20,97,93 20,97,93 20,97,93 20,97,93 221 4,105	203	51,000			
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209 100.347 210 30.072 211 144,114 40.656.19 204.60 214 56.855 4.314.06 3.434.55 7.748.61 215 10.700 2 2 7.743.000 2 216 155.299 - - - - 217 43.000 - - - - 218 11.700 - - - - - 220 8.000 - - - - - - 221 40.465 14.939.54 14.939.54 14.939.54 14.939.54 222 17.500 -	208A	137,725	14,505,42	46,525.42	61,030.84
210 30,072 40,656.19 40,656.19 20,656.19 211 143,114 20,460 204.60 204.60 214 56,895 4,314.06 3,434.55 7,748.61 215 10,700 7,748.61 7,748.61 216 156,289 7,748.61 7,748.61 217 43,000 3,75 3,75 220 8,000 3.75 3,75 221 40,455 14,939.54 14,939.54 222 17,500 3,75 3,75 225 89,600 15,226.45 18,345.24 43,456.26 226 44,000 9,240.72 9,400.72 9,400.72 227 34,855 9,661.31 15,671.11 23,468.42 228 48,550 4,406.88 220.73 4,677.61 229 130,000 22,400.00 22,400.00 22,400.00 230 56,305 0,007.93 20,007.93 20,007.93 231 45,304 3,027.54	209	100,347			
211 149,114 40,656.19 40,656.19 204,60 213 13,550 204,60 204,60 204,60 214 56,895 4,314,06 3,434,55 7,788,61 215 10,700 7,788,61 7,788,61 216 156,289 7,788,61 7,788,61 217 43,000 3,75 3,75 220 8,000 3,75 3,75 224 8,000 16,226,45 18,346,24 34,552,69 225 89,600 16,226,45 18,346,24 34,552,69 226 44,000 9,240,72 9,240,72 3,467,761 227 34,655 9,861,31 13,15,617,11 23,488,42 228 48,540 4,406,88 270,73 4,677,61 229 130,000 92,400,00 92,400,00 92,400,00 231 45,340 7,652,64 7,652,64 7,652,64 236 9,265 10,106,04 32,012,65 42,118,69 237 87,065 33,028,38 33,034,56 3,133,66 239 80,000 201,22 223,79 475,01 241 85,050 13,33,66 3,133,66 3,133,66 244	210	30,072			
213 13,550 204,60 204,60 214 56,695 4,314,06 3,434,55 7,748,61 215 10,700	211	149,114		40,656.19	40,656.19
214 59,895 4,314.06 3,434.55 7,748,61 215 10,700	213	13,550	204.60		204.60
215 10,700 216 156,299 217 43,000 229 11,200 220 8,000 221 40,465 14,99.54 14,939.54 222 17,500 3.75 3.75 224 8,000 16,236.45 18,346.24 34,652.49 226 44,000 9,240.72 9,240.72 9,240.72 227 33,455 9,661.31 13,677.11 23,498.42 228 40,350 4,677.61 29 130,000 29,430.00 92,430.00 230 55,355 20,057.93 20,57.93 20,57.93 231 45,340 4,067.41 32,012.65 42,118.69 235 49,850 10,106.04 32,012.65 42,118.69 235 49,850 10,106.04 32,012.65 42,118.69 236 38,143 3,133.66 31,133.66 31,133.66 236 39,000 251.22 23.79 475.01 244	214	58,895	4,314.06	3,434.55	7,748.61
216 156,289 217 43,000 220 8,000 221 40,465 14,99,54 14,939.54 222 17,500 3.75 3.75 225 89,600 16,236.45 13,467.21 9,240.72 226 44,000 9,240.72 9,240.72 9,240.72 227 33,455 9,661.31 13,637.11 23,498.42 228 443,540 4,407.61 92,440.00 92,440.00 230 55,555 20,067.93 20,057.93 20,057.93 231 45,340 - - - - 233 13,405 7,652.64 7,652.64 - - 234 5,000 - 33,026.38 -	215	10,700			
217 43,000 219 11,200 220 8,000 221 40,465 14,939,54 222 17,500 3.75 225 89,600 16,236.45 18,346.24 34,582.49 226 44,000 9,240.72 9,240.72 2,240.72 227 34,655 9,661.31 13,637.11 23,498.42 228 48,540 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.33 20,05.93 231 45,340 4,06.88 270.73 4,677.61 232 4,105 7,652.64 7,652.64 7,652.64 233 138,405 7,672.64 30,028.38 30,028.38 233 80,000 30,494.26 30,494.26 30,494.26 234 8,500 13,727.62 19,300.76 33,028.38 233 80,000 13,13.66 3,133.66 3,133.66 244 9,700 30,494.26 30,494.26 30,494.2	216	156,289			
219 11,200 220 8,000 221 40,465 224 8,000 225 80,600 226 8,000 227 34,655 228 48,540 44,000 9,240,72 227 34,655 9,661,31 13,657,11 229 130,000 230 56,305 230 56,305 231 45,340 232 4,105 233 138,405 7,652,64 7,652,64 7,652,64 7,652,64 233 138,405 234 5,000 235 49,680 236 7,022 237 67,065 238 7,022 240 88,000 241 6,500 2420 88,000 243 3,445 3,000/yr. 30,0615 30,000/yr. 30,0615 30	217	43,000			
220 8,000 14,939.54 14,939.54 221 40,455 5.75 5.75 224 8,000 3.75 5.75 225 89,600 16,236.45 18,346.24 34,562.69 226 44,000 9,240.72 9,240.72 9,240.72 227 34,655 9,861.31 13,637.11 23,498.42 226 48,560 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 20,057.93 231 43,540 7,652.64 7,652.64 7,652.64 233 138,405 7,652.64 7,652.64 7,652.64 236 49,850 10,106.04 32,012.65 42,118.69 233 7,228 13,727.62 19,300.76 33,028.38 239 80,000 159.00 159.00 159.00 240 88,000 159.00 159.00 159.00	219	11,200			
221 40,465 14,939.54 14,939.54 222 17,500 3.75 3.75 224 8,000 3.75 9,260.72 9,240.72 226 44,000 9,260.72 9,240.72 9,240.72 227 34,655 9,661.31 13,637.11 23,446.42 228 48,540 4,406.88 20.73 4,677.61 229 130,000 22,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 20,057.93 231 44,105 7,652.64 7,652.64 7,652.64 233 138,405 7,652.64 7,652.64 42,118.69 234 5,000 30,494.26 30,494.26 30,494.26 236 88,143 3 3,133.66 3,133.66 3,133.66 239 80,000 20,494.26 30,494.26 30,494.26 30,494.26 244 9,700 31,036.15 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 3,133.66 <t< td=""><td>220</td><td>8,000</td><td></td><td></td><td></td></t<>	220	8,000			
222 17,500 3.75 3.75 224 8,000 3.75 3.75 225 89,600 16,236.45 18,346.24 34,592.69 226 44,000 9,240.72 9,240.72 9,240.72 227 34,855 9,661.31 13.637.11 22,496.42 228 46,540 4,406.88 270.73 4,677.61 229 130,000 22,430.00 92,430.00 22,430.00 230 56,505 20,057.93 20,057.93 20,057.93 231 45,340 - - - 232 4,105 - - - 233 138,405 7,652.64 7,652.64 - 234 5,000 - - - - 235 49,850 10,106.04 32,012.65 42,118.69 - 236 88,143 - - - - - - - - - - - -	221	40,465		14,939.54	14,939.54
224 8,000 3.75 3.75 225 89,600 16,336.45 18,346.24 34,582.69 226 44,000 9,240.72 9,240.72 227 34,855 9,861.31 13,637.11 23,498.42 228 48,540 4,406.88 270.73 4.677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,079.3 20,079.93 231 45,340	222	17,500			
225 89,600 16,236.45 18,346.24 34,552.69 226 44,000 9,240.72 9,240.72 227 34,855 9,661.31 13,637.11 22,438.42 228 48,550 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 20,057.93 231 45,340	224	8,000	3.75		3.75
226 44,000 9,240.72 9,240.72 227 34,855 9,861.31 13,637.11 23,498.42 228 48,540 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 231 45,340 7,652.64 7,652.64 232 4,105 7,652.64 7,652.64 234 5,000 32,012.65 42,118.69 235 49,650 10,106.04 32,012.65 42,118.69 236 88,143 31,727.62 19,300.76 33,028.38 239 80,000 30,494.26 30,494.26 241 8,500 159.00 159.00 243 3,445 3,133.66 3,133.66 244 9,700 23.036.15 33,036.15 246 118,000 251.22 223.79 475.01 246 118,000 251.22 223.79 475.01 246 118,000 510.7 34,036.15 33,036.15 <tr< td=""><td>225</td><td>89,600</td><td>16,236.45</td><td>18,346.24</td><td>34,582.69</td></tr<>	225	89,600	16,236.45	18,346.24	34,582.69
227 34,855 9,661.31 13,637.11 23,498.42 228 44,540 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 55,305 20,057.93 20,057.93 231 45,340 - - 232 4,105 - - 233 138,495 7,652.64 7,652.64 234 5,000 - - 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143 - - - 237 87,065 - - - 238 7,228 13,727.62 19,300.76 33,028.38 239 80,000 - - - - 240 88,000 - 159.00 159.00 159.00 243 3,445 3,133.66 - 31,33.66 - - 244 9,700 - 30,036.15 33,036.15 - - - - - - <td>226</td> <td>44,000</td> <td></td> <td>9,240.72</td> <td>9,240.72</td>	226	44,000		9,240.72	9,240.72
228 48,540 4,406.88 270.73 4,677.61 229 130,000 92,430.00 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 231 45,340	227	34,855	9,861.31	13,637.11	23,498.42
229 130,000 92,430.00 92,430.00 230 56,305 20,057.93 20,057.93 231 45,340 20,057.93 20,057.93 232 4,105 7,652.64 7,652.64 233 138,405 7,652.64 7,652.64 234 5,000 32,012.65 42,118.69 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143 - - - 237 87,065 - - - 238 79,228 13,727.62 19,300.76 33,028.38 239 80,000 - - - - 241 8,500 159.00 159.00 159.00 - 243 3,445 3,133.66 - - - - 244 9,700 - - 30,036.15 33,036.15 - - 245 1,000 251.22 223.79 475.01 - - - - - - - - - -	228	48,540	4,406.88	270.73	4,677.61
230 56,305 20,057.93 20,057.93 231 45,340 22,24,105 7,552.64 7,552.64 233 138,405 7,552.64 7,552.64 7,552.64 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143	229	130,000		92,430.00	92,430.00
231 45,340 232 4,105 233 138,405 7,652.64 7,652.64 234 5,000 32,012.65 42,118.69 235 49,650 10,106.04 32,012.65 42,118.69 236 88,143	230	56,305		20,057.93	20,057.93
232 4,105 7,652.64 7,652.64 233 138,405 7,652.64 7,652.64 234 5,000 32,012.65 42,118.69 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143	231	45,340			
233 138,405 7,652.64 7,652.64 234 5,000 32,012.65 42,118.69 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143	232	4,105			
234 5,000 235 49,850 10,106.04 32,012.65 42,118.69 236 88,143	233	138,405		7,652.64	7,652.64
235 49,850 10,106.04 32,012.65 42,118.69 236 88,143 237 87,065 33,028.38 239 80,000 30,494.26 30,494.26 240 88,000 159.00 159.00 241 8,500 159.00 159.00 243 3,445 3,133.66 3,133.66 244 9,700 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 42,403.60 247 88,260 33,036.15 33,036.15 52,05.7 1027 30,000/yr. 33,036.15 33,036.15 52,05.7 Sub-Total \$117,994.01 \$414,671.61 \$532,665.62 HPR-1(89) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(90) NCHRP 1,871.63 297.51 2,169.14 HPR-1(90) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & <td>234</td> <td>5,000</td> <td></td> <td></td> <td></td>	234	5,000			
236 88,143 237 87,065 238 77,228 13,727.62 19,300.76 33,028.38 239 80,000 30,494.26 30,494.26 240 88,000 159,00 159,00 241 8,500 3,133.66 3,133.66 243 3,445 3,133.66 3,133.66 244 9,700 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 21.22 223.79 475.01 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 Sub-Total \$117,994.01 \$414,671.61 \$532,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(90) NCHRP 15,297.48 2,388.80 17,666.28 HPR-1(90) NCHRP 1,371.63 297.51 2,169.14 HPR-PR-PL-1(17) 1881 Planning š 1,371.63 297.51 2,169.14 HPR-PR-PL-1(17) 1881 Planning š 29,189.00 29,189.00 <	235	49,850	10,106.04	32,012.65	42,118.69
237 87,065 33,028.38 238 70,228 13,727.62 19,300.76 33,028.38 239 80,000 30,494.26 30,494.26 240 88,000 159.00 159.00 241 8,500 3,133.66 3,133.66 243 3,445 3,133.66 3,133.66 244 9,700 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 21.22 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 33,036.15 1027 30,000/yr. 36,883.03 5,520.57 42,403.60 14,584.77 2,131.68 16,716.45 16,716.45 HPR-1(88) NCHRP 16,883.03 5,520.57 42,403.60 HPR-1(90) NCHRP 1,871.63 297.51 2,169.14 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 </td <td>236</td> <td>88,143</td> <td></td> <td></td> <td></td>	236	88,143			
238 75,228 13,727.62 19,300.76 33,028.38 239 80,000 30,494.26 30,494.26 240 88,000 159.00 159.00 241 8,500 3,133.66 3,133.66 243 3,445 3,133.66 3,133.66 244 9,700 251.22 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 33,036.15 Sub-Total \$117,994.01 \$414,671.61 \$5532,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(89) NCHRP 36,883.03 5,520.577 42,403.60 HPR-1(90) NCHRP 15,297.48 2,388.80 17,686.28 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PL-11(17) 1981 Planning & Planning & 29,189.00 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830.09 <td>237</td> <td>87,065</td> <td></td> <td>10,000,70</td> <td>22 020 20</td>	237	87,065		10,000,70	22 020 20
239 80,000 30,434.26 30,434.26 240 88,000 159.00 159.00 241 8,500 3,133.66 3,133.66 243 3,445 3,133.66 3,133.66 244 9,700 251.22 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 Sub-Total \$117,994.01 \$414,671.61 \$532,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(88) NCHRP 15,297.48 2,388.80 17,686.28 HPR-1(90) NCHRP 1,871.63 297.51 2,169.14 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & Research Program 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830.09	238	79,228	13,727.62	19,300.76	30,404,26
240 88,000 159,00 159,00 241 8,500 3,133.66 3,133.66 243 3,445 3,133.66 3,133.66 244 9,700 251.22 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 33,036.15 Sub-Total \$117,994.01 \$414,671.61 \$532,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(89) NCHRP 36,883.03 5,520.57 42,403.60 HPR-1(90) NCHRP 15,297.48 2,388.80 17,686.28 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & Research Program 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830.09	239	80,000		30,494.20	50,454.20
241 8,500 133.00 133.00 133.00 243 3,445 3,133.66 3,133.66 244 9,700 251.22 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 3,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 522,665.62 MPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(89) NCHRP 36,883.03 5,520.57 42,403.60 HPR-1(90) NCHRP 15,297.48 2,388.80 17,686.28 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830,09	240	88,000		150 00	159 00
243 3,445 3,133.00 3,133.00 3,103.00 244 9,700 223.79 475.01 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 552,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(89) NCHRP 36,883.03 5,520.57 42,403.60 HPR-1(90) NCHRP 15,297.48 2,388.80 17,686.28 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & 29,189.00 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830.09	241	8,500	2 122 55	133.00	3 133 66
244 9,700 245 1,000 251.22 223.79 475.01 246 118,000 247 88,260 33,036.15 33,036.15 1027 30,000/yr. 33,036.15 33,036.15 33,036.15 Sub-Total \$117,994.01 \$414,671.61 \$532,665.62 HPR-1(88) NCHRP 14,584.77 2,131.68 16,716.45 HPR-1(89) NCHRP 36,883.03 5,520.57 42,403.60 HPR-1(90) NCHRP 15,297.48 2,388.80 17,686.28 HPR-2(120) NCHRP 1,871.63 297.51 2,169.14 HPR-PR-PL-1(17) 1981 Planning & 29,189.00 29,189.00 29,189.00 TOTAL \$186,630.92 \$454,199.17 \$640,830.09	243	3,445	3,133.00		5,150,000
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5

RESEARCH PROJECT DESCRIPTIONS

The following portion of this report briefly describes research projects for which open files were maintained in the Office of Materials, Research Section during all or part of the fiscal year beginning July 1, 1981, and ending June 30, 1982. An open file for each project is maintained from the project's inception to completion; completion is signified by the acceptance of the final report and making the final payment. Each project description contains an implementation statement of the use now being made, or expected as a result of the research effort.

6

Project Title: Collection and Analysis of Stream Flow Data

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

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

Research Period: Project continued to September 30, 1982, by approval of the Director-Highway Division

Research Funding: \$48,410 per year (matched by \$48,410 from the Department of the Interior)

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

Iowa DOT Project Control: Mark F. Looschen, Bridge Design

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

Progress: The Water Resources Division employs a staff of engineers and technicians who monitor and maintain a network of stream 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 1981-1982 was in accordance with schedules established by the Water Resources Division.

Reports: Periodically, a summary report of magnitude and frequency of Iowa floods is prepared. 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-173

Project Title: A Computer Based Information System for County Equipment Cost Records

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: S. Johnson, J.K. Poyzer, J.D. Poyzer

Research Period: December 7, 1981, to April 30, 1982

Research Funding: \$10,060

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

Objective: To enhance the current "Computer Based Information System for County Equipment Cost Records" so it provides more accurate and more timely reports to county engineers who use it.

Progress: A contract for services was negotiated with James Poyzer, a programmer/analyst from Des Moines. Co-principal investigator is John Poyzer who worked on the original programs in 1975. The programs have been revised to allow for easy access to update and correct improper data entries. Also, the programs have been changed to accept individual county data for processing and to allow for several runs of data during the year. Several other minor changes are being initiated to make the program more responsive to the counties' needs. The program will be run this fall to test the improvements.

Reports: None

Implementation: Problems with the original program for county equipment cost records have made the output data unreliable for some counties. Program changes will allow for easy input of county equipment cost information and will result in much quicker return of accurate output data to the counties so the most cost-effective equipment can be identified and specified for future purchases.

Project Title: Recycled Asphalt Pavement

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

Principal Investigator: R. Schiek, Kossuth County

Research Period: May 1, 1975, to March 30, 1982

Research Funding: \$50,000

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

- Objective: To conserve materials and establish techniques that will lead to more economical reconstruction of asphalt paving.
- Progress: Construction of the proposed project was completed during the summer of 1975. Road Rater testing and friction testing has been completed on the road annually.

Reports: Final Report, April 1982

Implementation: This project proved recycling of asphalt concrete is feasible and additional research was needed to solve related problems. Research project HR-1008 was constructed in 1976 due to recommendations resulting from this project. In 1977 research project HR-188 established asphalt recycling as a viable method of construction that will conserve energy and materials. Kossuth County has accepted recycled asphalt pavement as a standard reconstruction practice.

Project Number: HR-181

Project Title: The Evaluation of Macadam Stone Shoulders

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R.A. Shelquist, Materials

Research Period: May 25, 1976, to September 30, 1981

Research Funding: \$8,143

Funding Source: 100 percent State--Primary funds

Objective: To determine the feasibility of using a macadam stone shoulder in place of the standard paved shoulder; to determine if there are any major problems associated with the construction and maintenance of macadam stone shoulders; and to evaluate the performance of macadam stone shoulders.

Progress: This experimental type of shoulder construction was incorporated into a Dallas County project on U.S. 6. Shoulder construction operations were observed and methods and procedures were recorded. The shoulder construction work was completed in 1977. Visual observations showed the shoulders with the asphalt concrete surface were performing well with no apparent surface deterioration. The side with the cover aggregate seal has some damage and open surface. Structural number comparisons between macadam shoulders and recently constructed stabilized and paved shoulders were made.

Reports: Final Report, September 1981

Implementation: This project will provide an alternate cost effective shoulder design for high traffic volume roadways.

Evaluation of Changes in Productivity Resulting from Removal of Soil for Highway Project Title: Construction

Iowa State University Agency:

Principal Investigator: S.J. Henning, Iowa State University

Research Period: January 1, 1977, to December 31, 1982

Research Funding: \$172,085

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

Objective: To evaluate changes in soil productivity caused by removal of soil, to measure the effect on crop yields of returning surface soil under varying conditions and various tillage practices, and to determine the effects of land surface elevation above drainage tile or perched water tables.

Progress: Four borrow pit sites were obtained in Audubon, Buchanan, Hamilton, and Lee counties. These four locations were representative of the range of soil conditions present in Iowa. Corn, soybeans, and alfalfa plots were planted with various top soil replacement and ground preparations. Crop yields resulting from the various conditions have been compared. Research on the Audubon, Buchanan and Lee county sites has been completed. Research on the Hamilton County site will continue at least through the 1982 crop season.

Reports: Summary Report, February 1982

Implementation: Following completion of the project, a manual of practices and procedures for selection and treatment of borrow areas will be prepared.

Project Number: HR-188

Project Title: Evaluation of Air Pollution Control Devices for Asphalt Pavement Recycling Operations

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

Principal Investigator: R. Schiek

Research Period: April 11, 1977, to December 31, 1982

Research Funding: \$50,000

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

Objective: To seek acceptable solutions to the air pollution problem created in the asphalt recycling process using modified conventional equipment.

Progress: The project was constructed in 1977 and all aspects were considered to be very successful. Recycled asphalt proved to be good quality material at a savings of approximately 30 cents per ton over virgin material. Through modifications of equipment, all D.E.Q. requirements for air pollution were easily met and the project gained nationwide and worldwide recognition. A final report is to be submitted by December 31, 1982.

Reports: Progress Report, December 1977

Implementation: In the interest of conserving energy and material, the elimination of the problem of air pollution in the asphalt recycling process is a very desirable goal. The "drum in a drum" asphalt plant modification will prevent pollution while allowing normal production utilizing recycled materials. The plant modification is commercially available and will promote recycling, and in turn, conservation of natural resources.

Project Title: An Evaluation of Dense Bridge Floor Concrete

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R. A. Britson

Research Period: May, 1977, to December 31, 1982

Research Funding: \$3,340

Funding Source: 100 percent State--Primary funds

Objective: To determine the feasibility of mixing, placing and finishing dense portland cement concrete using a super water reducing admixture in a bridge floor. To determine the economics, longevity and maintenance performance of dense portland cement concrete.

Progress: The project is located in the Town of Ackley on U.S. 20 in Hardin County. The construction involved the redecking of a multiple span overhead crossing over a railroad. It was proposed that approximately 25 percent of the bridge deck be placed full depth using a concrete containing a super water reducing admixture. A portion of a full depth bridge deck using concrete with a high range water reducer was placed in August 1977. Problems were encountered in pumping the concrete and in controlling slump and air content. Cores from the deck yielded good air contents for both the Standard D-57 concrete and the high range water reducer (HRWR) concrete. The calculated one-year strength for the D-57 concrete was 6650 psi and 8500 psi for the HRWR concrete. The chloride content was slightly higher in the D-57 concrete. The cores revealed good consolidation of both concretes, even though the bottom surface of the HRWR exhibited an open honeycomb appearance.

Reports: Construction Report, December 1977

Implementation: There is still a need for an improved concrete to retard the intrusion of chlorides. This project will determine if the admixture is a solution to the problem of corrosion of steel in bridge decks.

Project Number: HR-198

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

Agency: State Archaeologist (University of Iowa)

Principal Investigator: D. Anderson, State Archaeologist

Research Period: July 1, 1977, to June 30, 1982

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

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

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

Progress: The Iowa Department of Transportation has an ongoing contract with the State Archaeologist to perform the needed preliminary investigations and prepare the necessary reports. Secondary road construction sites with archaeological value are being examined in advance of construction. Under a new Iowa DOT policy, a revolving fund has been established within the Secondary Road Research Fund to initially pay for the services of a survey contractor. Billings are then made to the counties and cities for their proportionate share of costs incurred. Additional funds were allocated to the revolving fund due to an unanticipated heavy load of Phase 2 testing activity. High potential sites, located through Phase 1 surface survey techniques, required additional subsurface examination in order to establish significance.

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

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

Project Title: Upgrading Asphalt Surface Friction by Aggregate Sprinkle Treatments

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R.A. Shelquist

Research Period: June 1, 1978, to December 31, 1983

Research Funding: \$42,500

Funding Source: 100 percent State--Primary funds

Objective: To determine the feasibility and cost effectiveness of using standard asphalt mixtures of local aggregates for 1" and 11" thick surface courses, followed by a surface sprinkle treatment of precoated hard, durable chips to produce a long lasting non-skid pavement surface.

Progress: This experimental type of resurfacing was applied on old U.S. 30 between Interstate 35 and the City of Nevada in 1978. Appearance is very good, with the exception of some corregation which occurred during application. Texture depth tests by the silly putty method and friction tests of the sections are being conducted on a periodic basis.

Reports: Progress Report, October 1979

Implementation: This project will be utilized in the evaluation of paving materials and texturing. It will also assist in determining the effectiveness of sprinkle treatment in providing durable friction properties.

Project Number: HR-203 Project Title: Transverse Joint Sealing with Various Sealants Dallas County and the Iowa Department of Transportation, Highway Division Agency: Principal Investigator: G. Hardy, V.J. Marks

Research Period: July 25, 1978, to December 31, 1983

Research Funding: \$51,000

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

To evaluate the performance of pcc pavement contraction joints utilizing a variety of sealants Objective: and joint preparations and to identify an effective joint sealant system.

Progress: These experimental pavement joints were incorporated into a Secondary Road paving project in Dallas County during the 1978 construction season. Joint sealing procedures, materials and specifications were determined prior to construction. Six different sealant materials were used with three methods of joint cleaning. Other variables were introduced and some cost comparisons were made. Core samples for joint sealant analysis were taken in 1979 and 1980. Visual observations are being made annually. Evaluation of the various joint sealing procedures is continuing. Attempts to find an effective joint sealant system will continue.

Reports: Progress Report, July 1979

Deterioration of joints and joint-related distress of pcc pavements has continued to be Implementation: a major maintenance problem. This project will identify the effective methods of joint preparation and sealing.

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

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V.J. Marks

Research Period: December 14, 1978, to December 31, 1985

Research Funding: \$3,150

Funding Source: 100 percent State--Primary funds

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

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

Reports: None

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

Project Number: HR-206

Project Title: Cement Produced from Fly Ash and Lime

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W. Rippie

Research Period: April 1, 1979, to October 31, 1982

Research Funding: \$2,510

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

Objective: To determine if a fly ash-lime cement with desirable characteristics can be produced, and to determine the combination of ingredients necessary to attain this end.

Progress: Fine crushed limestone and fly ash were obtained, pulverized and blended. The mixture was submitted to the Coal Research Laboratory of the University of West Virginia for fusion in an induction furnace. Some concrete strength specimens have been made and tested using the fused and crushed material as the cementateous ingredient.

Reports: None

Implementation: In view of continued shortages of portland cement, utilization of fly ash, a waste product, will conserve energy and increase the cement supply for construction projects.

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

Agency: Iowa State University

Principal Investigators: R.A. Lohnes, F.W. Klaiber, and M.D. Dougal

Research Period: December 1, 1980, to November 30, 1983

Research Funding: \$137,725

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

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

Progress: Six demonstration sites, three in Shelby County and three in Pottawattamie County, have been selected for initial field installation and operational studies. Preliminary designs for the control structures have been completed. The designs include three vertical sheetpile structures, two soilcement structures, and one pre-cast concrete structure. Hydraulic and structural analysis of the proposed structures are in progress.

Reports: Progress Reports, May 1981 and December 1981

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

Project Number: HR-209

Project Title: Pavement Surface on Macadam Base

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

Principal Investigator: D.J. Lynam

Research Period: June 26, 1979, to December 31, 1983

Research Funding: \$100,347

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

Objective: To determine the feasibility, economics and performance of placing pc concrete on macadam base while developing design criteria by varying the thickness of the pc concrete and to determine if the macadam base is effective in reducing D-cracking deterioration of concrete produced with limestone having poor durability characteristics.

Progress: Construction was completed on approximately two miles of Adair County Road G-61 in 1979. Seven different roadway typical sections were utilized. A variation in shoulder construction with improved drainage was incorporated into one section. One mile adjacent to the experimental construction was included in the evaluation of the research. Minor construction problems were initially encountered in placing the thin section of pcc on the stone base. Road Rater evaluations of the pavement have been made. Some small areas of distress are visable, but the overall appearance of the pavement is good.

Reports: Construction Report, 1980

Implementation: This study will result in the ability to construct a pavement with improved performance in regard to D-cracking and subgrade failure at a lower cost.

Project Title: The Effect of Deer Reflectors on Deer-Vehicle Accidents

Agency: Iowa Conservation Commission, Iowa Department of Transportation, Highway Division

Principal Investigators: L. Gladfelter, H. Dolling

Research Period: June 15, 1979, to September 30, 1983

Research Funding: \$30,072

Funding Source: 100 percent State--Primary funds

Objective: To evaluate the "Swareflex" and Bosch reflector system in reducing deer-vehicle accidents, to determine a cost benefit ratio for the system and to identify deer crossing areas throughout the state for possible implementation of the system.

Progress: Traffic counting equipment was installed at five designated sites. Deer-vehicle accident records were maintained for one year prior to the installation of the reflectors. The study areas selected are distributed around the state to include different driving conditions, traffic volumes and deer densities. Red Swareflex reflectors were mounted at four sites. Silver reflectors purchased from the Robert Bosch Corporation were installed at one site for comparison purposes. A number of Swareflex reflectors had to be replaced due to a design problem. Additional data will be needed to determine any meaningful results from the installation of the deer reflectors. However, results from the first and second years of data indicate a possible decrease in deer-vehicle accidents.

Reports: Progress reports, June 1980, June 1981 and June 1982

Implementation: An effective deer reflector will reduce deer-vehicle accidents and thereby result in savings to the motorist.

Project Number: HR-211

Project Title: Performance of Randomly-Oriented Fiber-Reinforced Roadway Soils (A Laboratory and Field Investigation)

Agency: Iowa State University

Principal Investigator: J.M. Hoover

Research Period: July 1, 1979, to October 31, 1982

Research Funding: \$143,207

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

Objective: To conduct a laboratory and field investigation into the potential for improving soil-aggregate surface and roadway subgrade materials, and local base course materials by strengthening these materials through fibrous reinforcement.

Progress: Field demonstration sections using a variety of fibers were constructed in Linn and Story counties during the summer of 1980. On the Linn County project, three different types and three different percentages of fibers were used. The Story County project was constructed on an existing gravel road. Some difficulty was experienced in mixing the fibers into the roadbed due to equipment failure.

Reports: Five Progress Reports through January 1982

Implementation: Due to economic restraints, new and cost-effective methods are needed for the improvement of subgrade base course construction. This project will aid in the development of new and improved design procedures.

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

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R.R. Samuelson

Research Period: November 12, 1979, to March 1, 1985

Research Funding: \$13,500

Funding Source: 100 percent State--Primary funds

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

Progress: A Vanguard 2000 PSI waterblaster was purchased from a Des Moines distributor. This high-pressure washer was used extensively for joint and crack maintenance on various primary and interstate highways.

Reports: None

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

Project Number: HR-214

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

Agency: Iowa State University

Principal Investigator: F.W. Klaiber

Research Period: March 12, 1980, to May 31, 1981

Research Funding: \$58,895

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

Objective: The development of economical techniques to increase both the live load and dead load carrying capacity of existing single span steel beam concrete deck bridges.

Progress: The final report has been received. A one-half scale model of a 50' x 30' I-beam bridge was constructed for laboratory testing. Strain gauges were attached to the concrete deck to measure concrete strains. Post tensioning rods were attached to individual beams with bolted-on brackets designed for that purpose. The bridge was loaded and strain measurements were made. It was determined that existing composite concrete deck, steel I-beam bridges can be strengthened by post tensioning.

Reports: Final Report, June 1981

Implementation: There are a number of old single span steel beam concrete bridges that are not in compliance with present bridge standards. This research determined the feasibility of strengthening these bridges to avoid posting load limits. A field test has been approved at two locations.

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Project Title: Improvement of Longitudinal Joints in Asphalt Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R.A. Shelquist

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

Research Funding: \$10,700

Funding Source: 100 percent State--Primary funds

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

Progress: Asphalt widening and resurfacing were completed on Iowa 44 in Guthrie and Dallas counties in August 1980. Core samples to determine densities were taken that fall. Visual observations are made annually.

Reports: Construction Report, February 1981

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

Project Number: HR-216

Project Title: Emulsion Treated Macadam Base

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

Principal Investigator: C.L. Baule

Research Period: April 28, 1980, to January 15, 1985

Research Funding: \$156,289

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

Objective: To identify and construct a cost-effective asphalt emulsion bound macadam section and to evaluate the performance of an asphalt bound macadam as compared to unbound macadam.

Progress: Construction of the macadam sections was completed in September 1980. The most serious problem encountered in the project was the inability to obtain complete coating of the emulsion treated materials. More favorable weather conditions and modified construction procedures helped alleviate this problem. Riding quality and overall appearance of this experimental pavement is satisfactory. Evaluation will continue for a five-year period.

Reports: Construction Report, January 1981

Implementation: Macadam base projects in the past have provided excellent drainage characteristics. The use of asphalt emulsion binder and engineering fabrics will result in energy savings and improved stability, while still providing a relatively low-cost roadway base.

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Project Title: Reducing the Adverse Effect of Transverse Cracking

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V.J. Marks

Research Period: March 7, 1980, to January 31, 1984

Research Funding: \$43,000

Funding Source: 100 percent State--Primary funds

Objective: To identify a method of reducing the adverse effect of transverse cracking and improving the performance of asphalt pavement.

Progress: The research was incorporated into a Jones County primary project on Iowa 64, which was completed in September 1980. Some of the variations from standard construction practices used in this project included the following: 1. Use of an asphalt that is partially blown and less susceptible to temperature variations; 2. Variation in mix designs; 3. The sawing and sealing of transverse joints. No particular problems were experienced in this research. Density and gradation requirements were satisfactorily met. There is very little cracking in the pavement produced from the asphalt cement exhibiting low temperature susceptibility. The pavement produced from the highly temperature susceptible asphalt cement exhibits severe cracking. The sealant has failed in the sawed joints.

Reports: Construction Report, February 1981

Implementation: With the prevention of transverse cracking and subsequent crack deterioration, asphalt surfaced roads will last longer and require less maintenance and less frequent resurfacing.

Project Number: HR-219

Project Title: Settlement at Culverts and Bridges

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W.E. Buss

Research Period: May 1980, to January 31, 1984

Research Funding: \$11,200

Funding Source: 100 percent State--Primary funds

Objective: To identify cost-effective construction methods that may prevent settlement at culverts and bridges.

Progress: This research was incorporated into a grade, culvert, pavement widening and resurfacing project on Iowa 44 in Dallas County. Various methods of backfilling and bedding for bridges and culverts were completed by the contractor by extra work order. K-Krete, sand and Class A material with moisture control were used on the bridge approaches. K-Krete and Class A, B and C road stone were used in various combinations in the culvert replacement and backfill. No significant settlement has been noted to date.

Reports: Construction Report, December 1981

Implementation: The reduction in settlement will result in less maintenance and will provide the best method of backfill at a reasonable cost.

Project Title: Protection of Structural Concrete Substructures

Agency: Iowa Department of Transportation, Highway Division

Principal Investigators: J. Risch, J. Whiting

Research Period: May 1980, to July 15, 1985

Research Funding: \$8,000

Funding Source: 100 percent State--Primary funds

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

Progress: A substantial number of cores were drilled from bridge pier columns on I-235 in Des Moines and I-380 in Cedar Rapids to determine the chloride contamination. 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 will be taken annually to monitor the chloride content of the pier column concrete.

Reports: Construction Report, February 1981

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-221

Project Title: Construction and Maintenance Practices to Minimize the Potential Liability of Counties for Roads in Rural Subdivisions

Agency: Iowa State University

Principal Investigator: R.L. Carstens

Research Period: July 1, 1980, to August 31, 1981

Research Funding: \$40,465

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

Objective: To identify specific street-related problems that have given rise to claims against municipalities, and to determine corrective actions that have been shown to be effective as countermeasures in avoiding or mitigating situations that typically lead to street-related tort claims. A survey asking information on highway-related tort claims was mailed to 259 Iowa cities. Of these, 63 percent were completed and returned. Over one-third of the claims reported were based on alleged street defects. Another 34 percent of the claims contained allegations of damages due to backup of sanitary sewers or defects in sidewalks. Several recommendations were made concerning the review of subdivision plats and the conduct of maintenance in cities and rural subdivisions.

Reports: Final Report, August 1981

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

Project Title: Retardation of Reflection Cracking Using Stabilizing Additive 5990

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: R.A. Shelquist

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

Research Funding: \$17,500

Funding Source: 100 percent State--Primary funds

- Objective: To evaluate the use of Stabilizing Additive 5990 (a mixed polymer in granular form) as a method of reducing cracking in asphaltic concrete overlays.
- Progress: A crack survey was made of the existing portland cement concrete prior to construction. The asphaltic concrete resurfacing has been laid. Periodic crack surveys have been made.

Reports: None

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

Project Number: HR-224

Project Title: Restoration of Frictional Characteristics on Older PCC Pavement

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V.J. Marks

Research Period: July 1, 1980, to December 31, 1983

Research Funding: \$8,000

Funding Source: 100 percent State--Primary funds

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

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

Reports: Construction Report, April 1981

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

Project Title: Characterization of Fly Ash for Use in Concrete

Agency: Iowa State University

Principal Investigator: Turgut Demirel

Research Period: August 1, 1980, to January 31, 1982

Research Funding: \$89,660

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

Objective: To determine the components or combinations of components in fly ash responsible for good or poor performance of concrete and to quantify fly ash variability.

<u>Progress</u>: Thirty-five fly ash samples were collected from seven power plants. Elemental analyses of all fly ash samples have been performed using x-ray fluorescence. Concrete mixes have been prepared and subjected to freeze-thaw testing and x-ray diffraction analysis.

Reports: Interim Report, December 31, 1981

Implementation: The research will establish criteria for predicting the suitability of a given fly ash for use in highways in Iowa.

Project Number: HR-226

Project Title: Iowa Research with Chem-Crete Bitumen

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

Principal Investigators: D. Jespersen, K. Jones

Research Period: August 1980, to October 31, 1984

Research Funding: \$44,000

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

Objective: To determine if Chem-Crete bitumen will provide significantly improved performance of the mix designs used, and to determine if a satisfactory asphalt concrete base can be made using a poorly graded sand.

Progress: Test sections of Chem-Crete resurfacing and standard asphalt resurfacing were constructed in September 1980 on Story County Roads E-57 and North Dakota Street Extension (Ames). Soon after construction, cracks in the Chem-Crete test sections appeared. The Chem-Crete Corporation is working with Story County to determine how to correct the problem. Evaluation will continue for a four-year period.

Reports: Construction Report, November 1981

Implementation: Products which result in improved characteristics of low quality aggregate will allow the use of locally available aggregate, thereby conserving resources and reducing cost.

Project Title: Piling Stresses in Bridges with Integral Abutments

Agency: Iowa State University

Principal Investigators: Lowell F. Greimann and Amde M. Wolde-Tinsae

Research Period: December 1, 1980, to August 31, 1982

Research Funding: \$34,855

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

Objective: To determine the maximum length to which bridges with integral abutments can be safely designed.

<u>Progress</u>: A questionnaire was sent to the 50 states, Puerto Rico, and the FHWA Region 15 Construction Office. The questions concerned limitations in bridge length, type and skew. The research for the original study was completed in February 1982, showing the 265-foot limitation to be very conservative. The study was extended to include skewed bridges with no additional funding.

Reports: Final Report, February 1982

Implementation: Currently, bridges with integral abutments are limited to 265 feet in Iowa. If the maximum safe length of these bridges is determined to be longer, savings of highway dollars would be realized.

Project Number: HR-228

Project Title: Engineering Study - Automating Iowa's Speed Monitoring Program

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: Shyamal Basu

Research Period: March 1, 1981, to October 30, 1982

Research Funding: \$48,540

Funding Source: 100 percent State funds--78 percent Primary, 22 percent Farm-to-Market

- Objective: To develop and make operational a system with flexible capabilities of collecting accurate speed data on all road systems in Iowa.
- Progress: Inductance loops have been installed in the pavement at 33 sites. Six print/punch automatic speed monitoring devices have been obtained and checked for accuracy.

Reports: Progress Report, November 1981

Implementation: The use of this automatic equipment will result in reduced cost of data collection while improving the quality of that data.

Project Title: Alternate Flexible Overlays

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

Principal Investigators: P. Schwarting, C. Leonard

Research Period: March 1981, to October 1987

Research Funding: \$130,000

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

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

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

Reports: A construction report will be submitted in February 1983

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

Project Number: HR-230

Project Title: An Investigation of Signing Needs at Uncontrolled Local Road Intersections

Agency: Iowa State University

Principal Investigators: K.A. Brewer, W.F. Woodman

Research Period: April 1, 1981, to March 31, 1982

Research Funding: \$56,305

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

Objective: To investigate the variety of legend and symbol face combinations of sign designs to determine whether there are any other combinations which may better communicate with drivers approaching local uncontrolled intersections. To identify the alternative courses of action available to any county encountering such a problem intersection on their local road system.

Progress: An Apple II computer was programmed to display a view of selected local road intersection approaches from "over the driver's shoulder." An array of sign displays was shown between each intersection type. A booth at the 1981 Iowa State Fair was used to obtain participation from rural residents in the driver communication tests. Four hundred and five responses were recorded and used for statistical analysis. The report contains findings from the surveys that were conducted as well as recommendations for dealing with problem local uncontrolled intersections.

Reports: Final Report, April 1982

Implementation: The project will identify courses of action counties may consider for a problem intersection on their local road system to improve safety, thus reducing accidents.

Project Title: Special Surface Preparation Prior to Bituminous Overlay

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

Principal Investigator: W. Davison

Research Period: May 1981, to April 1986

Research Funding: \$45,340

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

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

Progress: Four crack sealing methods were done in May 1982 on Cerro Gordo County Road S-25. The crack filling materials were standard emulsion sealer, rubberized asphalt sealer, pressure-injected fly ash-cement slurry and pressure-injected limestone-emulsion slurry. Three test sections were formed by repeating the four crack sealing procedures along the length of the project. Overlays for the three sections were 2" of Type "B" asphalt cement concrete, 11" of Type "B" asphalt cement concrete, and a limestone-emulsion slurry seal. Crack sealing with the limestone-emulsion slurry was discontinued after several unsuccessful attempts at mixing the material. Evaluation will continue for a five-year period.

Reports: None

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

Project Number: HR-232

Project Title: Reducing the Problem of Transverse Cracking Iowa Department of Transportation, Highway Division Agency:

Principal Investigators: R. Merritt and V. Marks

Research Period: May 1, 1981, to March 1, 1985

Research Funding: \$4,105

Funding Source: 100 percent State--Primary funds

Objective: To identify a method of reducing the adverse effect of transverse cracking and improving the performance of asphalt pavement.

Engineering fabric was used in full depth asphalt construction on a Jones County project. For Progress: two experimental sections, the fabric was placed on grade beneath the asphalt treated base. The fabric was placed between lifts of the asphalt treated base for two other sections. No cracking has been noted to date.

Reports: None

The prevention of transverse cracking and subsequent deterioration will increase the life Implementation: of asphalt surfaced roads and require less maintenance and less frequent resurfacing.
Project Title: Field Demonstration and Evaluation of Foamed Asphalt

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

Principal Investigators: E. Schornhorst, D.Y. Lee

Research Period: May 1, 1981, to March 1, 1986

Research Funding: \$138,405

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

Objective: To evaluate the performance of foamed asphalt as a stabilizing agent using existing soils and granular surfacing material; to correlate field strength characteristics and performances of foamed mixes with laboratory strength characteristics and performances; and to develop specifications and evaluate construction procedures and inspection tests.

Progress: The planned project is a three-mile section of Shelby County Road M-56. Eight test sections comprised of a base six inches deep, using existing soil and granular surfacing material with AC-5 foamed asphalt cement as the binder material will be constructed. The eight test sections will include two levels of moisture content and four levels of surface treatments: no surface treatments, fog seal, single chip seal and double chip seal.

Reports: None

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

Project Number: HR-234

Project Title: Compilation of Iowa Highway Laws

Agency: Iowa Department of Transportation, Office of General Counsel

Principal Investigator: R. Goodwin

Research Period: May 15, 1981, to September 1, 1981

Research Funding: \$5,000

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

Objective: To provide a current annotated Iowa Highway, Road and Street Law publication.

Progress: Two law clerks were retained on a temporary basis to search out the laws and pertinent court cases and draft the publication for the Director of the Iowa DOT General Counsel Division.

Reports: None

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

Project Title: Warrants for Rumble Strips on Rural Highways

Agency: Iowa State University

Principal Investigator: R.L. Carstens

Research Period: June 16, 1981, to June 30, 1982

Research Funding: \$49,850

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

Objective: To improve safety on rural highways by recommending guidelines or warrants for the use of rumble strips; to reassess the conclusions regarding rumble strip installations that were studied in the research project HR-184, "Determination of Rumble Strip Effectiveness."

Progress: An inventory of rumble strips in use on highways in Iowa was undertaken. Data was collected for 147 comparitive locations and 109 locations, with before and after installation records. Accident data and physical characteristics of the locations were analyzed to determine what factors distinguished locations that experienced a reduction in accidents following rumble strip installation from those where no such reduction had occurred. The report suggests that in many instances, the installation of rumble strips will have no effect on the occurrence of accidents. However, analysis of before and after samples indicated that the accident rate could be expected to improve following installation of rumble strips only if it were above 2.5 accidents per million entering vehicles (MEV) at secondary locations and above 2.0 accidents per MEV at primary locations.

Reports: Final Report, June 1982

Implementation: A reduction of accidents would occur if rumble strips are installed where they are warranted but do not exist. Cost savings will arise if rumble strips are not installed where they are not warranted.

Project Number: HR-236

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

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

Principal Investigators: C.E. Hales, R.A. Lohnes, F.W. Klaiber, T. Austin

Research Period: July 10, 1981, to June 1, 1986

Research Funding: \$88,143

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

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

Progress: Preliminary designs for the control structures have been completed. The designs include a vertical sheet-pile structure, a soil-cement structure, and a pre-cast concrete structure. Hydraulic and structural analysis of the proposed structures are in progress.

Reports: None

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

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

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

Principal Investigators: E. Schornhorst, R.A. Lohnes, F.W. Klaiber, T. Austin

Research Period: July 10, 1981, to June 1, 1986

Research Funding: \$87,065

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

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

Progress: Preliminary designs for the control structures have been completed. The designs include two vertical sheet-pile structures and a soil-cement structure. Hydraulic and structural analysis of the proposed structures are in progress.

Reports: None

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

Project Number: HR-238

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

Agency: Iowa State University

Principal Investigator: F.W. Klaiber

Research Period: July 1, 1981, to September 30, 1984

Research Funding: \$79,228

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

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

<u>Progress</u>: A bridge on a Farm-to-Market road in Dickinson County and a bridge on Iowa 144 in Greene have been selected for post-tensioning. Brackets have been fabricated to hold the post-tensioning bars in place.

Reports: Progress Report, December 31, 1981

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

Project 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: J.P. Harkin

Research Period: August 25, 1981, to October 31, 1982

Research Funding: \$80,000

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

Objective: To reanalyze the secondary bridge standard designs according to current length and weight laws of the state of Iowa.

<u>Progress</u>: An agreement was authorized with Wallace, Holland, Kastler and Schmitz Consulting Engineers to conduct the major portion of the work. Over 500 standard bridge designs are being rated. Two final reports will be submitted by October 1982. The first report will contain the rating for each standard bridge and the second will contain the calculations used to arrive at those ratings.

Reports: None

<u>Implementation</u>: The study will: 1. Avoid duplication of bridge evaluations and result in a cost savings for the counties; 2. Facilitate the bridge posting on the secondary road system; and 3. Aid in the evaluation of damaged or deteriorated bridges on the secondary road system.

<u>Project Number</u>: HR-240
<u>Project Title</u>: Systems to Control Corrosion in Concrete
<u>Agency</u>: Iowa Department of Transportation, Highway Division
Principal Investigators: J.E. Whiting, V.J. Marks

Research Period: April 1, 1982, to March 15, 1985

Research Funding: \$88,000

Funding Source: 100 percent State--Primary funds

Objective: To field test protective systems for substructures and identify a system or systems that will halt corrosive activity.

Progress: The site selected for this research was Interstate 235 in Des Moines from 2nd Avenue to 9th Street. The research is to be incorporated into a pier rehabilitation project. The protective systems to be considered are cathodic protection, moisture starvation and oxygen starvation. Delays have been encountered due to problems of executing a contract with the cathodic specialty contractor.

Reports: None

Implementation: Many of the older bridge structures are exhibiting substantial deterioration. A system to halt corrosive activity would save millions of dollars in pier column rehabilitation.

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Project Title: Development of Electronic Distance Measuring Instrument (EDMI) Calibration Baseline

Agency: Iowa State University

Principal Investigator: K. Jeyapalan

Research Period: March 8, 1982, to March 31, 1984

Research Funding: \$8,500

Funding Source: 100 percent State--47 percent Primary, 53 percent Farm-to-Market funds

Objective: To develop a mathematical model to determine the scale and constant of the EDMI; to develop a computer program for calculation of the EDMI scale and constant; and to evaluate the stability of the baseline.

Progress: The baseline was established on an Iowa State University farm just southwest of Ames.

Reports: None

Implementation: Use of the baseline and EDMI calibration procedure will assure survey accuracy and prevent loss due to legal action.

Project Number: HR-243

Project Title: Production and Evaluation of Calcium Magnesium Acetate (CMA)

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: W. Rippie

Research Period: January 2, 1982, to April 30, 1982

Research Funding: \$3,445

Funding Source: 100 percent State--Primary funds

- Objective: To evaluate the effectiveness of CMA as a deicer under actual use conditions and investigate the possibilities of producing CMA with a high magnesium acetate content and evaluate its properties.
- <u>Progress</u>: About 10 tons of CMA deicer were produced in the Materials Laboratory for field use. Production was with a 6-cubic foot cement mixer and an older pug mill-type mixer. Two sections of highway near Ames were used in field trials.
- Reports: None
- Implementation: CMA as a deicing agent offers a potential savings by reducing corrosion of reinforcing steel in bridges.

Project Title: Detection of Concrete Delaminations by Infrared Thermography

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: B. Brown

Research Period: May 1, 1982, to December 1, 1982

Research Funding: \$9,700

Funding Source: 100 percent State--Primary funds

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

Progress: Fifteen bridges and five miles of thin bonded portland cement concrete have been surveyed by Donohue and Associates of Sheboygan, Wisconsin.

Reports: None

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

Project Number: HR-245

Project Title: Dynamic Deflections to Determine Roadway Support Ratings

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: V.J. Marks

Research Period: April 18, 1982, to March 31, 1983

Research Funding: \$1,000

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

Objective: To determine if the Iowa DOT Road Rater can be used to determine support values for selected rigid pavements and layered systems.

Progress: The Iowa DOT Road Rater and the FHWA "Thumper" were used to determine the dynamic deflections on 25 different roadway sections. The sections included a variety of bases and pavements varying from a gravel surface on new grade to 10" of pcc and a 25" thick bituminous roadway. The Road Rater data has been summarized, but the Thumper data is not yet available.

Reports: None

Implementation: Improved testing and design procedures will yield the most cost effective pavement thicknesses that will provide the desired service life.

Project Title: Engineering Study - Reducing Sign Vandalism

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: K. Jones

Research Period: June 14, 1982, to February 1988

Research Funding: \$118,000

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

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

Progress: A survey will be sent to the counties asking about accidents at locations where a sign had been vandalized. Educational material and sign identification material will be developed to be distributed to school children, the general public, and to the Iowa counties. Several counties will be selected to participate in the study by recording specific sign replacement information.

Reports: None

<u>Implementation</u>: The Federal Highway Administration estimates that at least 10 percent of all highway signs are vandalized each year. This costs the Iowa counties over \$1 million per year. One state conducted a public awareness campaign and achieved over a 50 percent reduction in signs being vandalized.

<u>Project Number</u>: HR-247
<u>Project Title</u>: Design Criteria for Low Water Crossings
<u>Agency</u>: Iowa State University
<u>Principal Investigator</u>: R.L. Rossmiller
Research Period: June 1, 1982, to May 31, 1984

Research Funding: \$88,260

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

Objective: To develop a design procedure for low water stream crossings for use by the Iowa county engineers and to demonstrate the design procedure through field demonstration projects and training seminars.

Progress: The design procedure to be developed will include design criteria for the evaluation of the hydraulic, hydrologic, erosion control, structural, and location considerations for low water stream crossings in Iowa. Iowa counties currently experimenting with the crossings will be contacted and asked for their input.

Reports: None

Implementation: Iowa has nearly 8,000 deficient bridges on roads carrying less than 50 vehicles per day. Public demand is strong in favor of keeping these roads open. It is not economically feasible to replace the deficient bridges with new bridge structures. Low water stream crossings are a possible solution on many of very low volume roadways.

Project Title: Secondary Road Research Coordinator

Agency: Iowa Department of Transportation, Highway Division

Principal Investigator: K. Jones

Research Period: March 5, 1980, to present

Research Funding: \$30,000 per year

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

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

Progress: Kevin Jones, an Engineer-in-Training with the Iowa DOT, currently holds the position of "Secondary Road Research Coordinator" in the Office of Materials. Many of the county engineers have been visited to discuss problems being encountered by the secondary road departments and to discuss present research of interest. The Secondary Road Research Coordinator was instrumental in initiating three secondary research projects during the year. At present, there are 12 active research projects that involve experimental construction by counties. The coordinator assists these counties with special testing, evaluation, and writing of construction and final reports necessary to the research.

Reports: None

<u>Implementation</u>: 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 to understanding the problem and formulating solutions. Proper documentation and dissemination of reports will allow for timely technology transfer between the counties.



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