**ANNUAL REPORT
OF THE ASSISTANT DIRECTOR
1957-1958**

**OCT. 1958
No. 28**

by

H. L. MICHAEL

**Joint
Highway
Research
Project**

**PURDUE UNIVERSITY
LAFAYETTE INDIANA**

ANNUAL REPORT OF THE ASSISTANT DIRECTOR, 1957-1958

TO: Professor K. B. Woods, Director
Joint Highway Research Project

October 23, 1958
File: 10-2-3

FROM: Harold L. Michael, Assistant Director

Attached is a copy of the "Annual Report of the Assistant Director, 1957-1958." This report, the 20th in a series, presents the activities of the Joint Highway Research Project during the past year. A very brief summary of the contents of the report is included in this letter of transmittal.

The Project conducted research in nine areas during 1957-58 with forty (40) research projects being active. Of these studies, fifteen (15) were completed and twelve (12) new projects were initiated. Eleven of the completed projects were conducted by staff members who also utilized the research in the preparation of a graduate thesis. The following table lists each of the nine areas and the distribution of active projects, completed projects, theses and new projects.

Research Projects 1957-58

<u>Research Area</u>	<u>Number of</u>			
	<u>Active Projects</u>	<u>Projects Completed</u>	<u>Theses</u>	<u>New Projects</u>
Airphoto Interpretation	5	1	1	0
Bituminous Materials and Flexible Pavements	4	2	1	1
Chemistry of Materials	2	0	0	0
Concrete Materials and Rigid Pavements	5	0	0	1
Economics, Administration and Finance	4	3	2	2
Soils and Pavement Design	5	2	1	2
Structures	2	1	1	1
Traffic Engineering and Safety	8	4	4	2
Special Projects	<u>5</u>	<u>2</u>	<u>1</u>	<u>3</u>
TOTAL	40	15	11	12

Fifty-seven (57) formal reports were presented to the Advisory Board during the year, totaling 2,363 pages of information. Seventeen (17) of these were research reports, twenty-one (21) were technical papers, fifteen (15) were plans of study and four (4) were administrative reports.

Major research projects that were active included highway location studies using the Kelsh Plotter; the preparation of an atlas of the ninety-two (92) county drainage maps (approximately 260 drainage and soil maps were sold to about 100 individuals or organizations during the year); continuation of the county soil mapping study; a study of the strength and deformation characteristics of bituminous mixtures; completion of a project on the skid characteristics of bituminous mixtures; continuation of a study of test methods related to alkali aggregate reactivity; studies of aggregate durability, deleterious substances in aggregates, and fatigue properties of air-entrained concrete; completion of the highway needs study and a reevaluation of the Kokomo and Lebanon bypasses; initiation of a study of soil pressures under flexible pavements; studies of stresses and deflections in portland cement concrete pavement slabs, the effect of pavement edge marking, the causes of high-accident rates on some roads, and the effect of rate of strain on the strength of remolded soil; initiation of a study on the hydraulics of river flow under arch bridges and the measurement of the moisture gradient in hardened concrete; and completion of a research project on warping stresses and deflections in concrete slabs.

Three of the research projects initiated during the year were developed as cooperative projects between the Bureau of Public Roads and the State Highway Department of Indiana and will utilize HPS funds in part.

Highway extension activities also continued with the 44th Annual Road School serving as the major activity. About 850 attended this conference. Three studies--classification of roads for Dubois and Jay Counties and a thoroughfare and parking study for Crown Point, Indiana--were completed and numerous requests for advice and assistance from counties and cities were filled.

Among many outstanding recognitions and honors received by the staff were the following: Professor Woods was elected National President of the American Society of Testing Materials and also continued as Chairman of the Advisory Committee for the American Association of State Highway Officials Road Test; Professor Petty was the first recipient of the "Ben H. Petty Award" for outstanding contributions to highway development; and Professor Goetz was elected National President of the Association of Asphalt Paving Technologists.

Only one change occurred in the personnel of the Advisory Board during the year--Professor Berry resigned upon leaving Purdue in August, 1957. Advisory Board Members Cooper, Havey, Vogelgesang, Mills and Woods and Secretary Michael attended each of the eight board meetings. In fact,

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only a total of 10 absences at Board Meetings for the eleven members and Secretary Michael were recorded during the year.

On June 30, 1958, the staff of the project consisted of thirteen (13) research engineers, three (3) research associates, four (4) research assistants, eleven (11) graduate assistants, three (3) service personnel, and three (3) clerical personnel--a total of thirty-seven (37). Twenty (20) staff members resigned during the year and twenty-one (21) new members were employed. Five (5), a new high, of the new members returned to the staff after an absence of some time. In terms of years of service on the Project, Professor Petty is the oldest having first been employed on July 1, 1936. Professor Goetz, employed May 13, 1938; Mr. Luttrell, employed August 6, 1938; and Professor K. B. Woods, employed February 1, 1939, have also served the project for many years.

The Project employed seventy-nine (79) extra labor employees during the year with about thirty (30) of these being employed at any one time.

Major items of equipment purchased during the year included a Marchant calculator, a Marshall test mold, a gasoline powered earth auger, and a mechanical kneading compactor.

Members of the Staff participated in many national and international meetings. Papers were presented at national meetings of the American Association for the Advancement of Science, Association of Asphalt Paving Technologists, American Association of State Highway Officials, The Mississippi Valley Conference of the American Association of State Highway Officials, American Road Builders Association--County Division, American Society of Testing Materials, and the Highway Research Board. Five members of the staff are members of a Department of the Highway Research Board or are chairmen of a committee of that group.

Members also attended national meetings of the American Society of Civil Engineers, the American Concrete Institute, the American Railway Engineering Association, a national conference on electronic controls, and the Institute of Traffic Engineers. State and local meetings of the American Society of Civil Engineers, the Society of Professional Engineers, the American Society of Civil Engineers and the American Society of Engineering Education were also attended by members of the Project staff.

Staff members presented fifty-seven (57) talks, gave twenty-one (21) papers, and had thirty-seven (37) publications during the year. Eleven of the latter were made Civil Engineering Reprints. In addition, Professor Petty edited the Proceedings of the Road School, the 1957 Directory of Indiana State, County and City Officials and a monthly newsletter, all of which were published by the Project.

October 23, 1958

From the financial point of view, the activities of the Project resulted in the encumbering of \$136,140.58 of the \$150,000 received during the year.

Detailed accounts of the research and the other activities are included in the report. All of these activities made possible by the fine cooperation of the staff resulted in a progressive and successful year for the Joint Highway Research Project.

Respectfully submitted,

Harold L. Michael

Harold L. Michael, Assistant Director
Joint Highway Research Project

HLM:ht

Attachment

cc: J. R. Ball	J. T. Hallett	B. H. Petty
A. K. Branham	F. F. Havey	R. L. Schuster
I. W. Burr	G. A. Hawkins	M. B. Scott
J. R. Cooper	G. A. Leonards	C. E. Vogelgesang
P. D. Cribbins	C. W. Lovell	J. L. Waling
W. L. Dolch	J. F. McLaughlin	R. D. Walker
W. H. Goetz	R. D. Miles	J. E. Wilson
F. H. Green	R. E. Mills	P. T. Yeh
M. J. Gutzwiller	Merle Parvis	E. J. Yoder

ANNUAL REPORT OF THE ASSISTANT DIRECTOR

1957-1958

by
Harold L. Michael
Assistant Director

Joint Highway Research Project
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Purdue University
Lafayette, Indiana

October 23, 1958

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ANNUAL REPORT OF THE ASSISTANT DIRECTOR

July 1, 1957 to June 30, 1958

RESEARCHES OF THE JOINT HIGHWAY RESEARCH PROJECT

The Joint Highway Research Project in the School of Civil Engineering is organized to do cooperative research with the State Highway Department of Indiana. Research was initiated on June 1, 1936, and formally authorized by an act of the Indiana State Legislature on March 11, 1937, and amended March, 1949. The purpose of this organization is to make basic studies of materials used in highways; to facilitate economical design, construction, and maintenance of county and state highways; to investigate traffic, safety, and economics; to provide advanced instruction in the fundamentals of highway engineering and related research; and to provide practical experience in construction and maintenance procedures and use of highway materials. The Project is guided by an Advisory Board consisting of five members of the State Highway Department and six members of the staff of the School of Civil Engineering at Purdue University.

Sponsored research in the field of highway engineering is also conducted by this organization and several such projects were active during the past year.

The research conducted during the year in the nine areas of the Project for the State Highway Department was varied and important. Forty (40) different research studies were in progress. Fifteen (15) of these were completed and twelve (12) were initiated. Fifty-seven formal reports were presented to the Advisory Board during the year of which seventeen (17) were

detailed reports of research conducted, twenty-one (21) were technical papers prepared for publication, four (4) were administrative reports, and fifteen (15) were working plans for new or continued research. The Board received and accepted 2,363 pages of information during the year. Titles of the various reports, together with other pertinent information, are given in another section of this report.

A broad program of research in the area of materials engineering continued during the year. Major studies in progress included research on subgrades and foundations, rigid and flexible pavement design, the use of aerial photographs in engineering soil studies and terrain evaluation, the design of portland cement and bituminous concretes, dampproofing materials, aggregates for road and airfield construction, and the skid characteristics of road surfaces as affected by aggregate type and mixture design.

Activities in the Soils Laboratory have centered around fundamental and applied research in pavement design. The final report on field and laboratory studies of rigid pavements built over thin base courses was made.

Laboratory investigations into the effect of rate of loading on soil strength and on soil pressure measurements have been conducted. New research activities include studies of design procedures for flexible pavements.

In the field of portland cement concrete, the emphasis has continued on research dealing with basic properties of concrete materials. A research study concerned with the effect of deleterious materials on concrete durability has been reactivated. The emphasis in the present study is on quantifying the effects of various classes of deleterious materials on concrete durability and also on better methods of identification.

Activity in the bituminous area has been concerned, for the most part, with the evaluation of bituminous mixture performance in service and the

testing of these mixtures in the laboratory for strength characteristics. The studies have included strength and deformation characteristics of bituminous mixtures under various conditions of loading and temperature. Repeated load tests and tests under high confining pressure are especially significant to these studies.

An expanded program of research in the area of Traffic Engineering featured the activities in Transportation Engineering during the year. Research projects on pavement edge lines, lane use controls and four-way stop signs were completed. An evaluation study of two non-limited-access by-passes resulted in factual information pointing to the necessity of controlling the access on all such roads. The effect of shopping centers on a metropolitan area was investigated and reported.

The Highway Needs Study which has been in progress in this area for the past three years was completed. A sufficiency rating study of all state highways was also completed as a valuable supplement to the Needs Study. A study of sampling techniques for determining the improvements needed for county roads was also initiated with the co-operation of the Bureau of Public Roads.

Research on speed and truck weight trends continued with the co-operation of the State Highway Department of Indiana. In the field of traffic safety, a project was initiated relative to the causes of accidents on highway facilities which have a high accident rate. The effect of illumination of highway locations was also under study.

Work also continued in the Structural Laboratory on a project involving theoretical and experimental studies pertinent to the development of continuously reinforced concrete pavement slabs. Experimental research to determine the creep characteristics of concrete made of Indiana aggregates to

establish the proper allowance for creep in the design of prestressed concrete structures was also in progress.

A new theory was developed during the year whereby the stresses, deflections, and degree of support of concrete slabs on ground, subject to ambient temperature and moisture gradients, can be computed for finite slab sizes. The theory is a generalization of Westergaard's well-known theory, and is an important contribution to improved design concepts for concrete highway and airport pavements. Work in progress involves extension of the theory to account for any combination of superimposed loads.

An extensive project is also under way to determine the hydraulic characteristics of river flow under arch bridges. The results will be of value to the highway engineer in making a more reliable hydraulic design of arch bridge supports. Another project, also related to highway drainage design concerns the determination of run-off from small watersheds and the improvement of current methods used in the design of highway drainage structures serving these areas.

Three of the research projects initiated during the year were developed as cooperative research projects between the State Highway Department of Indiana and the Bureau of Public Roads. They will be conducted at Purdue University but partially financed by 1 1/2 percent funds available to the State Highway Department. These three projects are entitled:

1. "Hydraulics of River Flow Under Arch Bridges"
2. "Measurement of Moisture Gradients in Concrete Pavements"
3. "Highway Needs From Statistical Sampling"

Outstanding among honors and recognitions received during the year by many staff members were the following:

1. Professor K. B. Woods was elected National President of the

American Society of Testing Materials and he continued to serve as Chairman of the Advisory Committee for the AASHO Road Test in Illinois.

2. Professor B. H. Petty was awarded the first "The Ben H. Petty Award" for his outstanding contributions to highway development. (Given at the 1958 Purdue Road School).
3. Professor W. H. Goetz was elected National President of the Association of Asphalt Paving Technologists.

Highway and traffic extension activities also increased during the year. An outstanding Road School was held April 7-10, 1958, with 833 in attendance. Professors Woods and Petty served as co-chairmen of this Road School. Members of the staff attended numerous meetings with county and city groups and offered advice and counsel on highway and street matters to those in attendance.

Each research project which was active during the past year is briefly discussed in the following pages:

Airphoto Interpretation Research

Topographic Mapping from Airphotos (C-36-32L)

Investigator: R. D. Miles.

A study of the use of a Kelsh Plotter and photogrammetric techniques in the preparation of large scale topographic maps of individual bridge sites and of proposed highway locations. Maps have been made of several bridge sites at a scale of 1 inch equals 30 feet and 4 miles of road plans have been mapped at a scale of 1 inch equals 50 feet. Employees of the State Highway Department of Indiana have been trained in the use of the Kelsh Plotter during the project.

Preliminary Highway Location Studies (C-36-32M)

Investigator: Dale Bailey, under the direction of R. D. Miles.

This is a study to determine the application of photogrammetric techniques to location studies for the Indiana State Highway Department. A topographic map showing ten foot contours was prepared of an area 2 miles wide by 4 miles long. The area selected represents the most rugged terrain in Indiana and is at the New Albany Escarpment. Several highway routes were studied and the cost-benefit ratios of two routes were computed. It was concluded that a 2100 foot tunnel route, although costing more, had a slightly better cost-benefit ratio than another route with a 140 foot open rock cut.

County Drainage Maps From Airphotos (C-36-51A)

Investigator: Merle Parvis.

An atlas of the completed 92 county drainage maps in the state of Indiana is being prepared for publication. The format has been resolved and the first drafts of county descriptions to accompany the maps have been prepared and are partially edited.

Indiana Engineering Soils Mapping (C-36-51B)

Investigator: P. T. Yeh, under the direction of R. D. Miles.

The object of this project is twofold: First, to investigate and to develop the airphoto patterns of different types of engineering soils in Indiana; second, to obtain a complete engineering soils map for the State. Soils of different engineering characteristics are mapped exclusively from airphotos on a regional basis or on a county basis. Only very limited field investigations are conducted to secure representative soil samples and to check the interpretations. About one-half of the State has been mapped in this study.

State Drainage Map (C-36-51L)

Investigator: P. T. Yeh.

A project undertaken to prepare a State drainage map at a scale of 1/4 inch equals one mile utilizing individual detailed county drainage maps previously prepared. Fifty counties have been plotted to date.

Bituminous Materials and Flexible Pavement Research

Strength and Deformation Characteristics of Bituminous Mixtures (C-36-6J)

Investigator: L. E. Wood, under the direction of W. H. Goetz.

The strength and deformation characteristics of various bituminous mixtures were studied at several temperatures by means of confined and unconfined compression tests using different rates of deformation. Included in this study were the effects of static and repeated loads upon mixture properties. The rheological characteristics of bituminous aggregate mixtures are also being studied using static loads on specimens at different temperatures to obtain the deformation time relationship.

Evaluation of Bituminous Concrete by Repeated Load Test on a Slab-Type

Specimen (C-36-6N)

Investigator: John H. Dennis, under the direction of W. H. Goetz.

This study is to determine if the repeated-load test can be used to evaluate the stability of a bituminous concrete mixture.

Slab-type specimens are being tested in the repeated-load machine at different pressures and at a set number of permanent deformations. Cores are being cut from the tested portion of the specimens and density and Nveem Stabilometer tests are being made on these cores.

Bituminous Concrete Pavement Design (C-36-55E)

Project Director: W. H. Goetz.

A continuing study is being made of bituminous mixture densification

and change in Marshall tests properties as affected by traffic. Also, a series of design tests is being performed using the Hveem Stabilometer as applied to Indiana hot-mixed base, binder and surface courses.

Skid Characteristics of Bituminous Mixtures (C-36-53D)

Investigator: J. W. Shupe, under the direction of W. H. Goetz.

The initial phase of this laboratory investigation on the skidding characteristics of bituminous paving mixtures has been completed. Included was an evaluation of the polishing characteristics of 22 mineral aggregates and a study of the relationship between the polish-susceptibility and the basic properties of an aggregate. Also investigated were the effects of aggregate shape and gradation on the skid resistance of a pavement surface, and a variety of blending procedures for improving the anti-skid characteristics of a polish-susceptible aggregate. Current and future work on this project includes an evaluation of the skidding characteristics of bituminous mixtures composed of aggregates not included in the initial study, with particular emphasis on Indiana sandstone. A rather comprehensive related study has also been initiated on the skidding characteristics of portland cement concrete surfaces.

Chemistry of Materials Research

Dampproofing Treatment of Bridges (C-36-37Z)

Investigator: J. F. McLaughlin and W. L. Dolch.

In the fall of 1956 parts of two new overpass highway bridges near Marion, Indiana, were treated with a silicone solution through the courtesy of the manufacturer of the product.

The two treated bridges were observed after the first winter of exposure and no deterioration was found on either the treated or untreated parts. Observation of durability will continue.

Test Methods Related to the Alkali Aggregate Reaction (C-36-47G)

Investigator: W. L. Dolch.

A method has been devised for the determination of potassium in portland cement with sodium tetraphenyl boron. This method is accurate, precise, inexpensive, and much more rapid than present gravimetric procedures.

Concrete Materials and Rigid Pavement Research

Evaluation of Aggregate Durability by Freezing and Thawing Tests of

Concrete (C-36-37X)

Investigator: J. F. McLaughlin.

This is a project consisting of the testing of aggregates in concrete subjected to freezing and thawing in automatic equipment. Aggregates from many sources are to be tested to obtain information helpful in setting up better specifications for concrete aggregates.

The investigation also includes various studies of factors affecting concrete durability, such as maximum aggregate size and water/cement ratio. Studies of variations in test method for freezing and thawing tests, are included.

Durability and Deterioration of Structural Concrete (C-36-37R)

Investigator: J. F. McLaughlin.

A field study of structures to determine the scope of the problem of concrete deterioration and the probable causes forms the basis of this study. The present phase is concentrated on new structures in which air-entrained concrete was used.

Field Survey of Air-Entrained Concrete Pavements (C-36-37W)

Investigator: J. F. McLaughlin.

This project is a continuing condition survey of concrete pavements built since the introduction of air-entrained concrete for Indiana roads.

The survey is being conducted as the field phase of the evaluation of aggregate durability to obtain information helpful in setting up specification tests based on freezing and thawing of concrete.

During the past year, major emphasis was placed on concrete pavements in Southwestern Indiana which were built with cherty gravels.

Further Studies of Deleterious Substances in Indiana Aggregates (C-36-42F)

Investigator: R. L. Schuster, under the direction of J. F. McLaughlin.

The purposes of this study are: (a) to learn more about those properties of the deleterious constituents of Indiana's aggregates which relate to the durability of concrete in which these deleterious materials are used as part of the aggregate; (b) to determine whether Indiana's present specifications on deleterious substances categorize aggregates on a realistic basis; and (c) to suggest, if possible, a simplified version of the present specifications on the basis of the conducted tests.

This investigation is being conducted primarily as a study of the durability of concrete produced from different deleterious materials in combination with a standard fine aggregate and a standard crushed stone coarse aggregate (both with good field service records), and a standard portland cement. This study is active but incomplete.

Fatigue Properties of Air-Entrained Concrete (C-36-58B)

Investigator: John Antrim, under the direction of J. F. McLaughlin.

The investigation was concerned with establishing whether or not there is a definite distinction between the resistance to fatigue of air-entrained plain concrete and non-air-entrained plain concrete. Two mix designs, one for the non-air-entrained plain concrete and one for the air-entrained concrete (8 percent air content) with design strengths of 4000 psi were used. The specimens were 3-in. in diameter by 6-in. in height concrete cylinders

which were tested in compression at specific stress levels at a speed of 1000 cpm in the Krouse-Purdue Axial-load Fatigue Testing Machine. A statistically sound analysis was insured by using over 50 specimens for the fatigue testing and over 200 specimens for the static testing. The major result of this study is that within the limits of the investigation, there is no difference in the behavior of air-entrained concrete and non-air-entrained concrete. The results also show that the test data for the air-entrained concrete has less variability than the test data for the non-air-entrained concrete.

Economics, Administration and Finance Research

State Highway Needs Study (C-36-54T)

Investigators: A. K. Branham, D. O. Covault, J. E. Baerwald and
P. D. Cribbins, under the direction of H. L. Michael.

During the past two years an engineering appraisal of the needs of the State, County and City Systems in Indiana, has been performed. Present and future deficiencies that will occur or have occurred on these systems have been determined. Other needs of a non-fiscal nature were studied; among these needs are highway safety, classification of roads and streets, traffic engineering and the supply of engineers and technicians.

The results of this two-year study indicate the magnitude of the highway problem in Indiana and that present financial policies will not produce sufficient revenue to eliminate the needs within the next 15 years. Recommendations concerning the highway area are made. An evaluation of the relative adequacy of each section of primary and secondary rural state highways was also made. Capacity, structural characteristics of the pavement, and safety features were considered in the evaluation and the rating adjusted to 1956 traffic volumes. The priority of improvement for each section was then developed and presented in a report by listings and large scale maps.

Estimated Effects of Four Proposed Shopping Centers on Metropolitan Lafayette (C-36-54Y)

Investigator: Mart Kask, under the direction of H. L. Michael.

The primary purpose of this study was to determine the probable effects of four proposed shopping centers on Metropolitan Lafayette. In the study an economic analysis was made to determine whether Metropolitan Lafayette will be able to support all the shopping center developments presently planned for the future. This involved: an appraisal of Lafayette's trade area by the application of the law of retail gravitation; an estimation of present population and the anticipated future growth; and a study of incomes of residents and their retail expenditures in the trade area. A thorough review of literature in the shopping center field provided a guide for the procedure followed in the economic analysis.

The existing traffic flow in the vicinity of the proposed shopping centers was determined from automatic traffic recording counts while traffic volumes for the year of 1963 were estimated based on present traffic volumes and anticipated future developments.

The estimated 1963 pre-Christmas peak hour traffic flow in the vicinity of the three proposed shopping centers consisting of shopper traffic and non-shopper traffic served to indicate the locations where major traffic congestion attributable to shopper traffic would occur.

An Evaluation Study of Two Non-limited Access Bypasses in Indiana (C-36-54Z)

Investigator: Charles Pinnell, under the direction of H. L. Michael.

The purpose of this study was to evaluate the operational efficiency of non-limited access by-pass facilities and to determine the long-range economic effects of highway by-passes upon communities through which they pass. Travel times and accident rates were used as a criteria of efficiency

and the economic effects were studied in terms of the effects on land values, land use and business.

Travel-time data were obtained from travel-time studies performed on each of the by-passes and accident data were obtained from the records of the Indiana State Police. Land use maps were prepared from data recorded in previous studies, from aerial photographs and from field studies. The data for evaluating land values were obtained from available records, previous studies and interviews with competent real estate dealers in the affected communities. Business data were obtained by personal interviews with businessmen.

The study revealed that the operational efficiency of non-limited access by-passes is very inadequate and that the observed increase in travel times and a large percentage of the accidents on the by-passes were due to the lack of access control. Also, it was found that the long-range economic effects of by-passes are very beneficial.

Highway Needs From Statistical Sampling (C-36-54AA)

Investigator: D. O. Covault, under the direction of H. L. Michael.

The estimation of highway needs has always been an expensive and time consuming project. A statistical sampling method, however, may be used to estimate highway needs on county road and city street systems. The applicability of county primary road systems to sampling methods are being investigated as to:

- 1) The various types of sampling techniques which may be used to evaluate needs.
- 2) The methodology of the statistical approach to be used as applied to the highway needs problem.
- 3) The cost of the various types of sampling techniques which may be used.

- 4) The most efficient sampling technique from the standpoint of the ease of gathering and processing data. Cost considerations will be of primary importance in selecting efficient methods.

Soils and Pavement Design Research

Effect of Rate of Strain on the Strength of Remolded Soil (C-36-14B)

Investigator: Delon Hampton, under the direction of E. J. Yoder.

This study reports the results of a laboratory investigation of the effect of rate of strain on the strength of remolded soil. Two soils were selected for the purpose of this study - a clay and a silty clay. Both soils are native to Indiana.

Rate of strain was varied between the limits of 0.55 in./min and 1780 in./min. Also, three compacted efforts were used and specimens were molded and tested, in unconfined compression, on both sides of optimum moisture content of each compactive effort.

The effect of the aforementioned variables upon the ultimate strength and modulus of deformation of the samples were determined. Also, applications of the relationships obtained to problems in slope stability and airport pavement design were noted.

Soil Temperature and Moisture (C-36-16A)

Investigator: E. J. Yoder.

Continuous soil temperature and ground water measurements have been obtained north of Lafayette for the past 10 years. These measurements have been made on a silty clay under a flexible pavement subject to normal climatic variations.

Performance of Rigid Pavements on Base Courses (C-36-45F)

Investigator: E. J. Yoder

Field studies of rigid airfield and highway pavements built over base

courses have been completed. These data have been summarized and recommendations for base courses have been submitted.

Flexible Pavement Design (C-36-52B)

Investigator: R. D. Walker, under the direction of E. J. Yoder.

Field correlation studies have been undertaken into design techniques which can be adopted for Indiana. Studies will be made of failure criteria and methods of evaluating flexible pavements.

Soil Pressures under Flexible Pavements (C-36-52D)

Investigator: T. F. McMahon, under the direction of E. J. Yoder.

This project consists of two parts:

Part I, is concerned with the development of a pressure sensitive cell for the measurement of pressures in subgrade materials under pavements. S R-4 strain gages cemented to a flexible diaphragm are being used for this purpose.

Part II, is concerned with the measurement, in model studies, of the pressures in a subgrade and the effects of a layered system on these pressures.

Structural Research

Stresses and Deflections in Plain and Reinforced Concrete Pavements (C-36-46M)

Investigator: M. M. Miller, under the direction of M. J. Gutzwiller

This investigation is primarily concerned with the investigation of stresses in and deflections of continuously reinforced concrete pavements under the action of static transverse and longitudinal forces acting simultaneously. The pavement is assumed to be made up of a series of segments produced by equally spaced cracks. The segments are assumed to be straight between cracks, the angle changes, ϕ_n , in the slab being concentrated at the cracks.

Further assumptions are:

- 1) The moment at a crack is some function of the angle change, i.e., $M/\phi = C$,
- 2) The subgrade modulus, k , is a constant throughout the full range of deflection, and
- 3) The deflection at a point some distance from the transverse load is equal to zero.

By considering the geometry of the deflected pavement and the equilibrium of each segment, a series of simultaneous equations may be written in terms of either the deflections at the cracks or the angle changes at the cracks. The equations expressed as functions of the angle changes are by far the simpler; therefore, this approach is used. Equations for deflections, bending moments, and shears at cracks are given.

The Effect of Freezing and Thawing on Prestressed Concrete (C-36-58C)

Investigators: F. E. Musleh, under the direction of M. J. Gutzwiller.

The purposes of this study are: 1) To study the durability of prestressed concrete under repeated cycles of freezing and thawing. 2) To compare the freezing and thawing effects on:

- a. prestressed and ordinary concrete with an ultimate strength of 5000 psi.
- b. prestressed concrete with an ultimate strength of 5000 psi after 28 days and ordinary concrete with an ultimate strength of 3000 psi after 28 days.

The procedure being used is as follows: Three batches of concrete with an ultimate strength of 5000 psi have been mixed. Six beams four inches thick by three inches wide by sixteen inches long have been cast from each batch of concrete with four of these beams prestressed. One batch of concrete

has been mixed with an ultimate strength of 3000 psi. Six beams have been prepared from this mix and will be stress free. All beams are to be subjected to many cycles of freezing and thawing and compared for deterioration rates.

Traffic Engineering and Highway Safety Research

Periodic Speed Studies (C-36-10C)

Investigator: Charles Pinnell, under the direction of H. L. Michael.

Since 1941, periodic traffic speed studies have been carried out by the Joint Highway Research Project. Speeds are taken at the same stations each time in order to be able to compare the studies.

In the latest study, an increase since August, 1956, of approximately two miles per hour was noted for passenger cars while truck speeds increased approximately one-half mile per hour.

Truck Speed-Weight Studies (C-36-10D)

Investigator: Charles Pinnell, under the direction of H. L. Michael.

Annually in August in co-operation with the Highway Planning Survey Unit of the State Highway Department of Indiana speeds and weights of trucks are obtained. A correlation is made and the trend of speed and weight is analyzed. Indiana is one of many states conducting such a study under the national direction of the Bureau of Public Roads.

Intersection Lane Controls (C-36-17K)

Investigator: K. A. MacNaughton, under the direction of D. S. Berry.

The purpose of this study was to investigate lane use controls in Lafayette, to determine an efficient method for gathering data on lane use, and to assemble information on lane use controls in several other cities.

Several recording methods were investigated, and a system was developed and tested utilizing adding machines as recorders.

Two adding machines and two operators recorded data for all four approaches of an intersection with lane use control in Lafayette, Indiana. The lane use control restricted the center lane, on all approaches, to left turning vehicles. The control on one leg was then changed to allow straight through vehicles to use both lanes of the approach. The capacities before and after the change were compared.

In this study it was found that: driver obedience to lane use controls in the Lafayette area is very good; this obedience increased when the lane lines and arrows on the pavement were repainted; when a "left-turn-only" lane was installed at an intersection approach with less than 10% left turns, capacity of the approach was seriously impaired.

Effect on Certain Traffic Characteristics of Improving Visibility at Intersections (C-36-17N)

Investigator: L. D. Powers, under the direction of H. L. Michael.

Little is known about the effects of better visibility on speeds and other operating characteristics at highway intersections. The purpose of this study is to investigate certain operating characteristics of vehicles (passenger and commercial) at various points at, and along the approaches to, a rural highway intersection and determine what effect, changes in conditions of visibility have on these characteristics. The characteristics under investigation are magnitude and distribution of speeds and the observance of operational controls.

Supplementary Legend at Four-Way Stop Intersections (C-36-17Q)

Investigator: B. K. Cooper, under the direction of D. S. Berry.

The purpose of this study was to determine whether the efficiency of four-way stop intersections could be improved with the addition of the supplementary legend "4-Way" on the standard stop sign.

Standard stop signs were used for the before study. The supplementary legend was painted in the upper panel of the existing signs for the after study.

Some of the more important findings were as follows: The critical lag at intersections which are similar to the intersections included in this study can usually be reduced by adding the supplementary legend, thus increasing the possible capacity; the addition of the supplementary legend will generally decrease the observance of stop signs; an intersection has approximately the same critical lag for different periods of the day, different days of the week and different weeks; local motorists accept a shorter time lag than foreign motorists; and each intersection has a different critical lag which depends upon many variables.

Effect of Edge Markings on Lateral Placement (C-36-17R)

Investigator: Paul Weckesser, under the direction of H. L. Michael.

The purpose of the project was to investigate the lateral placement of passenger cars on 20', 22', and 24' bituminous pavements and semi-trailer trucks on a 24' bituminous pavement before and after the placement of edge lines and determine if the presence of edge lines had any effect on the lateral placement of these vehicles.

The lateral positions of the vehicles were determined by means of a segmented electrical detector.

The study showed that the presence of edge lines on the pavement has no significant effect on the mean lateral placements or the variance in the lateral positions of passenger cars or semi-trailer trucks. It was found, however, that the mean lateral placement of passenger cars is approximately 4" greater on the 22' pavement and approximately 10" greater on the 24' pavement than on the 20' pavement during both day and night, before and after

edge-lining. Also it was found that the variability of lateral placement of passenger cars and semi-trailer trucks was decreased slightly in all cases after edge-lining both at night and during the day.

Correlation of Roadway Factors and Accident Rates (C-36-59C)

Investigator: J. C. H. Woo, under the direction of H. L. Michael.

The primary purpose of this study was to investigate the correlation between motor vehicle accidents and roadway factors in the State of Indiana. The roadway factors evaluated were annual average daily traffic volume, capacity, congestion index, number of lanes, lane width, shoulder width, horizontal alignment, and number of entrances per mile. The factor of number of lanes, however, was eliminated early in the study because of the predominant mileage of two-lane highways.

The accident rates used in the study were number of fatalities per mile, number of non-fatal accidents per mile, total number of accidents per mile and total number of accidents per one million vehicle miles on the State Rural Primary System for the two-year period, 1954 and 1955. Only non-intersectional accidents were used.

The results of the analysis revealed that there were positive and linear relationships between annual average daily traffic volume, congestion index, lane width, and total number of entrances per mile with total number of accidents per roadway mile for the two-year period, 1954 and 1955.

A regression equation was also developed in an attempt to predict the number of accidents per mile by the use of the four significant roadway factors.

A Study of High Accident Rates on Certain Highways in Indiana (C-36-59D)

Investigator: H. H. Blindauer, under the direction of H. L. Michael.

The purpose of this study is to investigate a number of highways in Indiana having high accident rates to determine causes of the accidents and

possible methods for reducing the accident rates. Certain roads have been selected and divided into segments. The accidents occurring on each segment and the highway elements present on each segment will be analyzed through histograms, correlation coefficients, and actual field inspections.

Special Research Projects

Lateral Placement on U. S. 31 Test Road (C-36-53F)

Investigator: P. M. Weckesser, under the direction of H. L. Michael.

The purpose of this study was to investigate the lateral placement of passenger cars and semi-trailer trucks on a four-lane divided highway with similar sections of bituminous concrete and portland cement concrete pavement and determine if there were any effects on the lateral placement of these vehicles due to the type of pavement.

This study indicated that the mean lateral placements of passenger cars and semi-trailer trucks were not significantly different between the two types of pavement. The mean lateral placement of passenger cars was not significantly different between day and night on either pavement type; however, the mean for semi-trailer trucks was significantly farther from the edge at night than during the day on both types of pavement.

Study of Runoff from Small Drainage Areas for Highway Drainage Design in the State of Indiana (C-36-62A)

Investigator: Don De Coursey, under the direction of J. W. Delleur.

The purpose of this project is to study the runoff from small drainage areas for highway drainage design in the State of Indiana. The use of stream flow records for determining the required size of highway drainage structures is a logical procedure. It happens, however, that stream flow records are almost completely lacking for drainage areas smaller than 100 square miles. The designer is thus forced to use empirical methods, and is handicapped by the

limitations inherent in such methods.

It is thus necessary to investigate the hydrology of watersheds of less than 100 square miles throughout the State of Indiana, to improve the existing methods for estimating the runoff from these watersheds and to improve the existing methods of design of highway drainage structures. Stream flow records and rainfall data have been obtained. An analysis of the rainfall data has been initiated in order to evaluate the intensity and duration of rainfall that can be expected in different parts of the State. It is intended to obtain a set of frequency-intensity-duration curves for each first order station and substation within the State. These curves may then be used for determining the runoff by the "rational formula."

This method is probably the next best to the development of area-discharge-return period curves computed from actual stream measurements. But an examination of the United States Geological Survey Water Supply papers for the State of Indiana indicates that there are too few measurements for the establishment of the area-discharge-return period curves. The computation of frequency-intensity-duration curves is thus necessary until more stream flow records are available. The set of curves has been obtained for one station.

Hydraulics of River Flow under Arch Bridges (C-36-62B)

Investigators: H. J. Owen and S. T. Husain, under the direction of
J. W. Delleur.

A short survey of the research literature published in this country and abroad indicates that there is no systematic study of the loss of hydraulic efficiency of waterways under arch bridges. This interference is particularly important when the roadway embankment extends on the flood plain, and may become very critical in the case of arch bridges. In this case there is an increasing obstruction to efficient stream flow as the river flow rises.

The purpose of this research is to study the hydraulic characteristic of stream flow under arch bridges, to provide a criterion to determine the proper clear span of arch bridges, and to provide a method for computing the backwater upstream of arch bridges.

The experimental part of the investigation will be done with the help of a hydraulic model. In order to facilitate the design of a test flume, and in order to gain a better understanding of the problem, a miniature flume has been built. The miniature flume is equipped with devices for measuring discharges and water surface elevation.

Warping Stresses and Deflections In Concrete Slabs (C-36-63B)

Investigator: M. E. Harr, under the direction of G. A. Leonards.

A theory was developed whereby the stresses, deflections, and degree of support of concrete slabs on ground, subject to ambient temperature and moisture gradients, can be computed for finite slab sizes. Solutions to the resulting equations were programmed for the Datatron computer at Purdue University.

Comparisons between computed deflections and available measured deflections strongly indicate that the theory is applicable to concrete highway pavements not subject to superimposed traffic loads.

Measurement of Moisture Gradients in Concrete Pavements (C-36-63C)

Investigator: J. R. Bell, under the direction of G. A. Leonards.

This project is a preliminary investigation of the problem of measuring, by non-destructive test methods, moisture contents and moisture gradients in hardened portland cement concrete. The various phases of the investigation are designed to: (1) determine the requirements for a satisfactory moisture meter, (2) investigate by means of a literature study and simple laboratory tests the various methods of determining the moisture content of porous media,

and (3) outline a research program for additional study of those methods worthy of intensive investigation.

TRAFFIC ENGINEERING SERVICES

In 1954, a unit known as Traffic Engineering Services Unit was organized within the Joint Highway Research Project at Purdue University to provide traffic and transportation engineering services for the city and county governmental units of Indiana. The services offered are primarily advice and counsel on traffic and highway problems on an extension basis. Arrangements may also be made, however, for this Unit to supervise and assist in the conduct and analysis of traffic and highway studies with the cost borne by the governmental unit concerned. The activity of the Unit during the past year has been as follows:

<u>Item No.</u>	<u>Govern- mental Unit</u>	<u>Services Rendered</u>	<u>Status</u>
1	West Lafayette	Advice and counsel on the traffic problems and parking needs of the city. Numerous meetings held with Citizens Committee and city officials.	Active
2	Crown Point	Advice and counsel on a thoroughfare plan and a parking plan for the city. Supervision of a parking and volume count study of the city was provided. A report has been made to the city.	Active
3	Anderson	Assistance given City Engineer on street classification for city.	Complete
4	Jay County	Road Classification study in progress. Inventory done by State. Final report made.	Complete
5	Greensburg	Advice given to city Safety Committee on operation of city streets.	Inactive

The procedure for a city or county to obtain the services of the Unit are well established and all inquiries for services to date have been

quickly fulfilled. Acceptance of some of the services has been rejected in a few cases where the city did not wish to expend the funds required.

PERSONNEL OF JOINT HIGHWAY RESEARCH PROJECT

June 30, 1958

Advisory Board

C. E. Vogelgesang	(State Highway Department of Indiana), Chairman
J. R. Cooper	(State Highway Department of Indiana)
J. T. Hallett	(State Highway Department of Indiana)
F. F. Havey	(State Highway Department of Indiana)
J. E. Wilson	(State Highway Department of Indiana)
K. B. Woods	(Purdue), Vice-Chairman
*D. S. Berry	(Purdue)
G. A. Leonards	(Purdue)
R. E. Mills	(Purdue)
B. H. Petty	(Purdue)
J. L. Waling	(Purdue)
**G. A. Hawkins (M. B. Scott)	(Purdue)
***H. L. Michael	(Purdue), Secretary

* Professor Berry resigned August 15, 1957. No replacement was appointed.

** Professor Scott attends as representative of Dean G. A. Hawkins and is a non-voting member.

*** Non-voting member.

Record of Meetings and Attendance

The Joint Highway Research Project Advisory Board July 1, 1957 - June 30, 1958

		Total to June 30, 58								
		182 (while Board Member)								
Meeting No.		175	176	177	178	179	180	181	182	
Date		July 24	Sept. 18	Oct. 23	Dec. 18	Jan. 30	Feb. 28	Apr. 10	May 21	
		1957	1957	1957	1957	1958	1958	1958	1958	
					(4)	(5)		(6)		
<u>Members</u>										
D. S. Berry (1)		X	-	-	-	-	-	-	-	8
J. R. Cooper		X	X	X	X	X	X	X	X	97
J. T. Hallett		X	X	X	X	A	X	X	X	103
F. F. Havey		X	X	X	X	X	X	X	X	140
G. A. Leonards		A	X	X	X	X	A	X	X	21
R. E. Mills		X	X	X	X	X	X	X	X	60
B. H. Petty		X	X	A	A	A	X	A	X	141
C. E. Vogelgesang (Chm)		X	X	X	X	X	X	X	X	97
J. L. Waling		X	X	X	A	X	X	X	X	21
J. E. Wilson		A	X	X	X	X	X	A	A	8
K. B. Woods (V. Chm)		X	X	X	X	X	X	X	X	165
G. A. Hawkins (M. B. Scott)(2)		-	-	X	X	-	X	-	-	3
H. L. Michael (Sec'y)(3)		X	X	X	X	X	X	X	X	35
(1) Resigned August 15, 1957. No replacement has been appointed.										
(2) Non-voting representative of Dean Hawkins. Attends when possible.										
(3) Non-voting member.										
(4) Prof. Goetz attended for Prof. Petty and Prof. Goldberg attended for Prof. Waling.										
(5) Mr. Ashbacher attended for Mr. Hallett.										
(6) Mr. W. A. Sutton, SHDI, attended as a guest.										

Research Staff

Director

K. B. Woods

Assistant Director

H. L. Michael

Highway Specialist

B. H. Petty

Research Engineers

D. O. Covault	(Traffic)
W. H. Goetz	(In charge, Bituminous)
F. H. Green	(Traffic)
M. J. Gutzwiller	(Structures)
C. W. Lovell, Jr.	(Soils)
J. F. McLaughlin	(In charge, Concrete)
R. D. Miles	(In charge, Airphoto)
Merle Parvis	(Airphoto)
P. T. Yeh	(Airphoto)
E. J. Yoder	(In charge, Soils)

Research Associates

A. K. Branham	(In charge, Economics)
I. W. Burr	(Statistics)
W. L. Bolch	(In charge, Chemistry)

Research Assistants

J. E. Bell	(Special Project)
P. D. Gribbins	(Economics)
R. L. Schuster	(Concrete)
R. D. Walker	(Soils)

Graduate Assistants

J. deC Antrim	(Concrete)	T. F. McMahon	(Soils)
D. H. Bailey	(Airphoto)	T. O. Miller	(Bituminous)
H. H. Blindauer	(Traffic)	H. J. Owen	(Hydraulics)
J. H. Dennis	(Bituminous)	Sandor Popovics	(Concrete)
Delon Hampton	(Soils)	L. D. Powers	(Traffic)
S. T. Husain	(Hydraulics)		

Services

E. L. Black	(Photographer and Duplicating)
W. B. Luttrell	(Shop)
Morris Stewart	(Laboratory Assistant)

Clerical

Anita Conrad	(Stenographer)
Gayle Pribie	(Purchasing)
Helene Treat	(Typist)

Date of Appointment of Present Staff

<u>Name</u>	<u>Present Title</u>	<u>Appointed</u>
Antrim, J. deC	Graduate Assistant	September 1, 1956 (A)
Bailey, Dale H.	Graduate Assistant	September 1, 1956
Bell, J. R.	Research Assistant	September 16, 1954 (B)
Blindauer, H. H.	Graduate Assistant	September 16, 1957
Black, E. L.	Laboratory Technician	November 1, 1953
Branham, A. K. (1)	Research Associate	September 1, 1939 (C)
Burr, I. W. (3)	Research Associate	February 1, 1958
Covault, D. O.	Research Engineer	September 22, 1955
Conrad, Anita	Stenographer	October 2, 1957
Cribbins, P. D.	Research Assistant	February 1, 1957
Dennis, J. H.	Graduate Assistant	January 28, 1957 (D)
Dolch, W. L. (1)	Research Associate	September 15, 1947

Goetz, W. H. (3)	Research Engineer	May 13, 1938
Green, F. H. (2)	Research Engineer	February 1, 1945
Gutzwiller, M. J. (2)	Research Engineer	September 1, 1957
Hampton, Delon	Graduate Assistant	February 1, 1957
Husain, S. T.	Graduate Assistant	February 1, 1958
Lovell, C. W. (1)	Research Engineer	September 1, 1948
Luttrell, W. B.	Laboratory Assistant	August 6, 1938
McLaughlin J. F. (1)	Research Engineer	September 1, 1950
McMahon, T. F.	Graduate Assistant	June 1, 1957
Michael, H. L. (1)	Assistant Director	February 1, 1950
Miles, R. D. (1)	Research Engineer	September 1, 1949
Miller, T. O.	Graduate Assistant	June 1, 1958
Parvis, Merle (2)	Research Engineer	March 1, 1946
Petty, B. H. (3)	Highway Specialist	July 1, 1936
Popovics, Sandor	Graduate Assistant	September 1, 1957
Powers, L. D.	Graduate Assistant	September 16, 1957
Pribie, Gayle	Purchasing Clerk	June 9, 1958
Schuster, R. L.	Research Assistant	February 1, 1957
Stewart, Morris R.	Laboratory Assistant	June 1, 1957 (E)
Treat, Helene	Typist	June 9, 1958
Walker, R. D.	Research Assistant	September 15, 1953 (F)
Woods, K. B. (4)	Director	February 1, 1939
Yeh, P. T.	Research Engineer	February 1, 1953
Yoder, E. J. (2)	Research Engineer	September 1, 1949 (G)

(1) Assistant Professor

(3) Professor

(2) Associate Professor

(4) Head

- A. Resigned May 31, 1957 and reappointed September 1, 1957
- B. Resigned June 30, 1956 and reappointed February 1, 1958
- C. Resigned August 18, 1941 and reappointed August 1, 1949
- D. Resigned May 31, 1957 and reappointed September 1, 1957
- E. Resigned September 15, 1957 and reappointed June 1, 1958
- F. Resigned June 30, 1955 and reappointed August 1, 1957
- G. Resigned December 31, 1947 and reappointed September 1, 1949

NEW STAFF MEMBERS DURING PAST YEAR
July 1, 1957 to June 30, 1958

Name	Rank	Degree Held	School	Date Appointed
Antrim, John deC*	Graduate Assistant	BSCE 1956	Lehigh University	September 1, 1957
Bell, J. R. **	Research Assistant	BSCE 1952 MSCE 1956	Purdue University Purdue University	February 1, 1958
Blindauer, H. H.	Graduate Assistant	BSCE 1949	Montana State Col.	September 1, 1957
Burr, I. W.	Research Associate	BS 1930 SM 1935 PhD 1941	Antioch College University of Chicago University of Michigan	February 1, 1958
Dennis, J. H.***	Graduate Assistant	BS 1957	Penn. State	September 1, 1957
Gutzwiller, M. J.	Research Engineer	BSCE 1944 MSCE 1949	Purdue University Purdue University	September 1, 1957
Husain, S. T.	Research Assistant	BEC 1946	Osmenia (India)	February 1, 1958
Ingram, G. E.	Research Engineer	BSCE 1949 MSCE 1957	University of Ariz. Purdue University	July 1, 1957
Lowry, R. H.****	Graduate Assistant	BSCE 1954 MSCE 1958	Purdue University Purdue University	September 1, 1957
Miller, T. O.	Instructor	BSCE 1958	Duke University	June 6, 1958
Musleh, F. E.	Graduate Assistant	BSCE 1958	Purdue University	February 1, 1958

* This is a reappointment; Mr. Antrim was also on the staff from September 1, 1956 to May 31, 1957
 ** This is a reappointment; Mr. Bell was also on the staff from September 16, 1954 to June 30, 1956
 *** This is a reappointment; Mr. Dennis was also on the staff from January 28, 1957 to May 31, 1957
 **** This is a reappointment; Mr. Lowry was also on the staff from February 1, 1958 to May 31, 1958

Name	Rank	Degree Held	School	Date Appointed
Owen, H. J.	Graduate Assistant	BSCE 1958	Purdue University	June 1, 1958
Popovics, S.	Graduate Assistant	BSCE 1944	Univ. of Budepest (Hungary)	July 1, 1957
Powers, L. D.	Graduate Assistant	BCE 1957	City College of N. Y.	September 16, 1957
Stewart, Morris R.*****Laboratory Assistant				June 1, 1958
Walker, R. D.*****	Research Assistant	BSCE 1953 MSCE 1955	Univ. of Maryland Purdue University	August 1, 1957
Conrad, Anita (Mrs.)	Stenographer			October 2, 1957
Lewis, Sally (Mrs.)	Purchasing Clerk			September 4, 1957
Pribie, Gayle E. (Miss)	Purchasing Clerk			June 9, 1958
Sherry, Virginia (Mrs.)	Typist			November 2, 1957
Treat, Helene (Mrs.)	Typist	BS 1958	Purdue University	June 9, 1958
****	This is a reappointment; Mr. Walker was also on the staff from September 15, 1953 to June 30, 1955			
*****	This is a reappointment; Mr. Stewart was also on the staff from June 1, 1957 to September 15, 1958			

STAFF RESIGNATIONS DURING THE PAST YEAR *

July 1, 1956 to June 30, 1957

Name	Title	Degree Held	School	Appointed	Resigned
Berry, D. S.	Research Engineer	BSCOE 1931 MS 1933 PhD 1936	S. Dakota Sch of Mines Iowa State Univ. of Michigan	7/1/56	8/15/57
Harr, M. E.	Research Assistant	BS 1949 MS 1955 PhD 1958	Northwestern U Rutgers Purdue University	2/1/56	6/30/58
Ingram, G. E.	Research Engineer	BSCOE 1949 MSCE 1957	U. of Arizona Purdue	7/1/57	8/31/57
Kask, Mart	Graduate Assistant	BSCOE 1956 MS 1957	St. Martin's Col Purdue University	6/11/56	7/17/57
Lowry, R. H.	Graduate Assistant	BSCOE 1954 MSCE 1958	Purdue University Purdue University	2/1/57	5/31/58
McNaughton, K. E.	Graduate Assistant	BCE 1956 MSCE 1958	Univ. of Detroit Purdue University	6/11/56	8/27/57
Misleh, F. E.	Graduate Assistant	BSCOE 1958	Purdue University	2/1/58	5/31/58
Myloia, Willa (Mrs.)	Research Engineer	BSCOE 1940 MS (RP) 1952	U. of Wash. U. of Wash.	8/10/56	6/30/58
Pinnell, Charles	Graduate Assistant	BSCOE 1952 MSCE 1958	Texas Tech Purdue University	6/1/57	1/31/58
Schaub, J. H.		BSCOE 1948 SMCE 1949	Va. Poly. Inst. Harvard Univ.	7/1/57	8/31/57

Name	Title	Degree Held	School	Appointed	Resigned
Scholer, Charles F.	Graduate Assistant	BSCE 1956	Kansas State	9/20/56	8/21/57
Shurig, D. G.	Research Assistant	BSGE 1948 MSE 1957	Wash. Univ. Purdue Univ.	2/1/55	8/31/57
Weckesser, P. M.	Graduate Assistant	BSCE 1956 MSCE 1958	U. of Detroit Purdue University	9/17/56	10/31/57
Wood, L. E.	Research Engineer	BS 1948 MS 1949 PhD 1956	Kansas St. College Kansas St. College Purdue University	9/1/53	8/31/57
Beasley, Helen (Mrs.)	Stenographer			9/10/56	12/31/58
Foxworthy, Nancy	Purchasing Clerk			3/18/57	9/13/57
Lewis, Sally A. (Mrs.)	Purchasing Clerk			9/4/57	6/20/58
Idu, Edna (Miss)	Typist			9/1/55	2/17/58
Sherry, Virginia (Mrs.)	Typist			11/2/57	5/23/58
Stewart, Morris R.	Laboratory Assistant			6/1/57	9/16/57

* For a summary of staff resignations from July 1, 1936 to June 30, 1955, see the Annual Report of the Assistant Director, 1954-55. See annual report of each year, 1955-56 and thereafter, for other resignations.

CHANGES IN RANK OR TITLE

Name	Old Title	Present Title	Effective Date	Degree	School	Date
Branham, A. K.	Research Associate Instructor of Highway Engineering	Research Associate Assistant Professor of Highway Engineering	July 1, 1957	BS MA	Bradley Poly. Iowa Univ.	1934 1938

LEAVES OF ABSENCE

Name	Title	Degrees	School	Appointed	From	To
Branham, A. K.	Research Associate	BS 1934 MA 1938	Bradley Poly. Iowa Univ.	9/1/39	8/1/57	9/15/57
Covault, D. O.	Research Engineer	BSCE 1948 MSCE 1950	Purdue Univ. Purdue Univ.	9/22/55	6/1/57	9/30/57
Parvis, Merle	Research Engineer	BSCE 1927 MSCE 1946 CE 1947	Purdue Univ. Purdue Univ. Purdue Univ.	3/1/46	4/1/58	6/30/58

EDUCATIONAL ACTIVITIES PARTICIPATED IN BY STAFF

In addition to their research activities, many of the members of the staff of the Joint Highway Research Project served as members of the teaching staff of Civil Engineering. Almost all staff members, except graduate assistants, served on the teaching staff, primarily at the graduate level, for approximately one-half of their time. In 1957-58, there were 44 students enrolled in graduate programs of study in Transportation and Materials Engineering. During this period, 23 of these were awarded advanced degrees. Nine (9) of those awarded degrees--1 Ph. D., 6 MSCE, and 2 MS--performed research for the Project and used the research report as their thesis. In addition one man majoring in Structures and one man majoring in Soil Mechanics received MSCE and Ph. D. degrees, respectively, and performed their thesis as research for the Project. These eleven were distributed among the areas of the Project as follows:

Airphoto Interpretation	1
Bituminous Materials and Flexible Pavements	1
Chemistry of Materials	0
Concrete Materials and Rigid Pavements	0
Economics, Administration and Finance	2
Soils and Pavement Design	1
Structures	1
Traffic Engineering and Safety	4
Special Projects	1

In the undergraduate area, the Cooperative Program with Industry in the School of Civil Engineering had an enrollment of twenty-four students--fourteen of them with the State Highway Department of Indiana. The first graduate of the Cooperative Program--and he was one who was enrolled with

the State Highway Department--received his degree in June 1958.

The School of Civil Engineering has also assisted the Division of Technical Institutes in the development of a two-year program to train highway technicians to serve as supporting personnel to civil engineers. The School of Civil Engineering also assisted the Division of Technical Institutes in the development of an eight-week short course for highway technicians to be employed by the State Highway Department. The short course was scheduled to be given in the Calumet, Ft. Wayne, Indianapolis, Lafayette, and Michigan City Centers during the summer of 1958. This short course was initiated in the summer of 1956 and repeated in the summer of 1957.

Personnel of the Project also assisted in the area of Adult Education. In addition to the annual Road School in which most of the staff participated, assistance was given at traffic control and traffic engineering conferences sponsored by the Purdue Public Safety Institute and at other conferences sponsored by the School of Civil Engineering.

MAJOR RESEARCH EQUIPMENT PURCHASED

Several items of important equipment were added during the year. These included a Marchant calculator, a Marshall test mold, an earth auger, and a mechanical kneading compactor for use in flexible pavement research.

OTHER PROFESSIONAL ACTIVITIES OF STAFF

The staff continued to be active in national and international engineering affairs during 1957-58. Mr. R. L. Schuster attended the Annual Meeting of the American Association for the Advancement of Science held in Indianapolis in late December where he presented a paper entitled, "Sand and Gravel Resources of Indiana."

The Annual Meeting of the Association of Asphalt Paving Technologists, which met in Montreal, Canada, February 13-22, was under the general chairmanship of Professor W. H. Goetz, National President. He also presented two papers at the meeting--"Triaxial Testing of Open-Type Bituminous Mixtures" and "The Relationship Between the Unconfined Compressive Strength of a Bituminous Mixture and the Viscosity of the Binder."

The Annual Meeting of the American Association of State Highway Officials, held in Chicago, November 13-22, 1957, was attended by Professors K. B. Woods and A. K. Branham with the latter presenting a paper on "The Federal Aid Act of 1956--Its Implications, Benefits and the Problem of Highway Cost Allocation." Several meetings of the Advisory Committee, AASHO Road Test, were held in LaSalle, Illinois, at various times during the year under the chairmanship of Professor K. B. Woods. Professor Woods also presented a paper entitled, "Changes in Engineering Curricula and Influence on Highway Programs," at the Annual Meeting of the Mississippi Valley Conference of State Highway Officials held in Chicago on March 6-7.

The American Society for Civil Engineers held a joint meeting with The American Concrete Institute in Chicago, February 24-27. Six staff members were in attendance.

The Annual Meeting of the American Iron and Steel Institute which met in White Sulphur Springs, West Virginia, June 24-26, 1957, was attended by

Professor M. J. Gutzwiller.

The several national meetings of the American Railway Engineering Association were attended by members as follows: W. L. Dolch, Baltimore, Maryland, October 24-25; H. L. Michael, Chicago, Illinois, March 10-12; J. M. Hayes, Pittsburgh, April 23-24; B. B. Lewis, Washington, D. C., April 25; and J. M. Hayes, Chicago, Illinois, June 12.

The meeting of the County Division of the American Road Builders Association was held in French Lick, Indiana, in October 1957. Professors A. K. Branham and H. L. Michael attended--the latter presented a paper written by Professor Ben H. Petty entitled, "Trends in Highway Engineering Education."

The American Society for Testing Materials held its Annual Meeting in Boston, June 23-27, 1958. Professor K. B. Woods, who served as Vice-President in 1957-58, became President during the Annual Meeting. He also served as a member of the Board of Directors.

Other members of the staff attending the Annual Meeting were W. L. Dolch, W. H. Goetz, J. F. McLaughlin, J. W. Shupe, and D. G. Shurig. Professor Goetz served as Chairman of the Committee on the Effect of Water in Bituminous Coated Aggregates and presented a paper entitled, "Methods of Testing for Water Resistance of Bituminous Paving Mixtures." Mr. Shupe presented a paper, "A Laboratory Method for Determining the Skidding Resistance of Bituminous Paving Mixtures." Professor Woods presented a paper, "Investigation of Banded Sediments along the St. Lawrence North Shore in Quebec." Mr. Shurig presented a discussion of his paper, "Experience with Core Drills, Power Augers, and Electrical Resistivity on the Pennsylvania Turnpike."

In addition to the above meeting, staff members attended the national ASTM meetings as follows: K. B. Woods, Mexico City, November 30 - December 13, where he presented a discussion of the "Effect of Tire Pressures and Lift

Thickness on Compaction of Soil with Rubber-Tired Rollers"; W. H. Goetz, St. Louis, Missouri, February 12-13.

Professor K. B. Woods participated in the celebration of the 20th Anniversary of the Automotive Safety Foundation held in Detroit, November 6.

Professor K. B. Woods attended meetings of the Board of Consultants, Airfield Branch, Corps of Engineers, held in Boston, Massachusetts, February 5-8, and Cincinnati, Ohio, April 1-4.

Professor W. H. Goetz, a member of the Board of Consultants, Bituminous Pavements, Corps of Engineers, attended meetings in Vicksburg, Mississippi, on September 3-4 and March 4-5.

Professor H. L. Michael participated in a Conference on Electronic Controls and Traffic Safety held at Columbia University, New York City, May 14-16.

Professor K. B. Woods participated in two meetings of the Indiana Flood Control and Water Resources Commission in Indianapolis, Indiana, October 25 and May 23.

Professor A. K. Branham participated in the Annual Meeting of the Board of Directors, International Road Federation, Washington, D. C., April 12.

Professor H. L. Michael attended the Annual Meeting of the Institute of Traffic Engineers in Detroit, Michigan, September 23-26, 1957.

The Annual Meeting of the Highway Research Board, held in Washington, D. C., January 6-11, found the following staff members in attendance: A. K. Branham, D. O. Covault, P. D. Cribbins, W. H. Goetz, F. H. Green, M. J. Gutzwiller, G. A. Leonards, C. W. Lovell, J. F. McLaughlin, H. L. Michael, W. W. Mylroie, J. W. Shupe, J. I. Waling, L. E. Wood, K. B. Woods, and E. J. Yoder.

Members of the staff presented formal papers at the Annual Meeting of the Highway Research Board as follows:

Mr. D. O. Covault presented, "Indiana's Highway Needs Study."

Professor W. H. Goetz presented, "Triaxial Testing of Bituminous Mixtures Under High Confining Pressures."

Professor J. F. McLaughlin presented, "Application of Pulse Velocity Technique to the Laboratory Study of Materials."

Professor E. J. Yoder presented, "Effect of Base Course Gradation on Results of Laboratory Pumping Tests."

Several staff members served as members of the various departments and chairmen of committees of the Highway Research Board as follows:

Prof. A. K. Branham, member of the Department of Economics, Finance, and Administration; and Chairman of the Committee on Highway Taxation and Finance.

Professor W. H. Goetz, member of the Department of Materials and Construction; and Chairman of Committee on Surface Treatments.

Professor H. L. Michael, member of the Department of Traffic and Operations; and Chairman of the Committee on Speed Characteristics.

Professor K. B. Woods, member of the Executive Committee, member of the Engineering Division, National Research Council (Parent organization of HRB). As a member of the Executive Committee, he attended a meeting of that committee in Charleston, S. C. on June 27-28.

Professor E. J. Yoder, member of the Soils Department; and Chairman of the Committee on Soil-Sodium Chloride Stabilization.

Members of the staff also serve as members of numerous committees of the Highway Research Board.

Several members of the staff served as consultants to agencies of the Federal Government and related agencies as follows:

A. K. Branham, U. S. Bureau of Public Roads

F. H. Green, World Bank for Reconstruction and Development

W. H. Goetz, Corps of Engineers

K. B. Woods, Corps of Engineers

Professor K. B. Woods also served as a consultant to John Mowlem and Company, London, England, with assignment to Tehran, Iran, during the period July 11 to July 22, 1957.

Members of the staff also participated in numerous state and local meetings of several technical societies. These included the Indiana Society of Professional Engineers and its Lafayette Chapter, the Indiana Section of the American Society of Civil Engineers, the Indiana Section of the Institute of Traffic Engineers, and the local section of the American Society of Engineering Education.

Fifty-seven (57) talks were also presented by members of the Project staff during the year to professional groups, civic organizations and others.

Several members of the staff also performed service of a civic nature by membership on several Citizens Committees of West Lafayette, Indiana.

PUBLICATIONS

Papers, Bulletins, Reprints, and Theses

July 1, 1937 to June 30, 1956

Research Activities Bulletin-Engineering Experiment Station
(From January 1946 to date)

EES Bull.	Vol.	No.	Date	Publications (inclusive)	Period Covered
89	25	4	Sept. 1941	1P - 47P	Jan. 1940 - June 1941
89	26	4	July 1942	46P - 60P	July 1941 - June 1942
91	27	6	Nov. 1942	61P - 92P	July 1942 - June 1943
94	29	1	Jan. 1945	74P - 91P	July 1943 - June 1944
95	29	4	July 1944	92P - 103P	July 1944 - June 1945
100*	31	2	Jan. 1945	104P - 121P	July 1945 - June 1946
102	31	3	Sept. 1947	119P - 127P	July 1946 - June 1947
107	32	4	Jan. 1948	158P - 176P	July 1947 - June 1948
130	34	2	Mar. 1949	177P - 212P	July 1948 - June 1949
133	35	4	July 1949	213P - 243P	July 1949 - June 1950
115	36	3	Nov. 1950	244P - 272P	July 1950 - June 1951
117	37	3	Nov. 1951	273P - 307P	July 1951 - June 1952
120	37	6	Nov. 1953	308P - 315P	July 1952 - June 1953
122	38	6	Nov. 1954	316P - 374P	July 1953 - June 1954
125	39	6	Nov. 1955	375P - 400P	July 1954 - June 1955
132	40	4	Dec. 1956	401P - 412P	July 1955 - June 1956
135	41	4	Dec. 1957	413P - 472P	July 1956 - June 1957

* Also see EES Bulletin No. 99 which covers a complete listing of publications 1-122P. These Bulletins contain summaries of the various research projects as well as some information on the publications by the staff. The Abstracts Bulletin initiated in 1956 contains a short abstract of each staff publication or thesis.

Abstracts of Important State Publications and Theses

<u>EES Bull.</u>	<u>Vol.</u>	<u>No.</u>	<u>Date</u>	<u>Includes Publications</u>	<u>Period</u>
135	41	1	March 1957	401P - 442P	July 1, 1955 - June 1956
137	42	1	March 1958	443P - 472P	July 1, 1956 - June 1957

Reprints

- 473P "Highway Subsurface Exploration," by D. G. Churg and E. J. Yoder, Proceedings of the 43rd Annual Purdue Road School, Extension Series No. 92, Vol. 41, No. 3, pp. 111-132, September, 1957 (Civil Engineering Reprint No. 123).
- 474P "Selection and Retention of Civil Engineer Employees," by A. E. Brankam, Proceedings of the 43rd Annual Purdue Road School, Extension Series No. 92, Vol. 41, No. 3, pp. 191-202, September, 1957 (Civil Engineering Reprint No. 129).
- 475P "Principles of Soil Stabilization," by E. J. Yoder, Proceedings of the 43rd Annual Purdue Road School, Extension Series No. 92, Vol. 41, No. 3, pp. 95-205, September, 1957 (Civil Engineering Reprint No. 130).
- 476P "Performance Data for Some Bituminous Concrete Overlays in Indiana," by W. H. Goetz and J. F. McLaughlin, Proceedings of the 43rd Annual Purdue Road School, Extension Series No. 92, Vol. 41, No. 3, pp. 107-125, September, 1957 (Civil Engineering Reprint No. 131).
- 477P "Equipment, Methods, and Standards of Accuracy Applicable to Aerial Surveys," by R. D. Miles, Highway Research Board Bulletin 157, pp. 15-22, 1957 (Civil Engineering Reprint No. 132).
- 478P "Soil Explorations for Site Selection and Engineering Design," by K. E. Woods, Special Technical Publication, No. 206, American Society for Testing Materials, 12 pp., 1957 (Civil Engineering Reprint No. 134).
- 479P "Subgrade Support Characteristics as Indicated by Measurements of Deflection and Strain," by E. C. Goldammer, R. L. Anderson, J. W. Dunlap, G. R. Farbridge, H. E. Hunt, and L. E. Wood, Proceedings of the Highway Research Board, Vol. 36, pp. 479-496, 1957 (Civil Engineering Reprint No. 135).
- 480P "A Study of Interactions of Selected Combinations of Subgrade and Base Course Subjected to Repeated Loading," by J. A. Havers and E. J. Yoder, Proceedings of the Highway Research Board, Vol. 36, pp. 443-478, 1957 (Civil Engineering Reprint No. 137).
- 481P "Pumping of Highway and Airfield Pavements," by E. J. Yoder, Proceedings of the Highway Research Board, Vol. 36, pp. 388-432, 1957 (Civil Engineering Reprint No. 138).

- 482P "Load Deformation Characteristics of Bituminous Mixtures Under Various Conditions of Loading," by W. H. Joetz, J. W. McLaughlin and L. E. Wood, Proceedings of the Association of Asphalt Paving Technologists, Vol. 26, pp. 237-296, 1957 (Civil Engineering Reprint No. 139).
- 483P "The Federal Aid Highway Act of 1956--Its Implications, Benefits and the Problem of Highway Cost Allocation," by A. R. Fronham, Proceedings of the American Association of State Highway Officials, 1957 (Civil Engineering Reprint No. 140).

Theses

- 484P "A Supplementary Legend At Four-Way Stop Intersections," A thesis submitted to the faculty of Purdue University by Philip Ray Exner in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, August, 1957.
- 485P "The Estimated Effects of Four Proposed Shopping Centers on Metropolitan Lafayette," A thesis submitted to the faculty of Purdue University by Mart Mack in partial fulfillment of the requirements for the degree of Master of Science, August, 1957.
- 486P "Correlation of Accident Rates and Roadway Factors," A thesis submitted to the faculty of Purdue University by Chi Hyong Woo in partial fulfillment of the requirements for the degree of Master of Science, August, 1957.
- 487P "Lane Use Control on Urban Thoroughfares," A thesis submitted to the faculty of Purdue University by Edwin Anthony MacLaughlin in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January, 1958.
- 488P "Stresses and Reflections in Continuously Reinforced Concrete Pavements," A thesis submitted to the faculty of Purdue University by Melton Myron Miller, Jr. in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January, 1958.
- 489P "An Evaluation of Two Unlimited Access By-Passes in Indiana," A thesis submitted to the faculty of Purdue University by Charles Pinrell in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January, 1958.
- 490P "The Effect of Pavement Lanes and Edge Lines on Lateral Placement," A thesis submitted to the faculty of Purdue University by Paul Maurice Weckesser in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, January, 1958.
- 491P "Warping Stresses and Deflections in Concrete Pavements," A thesis submitted to the faculty of Purdue University by Milton Edward Harg in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June, 1958.

- 492P "A Laboratory Investigation of Factors Affecting the Slipperiness of Bituminous Paving Mixtures," A thesis submitted to the faculty of Purdue University by John Wallace Shupe in partial fulfillment of the requirements for the degree of Doctor of Philosophy, June, 1956.
- 493P "The Preliminary Location of a Proposed Highway by Photogrammetric Surveys," A thesis submitted to the faculty of Purdue University by Dale Alden Bailey in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, June, 1956.
- 494P "Effect of Rate of Strain on the Strength of Remolded Soil," A thesis submitted to the faculty of Purdue University by Delon Hampton in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, June, 1956.

Other Publications
(See also list of Reprints)

- 495P "Plastic Moisture Barriers for Highway Subgrade Protection," by J. Richard Bell and E. J. Yoder, Proceedings, Highway Research Board, pp. 713-735, 1957.
- 496P "Highway Highlights of 1956 and the Challenge Ahead," by A. K. Branham, Proceedings of the 39th Annual Tennessee Highway Conference, Bulletin No. 19, Engineering Experiment Station, The University of Tennessee, pp. 8-21, August, 1957.
- 497P "Summary Report on State Highway Needs in Indiana," by D. O. Covault, H. L. Michael and A. K. Branham, Proceedings of the 43rd Annual Road School, Purdue University, pp. 124-140, September, 1957.
- 498P "Highway Design Standards," by Forest H. Green, Transportation Section, International Bank for Reconstruction and Development, Washington, D. C., April, 1957.
- 499P "Total Rural Mileage Surfaced," by Ben H. Petty, Calcium Chloride Institute News, Vol. 7, No. 6, November-December, 1957.
- 500P "Trends in Highway Engineering Education," by Ben H. Petty, Indiana County Commissioners Magazine, Vol. 1, No. 18, November, 1957.
- 501P "It All Starts in Classrooms," by Ben H. Petty, Construction Digest, Vol. 30, No. 21, December, 1957.
- 502P "Basic Principles for Blacktopping Roads," by Ben H. Petty, Calcium Chloride Institute News, Vol. 8, No. 2, March-April, 1958.
- 503P "Statewide Road Service," by Ben H. Petty, Rural Roads, May-June, 1958.
- 504P "The Strength of Bituminous Mixtures and Their Behavior Under Repeated Loads, Part II," by L. E. Wood and W. H. Goetz, Proceedings, Highway Research Board, Vol. 36, 1957.

- 505P "Highway Research and the Expanded Highway Construction Program," by K. B. Woods, News Report, National Academy of Sciences, National Research Council, Vol. VII, No. 6, November-December, 1957.
- 506P "A Panel Discussion of Rigid Type Pavements," by K. B. Woods, A. T. Goldbeck, J. D. Lindsay, W. A. Warrick and William Van Breenen, The American Road Builder, November, 1957.
- 507P Discussion by K. B. Woods of paper entitled, "Effect of Tire Pressures and Lift Thicknesses on Compaction of Soil with Rubber-Tired Rollers," by W. J. Turnbull and C. R. Foster, ASTM Special Technical Publication STP No. 232, December, 1957.
- 508P "Soil Stabilization," by E. J. Yoder, Public Works Newsletter, October, 1957.
- 509P "Soil Stabilization," by E. J. Yoder, Proceedings Great Lakes Park Training Institute, March, 1958.

Note 1. In addition, "Proceedings of the 43rd Annual Purdue Road School," Extension Series No. 92, Vol. 41, No. 3, September 1957, 221 pp.; "1958 Directory, Indiana State, County, and City Highway Officials," 27 pp.; and "Highway Extension News" monthly, 12 issues, 2 pp. each were edited by B. H. Petty and published by the Joint Highway Research Project.

JOINT HIGHWAY RESEARCH PROJECTS AND ADVISORY BOARD REPORTS

July 1, 1957 to June 30, 1958

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Bk.	Vol.	No.	Pt.	Pg.
905-Technical Paper "Load Deformation Characteristics of Bituminous Mixtures Under Various Conditions of Loading" (1957 JHRP Report No. 17)	6	Goetz McLaughlin Wood	7/24	104	29	126	XIX	3	A	3
906-Technical Paper "Summary Report on State Highway Needs in Indiana" (1957 JHRP Report No. 20)	54X	Covault Michael Branham	7/24	25	10	126	XIX	3	A	107
907-Technical Paper "Selection and Retention of Civil Engineer Employees" (1957 JHRP Report No. 21)	54	Branham	7/24	43	2	126	XIX	3	A	122
908-Technical Paper "Highway Subsurface Exploration" (1957 JHRP Report No. 22)	26E	Shurig Yoder	7/24	13	6	126	XIX	3	A	175
909-Technical Paper "Principles of Soil Stabilization" (1957 JHRP Report No. 23)	--	Yoder	7/24	21	6	126	XIX	3	A	193
910-Final Report "A Supplementary Legend at Four-Way Stop Intersections" (1957 JHRP Report No. 24)	17Q	Cooper	7/24	63	9	126	XIX	3	A	214
911-Final Report "The Estimated Effects of Four Proposed Shopping Centers on Metropolitan Lafayette" (1957 JHRP Report No. 25)	54Y	Kask	7/24	132	42	126	XIX	3	A	277
912-Progress Report "Correlation of Accident Rates and Roadway Factors"	59C	Woo	7/24	19	1	126	XIX	3	A	409

Report No.	Proj.	Author	Date	Pages	Figs.	Blk.	Vol.	No.	Pt.	Pg.
	9-26									
913-Final Report "Correlation of Accident Rates and Roadway Factors" (1957 JHRP Report No. 27)	59C	Woo	7/24	74	14	126	XIX	3	A	428
914-Annual Report of the Assistant Director (1957 JHRP Report No. 28)	-	Michael	7/24	83	0	126	XIX	3	A	502
915-Progress Report "Determination of Lightweight Chert in Nine Gravel Sources"	42E	Schuster	7/24	3	0	126	XIX	3	A	583
916-Plan of Study "An Evaluation Study of Two Nonlimited-Access By-Passes in Indians"	54Z	Pinnell	7/24	12	0	126	XIX	3	A	593
917-Plan of Study "Environmental Warping of Concrete Highway Pavements"	52C	Harr	7/24	32	6	126	XIX	3	A	605
918-Proposed Budget for Period October 1, - December 31, 1957	-	Michael	9/18	6	0	126	XIX	3	A	642
919-Informational Report "Results of Tests on Soils Stabilized With Lime-Fly Ash Admixtures" (1957 JHRP Report No. 26)	-	Kocataşkin Yoder	7/24	38	14	126	XIX	3	A	652
920-Final Report "Lane Use Control on Urban Thoroughfares" (1957 JHRP Report No. 29)	17K	MacNaughton	9/18	81	30	126	XIX	3	A	690
921-Plan of Study "Further Studies of Deleterious Substances in Indiana Aggregates"	42E	Schuster	10/1957	19	0	127	XIX	4	A	3
922-Plan of Study "Soil Pressures Under Flexible Pavements"	52D	McMahon	10/23	18	6	127	XIX	4	A	22

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Bk.	Vol.	No.	Pt.	Pg.
923-Plan of Study "Hydraulics of River Flow Under Arch Bridges"	62B	Delleur	12/1	13	2	127	XIX	4	A	46
924-Plan of Study "Warping of Concrete Highway Pavements"	52C	Harr	12/18	20	2	127	XIX	4	A	59
925-Plan of Study "The Measurement of Moisture Gradients in Concrete Pavement Slabs"	63C	Bell	12/18	17	0	127	XIX	4	A	79
926-Plan of Study "The Use of Statistical Sampling to Determine Highway Needs"	54AA	Covault	12/18	8	0	127	XIX	4	A	96
927-Plan of Study "The Use of Statistical Sampling to Determine Highway Needs" (Revised)	54AA	Covault	12/18	8	0	127	XIX	4	A	104
928-Plan of Study "Evaluation of Bituminous Concrete by Repeated Load Test on a Slab Type Specimen"	6N	Dennis	12/18	8	0	127	XIX	4	A	112
929-Proposed Budget for Period January 1, - March 31, 1958	--	Michael	12/18	6	0	127	XIX	4	A	120
930-Technical Paper "A Review of Research on Deleterious Substances in Concrete Aggregates" (1957 JHRP Report No. 37)	42E	Schuster	12/18	32	0	127	XIX	4	A	126
931-Final Report "The Effect of Pavement Type and Edge Lines on Lateral Placement" (1957 JHRP Report No. 31)	17R	Weckesser	12/18	129	32	127	XIX	4	A	160
932-Progress Report "Traffic Speed Report No. 62" (1957 JHRP Report No. 33)	10C	Pinnell	12/18	18	7	127	XIX	4	A	297

Report and No.	Proj.	Author	Date	Pages	Figs.	Bk.	Vol.	No.	Pt.	Pg.
	G-36									
933-Progress Report "Traffic Speed Report No. 63" (1957 JHRP Report No. 34)	10D	Pinnell	12/18	18	6	127	XIX	4	A	316
934-Technical Paper "The Federal Aid Highway Act of 1956--its Implications, Benefits and the Problem of Highway Cost Allocation" (1957 JHRP Report No. 32)	--	Branham	12/18	21	0	127	XIX	4	A	334
935-Technical Paper "Correlation Between Concrete Durability and Air-Void Characteristics" (1957 JHRP Report No. 30)	37Q	Fears	12/18	50	8	127	XIX	4	A	355
936-Technical Paper "Indiana's Highway Needs Study" (1957 JHRP Report No. 35)	54T	Covault	12/18	27	12	127	XIX	4	A	405
937-Technical Paper "Application of Pulse Velocity Tests to Several Laboratory Studies of Materials" (1957 JHRP Report No. 36)	25	Woods McLaughlin	12/18	38	9	127	XIX	4	A	432
938-Technical Paper "The Effect of Base Course Gradation on the Results of Laboratory Pumping Tests" (1957 JHRP Report No. 38)	--	Chamberlin Yoder	12/18	51	13	127	XIX	4	A	470
939-Technical Paper "Triaxial Testing of Bituminous Mixtures at High Confining Pressures" (1957 JHRP Report No. 40)	6K	Oppenlander Goetz	12/18	52	16	127	XIX	4	A	521
940-Progress Report, "Highway Sufficiency Rating Study - Rural State Highways in Indiana" (1958 JHRP Report No. 5)	54T	Covault Blindner Powers	1/30	110	5	128	XX	1	A	2
941-Final Report "An Evaluation Study of Two Nonlimited Access By-Passes in Indiana" (1958 JHRP Report No. 1)	54Z	Pinnell	1/30	90	32	128	XX	1	A	112

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Rk.	Vol.	No.	Pt.	Pg.
942-Final Report "Stresses and Deflections in Continuously Reinforced Concrete Pavements" (1958 JHRP Report No. 2)	46M	Miller	1/30	40	10	128	XX	1	A	202
943-Technical Paper "Triaxial Testing of Open-Type Bituminous Mixtures" (1958 JHRP Report No. 4)	6K	Oppenlander Goetz	1/30	59	17	128	XX	1	A	242
944-Informational Report "An Investigation of the Use of a Mechanically Precipitated Fly-Ash as a Filler for Bituminous Concrete" (1957 JHRP Report No. 39)	--	McLaughlin Goetz	12/10	28	7	128	XX	1	A	301
945-Technical Paper "Earth Motion Beneath a Prescribed Boundary Displacement" (1958 JHRP Report No. 6)	63A	Geldmacher Dunkin Anderson	2/28	27	8	128	XX	1	A	336
946-Technical Paper "A Laboratory Method of Determining the Skidding Resistance of Bituminous Paving Mixtures" (1958 JHRP Report No. 7)	53D	Shupe Goetz	2/28	90	21	128	XX	1	A	363
947-Proposed Budget for Period April 1 - June 30, 1958	--	Michael	4/10	5	0	129	XX	2	A	22
948-Plan of Study "The Effects of Freezing and Thawing on Prestressed Concrete"	58C	Mumleh	4/10	7	0	129	XX	2	A	27
949-Plan of Study "Effect of Intersection Illumination on Certain Characteristics of Traffic"	17N	Powers	4/10	8	0	129	XX	2	A	34
950-Plan of Study "A Study of High Accident Rates on Certain Highways in Indiana"	59D	Blindauer	4/10	8	0	129	XX	2	A	42

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Blk.	Vol.	No.	Pt.	Pg.
951-Technical Paper "Methods of Testing for Water Resistance of Bituminous Paving Mixtures" (1958 JHRP Report No. 8)	6	Goetz	4/10	21	0	129	XX	2	A	50
952-Technical Paper "Quality Aggregates for Indiana Highways" (1958 JHRP Report No. 9)	42	Woods McLaughlin Schuster	4/10	26	0	129	XX	2	A	71
953-Final Report "Airphoto Interpretation of Soils of Steuben County, Indiana" (1958 JHRP Report No. 10)	51B	Yeh	4/10	48	15	129	XX	2	A	97
954-Final Report "A Highway Classification and Needs Study for Jay County, Indiana"	--	JHRP Staff	4/1958	17	0	129	XX	2	A	153
955-Final Report "Warping Stresses and Deflections in Concrete Slabs" (1958 JHRP Report No. 12)	63B	Harr	5/21	93	14	129	XX	2	A	170
956-Final Report "A Laboratory Investigation of Factors Affecting the Slipperiness of Bituminous Paving Mixtures" (1958 JHRP Report No. 11)	53D	Shupe	5/21	194	29	129	XX	2	A	263
957-Plan of Study "Flexible Pavement Design for Indiana Using Repetitive Loading Tests"	52E	Walker	5/21	11	0	129	XX	2	A	457
958-Technical Paper "The Value of Planned Access on Urban Bypasses" (1958 JHRP Report No. 13)	54Z	Pinnell Michael	5/21	23	12	129	XX	2	A	468
959-Technical Paper "The Effect of Rate of Strain on Soil Strength" (1958 JHRP Report No. 14)	14B	Hampton Yoder	5/21	23	6	129	XX	2	A	491

Report and No.	Proj. C-36	Author	Date	Pages	Figs.	Blk.	Vol.	No.	Pt.	Pg.
960-Technical Paper "Application of Photogrammetry to Mapping for Highway Location Studies" (1958 JHRP Report No. 15)	32M	Bailey	5/21	20	8	129	XX	2	A	514
961-Technical Paper "The Relationship Between the Unconfined Compressive Strength of a Bituminous Mixture and the Viscosity of the Binder" (1958 JHRP Report No. 16)	6J	Wood Goetz	5/21	35	14	129	XX	2	A	534

SUMMARY TABULATION OF RESEARCH PROJECTS

Status as of June 30, 1958

KEY TO STATUS NUMBERS

Key Number

- 1 Complete--unpublished.
 2 Complete--published (including completed theses).
 3 Incomplete--inactive.
 4 Complete--publication in progress.
 5 Active--incomplete.
 6 Being started.
 7 Planned.

* Resigned

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
1	6-3	Jackson*	2	Test Road No. 1. old series
2	6-4	Jackson*	2	Test Road No. 1. new series
3	6-5	Jackson*	2	Test Road 2
4	2-3			Surface Treatment
	2-3-1	Shelburne*	2	A--1935 & Older Construction
	2-3-2	Shelburne*	2	B--1936 Construction
	2-3-3	Shelburne*	2	C--1937 Construction
5	6-6			Laboratory Soil Studies
	6-6-1	Graves*	1	A--Durability
	6-6-2	Winn*	2	B--Frost Action
	6-6-3	Kay*	2	C--Permeability
	6-6-4	Ihyo*	2	D--Compression
	6-6-5	Schaub	3	E--Compaction on Remolded Clays
6	2-4			Bituminous Mixtures
	2-4-1	Graves*	3	A--Pugmill
	2-4-2	Graves*	1	B--Patch Materials
	2-4-3	Graves*	3	C--Unconfined Compression Tests
	2-4-4	Layman*	2	D--Unconfined Compression & Squeeze Tests
	2-4-5	Chen*	2	E--Stability
	2-4-6	McLaughlin	2	F--Resurface Mixtures
	2-4-7	Herrin*	2	G--Particle Shape
	2-4-8	Havers* & Dusenbury*	2	H--Rubber Asphalt
	2-4-9	Osili*	2	I--Seal Coats

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
	2-4-10	Wood	2	J-Str. & Deform. Charac.
	2-4-11	Oppenlander*	2	K-Triaxial Testing at High Pressu
	2-4-12	Zegarra*	2	L-Aggregate Bitumen Mixtures
	2-4-13	Goetz	2	M-Strength by Marshall Test
	2-4-14	Dennis	5	N-Repeated Load Test Evaluation
7	2-5			Rock Asphalt
	2-5-1	Goetz, Tyler*	2	A-Exploratory Study
8	2-6			Bituminous Adhesion
	2-6-1	Goetz	2	A-Untreated
	2-6-2	Tyler*	3	B-Treated
	2-6-3	Andersland*	2	C-Sonic Test Evaluation
9	5-3			Aggregate Degradation
	5-3-1	Shelburne*	2	A-Under Road Rollers
10	8-3			Traffic Speeds
	8-3-1	Lawshe*	2	A-Bibliography
	8-3-2	Branham	2	B-Equipment Development
	8-3-3	Staff	5	C-Periodic Speed Studies
	8-3-4	Staff	5	D-Truck Speed - Weight Study
11	9-1			Climatic Data
	9-1-1	Staff	1	A-Winter Weather 1935-51
12	2-7			Test Road No. 3
	2-7-1	Goetz, Shelburne*	2	A-Resurvey
	2-7-2	Chang*	2	B-Sample Tests
13	6-7	Belcher*	2	Test Rd. Sur. Treat.
14	6-8			Triaxial Tests
	6-8-1	Yoder	1	A-U. S. 41 Test Road
	6-8-2	Yoder, Wood, Hampton	2	B-Effect of Rate of Loading
	6-8-3	Gregg*	2	C-Soil and Soil Mixtures
15	6-9			Drainage
	6-9-1	McAlpin*	2	A-Small Models
	6-9-2	McClelland*	2	B-Large Models
	6-9-3	Ku*	2	C-Capillarity
	6-9-4	Hittle*	3	D-Capillary Potential
	6-9-5	Robertson*	2	E-Permeability
	6-9-6		3	F-Agg. Grad. for Drains
	6-9-7	Slessor*	1	G-Soil-Vapor Press.
	6-9-8	Yeh	2	H-Hydrology
	6-9-9	Kashef*	2	I-Numerical Solution to Flow Problems

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
16	6-10			<u>Field Soil Temp. and Moisture</u>
	6-10-1	Yoder & Lowrie*	2	A-Field Installations
	6-10-2	Lennertz* & Lovell	3	B-Soil Temp. Gages
	6-10-3	Lovell	3	C-Soil Mois. Meas. Dev.
	6-10-4	Lovell	1	D-Freezing Index Maps
17	8-4			<u>Traffic Engineering Research</u>
	8-4-1	Green	3	A-Signs
	8-4-2	Wilson*	2	B-Intersections
	8-4-3	Green	3	C-Pvt. Usage
	8-4-4	O'Hara*	2	D-Accidents
	8-4-5	Quimby*	2	E-Effect of Narrow Bridges
	8-4-6	Overmyer*	2	F-Width, Pavement
	8-4-7	Baerwald*	2	G-Public Opinion Poll
	8-4-8	Lang*	2	H-Shoulders Influence
	8-4-9	Barkley*	2	I-Bibliography
	8-4-10	Baerwald*	3	J-Effect of Median Strip
	8-4-11	MacNaughton	2	K-Turn Lane Controls
	8-4-12	Rosenfield*	2	L-Lateral Placement of Vehicles
	8-4-13	Baerwald*	1	M-Drive-In Theatre Traffic
	8-4-14	Powers	5	N-Intersectional Visibility
	8-4-15	Jackman*	2	O-Driver Obedience to Signs
	8-4-16	Barr*	2	P-Scramble System
	8-4-17	Cooper*	2	Q-4-Way Stop
	8-4-18	Weckesser*	2	R-Edge Striping Effect on Lateral Placement
18	5-4			<u>Chert in Aggregate</u>
	5-4-1	Sweet*	2	A-In Indiana
19	5-5			<u>Concrete General</u>
	5-5-1	Jones*	2	A-Phys. Characteristics
	5-5-2	Robertson*	1	B-Cores, U. S. No. 40
	5-5-3	Jones*	1	C-Fatigue
20	4-3			<u>Salt Migration</u>
	4-3-1	Slessor*	2	A-Laboratory
	4-3-2	Frost*	1	B-Route 30 Heave
	4-3-3	Frost*	1	C-Buffalo-Laporte
21	2-8			<u>Local Aggregates</u>
	2-8-1	Hetcalif*	2	A-Sandstone
	2-8-2	Rice*	2	B-Sands
22	2-9			<u>Bituminous Emulsions</u>
	2-9-1	Tyler*	2	A-Bituminous Emulsions

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
23	5-6			<u>Concrete Sealing</u>
	5-6-1	Green	3	A--Linseed Oil
	5-6-2	Green	3	B--Field Studies
	5-6-3	Green, Shelburne*	3	C--U. S. 20 Study
24	2-10			<u>Bituminous Structure</u>
	2-10-1	Bonewits*	2	A--Microscopic Technique
25	9-2			<u>Dynamic Modulus</u>
	9-2-1	Bawa*	2	A--Bit.-Agg. Mix.
	9-2-2	Whitehurst*	2	B--Time of Set
	9-2-3	Yong*	2	C--Sonic vs. Mech. Test of Bitum.
	9-2-4	Whitehurst*	2	D--Soil-Cement and Soil-Lime
	9-2-5	Whitehurst*	2	E--Field Use
26	4-4			<u>Paints</u>
	4-4-1	Goetz	2	A--Traffic Paints
	4-4-2	Goetz	1	B--Blackout Paints
	4-4-3	Goetz	5	C--Laboratory & Field
	4-4-4	Goetz	3	D--Bridge Paint
	4-4-5	Blackburn*, Dolch	2	E--Waterproofing
	4-4-6	Goetz	3	F--Prison Paints
27	6-11	Shelburne*	1	<u>Test Road No. 4</u>
28	9-3			<u>Photoelasticity</u>
	9-3-1	Woodsmall*	2	A--Subg. Stress
	9-3-2	Baker*	2	B--Calculations
	9-3-3	Hittle*	1	C--Dowel Bars
	9-3-4	Hittle*	1	D--Conc. Arch
29	1-3			<u>Aerial Strip Maps</u>
	1-3-1	Mettes*	3	A--Highway Locations
	1-3-2	Hittle*	2	B--Use of Strip Maps
	1-3-3	Hiles	2	C--Strip Map Location
30	9-4			<u>Geology</u>
	9-4-1	Woods, Yoder & Johnstone*	2	A--Preglacial Marietta River
31	2-11			<u>Bituminous Performance</u>
	2-11-1	Shelburne*	1	A--Route 26
	2-11-2	Shelburne*	1	B--Route 17
	2-11-3	McLaughlin, Goetz	5	C--Bituminous Concrete Stability
	2-11-4	Shelburne*	1	D--Spring Breakup 1943
	2-11-5	Green	1	E--Spring Breakup 1945
	2-11-6	Goetz	1	F--Spring Breakup 1951

Project C-36	File No.	Assigned To	Status (See Key)	Title of Project
32	1-4			<u>Airphoto Interpretation</u>
	1-4-1	Belcher*	2	A--Granular Materials
	1-4-2	Frost*	3	B--Rough Topography
	1-4-3	Parvis	5	C--Airphoto Bibliography
	1-4-4	Frost*	1	D--Use in Location
	1-4-5	Parvis	2	E--Use in Drainage
	1-4-6	Montano*	3	F--Indiana Soils--Northern
	1-4-7	Frost*	3	G--Indiana Soils--Southern
	1-4-8	Frost*	1	H--U. S. 40, Terre Haute
	1-4-9	Mollard*	1	I--Valparaiso Moraine
	1-4-10	Hishimura*	2	J--Erie Moraines
	1-4-11	Howe*	2	K--Ground Water
	1-4-12	Miles	5	L--Topographic Mapping
	1-4-13	Bailey	5	M--Mapping for Preliminary Location
33	6-12	McAlpin* Belcher*	1	<u>Test Road No. 5</u>
34	6-13	Belcher*	1	<u>Test Road No. 6</u>
35	5-7			<u>Conc. Performance</u>
	5-7-1	Shelburne*	1	A--Route 67
	5-7-2	Tung*	1	B--Route 29
	5-7-3	Shelburne*	1	C--Route 6
	5-7-4	Shelburne*	1	D--Route 30
	5-7-5	Shelburne*	1	E--Roughness
	5-7-6	Camp*	1	F--U. S. No. 50
36	6-14			<u>Indiana Soil Problems</u>
	6-14-1		1	A--Equipment
	6-14-2	Lennertz*	2	B--Geophysical Testing
	6-14-3	Larow*	2	C--Landslides
	6-14-4	Woods	2	D--Soil Surveys
	6-14-5	Shurig*	2	E--Subsurface Exploration
	6-14-6	Moore*	2	F--Airphoto Evaluation
37	5-8			<u>Conc. Durability</u>
	5-8-1	Shelburne*	3	A--Curing
	5-8-2	Sweet*, Woods	2	B--Base Courses
	5-8-3	Soon*	3	C--Aggregate Absorption
	5-8-4	Lewis*, Sweet*	3	D--Sonic-Lab.
	5-8-5	Lewis*, Sweet*	3	E--Sonic Field
	5-8-6	Glover*, Lu*	3	F--Coef. Expansion
	5-8-7	Dugg*	2	G--Air Entrn. Admixtures
	5-8-8	Blackburn*	2	H--Disintegration Bibliography
	5-8-9	Pendley*	2	I--Restraint Effects
	5-8-10	Lu*	2	J--Therm. Shock
	5-8-11	Fears*	2	K--Pore Charac.

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
	5-8-12	Higgs*, McLaughlin	5	L--Fine Aggregate
	5-8-13	Blackburn*	2	M--Agg. Dur. in Air-Entr. Conc.
	5-8-14	Barkeley*	3	N--Concr. Admix.
	5-8-15	Batchelder*	2	O--Strength and Dynamic Properties
	5-8-16	Venters*, Lewis*, McLaughlin	5	P--Gravel, Non-durable Components
	5-8-17	Batchelder*, Fears*	2	Q--Air Content, Hardened Concrete
	5-8-18	Lewis*, Whitehurst*, McLaughlin	2	R--Bridge Concrete, Deterioration
	5-8-19	Lewis*, Irick*, Blackbourn*	2	S--Variability of Durability Tests
	5-8-20	Walker	2	T--Gravel-Stone Mixt.
	5-8-21	McLaughlin	5	U--HRB Cooperative Study
	5-8-22	McLaughlin	3	V--Dur. Pre-Stressed Conc.
	5-8-23	McLaughlin	5	W--Air-Entr. Conc. Pave. Survey
	5-8-24	McLaughlin	5	X--Freeze Thaw Tests
	5-8-25			Y--
	5-8-26	Dolch	5	Z--Dampproofing Treatment of Bridges
38	6-15			Soil Mapping
	6-15-1	Frost*, Hittle*	2	A--Field and Lab.
	6-15-2	Frost*	1	B--Route 20
	6-15-3	Frost*	1	C--U. S. No. 33
39	7-3			Highway Loading
	7-3-1	Woods	2	A--Loading and Design Trends
40	6-16	Belcher*	1	Test Road 7
41	4-5			Plastics
	4-5-1	Yohalem*	2	A--Durability
	4-5-2	Lewis*	2	B--Strength
	4-5-3	Slate*	3	C--New Plastic & Signs
	4-5-4	Slate*	2	D--Centerline Markings
42	5-9			Aggregate Survey
	5-9-1	Sweet*	2	A--Significance of Tests
	5-9-2	Woods	2	B--Origin & Destr.
	5-9-3	Fears*	2	C--Biblio. Aggreg.
	5-9-4	Lewis*, McLaughlin	5	D--Specifications
	5-9-5	Lewis*, McLaugh- lin, Schuster	5	E--Indiana Sources
	5-9-6	McLaughlin, Schuster	5	F--Further Studies of Dele- terious Substances

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
43	6-17			<u>Pedological Soils</u>
	6-17-1		3	A--St. Dens. Proctor
	6-17-2	Hittle*	3	B--Typ. Proctor Curves
44	5-10			<u>Concrete Pumping</u>
	5-10-1	Green	2	A--Field Surveys, 1943 and 1947
	5-10-2	Shelburne*, Green	2	B--Pvt. Jack
	5-10-3	Goetz, Green	2	C--Pumping Mixtures
	5-10-4	Goetz	3	D--Rig. Pvt. Salvage
	5-10-5	Lewis*	1	E--1951 Survey
	5-10-6	Lewis*	1	F--1954 Survey
45	6-18			<u>Base Courses</u>
	6-18-1	Yoder	2	A--Gran. Bases-Lab.
	6-18-2	Henderson*	2	B--U. S. 30 Bases
	6-18-3	Soon*	1	C--Temp. vs. Compaction
	6-18-4	Pollard*	3	D--Sand-Clay Distribution
	6-18-5	McCullough*	3	E--Ind. Sand-Clay Characteristics
	6-18-6	Yoder & Irick*	5	F--Rigid Pavement on Gran. Base
46	5-11			<u>Conc. Pvt. Design</u>
	5-11-1	Shelburne*	1	A--Deflection Stud.
	5-11-2	Sweet* & Woods	2	B--Blowup Survey-Perf.
	5-11-3	Hittle*	1	C--Thin Pvt. Surv.
	5-11-4	Lewis*	2	D--Resurf. Pvt. Surv.
	5-11-5	Lewis*	1	E--Joint Perf. Surv.
	5-11-6	Lewis*	1	F--Load Trans. Device
	5-11-7	Camp*	1	G--Conc. Exp.
	5-11-8	Melville*	1	H--Conc. Exp.
	5-11-9	Okamoto*	1	I--Freeze and Thaw
	5-11-10	Lewis*	1	J--Resurvey of Blowups
	5-11-11	Schneballi* Thorn & Lewis*	3	K--Strain Gauges
	5-11-12	Choksi*	2	L--Structural Design Bibliography
	5-11-13	Miller*	2	M--Theoretical Strains & Stresses
47	4-6			<u>Chemistry of Concrete</u>
	4-6-1	Slate*	3	A--Gels
	4-6-2		3	B--Thin Sections
	4-6-3	Dolch	5	C--Solubility of Aggregates
	4-6-4	Slate*	2	D--Bibliography
	4-6-5	Fox*	2	E--Thermal
	4-6-6	Dolch	5	F--Aggr. Voids
	4-6-7	Dolch	5	G--Alkali Aggregate Reaction
48	9-5			<u>Turf Studies</u>
	9-5-1	Yoder	2	A--Early Studies

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
49				
50	6-19			<u>Soil Stabilization</u>
	6-19-1	Slesser*	1	A--Chemical
	6-19-2	Hills*	1	B--Molasses
	6-19-3	Johnson*, Dolch, & Yoder	1	C--Line
	6-19-4	Sharma*	2	D--Bibliography
	6-19-5	Korran*	2	E--Soil Cal. Chloride Mix
	6-19-6	Yoder	1	F--Test Road Using DDAC
51	1-5			<u>Soil, Drainage Mapping</u>
	1-5-1	Parvis, Yeh, Magnusson*	5	A--Drainage Maps
	1-5-2	Montano*, Yeh	5	B--Soils Maps
	1-5-3	Moulthrop*	2	C--Loess Mapping
	1-5-4	McLarren*	2	D--SW Indiana Interbedded Shale
	1-5-5			E--
	1-5-6	Stylianopoulous*	2	F--SS and Shale of SW Indiana
	1-5-7	Robbins*	3	G--LS and Shale of SE Indiana
	1-5-8	Leighty*	2	H--Alluvial Terraces
	1-5-9	McGregor*	2	I--Agriculture Soil Map Use
	1-5-10	Yeh	5	J--State Drainage Map
	1-5-11	Montano*, Yeh	5	K--State Soils Map
	1-5-12	Dawson*	2	L--SS and Shale of SC Indiana
	1-5-13	Vantil*	2	M--LS of SC Indiana
	1-5-14	Stevens*	2	N--Illinoian Glacial Drift, SE Indiana
	1-5-15	Johnson*	2	O--Northern Indiana Sands
	1-5-16	Richert*	2	P--SS and Shale Areas
	1-5-17	Davis*	2	Q--NW Indiana Moraines
	1-5-18	Mintzer*	2	R--Illinoian Glacial Drift, SW Indiana
52	6-20			<u>Pavement Design</u>
	6-20-1	Ardaman* & Yoder	2	A--C.B.R. Tests
	6-20-2	Yoder	5	B--Flexible Pavement Design
	6-20-3			
	6-20-4	McMahon	5	D--Soil Pressures under Flexible Pvts.
	6-20-5	Walker	5	E--Repetitive Loading Tests
53	9-6			<u>Road Roughness & Skid</u>
	9-6-1	Metcalf*, Thanos* Holloway*	2	A--Equipment, Roughness
	9-6-2	Grunau*, Baer- wald*	2	B--Skid Resistance Equipment
	9-6-3	McLaughlin	1	C--Skid Characteristics Bibliography

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
	9-6-4	Shupe	2	D--Bit. Mixture Skid Character- istics
	9-6-5	Grunau*, Michael, Shupe	2	E--Skid Resistance of U. S. 31 Test Rd.
	9-6-6	Rosenfield* Weckesser*	2	F--Lateral Placement on U. S. 31 Test Rd.
	9-6-7	Grunau*, Michael	2	G--Skidding Characteristics, Ind.
	9-6-8	Grunau*, Shupe	2	H--Skid Tests on U. S. 421
	9-6-9	Holloway	2	I--Roughness Characteristics
	9-6-10	Stephens	5	J--Effects of Aggregate on Skidding
54	3-3			<u>Econ. & Admin.</u>
	3-3-1	Michael	3	A--Wabash River Bridge
	3-3-2	May*	2	B--Lebanon Bypass
	3-3-3	Michael	2	C--Kokomo Bypass
	3-3-4	Baerwald*	2	D--Public Opinion Poll
	3-3-5	Branham, Baerwald*	2	E--County Road Marking
	3-3-6	Branham, Baerwald*	3	F--Cost Allocation
	3-3-7	May* & Yoder	3	G--Air Transportation
	3-3-8	May*	3	H--Laf. Trans. Study
	3-3-9	May*	2	I--Logansport Study
	3-3-10	Michael	2	J--Richmond Study
	3-3-11	Michael	3	K--Bloomington Study
	3-3-12	Bauer*	3	L--Logansport Parking
	3-3-13	Kell*	2	M--O-D Surv. Methods
	3-3-14	Stoner*, Petty, Woods & Branham	2	N--Co. Highway Admin.
	3-3-15	Miller*	2	O--Sampling Techniques
	3-3-16	Baerwald*	2	P--County Classification
	3-3-17	Michael & Edwards*	2	Q--Huntington Survey
	3-3-18	Baerwald*	2	R--Allen Co. Study
	3-3-19	Branham	2	S--Recruitment of Engineers
	3-3-20	Michael	2	T--State Highway Needs Study
	3-3-21	May*	2	U--Evaluation of Limited Access Highways
	3-3-22	Barry*	2	V--Urban Characteristics for O-D Surveys
	3-3-23	Cribbins	3	W--Northern Indiana Seaport
	3-3-24	Branham	2	X--Engineer Retention Study
	3-3-25	Kask*	2	Y--W. Lafayette Shopping Center Study

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
	3-3-26	Pinnell*	2	Z--Bypass Reevaluation Studies
	3-3-27	Covault	5	AA--Sampling for County Needs
55	2-12			<u>Flex. Pavement Design</u>
	2-12-1	Goetz	5	A--General
	2-12-2	Lowrie*	2	B--Design
	2-12-3	Hetcalf*	3	C--Test Road, Churubusco
	2-12-4	Herrin*	3	D--Thickness Design
	2-12-5	McLaughlin	2	E--Bituminous Concrete
	2-12-6	Goetz	5	F--U. S. 31 Test Road Cores
56	7-4			<u>Bridges</u>
	7-4-1	McCarmon*	3	A--Dynamic Forces
	7-4-2	Hayes, Sbarounis*	2	B--Vibration
	7-4-3		3	C--Soil Pressure, U-Type Bridge
	7-4-4			D--
	7-4-5	Wyly*	3	E--Design of Washers for High Tensile Bolts
57	5-12			<u>Cement</u>
	5-12-1	Blackburn*	1	A--Slag Cement
58	5-13			<u>Prestressed Concrete</u>
	5-13-1	Midgaard*	2	A--Creep & Shrinkage
	5-13-2	Wordby*, Antrim	5	B--Endurance, Fatigue
	5-13-3	Musleh	5	C--Freeze & Thaw Affects
59	8-5			<u>Traffic Safety</u>
	8-5-1	Michael	5	A--Crash Injury
	8-5-2	Michael	5	B--Safety Belts
	8-5-3	Woo*	2	C--Accident Rate vs. Design Features
	8-5-4	Blindauer	5	D--High Accident Rates
60	3-4			<u>Highway Cost Studies</u>
	3-4-1	Belcher*	1	A--Mass Diagram
	3-4-2	Kyloie*	3	B--Receipts and Disbursements, N. C. States
61	5-14			<u>Concrete Characteristics</u>
	5-14-1	McLaughlin	5	A--Temp. Effect on Air Bubble Distribution
62	9-8			<u>Hydraulics</u>
	9-8-1	Delleur	5	A--Runoff from Small Drainage Areas
	9-8-2	Delleur	5	B--Hydraulics of Arch Bridges

Project C-36	File No.	Assigned to	Status (See Key)	Title of Project
63	9-7			<u>Pavement Deflection</u>
	9-7-1	Geldmacher*, Anderson* Dunkin* Wood* Harr*	2	A-Pavement Deflection
	9-7-2	Harr*	2	E- Environmental Effects
	9-7-3	Bell	5	C- Measurement of Moisture in Concrete

LISTING OF CODE NUMBERS FOR PROJECTS OTHER THAN FUND 5112
AS SHOWN IN ATTACHED LISTING OF EXTRA LABOR EMPLOYEES
OF THE JOINT HIGHWAY RESEARCH PROJECT

<u>Code Number</u>	<u>Fund Number</u>	<u>Fund Name</u>
1		Work on contracts
1a	5683	Fed. Res. CAA #2
1b	5678	Fed. Res. CAA #1
2	5661	Cal. Chloride Association
3	5722	Fed. Res. Permafrost Investigation
4	5761	PRF Fellowship No. 371A
5	5777	Lime-Soil Research
6	5796	AAR Concrete Research
7	5805	Fed. Res. Permafrost Investigation #2
8	5806	Fed. Res. Trafficability Study
9	5807	Fed. Res. Site Selection
10	5808	Fed. Res. Aerial Reconnaissance
11	5822	PRF Fellowship No. 578
12	5833	Waterways Experiment Station Research
13	5842	Calcium Chloride Soils Research
14	5843	Dow Chemical Concrete Research
15	5866	Soil Strength Characteristics
16	5869	Fed. Res. Prediction Trafficability
17	5870	Fed. Res. Airphoto Trafficability
18	5878	PRF Fellowship No. 796
19	5883	Permafrost Report Publication
20	5893	American Steel Dredge Research #2
21	4414	Conference 4414 (Technical Extension Div.) Short Course - Airphotos
22	5411	Fees - EES

23		State Highway Commission payrolls for the production of drainage and soil maps.
24		State Highway Commission payrolls covering the transportation surveys.
25	5411	Traffic Engineering Services
26	5112A	Indiana State Highway 5112A
27	5926	PRF #927
28	5934	PRF #953
29	5935	PRF #954
30	5936	Fed. Res. Soil Freezing Characteristics
31	5939	Yuma Test Branch Terrain Study
32	5940	Engineering Physiography of North America
33	5955	Bakelite Water Barrier
34	5201	International Salt Company
35	5249	Indiana Electric Association

EXTRA LABOR EMPLOYEES

Supplement No. 4*

Termination Between July 1, 1957 and June 30, 1958

<u>Employee</u>	<u>Work on Other Projects</u>	<u>Employed</u>	<u>Resigned</u>
Aghwan, Amjad		2-13-58	2-17-58
Allison, R. G.		10-1-56	3-31-58
Anene, E. O.	35	12-1-57	1-21-58
Barrientos, Julian		1-1-58	2-15-58
Bradley, B. R.	27, 33	1-1-56	5-15-58
Curry, Carlton E.		1-1-58	4-15-58
Dean, P. B.	33, 27	1-1-56	1-31-58
Denney, Murle E.	17	9-16-56	5-15-58
Devlin, Jacqueline		1-16-58	5-15-58
Dietrich, Richard T.		2-1-58	2-28-58
Egilmez, Ali C.	17	6-1-57	10-15-57
Enz, Edward H.	33, 27	12-1-56	1-31-58
Ewart, Howard		10-1-57	4-15-58
Federle, Paul		10-1-56	5-15-58
Ferraro, Wanda R.	35	12-1-57	1-31-58
Franklin, Don A.		2-16-58	4-15-58
Gawenda, Daniel F.		11-1-57	4-15-58
Haas, John M.	35	6-1-57	9-30-57
Haberlen, C. F.		1-1-58	2-28-58
Hardjodipuro, Suwanto		9-1-57	1-31-58
Hill, Francis R.		11-1-57	11-15-57
Humphrey, Lee		4-1-58	12-31-57
Johnson, Edmund C.		12-16-57	12-31-57
Kanouse, Kenneth		12-16-57	1-15-58
Kirschsieper, Shirley J.		2-1-58	2-28-58
Knox, Beverly		6-1-57	8-15-57
Kraft, Carl J.		2-15-57	7-31-57
Lippai, Sandor		10-16-57	12-15-57
Magnusson, L. R.		3-16-58	5-31-58
Miles, Thomas P.		12-16-57	4-15-58
Morrisette, James E.		7-16-57	8-31-57
Neufer, Edward L.		6-1-57	7-15-57
Norton, Donald W.		11-1-57	11-30-57
Oesterling, Thomas		11-1-57	3-15-58

<u>Employee</u>	<u>Work on Other Projects</u>	<u>Employed</u>	<u>Resigned</u>
Peeler, Don	35	2-1-55	1-15-57
Pierce, James S.		2-1-58	5-15-58
Pierick, Jerry		6-1-57	9-15-57
Porter, Ruth Mary	17	11-16-57	5-15-58
Probst, Philip W.		10-1-57	12-31-57
Purdue, Ronald E.		9-16-57	5-31-58
Reddy, Udamala I.	17	6-1-57	10-31-57
Richard, John C.	17	7-1-57	3-15-58
Roath, James A.	17	6-1-57	7-31-57
Romsro, Carlos, Jr.		1-16-58	2-15-58
Rosher, John C.		4-16-56	5-15-58
Schmidt, Hans		11-16-57	1-15-58
Shah, Ghulan Nabi		11-16-57	1-31-58
Smith, Julia F.		1-16-58	1-31-58
Stalder, W. R.	17	11-1-57	5-31-58
Thorud, Ingolf		5-1-56	2-15-58
Udahl, Svein		8-1-56	12-31-57
Witek, L. E.	33,27,17,35	3-1-55	5-15-58

* For listing of all terminations prior to July 1, 1954, see the "Annual Report of the Associate Director for 1953-54". For terminations after July 1, 1954 see the Annual Reports of the Assistant Director for 1954-1955, 1955-1956, and 1956-1957.

Still Employed on July 1, 1958

Employee	Work on Other Projects	Employed
Akinwumi, Alfred	17	6-1-58
Aksh, Zakarin	17	6-1-58
Allen, Roland K.		10-1-57
Andrews, Paul R.		6-1-58
Bellamy, Lee Ann		4-1-58
Biery, P. Fred		10-16-57
Brugos, David P.		3-16-57
Dogue, Ricardo R.		2-15-57
Garrett, Charles		6-16-58
Harris, Philip		6-16-58
Hiranandani, H. R.		4-1-58
Jansen, John F.		6-1-58
Kater, John		6-1-58
Lake, William R., Jr.		6-1-58
Lill, Paul A.		3-1-58
Manuel, Richard		1-16-58
Mendenhall, Gerald	17	6-1-57
Motwani, Dayo L.		1-16-58
Paul, John R.		2-1-58
Smith, Eleanor E.		6-1-58
Steele, James		9-16-57
Stewart, Morris R.		9-16-56
Surber, Richard		9-16-57
Taha, Issam		6-16-58
Van Sickle, John G.	33, 27, 17	11-1-56
Weidner, Ronald		6-1-58
Yunibhand, Seri		6-1-58