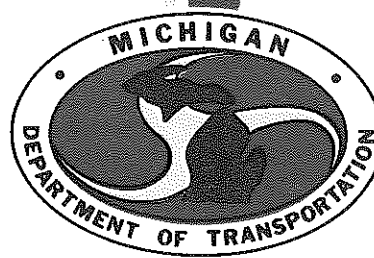


ANNUAL REPORT OF ACTIVITIES OF
THE MICHIGAN DEPARTMENT OF
TRANSPORTATION RESEARCH LABORATORY

MDOT REPORT NO. 359(A)



**TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION**



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activities of the Michigan
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THE MICHIGAN DEPARTMENT OF
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MDOT REPORT NO. 359(A)

Research Laboratory Section
Testing and Research Division
Research Report No. R-1241

Michigan Transportation Commission
William C. Marshall, Chairman;
Lawrence C. Patrick, Jr., Vice-Chairman;
Hannes Meyers, Jr., Carl V. Pellonpaa,
Weston E. Vivian, Rodger D. Young
James P. Pitz, Director
Lansing, March 1984

INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1983 calendar year. By better informing Department personnel of these activities, we hope to implement the research which is being conducted, and to integrate our research findings into Department practice.

The report is divided into seven sections. The first section outlines some of the highlights of the past year's research. Section two consists of a general index of reports and projects. Section three contains abstracts of all Research Reports published during 1983. The fourth section contains a list of New Materials projects completed during the year, the fifth section is a listing of Technical Investigations completed during the year, and the sixth section lists the Action Plans completed during the year. The seventh section lists the title, purpose, scope, progress past year, projected activities for the coming year, and salaries and wages for 1983, for all active Departmental and Highway Planning and Research projects (H.P. &R. projects are denoted by an asterisk).

Further information on any project described herein may be obtained by contacting L. T. Oehler, Engineer of Research, MDOT Secondary Governmental Complex, P.O. Box 30049, Lansing, MI 48909.

RESEARCH HIGHLIGHTS - 1983

Our Photometry Group assisted with the development of a portable free-standing sign to be used by the Michigan State Police in advance of an accident. This involved selection of a reflective material which was also fluorescent, and determining proper legend size, shape, spacing, and color for earliest recognition by the motorist. Final form of the sign is being evaluated at the State Police Academy in nighttime outdoor driving tests.

The Instrumentation and Data Systems Group has just completed the design, fabrication, and installation of a toll collection system for the Bluewater Bridge. This system counts all axles passing through the toll booths, calculates fares, and keeps track by company and vehicle number of all funds collected. All the reports needed by the bridge administrators are also generated by the system. All this is accomplished by using a micro-computer in each toll collection booth, and one master microcomputer located in the bridge office.

The Research Laboratory was an important participant in saving the State about \$400,000 by recycling—rather than removing and replacing—a 5.7 mile segment of portland cement concrete pavement on I 94 in Calhoun and Kalamazoo Counties. Also, about \$250,000 more was received from the Federal government for financing the project than if construction had been done by conventional means. The concrete recycling was the first done by the Department and received national attention.

An experimental oil skimming and sediment retaining chamber, which our Spectrochemistry Group was asked to evaluate, constructed near the Lake St. Clair end of the I 696 storm sewer, was put to use when a tanker truck tipped over during the summer of 1983. The petroleum product that spilled into the sewer was successfully recovered at the pumphouse and the skimmer chamber, preventing contamination of Lake St. Clair.

In its search to discover alternative substitutes for the highly corrosive sodium and calcium chlorides used for ice removal, the Federal Highway Administration identified calcium magnesium acetate (CMA) as a likely candidate. Support for producing 200 tons of CMA was derived from contributions by 23 states, and Michigan was selected as one of two states to receive 100 tons for field and laboratory testing. Our Soils and Bituminous Systems Unit supervised the field applications of both CMA and rock salt during winter storm conditions. Test applications were made during 1983, and are being continued through the 1983/84 winter storm season. At the same time, the Structural Research Unit evaluated the corrosive effects of CMA on structural metals. An environmental test chamber was designed and fabricated to house separate CMA and NaCl baths. Test specimens undergo cyclic immersion in solution then exposure to drying and ultraviolet light. Scaling studies were performed by our Materials Research Unit, to ascertain the effects of CMA on concrete surfaces. After this winter's season, the results of all phases of the experiment will be assessed.

The Structural Research Unit completed a major evaluation phase of weathering steel bridge corrosion. Primary results of the statistical analysis of corrosion data indicate that traffic spray from below is, in general, corroding the first few exposed beams at approximately twice the corrosion rate of the remainder of the structure. In addition, results show that structures built after 1975 appear to be corroding at a rate 1-1/2 to 2 times faster than all structures for a given environment. Several structures were extensively examined and repeat corrosion loss measurements were made. For the worst structure, corrosion losses on the lower portions of some of the beams were found to be in excess of 5 mils/year/surface and evidence of fatigue cracking was discovered in the fillet weld of one cover plate ending. Laboratory fatigue evaluations of specimens removed from bridges are about three-fourths completed. The Department no longer uses weathering steel on bridges.

The Structural Research Unit is also extensively involved with the repair of the Zilwaukee Bridge, providing technical assistance to the Design and Construction Divisions. Exact measurements for weight verification were made of the component members in the launching girder using special devices designed and fabricated by our machine shop. Baseline data were established on the deck, columns, and footing following the accident. The Unit monitored movement of the damaged expansion joint, changes in the footing and interior segment cracks, the relative movement between the columns and the footing, and changes in the deck profile. Our personnel affixed precision targets to the column, and readings were taken on these targets to record expansion and contraction effects and to determine a point of column rotation. Reference points were set on the columns and footing to detect elevation changes. Vibration monitoring was required for the drilling of the new footing caissons and for post-tensioning through the columns. It was also required during the jacking sequence of the cantilever to load the temporary falsework and the new footing, thus relieving the loads on the column. The Unit established an electronic tilt-sensing system in the cantilever and on the column to detect small angular movements, especially during the jacking sequence.

Implementation of a preventive maintenance system for concrete pavements, developed by the Materials Research Unit, was accomplished by awarding a contract utilizing these new maintenance techniques. The procedures are for use on relatively new pavements with minimal deterioration that can be corrected by partial-depth repairs. The repairs concern primarily joint grooves and transverse cracks where spalling has occurred, and are made with fast-set patching mortars to allow for same-day opening. Longitudinal and transverse joints are resealed and transverse cracks are routed and sealed to prevent further damage by moisture and infiltrating solids entering the slab.

After evaluating the results of experimental repairs utilizing drilled-in dowels, the Materials Research Unit wrote specifications for contract repair work. By the year's end, a total of 15 contracts for dowelled full-depth repairs had been awarded. The total area to be replaced by these contracts is equal to nearly 140,000 sq yd, which is equivalent to replacing 17,500 lane joints with a 6-ft long repair at each location. These repairs, on the basis of earlier experimental installations, should retain their

smoothness for a 10-year period, depending on the commercial traffic volume to which they are subjected.

One of the most detrimental factors in the deterioration of reinforced concrete surfaces is the entrance of chlorides from deicing salt. In an effort to slow the seepage of chlorides into concrete, several concrete sealers were evaluated in the laboratory. Each individual sealer was subjected to ponding with a sodium chloride solution for 90 days, after which the penetration of chloride ions was determined. After final evaluation of the data, the most promising sealers will be tested in the field.

The Materials Research Unit once again conducted the very successful schools for painting inspectors. These schools have been enthusiastically received, and will undoubtedly result in better, and more uniform inspection. Of the 82 students that participated, 23 were contractor representatives, two were from Wayne County, and two from the Pennsylvania DOT, the balance being Department personnel. In further development in our painting program, the state adopted a policy of totally painting new steel for bridge structures in the fabricating shop, rather than in the field. Although initial acceptance was somewhat reluctant, by the end of the year many of the advantages of this method became obvious. Costs savings are difficult to pin-down because of large fluctuations in the price of steel, but they appear to be at least 25, or possibly as high as 50 percent over the total cost of the old method of field painting.

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ABSTRACTS OF RESEARCH REPORTS
(January 1983 Through December 1983)

- R-1208 - "Degradation of Acid-Treated and Untreated Steel Furnace Slag as an Open Graded Base Course for Concrete Pavement," (80 TI-643). E. C. Novak, Jr.

Upon reviewing a prior report (R-1188) concerning the durability of acid-treated steel furnace slag for use as an open graded base course, a major slag producer indicated that steel furnace slag should be more durable when untreated and requested that another study be done using untreated material. This report summarizes the durability properties measured for acid-treated and untreated steel furnace slag, blast furnace slag, and natural aggregates. The study indicated that there was little difference in the degradation of the two slags, except under the T-180 compaction effort where the untreated slag degraded more than did the acid-treated slag.

- R-1209 - "Use of Recycled Asphalt Material in the Construction of a Bituminous Stabilized Base, I 75, Cheboygan County," (75 D-30). J. H. DeFoe

This is the final report describing features of Michigan's first large-scale cold recycling project; a previous report (R-1088) described the construction procedures, specifications, and road history. This report summarizes material characteristics determined by laboratory tests and measurements of the road's performance over the five-year evaluation period. The report concludes that cold in-place recycling of an existing bituminous pavement was successfully accomplished, and the recycled base roadway is structurally equivalent to a comparison roadway constructed with a separation course between the new and old bituminous material. Reflection cracking was essentially eliminated, and the physical properties of the recycled material as measured in the laboratory were equivalent to those of hot plant mixed black base materials typically used in Michigan.

- R-1210 - "Evaluation of the Straight Line Gradation Chart and the Particle Index Test," (75 E-57).

At the suggestion of the Committee on Aggregate Acceptance Criteria, this report was not published as submitted. It is anticipated to appear after further review and possible expansion.

- R-1211 - "Infiltration of Subbase Sand into Open Graded Drainage Course (OGDC) Bases," (80 TI-678). E. C. Novak, Jr.

This report presents the results of an abbreviated study to determine if OGDC bases could be expected to perform satisfactorily when placed directly on sand subbase and to evaluate the effectiveness of filter fabric for improving performance when placed between OGDC base and subbase layers. The study showed that unless a filter fabric separates base and

subbase layers, sand will infiltrate into the voids of OGDC bases. The degree to which sand infiltration takes place will govern the performance of these bases and ultimately influence pavement surface performance. Some tentative conclusions are offered, although the information from the study was not specific enough to offer definitive answers at this time.

*R-1212 - "Alternate Repainting Systems for Bridge Structural Steel," (76 G-219). F. J. Bashore

The primary objective of this Highway Planning and Research project was to determine by field evaluations whether a structural steel coating system based on a one or two-coat application could provide a rust-preventive system whose service life protection would be comparable to the Department's then-specified (1976) four-coat system when applied at equivalent dry-film thickness. This report describes the application of the coatings on the structure and discusses observations from periodic inspections made over six years. In an effort to lower maintenance repainting costs, a one-coat and two-coat system was tried, utilizing petroleum wax based vehicles. A two-coat inorganic zinc-rich primed, vinyl topcoated system was included, as well as Michigan's four-coat system. Unfortunately, the primary objectives of the project were not achieved to our satisfaction due to inadequate or incomplete surface preparation, and the lack of good application technique on the part of the painters. Certain observations concerning maintenance repainting were reinforced, and this project and others have helped in the development of our current coating systems (non-lead, two-coat).

R-1213 - "Annual Report of Activities of the Michigan Department of Transportation Research Laboratory."

R-1214 - "Air Quality Measurements for Movable Asphalt Plants for Recycling Paving Asphalt," (78 G-235). J. T. Ellis

Stack samples were taken from two movable asphalt plants that were processing a 50:50 ratio of recycled-to-virgin material. Both plants used a wet scrubber exhaust system. As previous investigations have shown, drum mix plants with wet scrubber exhaust systems have not yet shown they can achieve Federal air quality standards for particulate emissions when processing recycled paving asphalt. The need for modification of wet scrubber systems is indicated.

R-1215 - "Brake Lining Temperature Measurements for a Retarder Equipped Bus," (81 TI-728). L. E. DeFrain

Repeated braking of buses on busy urban runs results in high brake-shoe temperatures, with insufficient time to cool between applications, resulting in a relatively short useful shoe life. In this study, the effectiveness of a proprietary electric 'brake retarder' was evaluated as a means for reducing brake-shoe temperatures. This device supplies the majority of braking force until the bus speed is reduced to about 5 mph. The study showed that the device did result in a significant reduction in shoe temperature.

R-1216 - "Investigation of Steel Furnace Slag Open Graded Drainage Course Base on I 69/Airport Rd Ramps," (80 TI-643).

This study revealed problems with the attempt to construct open graded bases on the I 69/Airport Rd ramps. Part of the open graded drainage course (OGDC) on these ramps was to be constructed using a steel furnace slag conforming to a modified 17A grading. On-grade slag aggregate did not meet grading requirements, apparently breaking-down as a result of conventional materials handling techniques. These problems reduced the drainage properties of the bases to such a degree that the aggregate should not be considered as open graded base material. These bases, however, should drain better than would conventional 22A bases. As a result of the observations contained in this report, certain conclusions and recommendations are presented with respect to OGDC materials.

R-1217 - "Benkelman Beam Testing of Shoulder and Pavement Recycling Projects," (81 TI-727). J. H. DeFoe

The purpose of this study was to evaluate the strength and load carrying capacity of stabilized in-place recycled bases as compared with conventional hot plant-mixed bases used for constructing bituminous shoulders and pavements. The method of comparing the two base constructions involved elastic layer theory used in conjunction with pavement deflection analysis. Results of the study were expressed as estimated stiffness modulus values for the two base materials. In general, the report recommended that black bases be used under shoulders along highways having heavy commercial traffic; and where medium to heavy volumes of commercial traffic occur along with saturated layers of subbase or subgrade, e.g., usually over clay subgrades.

R-1218 -- "In-Place 22A Aggregate Acceptance Sampling Procedures," (76 G-222). Wen-Hou Kuo

Based on the results of an earlier study (R-1024) which favored inspection of aggregates at the job-site (in-place) rather than in the stockpile, this report describes the use of an 'acceptance sampling by attribution' plan on four construction projects. Based on the test results and the analysis of them, as well as the comments of the inspection and supervisory personnel, it is concluded that it is feasible and beneficial to implement in-place aggregate inspection procedures. Modification of the initial inspection procedures used here demonstrated that inspection cost reduction is large enough to justify the slight loss in statistical power to reject poorer quality aggregate, and thus is recommended for future in-place aggregate inspection.

R-1219 - "Traffic Regulator Vests," (77 G-229). G. M. Smith

It was decided that the publication of this report be delayed pending further revision.

R-1220 - "Evaluation of Sulfur-Asphalt Binder for Bituminous Resurfacing Mixtures," (74 D-29). J. H. DeFoe

This project, initiated in 1974, evaluated sulfur-asphalt binders in bituminous paving mixtures. Molten sulfur was blended with hot asphalt cement in specific and carefully controlled proportions to form a sulfur-asphalt binder which was then mixed with aggregate, sand, and mineral filler in the usual manner. Although this project demonstrated the technical feasibility of blending hot liquid sulfur and asphalt cement, the current sulfur-to-asphalt cost ratio must be much less than at present before the concept becomes economically desirable. Moreover, consideration must be given to the effects of the presence of sulfur when recycling paving mixtures, as recycling has become an attractive way of reusing paving materials.

R-1221 - "Evaluation of Breakaway Cable Terminal Endings on Guard-rail," (82 TI-853). B. W. Ness

It was decided that the findings weren't of sufficient significance to publish the report; recommendations and data were turned over to the Barrier Committee.

R-1222 - "Evaluation of Various Types of Railroad Crossings - Sixth Progress Report," (75 F-143). J. E. Simonsen

Michigan has been conducting an on-going research project in cooperation with the FHWA to investigate various proprietary railroad crossing materials and designs. This report describes five such crossings: Steel Plank, Saf and Dri, Parkco, Gen-Trac, and Cobra-X. Six criteria were used to evaluate the effectiveness of the crossings: surface wear, surface damage, alignment of units, fastening of rails, pavement/crossing joint, and crossing smoothness. In general, the materials continue to perform satisfactorily, though some problems have developed which have resulted in modification of the original designs or the design of new panels. We shall continue to monitor these installations, as some of the redesigned materials have only been subject to two or three years' wear, and periodic reports will be issued.

R-1223 - "Evaluation of Sprinkle Treatment for Improving Skid Resistance of Asphalt Surfaces - Final Report," (78 C-19). J. H. DeFoe

Sprinkle treatment consists of the application of 5 to 10 lb/sq yd of precoated, high quality aggregate particles, 1/2-in. nominal size, onto the surface of a wearing course, with embedment achieved by rolling. This project, done in cooperation with the FHWA, explored the feasibility of using sprinkle treatment techniques in an area of the state where limestone is the predominant aggregate material. Since limestone aggregates are prone to polishing under traffic, it was hoped that the application of a more durable aggregate to the surface might maintain better friction levels. A four-mile test area was treated and observed, and after three years it was found that sprinkle treatment provided significantly improved friction levels as compared with the bituminous concrete and bituminous aggregate surfaces used as control sections.

R-1224 - "Evaluation of 'Enkamat' as an Aid to Stabilizing a Cut Slope - Final Report," (81 E-62). J. H. DeFoe

The surface of a newly constructed cut slope was stabilized with "Enkamat," a flexible matting made from fused nylon monofilaments, as a means of preventing slope erosion and as an aid in establishing new turf. Installation of the Enkamat test section was observed by research personnel and inspected periodically throughout a seven-month evaluation period. No erosion, washout or slippage occurred and seeded turf was well established by the end of the evaluation period. Enkamat could be permitted wherever excelsior is called for and perhaps in certain situations where sod is required; its high cost, however, would probably restrict application to special problem situations.

R-1225 - "An Analytical Survey Procedure for Flexible Pavements," (83 TI-883).

Portions of this material have been incorporated into the procedures mandated by the Pavement Management Committee. A later report will provide a comprehensive description of the PMC final survey procedures.

R-1226 - "Stabilized Fly Ash as Lightweight Fill," (81 TI-785).

This report evaluates the properties of fly ash stabilized with various proportions of portland cement. The report concludes that where readily and economically available, and if protected from freeze-thaw conditions, cement stabilized fly ash could be used as a relatively lightweight fill material.

R-1227 - "High Density Concrete Deck Overlay with Superplasticizer," (82 TI-801). M. G. Brown

With the advent of high range-water reducers (HRWR) that have the capacity of fluidizing low-slump concrete without additional water, a renewed interest was created in the low-slump high density (LSHD) overlays for repairing concrete bridge decks. This concept makes it possible for the concrete to be batched at ready or central mix plants, hauled premixed to the job site in ready mix trucks where the HRWR is introduced, and discharged onto the bridge deck in a temporary high slump condition. Because of a random cracking problem, the report recommends no further LSHD-HRWR overlays be placed until further assessment can be made. We will also have a conception of the chloride penetration and long-term drying shrinkage—both of which at this time appear to be very serious problems.

R-1228 - "The Michigan Department of Transportation Circular Wear Track - Results of Supplemental Aggregate Polishing Tests," (71 C-13). R. W. Muethel

This report presents the results of seven additional aggregate polishing series completed on the Michigan Wear Track. This series included samples of crushed gravel, uncrushed gravel, crushed quarried carbonates,

crushed portland cement concrete, and steel furnace slag. Gravels with crushed and uncrushed material, and blends of high-polishing limestone with steel furnace and blast furnace slags were also tested. Each test series included the wear track gravel and limestone control aggregates.

R-1229 - "Scan 16 - Moisture, Frost, Ice Early Warning System - First Progress Report," (82 G-257). F. M. Spica.

This first progress report describes the installation and operation of this Surface Systems Inc. installation, located on the I 496 bridges in Lansing between River and Cedar Streets. The system detects temperature and humidity at the bridges. This information is fed by telephone line to a computer at the Research Laboratory. Information from the computer is then fed by leased telephone line to a video display terminal at the Mason Maintenance garage. The equipment is reportedly working well. Its value as an operating maintenance tool in lessening the incidence of icy bridge decks will be determined by future operation.

R-1230 - "Determination of Mean Vehicle Noise Emission Levels in Michigan," (78 G-244). F. W. Harwood, K. S. Bancroft, R. J. Holcom

Following procedures recommended by the FHWA, the Research Laboratory conducted a survey to determine noise emission levels emitted by various vehicle types on Michigan's highways. Using the energy mean emission levels computed from these data, with the FHWA's STAMINA 2.0 computer program, we will have a more accurate model for determining the amount of noise being generated on Michigan highways.

R-1231 - "Evaluation of Cast-In-Place Joint Repairs in Concrete Pavement," (75 F-150). C. A. Zapata

This report presents the Department's experience with, and the performance of, undowelled concrete pavement patches. During the life of this experimental project, there have been numerous developments in techniques of repair, pavement rating and management, preventive maintenance, and pressure relief. Also, it has become more and more obvious that repairs without load-transfer develop objectionable faulting in a few years. Because of the experience with undowelled patches, the Department has developed and now uses drilled-in dowels for load transfer for concrete pavement joint repair patches.

R-1232 - "An Aggregate Wear Index Reduction Factor for Uncrushed Material in Gravel," (71 C-13). R. W. Muethel

Publication of this report was deferred pending further review and research.

R-1233 - "Load Carrying Capacity of I 75 Bituminous Shoulders in the Flint Area," (83 TI-924)

Load deflection measurements were made of bituminous shoulders in an area that would soon be resurfaced in order to ascertain whether the shoulders could carry the diverted traffic. The information herein was transmitted to the Design Division.

R-1234 - "Petrographic Analysis of Coarse Aggregate: Michigan Stone Co. Pit 58-3 (Testing Laboratory Sample No. 83 A-10073)," (78 TI-510). R. W. Muethel

A sample of crushed stone coarse aggregate from the subject pit was submitted to the Research Laboratory's Materials Research Unit for petrographic analysis. The general petrographic composition of the material is included in the report, as are the specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

LISTING OF NEW MATERIALS PROJECTS
COMPLETED DURING THE YEAR

- 74 NM-416 - "Fel Pro" (Track Span) Railroad Crossing System
- 76 NM-501 - Onflex Expansion Joint, Structural Rubber Products Company
- 76 NM-509 - Stripe Out Traffic Line Remover
- 77 NM-542 - Galva-Fused Vinyl Chain Link Fence Fabric (Allied Tube and Conduit Corporation)
- 80 NM-618 - "Track Span" Railroad Crossing Material
- 82 NM-644 - Powder Coated Guardrail
- 82 NM-645 - TK 1077 Protective Coating for Structural Steel
- 82 NM-651 - Togotec 100 Paint System for Structural Steel
- 82 NM-654 - Epoxy Coated A-588 Steel
- 82 NM-655 - Life-Lite (Stimsonite 66) Reflectivity as a Pavement Marker
- 82 NM-656 - Hilti HVA Adhesive Anchor
- 82 NM-657 - Under-Kote and Poly-Kote Maintenance Coating for Steel
- 82 NM-658 - Tuff Skin Maintenance Coating for Steel
- 82 NM-659 - Re-Kote Maintenance Coating for Steel
- 82 NM-665 - Pre-Set Anchors
- 83 NM-675 - Perma-Zyme Soil Stabilization and Dust Control
- 83 NM-676 - Polypropylene Fiber for Concrete
- 83 NM-677 - SK 213 and SK 214, 3-M Epoxy Coatings for Light Standards
- 83 NM-679 - Kold-Seal Concrete Joint System

LISTING OF TECHNICAL INVESTIGATIONS
COMPLETED DURING THE YEAR

- 80 TI-678 - Study of Possible Infiltration of Sand Subbases into Overlying Open Graded Drainage Course
- 81 TI-727 - Benkelman Beam Testing of Shoulder and Pavement Recycling Projects
- 81 TI-775 - Vibration Study of International Bridge During Blasting for Power Canal
- 81 TI-782 - Folding Changeable Sign
- 82 TI-810 - EIA to TDI Converters for Computer Services Division
- 82 TI-811 - Vibration Monitoring During Pile Driving near Cadmus, Lenawee County
- 82 TI-843 - Comparison of Reflectivity of Old and New License Plates
- 82 TI-852 - Pavement Edge Marking Investigation in District 7
- 82 TI-867 - Measuring Zilwaukee Bridge Launching Girder
- 82 TI-871 - Noise Barrier Analysis I 75 at Wattles Creek Condominium
- 82 TI-875 - Air Quality Monitoring for SEMCOG at Corbutt Park in City of Ferndale
- 82 TI-878 - Analysis of Charcoal Collection Sampler with the Gas Chromatograph
- 82 TI-879 - Carbon Monoxide Analysis at South Haven Maintenance Garage
- 83 TI-881 - Fabricated Guard Rail Posts; Anderson Guard Rail Corp.
- 83 TI-882 - Calibration of Skidmore-Wilhelm Torque Tension Gages
- 83 TI-884 - Trichlorethane Testing in Bituminous Lab., Testing and Research Laboratory, Secondary Complex
- 83 TI-885 - Carbon Monoxide Analysis in Design Division, Green Room, Highway Building
- 83 TI-892 - Carbon Monoxide Testing at Kalamazoo Maintenance Garage
- 83 TI-893 - Analysis of Charcoal Tube Air Sampler

- 83 TI-896 - Investigation of Solvent Hood for Electronics Lab., Testing and Research Laboratory
- 83 TI-898 - Testing of Steel of Floor Beam Flanges, Bridge US 2 over Cut River
- 83 TI-900 - Profilometer Measurements for Chrysler Corp.
- 83 TI-901 - Strength Test of Bent Bar Tank Anchors
- 83 TI-909 - Investigation of Deflection of Repair Slabs US 23, South of I 75
- 83 TI-911 - Chloride and Hardness Analysis of Water Samples from Niles Garage area
- 83 TI-912 - Evaluation of a Michigan Pavement Condition Survey Method (Rigid Pavement and Overlays)
- 83 TI-914 - Investigation of Rocking of Repair Slabs, US 127 from US 12 to M 50
- 83 TI-918 - Vibration Monitoring on I '94 Concrete Pavement Recycling Project, Kalamazoo-Calhoun Counties
- 83 TI-926 - Alleged Vibration Damage to Houses in the Vicinity of I 75 and Livernois, City of Detroit
- 83 TI-928 - Investigation of Asphalt Softening I 94 at Stevensville Exit (E.B.)
- 83 TI-930 - Identify Deposits on Paint Coating, M 21 Fox Rd. Bridge near Port Huron
- 83 TI-935 - Vibration Complaint, 5112 Braden, Detroit (Mrs. A Hrabowecki)
- 83 TI-937 - Microwave Landing Systems for Bureau of Aeronautics
- 83 TI-938 - Ultra-Sonic Testing of Retainer Bolt (R01-56021) M 20 over Tittabawassee River in Midland
- 83 TI-940 - Noise Investigation along M 14 from the Bridge at Ridge Rd., West to the Bridge on N. Territorial Rd. (Plymouth Hills Mobile Court)
- 83 TI-941 - Chloride Contamination Investigation of Water Wells on Scott St. in Morley
- 83 TI-943 - Noise Investigation I 496 at Snow Rd. in Delta Township
- 83 TI-945 - Determination of Yield Strength of Structural Steel B01 of 43022-207116, US 10 over Baldwin Creek

- 83 TI-953 - Air Quality Analysis Technology Research Center, North of Ypsilanti
- 83 TI-956 - Analysis of a Trichloroethylene Sample Taken at a Field Bituminous Lab.
- 83 TI-957 - Vibration Complaint I 196 at 20th Ave. South of South Haven
- 83 TI-958 - Statistical Analysis of Continuous Acceptance of Portland Cement Concrete

LISTING OF ACTION PLANS
COMPLETED DURING THE YEAR

- 79 AP-25(A) - Air Quality M 24, Lake Orion, Northerly to Paint Creek
- 80 AP-34(A) - Air Quality Monitoring for Reconstruction of US 10 from Elizabeth Lake Rd. to I 75
- 83 AP-38(A) - Air Quality Monitoring I 94, Merriman and Middlebelt Interchanges

STATISTICAL ANALYSIS UNIT

Title

82 F-161 - Concrete Pavement Evaluation

Purpose

The purpose of this study is to compare newer construction projects since about 1965 with the performance of immediate post-war construction. Data must be obtained from tabulations of condition surveys. Specific variables such as joint spacing and joint seal will be examined.

Scope

Examination of Pavement performance for all post-1965 concrete construction.

Progress Past Year

Review of preliminary data suggests that joint performance varies considerably among projects and even between roadways of the same project.

Planned Program for Coming Year

Complete tabulation of remaining projects and make performance comparisons.

Salaries and Wages 1983: \$134

Title

77 G-231 - Pre-Icing of Bridge Decks

Purpose

The purpose of this study is to determine the magnitude of the bridge pre-icing problem. Accident histories for selected highway bridges and their approaching roadways will be examined and the various weather conditions noted. Variables such as relative humidity, air temperatures, precipitation history, etc., will be measured in order to certify hazardous conditions. Any quantitative relationships between these variables and accident frequency will be incorporated into an accident prediction model.

Scope

Ten-year accident histories including time of occurrence for at least 200 bridges will be tabulated together with weather data from the nearest weather station. Also tabulated are all statewide "Icy Bridge" accidents for 1973-1982.

Progress Past Year

All data have been collected and analyzed; report writing, graphics, etc., remain. Our findings indicate that the pre-frosting condition is either not frequent enough or strong enough to appreciably affect bridge accident occurrence. Rather precipitation, either prior or current, together with below freezing temperatures are strongly associated with relative increases in bridge accidents. Further, these conditions are especially critical in late fall when approach pavement is warm enough to keep from icing. Also of interest is the finding that accidents on bridges are much more numerous between 7 and 8 a.m. than any other hour of the day. Additional data have been obtained that identify all accidents coded to bridges (0.2 mile sections) under conditions of icy/snowy pavement surface. About 10 years of these data are now available and have been analyzed. From these data it appears that icy bridge accidents are proportional to the product of ADT and the square root of bridge length.

Planned Program for Coming Year

Completion of final report.

Salaries and Wages 1983: \$16,571

Title

78 G-239 - Comprehensive Analysis of Skid Resistance Data

Purpose

The Unit was asked to prepare a proposal on the examination of the Laboratory's records of bituminous surface skid resistance.

Scope

Fifteen years of friction test data for bituminous surfaces will be examined for correlations with design and construction variables.

Progress Past Year

None

Planned Program for Coming Year

Completion of proposal, and pending approval, tabulation of friction test and mix design variables.

Salaries and Wages 1983: \$0

Title

*80 G-249 - The Development of Acceptance Sampling Plans Assuming the Percentage of In-Place 22A Aggregate Within the Specification Limits

Purpose

The purpose of this project is to reduce sampling costs by changing the statistical approach (plan design) of the usual fraction defective procedure.

An example demonstrating usage of the manual for designing an in-place 22A aggregate inspection plan will be given.

Scope

Development of procedures for using sample information (sample averages and covariance) to estimate the percentage of material falling within specification limits.

Progress Past Year

Development of a theoretical basis for the new plans and first draft of final report.

Planned Program for Coming Year

Completion of final draft of procedures manual and final report.

Salaries and Wages 1983: \$17,896

MATERIALS RESEARCH UNIT

Title

57 B-39 - Use of Latex Modified Mortar and Concrete in the Restoration of Bridge Structures

Purpose

To monitor the preparation and application of latex modified mortar or concrete thin bonded overlays on selected deck repair projects and new two-course decks. The long-term performance of these overlays is to be evaluated by selected in-depth field inspections.

Scope

This project started by closely following latex mortar repair on one structure in 1957-58. Larger scale usage of latex overlays with District Maintenance forces was observed in 1969 to 1971, followed by contract repair projects in 1972 to date. General usage of latex concrete or low slump high density (LSHD) concrete on selected projects began in 1976 and as alternate systems in 1977. In 1978 a latex admixture produced by Arco Polymers (Dylex 1186) was used in the latex modified concrete overlay of 11 structures on one repair project. In 1979 and 1980 a third alternate latex, Thermoflex 8002, was used on three structures on I 496 in Lansing under one repair contract.

Progress Past Year

Data from the 1982 survey of 23 latex modified concrete deck overlays, ranging in age from 7 to 11 years, have been reduced and prepared for inclusion in a performance report. On the basis of a cursory examination of the data it appears that, in general, the overlays are performing quite well. Chloride content in the overlay increases with time, but other factors such as amount and number of salt applications apparently overshadow the time factor. Half-cell potential readings generally correlate with chloride content in the deck and normally the percentage of readings over -0.35 volt (corrosion is occurring) increase as the overlay ages. Other distress factors such as transverse and longitudinal cracking, map cracking, and delamination were noted on some decks, but in no case had they advanced to the degree that maintenance was needed.

Planned Program for Coming Year

A more comprehensive analysis of the available data will be made and a report is planned. Monitoring of the deck overlays will continue as time permits. Determination of depth of the delaminations, noted during the 1982 survey will be attempted by coring through the suspect

areas. Any new development in overlay materials and construction methods will be studied so as to possibly determine their effect on the overlay's performance.

Salaries and Wages 1983: \$1,848

Title

72 B-91 - Laboratory and Field Evaluation of Portland-Pozzolan Cement (Type 1P) in Concrete Pavement and Structures

Purpose

To determine the performance characteristics of portland-pozzolan cement concrete relative to our conventional concrete and recommend scopes of equal or superior usage for both pavements and structures.

Scope

One-third of a paving project on I 275 was utilized in 1974 to directly compare Type 1P cement with Type 1A. Sampling of the fresh and hardened concrete was done to evaluate strength and durability. In 1976 and 1977, structural grades of 1P-A cement concrete were evaluated against 1A control concrete in the bridges X01 and X03 of 82102 that carry M 14 over the C&O RR northwest of Plymouth. The portland- pozzolan cement was used in the eastbound structure (X03). Test specimens molded from fresh concrete samples were tested from both types of concrete. In 1977 and 1978, test cores to evaluate the hardened concrete were cut horizontally from the substructure units and vertically full-depth through the superstructure deck. These cores were tested to yield information on the concrete's compressive strength and consolidation characteristics. A performance inspection of the experimental portion of the I 275 paving project was made in 1978 and was included in the draft of the final report.

Progress Past Year

Reports on the I 275 paving project and the M 14 bridges were reviewed and revised.

Planned Program for Coming Year

Final type report for distribution which will close the project.

Salaries and Wages 1983: \$0

Title

72 B-92 - Experimental Bridge Deck Surfacing Methods

Purpose

To evaluate the initial construction phase and long-term performance of two types of new bridge deck construction; namely, a revibrated deck and two-stage construction using thin bonded overlays.

Scope

Three structures were closely followed in 1972 to evaluate construction phases of a revibrated deck, two-stage deck pour using 1-in. latex modified mortar, and a two-stage pour with 2-in. of a 7.5 sack concrete mix. Post-construction performance was to be evaluated by periodic testing and inspection. The revibration technique was not successful and the latex modified concrete overlay has become a standard system for two-course construction.

They were inspected and corrosion cell tests run late in 1975. The structures with the latex modified mortar overlay and with the concrete overlay were inspected, cored, and tested with a corrosion cell and delamination detector during 1977. Laboratory tests were run on selected cores to measure chloride penetration and shear bond.

Progress Past Year

Due to higher priority work, a final inspection and report on these three projects was not completed.

Planned Program for Coming Year

Make final inspections early in the year and include data with all previous information for final report on this project.

Salaries and Wages 1983: \$0

Title

75 B-93 - Low Slump High Density (LSHD) Concrete Bridge Deck Overlays

Purpose

Evaluation of low slump concrete as an alternate to the presently used latex concrete method of bridge deck overlay on selected field projects.

Scope

Determine the effectiveness of low slump high density overlays in rehabilitating spalled and chloride contaminated bridge decks. For this purpose two projects on I 96 were selected to monitor and evaluate this system. Long-term performance will be evaluated by periodic inspection

and testing. In 1977 the low slump high density overlays were used both for deck repair and on new two-course construction as an alternate to latex modified concrete. Additional structures were overlaid in 1978 with low slump high density concrete overlays. These included 11 decks under two repair contracts and eight new two-course structures on I 475 in Flint.

Progress Past Year

A comparison of 1976 and 1982 data on chloride content in the LSHD overlays shows that the increase from 1976 to 1982 ranges from 3/4 to 1-1/2 lb/cu yd at the 1-1/2-in. depth. The decks also exhibit an unusually large amount of very pronounced map cracking but to date there are no signs of delaminations in the surface. Map cracking was also found to be prevalent on all LSHD overlays (27 total) placed in 1977 and 1978. Seventeen decks were overlaid in 1982-83 using high density concrete containing a superplasticizer. These decks will be evaluated under a technical investigation project with an initial evaluation reported in Research Report No. R-1227.

Planned Program for Coming Year

Performance inspections, including Half-Cell potential readings, cores for chloride content determination, and delamination detection will continue.

Salaries and Wages 1983: \$1,359

Title

76 B-95 - Experimental 'Econcrete' Ramp Construction (Project F 64015-06526A), US 31 Near Shelby

Purpose

This study was initiated to evaluate the construction and performance of a composite concrete pavement using an econcrete mix in the lower half of the slab. This econcrete was to contain a cheaper sand-gravel blend and lower cement content to ensure at least half of the normal strength level. The performance of this composite or dual strength slab section was to be evaluated in a non-reinforced ramp carrying light commercial traffic.

Scope

In 1976, about 1,240 ft of Ramp A in the southwest quadrant of the Shelby Rd-US 31 interchange was constructed of a composite econcrete pavement. About 1,200 ft of Ramp A was constructed with 8 in. of grade 35P concrete. The econcrete mix contained 305 lb/cu yd of cement, a water-reducer, and a local 60-40 sand-gravel aggregate. The

composite econcrete pavement consisted of two layers each of 4-in. depth; the lower layer being econcrete and the upper layer being grade 35P concrete. The construction of the composite econcrete pavement was closely monitored. Fresh concrete specimens of both econcrete and grade 35P concrete were obtained and tested in the laboratory. Future inspections and testing were to include coring, measurements of joint openings, slab movement, profilometer, load-deflection and condition surveys of both the composite econcrete and the grade 35P concrete ramps.

Progress Past Year

No work was done on this project due to higher priority work assignments. Extensive longitudinal cracking and faulting was reported in the econcrete section.

Planned Program for Coming Year

A final survey is planned early in the year and a report is to be written to close the project.

Salaries and Wages 1983: \$0

Title

78 B-98 - Experimental Resurfacing of Chloride Contaminated Concrete Bridge Decks with Latex Modified Concrete

Purpose

This study is to assess the long-term performance of 1-1/2-in. latex concrete overlays on selected decks containing more than 4 lb/cu yd of chloride. The effect of the residual high chloride on possible continued corrosion of the top rebars and integrity of the overlay is to be assessed by corrosion cell tests, delamination surveys, selective coring, and visual surveys.

Scope

It was proposed that latex modified concrete be used to repair deck spalls and increase the cover over the top steel by at least 1-1/4-in. on five structures in the I 96-US 23 area east of Brighton. Four of the structures contain concrete having more than 4 lb/cu yd of chloride and the deck performance was to be compared with the fifth structure having an average of 1.6 lb/cu yd of chloride.

This study was initiated as a Category 2 project and Work Plan No. 64 was submitted and approved by the FHWA. Since the project was initiated, over 50 more structures have been approved for inclusion in the study. All of these structures were found to contain more than 4 lb/cu yd of chloride in portions of their decks.

Progress Past Year

Data from surveys conducted in 1981, 1982, and 1983 are currently being compiled and processed for inclusion in a progress report. The data concern chloride content in the overlay, half-cell potential readings, transverse and longitudinal cracking, map cracking, and delaminations in the overlay. The data collected to date indicate satisfactory performance of the overlays which range in age from two to five years.

Planned Program for Coming Year

A progress report covering three years evaluation is planned, and deck surveys will be continued.

Salaries and Wages 1983: \$6,881

Title

81 B-100 - Vibratory Consolidation Methods for Bridge Deck Concrete

Purpose

The purpose of this project was to demonstrate the improved bridge deck performance that could be obtained through uniform consolidation of the concrete. The importance of uniform consolidation was recently established by a research project on pozzolan concrete, where the test results indicated high variability of concrete consolidation. The report concluded that the random application of a probe vibrator was responsible and that isolated areas of high permeability were partially responsible for galvanic corrosion problems.

Scope

Voluntary field test arrangements with the Bidwell Co. were secured in an existing contract to construct a six-span bridge to carry relocated Francis Rd over I 69 about two miles northwest of Lansing. It was originally intended that the machine be used to provide consolidation for three or more of these spans during the 1981 construction season. Construction scheduling difficulties prevented the Bidwell Co. vibration machine from being used on the Francis/I 69 structure. Consequently, a new structure will be selected for demonstrating the consolidation capability of the machine. Subsequent to its construction, concrete cores will be used to evaluate the machine's effectiveness in comparison to cores from spans placed and finished by conventional means and equipment.

Progress Past Year

Higher priority work curtailed additional work on this project during 1983.

Planned Program for Coming Year

It will be attempted to include the demonstration as an experimental feature in a proposal for the construction of another bridge in the Lansing vicinity.

Salaries and Wages 1983: \$15

Title

71 C-13 - Study of Aggregate and Mix Requirements for Durable and Skid Resistant Bituminous Mixtures

Purpose

This project is to re-evaluate the 1963 ban on the use of crushed limestone and high-carbonate gravels in bituminous concrete wearing courses. Of particular concern was the effect of these restrictions on the pavement friction resistance of bituminous mixes and the economic factors involved in obtaining suitable aggregate in critical areas.

Scope

Both bituminous concrete and bituminous aggregate pavement friction data were re-examined on projects paved up to 1963 and also from 1963 to 1972. Primarily, bituminous concrete projects were examined under Phase 1, and bituminous aggregate jobs and initial wear track construction were done under Phase 2. Extensive wear track tests were to be run on selected coarse aggregates used in 4.12 and 4.11 mixes to define their relative wear characteristics on a continuing basis.

Progress Past Year

Wear Track Test Series No. 18 was completed in March of 1983. Included in Series No. 18 were four gravels and two carbonates to be tested for Aggregate Wear Index values. Series No. 19 was completed in May 1983. Included in Series No. 19 were crushed and rounded material from two additional gravel sources. The tests indicate about a 5.2 percent Aggregate Wear Index reduction for each 20 percent of uncrushed material. This information was incorporated in the development of an adjustment factor for an Aggregate Wear Index which was developed as a result of the wear track research program. Series No. 20 was completed in September 1983. Included in Series No. 20 were three samples of sandy limestone, one sample of blast furnace slag, one dolomite, and one blend of high-polishing limestone with sandy limestone. The blast furnace slag and sandy limestone aggregates recorded high resistance to polishing. A low polishing resistance was recorded by the dolomite. The blend of high-polishing limestone and sandy limestone recorded a proportional improve-

ment in frictional performance due to the sandy limestone. The Aggregate Wear Index, including a test method for computing values from petrographic sample data and established wear track factors, was prepared for review and implementation as a specification requirement for bituminous top course aggregates. A report including wear track data up through Series 19 was finished and submitted to the Engineering Operations Committee for review.

Planned Program for Coming Year

Wear Track Test Series No. 21, currently in progress includes two samples of blast furnace slag, one steel furnace slag, one siliceous dolomite, and one blend of high-polishing limestone with sandy limestone. The test series also includes wear track control gravel slabs scheduled for long-term polishing data. Series No. 22 is tentatively scheduled to include additional gravels for Aggregate Wear Index determination, blast furnace slag, and the long-term polishing test specimens with the wear track control gravel. A slide-audio presentation describing the development and implementation of the Aggregate Wear Index is to be prepared. A set of District maps, indicating state trunklines and aggregate sources with Aggregate Wear Index data, is also to be completed.

Salaries and Wages 1983: \$14,864

Title

77 C-18 - Evaluation of the Performance of Bituminous Wearing Course Containing Sandy Limestone

Purpose

Laboratory wear track data have indicated that sandy limestone from the Bayport Formation exhibits wear characteristics approximately equivalent to crushed gravel. This study was initiated to evaluate the field performance of an experimental pavement containing sandy limestone in the wearing course.

Scope

In July of 1977, approximately one mile of a resurfacing project on US 23 in Standish (Project Mb 06071-11004A) was paved with a bituminous wearing course specifying Bayport sandy limestone. Adjoining pavement sections contain crushed gravel. Annual trailer pavement friction tests are scheduled for a five-year period to monitor the long-term pavement friction performance of the test pavements. Included in the study are supplemental insoluble residue determinations and petrographic analyses of the test aggregates.

Progress Past Year

A final report on the study was prepared. The five-year pavement

friction numbers obtained on the test section containing sandy limestone were similar to friction numbers obtained on the test section containing a high carbonate crushed gravel, indicating that the aggregates were equivalent in resistance to traffic polishing.

Planned Program for Coming Year

The final report is to be submitted to Department management for review and distribution.

Salaries and Wages 1983: \$181

Title

57 F-46 - Continuously Reinforced Test Project, I 96, M 66 to Portland

Purpose

To study durability, construction efficiency, and costs as compared to standard jointed pavement practice.

Scope

The test pavement consists of approximately a four-mile long portion of I 96. It is composed of four distinct parts: continuously reinforced sections with deformed bar mat, continuously reinforced sections with welded wire mesh, a standard section with contraction joints spaced at 99 ft, and relief sections at the ends of the continuously reinforced sections.

Progress Past Year

A contract for a 7-in. unbonded concrete overlay on the mesh reinforced section was let, with construction to be completed in 1984. The overlay will be separated from the existing slab by placing a sand-asphalt layer about 1 in. thick. The overlay will be reinforced and have dowelled joints spaced at 41-ft maximum. The shoulders will be reinforced concrete with slab lengths the same as the mainline slabs.

Planned Program for Coming Year

Placing the overlay will be observed and test sections will be established to evaluate the overlay's performance. A contract may be set up for a bituminous overlay on the bar mat reinforced sections. Evaluation of the concrete overlay will be carried out under Research Project 83 F-162.

Salaries and Wages 1983: \$69

Title

61 F-64 - Continuously Reinforced Concrete Pavement No. 2, I 96,
Phillips Rd to Meridian Rd

Purpose

To determine end movements of anchorage and crack openings at transverse cracks.

Scope

The test pavement consists of approximately six miles of mesh reinforced pavement on the eastbound roadway and an equal length of bar mat reinforced pavement on the westbound roadway. The ends of the continuously reinforced sections are anchored with lugs.

Progress Past Year

Because of higher priority work assignments only a cursory survey of the pavement was made. It revealed that surface deteriorations on both roadways continue to develop to some extent. The dowelled repairs on the westbound roadway continue to retain their smoothness.

Planned Program for Coming Year

The pavement will be inspected at least once if time permits.

Salaries and Wages 1983: \$0

Title

61 F-64(1) - Continuously Reinforced Pavement (Seaway Freeway-
Fisher Freeway)

Purpose

Establish design considerations for use on continuously reinforced pavements in metropolitan freeway locations; handle problems during construction, to follow performance and to make recommendations for future construction.

Scope

This project includes all continuously reinforced pavements in the Detroit metropolitan area constructed with equipment riding on pavement forms. Various types of reinforcement were used and free ends were anchored or allowed to move at specially constructed WF joints. A variety of construction joints were used.

Progress Past Year

A contract for a bituminous overlay was let in September, 1983 covering the portion of I 75 from Goddard Rd to Grand Blvd omitting sections previously overlaid in 1980 and 1982. The contract also covers a portion of I 96 just north of I 75. The overlay consists of a latex modified bituminous mixture. Before placement, deteriorated areas were repaired with bituminous material. The portion of I 75 from Grand Blvd to Springwells was overlaid late this fall with completion of the project planned for 1984. Surface deteriorations are developing outside the areas scheduled for overlaying and are maintained with bituminous repair.

Planned Program for Coming Year

The pavement will be inspected periodically to check the performance of the overlays and the continuously reinforced concrete pavement sections.

Salaries and Wages 1983: \$0

Title

73 F-129 - Evaluation of Slipform Paving Methods for CRCP

Purpose

To determine if concrete is adequately consolidated, to determine accuracy of steel placement, and to evaluate the overall performance of slipformed CRCP.

Scope

All slipformed CRC pavements in metropolitan areas as well as the rural areas are included. Various consolidation methods, steel placement procedures, and reinforcement sizes have been used.

Progress Past Year

The result of the annual survey of the I 275 CRC pavement shows that the amount of longitudinal cracking continues to decrease. Routing and sealing of the cracks by maintenance personnel was completed this year. A recent check of the seal performance indicated that the seal is effective in keeping out moisture and sand from the cracks. No new punch-outs have occurred and the old ones are maintained with bituminous material. No significant change in the condition of the I 196 and US 31 CRC pavements was noted. The minor amount of longitudinal cracking present in these pavements appears to have stabilized.

Planned Program for Coming Year

Surveys will be conducted periodically to monitor the pavements'

performance with respect to continued increase in longitudinal cracking and formation of new punch-outs. The performance of sealed cracks will also be evaluated.

Salaries and Wages 1983: \$359

Title

74 F-141 - Development of Procedure for Epoxy Injection Repair of Bridge Deck Delamination (Kansas Method)

Purpose

To adapt the bridge deck epoxy injection concept used on bridges in Kansas to similarly affected Michigan bridges, and to evaluate the permanence of this type repair by long-term evaluation.

Scope

Select a test bridge in early stages of delamination to develop techniques of locating, drilling, injecting, and evaluating hollow areas. Evaluation of injection repair in combination with surface patching is also to be made. After completion of this first phase, select several other structures for delamination repair on a contract basis to be closely monitored by the Research Laboratory. A procedure and the expertise are to be developed to adapt the epoxy injection technique to the repair of concrete bridge deck delaminations. Injection on an annual basis of newly developing delaminations on a bridge deck are to be made to see if the deck can be returned to a condition of long-term functional stability, and annual inspection conducted of the bridge deck to determine if the procedure is achieving the desired results.

The first phase of this project was done as a joint voluntary venture between a contractor and the Department in 1975 to develop a procedure by which a bridge deck, in early stages of deterioration, could be restored to its original integrity without resorting to costly chipping and patching. The second phase of this project consisted of repairing the delaminations on four bridge decks that were in the initial stages of deterioration in the fall of 1976 and the summer and fall of 1977. The third phase of this project was carried out under contract in the summer of 1978, and the same bridges were surveyed and all newly developed delaminations injected. A portion of the repaired deck of one of the subject bridges was coated with a sealant to preclude the entrance of additional surface moisture and chlorides. Inspection in 1979 revealed that several new delaminations had developed, most of them occurring adjacent to areas successfully injected in 1978, others occurring as refractures in areas successfully injected in 1977. The performance was no better in the areas where the deck had been sealed; however, the performance of the sealants under traffic was less than ideal.

Progress Past Year

Higher priority work precluded additional work on this project.

Planned Program for Coming Year

A final inspection of the decks and a report is planned.

Salaries and Wages 1983: \$0

Title

75 F-143 - Evaluation of Various Types of Railroad Crossings

Purpose

To evaluate the performance of new crossing materials, to obtain information on construction procedures, and to determine the relative cost of each crossing type.

Scope

This is an open-ended Category 2 project; therefore, new crossing surface materials will be evaluated as requested by the Department's New Materials Committee.

Progress Past Year

Eight single crossings were added to the program in 1983. The yearly inspection revealed increased problems with the Gen-Trac crossings. There are now 12 crossings in need of repair, because the side pads wear into the ties which result in rocking pads. Three Park-co crossings were found to have broken panels in the wheel tracks. One crossing was replaced with the upgraded Park-co panels, and one other crossing is scheduled for replacement. A sixth progress report, Research Report No. R-1222 was issued.

Planned Program for Coming Year

The yearly inspections will be continued and special inspections will be made as requested. The installation of new materials will be observed when possible.

Salaries and Wages 1983: \$6,076

Title

78 F-154 - Evaluation of Promising Proprietary Bridge Deck Expansion Joint Devices

Purpose

The purpose of this project is to evaluate continuous single unit sealing element types of proprietary bridge expansion joint devices in the field. This is to include installation details and problems as well as long-term performance through a regular inspection program.

Scope

A progress report on field findings is to be made whenever at least three of any given type have been installed. Since difficulties sometimes do not appear for some time, field inspections will be made for several years.

Progress Past Year

A progress report has been written and is in the review stage. This report is an up-to-date discussion of the 11 types of expansion joint devices (450 installations) that have been installed in Michigan. The report presents the problems that have been encountered and the changes that have been incorporated to eliminate the problems.

Based on the results of field inspections, the standard details for the systems currently approved for use have been changed to incorporate an improved anchorage design.

Technical assistance has been provided to the Maintenance and Construction Divisions in regard to specialized problems encountered with some installations.

Planned Program for Coming Year

Inspection of the present installations will continue. Selected future installations will be monitored in the construction stage to determine if changes are required in the Standard Details. The evaluation of a new system is also scheduled.

Salaries and Wages 1983: \$6,229

Title

79 F-159 - Development of Tied Joints for Concrete Pavement Repairs

Purpose

To develop a tied joint detail for use with full-depth repairs between existing and new concrete that can be constructed rapidly without extensive hand labor.

Scope

Different types of tied joints will be tested in the Laboratory, and promising ones are planned for testing in the field by cooperative efforts with Maintenance or through repair contracts.

Progress Past Year

Construction of the experimental repairs was completed and a report detailing the construction procedures was written and is currently in review. Evaluation measurements of the repairs will be continued for several years. Data to date indicate no performance problems with dowelled joints, but failures have occurred of some of the tied joints constructed in 1982. A change in the inspection procedures was made and the 1983 tied repairs appear to be performing much better than those installed in 1982. As an extension of this project, several test sections were set up on contract repairs to evaluate the performance of dowelled repairs under varying traffic conditions. A specification covering the use of dowelled repairs was written and is to be included in the 1984 Standard Specifications.

Planned Program for Coming Year

Inspections and measurements of various performance factors concerning both experimental and contract repairs will be made semi-annually.

Salaries and Wages 1983: \$12,211

Title

83 F-162 - Performance Evaluation of Concrete Pavement Overlays

Purpose

To evaluate the performance of unbonded concrete overlays. Specifically, to determine if any particular construction problems are encountered, to determine the effectiveness of the debonding layer in controlling the occurrence of reflection cracking, and to determine the life-cycle cost of the overlays, based on long-term performance.

Scope

This project will consist of a 7.8 mile concrete overlay on US 23 from Ida Center Rd northerly to one mile north of M 50 in Monroe County (Project FRR 58034-20915A), and an 8.3 mile overlay on I 96 from east of M 66 easterly to the Grand River in Ionia County (Project IR 34044-20730A). Both overlays will be of the unbonded type by placing a bituminous-sand

mix layer (about 3/4 in. thick) on the existing concrete surface before overlaying with concrete. The overlays will both be 7 in. thick, reinforced and have dowelled joints at a maximum 41-ft spacing. Joints may not be placed within 3 ft of a joint or open transverse crack in the old pavement, this will require adjustment in slab length in some areas. In addition, the continuously reinforced portion of the I 96 project will be sawed into approximate 100-ft slabs prior to placement of the bituminous sand mix layer.

Underdrains will be installed at the slab-shoulder interface and reinforced concrete shoulders will be used on both projects. On the I 96 project the shoulder will be placed directly on the existing bituminous shoulder surface; whereas on the US 23 project, the existing seal coat will be removed and the shoulders reshaped prior to paving. Both overlay and shoulders will have neoprene sealed contraction joints while expansion joints will be sealed with hot-poured rubber-asphalt sealant.

Progress Past Year

A proposal detailing the evaluation procedure over a five-year period was prepared and approved.

Planned Program for Coming Year

Construction operations will be observed on both overlay projects and test sections established.

Salaries and Wages 1983: \$390

Title

47 G-36(35) - 1982 Supplemental Traffic Paint Performance Tests

Purpose

This project is the 1982 phase of annual, repetitive field performance and laboratory tests conducted on producers' samples to determine the best performing yet most economical paints to be purchased for roadway marking in 1984.

Scope

This is a cooperative project between the Research Laboratory, the Traffic and Safety Division, and the Maintenance Division. Personnel from the three groups cooperate in applying the test stripes while the Research Laboratory is responsible for the laboratory work, evaluation of test stripes, and reporting.

Progress Past Year

Field tests initiated in July 1982 for both alkyd type fast-dry paints and polyesters continued until June 1983 when a resurfacing contract started in the test area. A final report including recommendations as to eligibility of paints was made to the Paint Committee. No performance stripes were applied in 1983 due to the resurfacing of the test area.

Planned Program for Coming Year

A new series of performance tests will be initiated in July 1984 on the M 43 test area west of Lansing.

Salaries and Wages 1983: \$3,280

Title

57 G-87(1) - Revision of Existing Structural Steel Painting and Cleaning Specifications

Purpose

As per title, to revise and update existing painting and cleaning specifications for structural steel required in construction or maintenance contracts.

Scope

Work under this project entails revision of standard Department painting specifications and also writing specifications for experimental paint systems scheduled for field service tests. Technical background information is often obtained from work under Research Project 77 G-230. Revisions are generally cooperative with the using Division and are drawn-up to a Specification Unit format.

Progress Past Year

Formal training sessions for inspectors were held to inform them of reasons for specification provisions and to train them in the use of instruments necessary for enforcement. The course was also open to contractors.

Several specification revisions were made and a specification for complete shop painting of structural steel was written and implemented. This work was carried out under specification revisions.

Planned Program for Coming Year

Continue inspector training program.

Specification revisions will be made as necessary.

Salaries and Wages 1983: \$0

Title

62 G-116 - Extruded Neoprene Joint Sealer

Purpose

To evaluate the performance of neoprene seal installations in concrete pavement contraction and expansion joints.

Scope

Since neoprene has become a standard material for pavement joint seals, this project has been used to cover the study of special problems as they occur. Evaluations of new designs are included.

Progress Past Year

Two new sealer designs were evaluated in the laboratory and in the field. One design was approved and one design was rejected. The Department now has three approved designs.

Planned Program for Coming Year

New designs will be evaluated when submitted. Laboratory evaluations will be conducted on seals scheduled to be removed from a pavement which was sealed in 1967.

Salaries and Wages 1983: \$450

Title

62 G-122 - Use of Low-Alloy Steel in Highway End-Uses

Purpose

To determine merits and/or service life of subject steel, unpainted, in highway end-uses, mainly on bridge beams, guardrails, and light posts.

Scope

Since accelerated laboratory tests are unsuitable, we used field service tests to determine performance of unpainted subject steel in bridge girders and beam guardrail. The oldest bridge and beam guardrails date from 1964. In cooperative tests with the producer, exposed panels on the oldest bridge were removed periodically over an eight-year period to determine weight loss of metal through corrosion. Physical measurements of thickness loss of steel are made at a few other test sites. Loss of girder metal was shown to be increased under leaking deck joints, with those localized areas now requiring shop and field painting in new construction, per our specifications.

The cooperative panel weight loss tests conducted on the M 102 structure over the Lodge freeway, completed in May 1974, were finally reported by the producer early in 1977. The tests appear to have been conducted on an aggressive area since the losses were higher than expected for the eight-year long tests. Because of the abnormality, the tests were continued with Phase 2 panels. Since the producer did not submit the new test panels until mid-December 1976, all were exposed on the Detroit Armory roof on December 17, 1976.

On June 29, 1977, two-thirds of the above panels were removed from the Armory roof and installed over the Lodge freeway. Half were installed on the eastbound service structure over northbound traffic and half were installed on the westbound service structure over southbound traffic.

The first set of panels were removed in July 1979 and shipped to the producer's laboratories for corrosion measurements. Some of the panels from the initial eight-year tests had been cleaned, and then coated by the producer. These showed failure after 2-1/2 years outdoor exposure, probably because of insufficient film thickness.

The second set of panels were removed from the Armory roof and the structure over the Lodge freeway in September 1981. These were shipped to the producer after visual examination in the laboratory. It should be noted that another research study (78 G-241) is being conducted to assess actual corrosion in areas of high salt usage and atmospheric contaminants for both A588 and A36 steel structures.

Progress Past Year

None. No activity was scheduled.

Planned Program for Coming Year

The third set of test panels are planned to be removed after eight years in 1985.

Salaries and Wages 1983: \$0

Title

67 G-157 - Evaluation of Bridge Deck Surfacing for the Orthotropic Bridge Carrying Creyts Rd Over I 496

Purpose

This bridge was erected on an experimental basis to determine whether the orthotropic design and epoxy wearing surface on the steel plate deck were practical in this climate.

Scope

Two different epoxy mortars were selected for use on the two spans of the Creyts Rd structure. The field application was closely followed in 1979 and annual inspections are made to determine long-term performance of the surface.

Epoxy mortar surfacing was applied in 1969 to a minimum thickness of 5/8 in.; Guardkote 250 was applied to the south half of the bridge, and Epon 815-Versamid 140 to the north half. Subsequent inspections revealed several types of deterioration; shrinkage craze cracking was very distinct in the GK-250 and less prominent in the E815-V140, both mortars developed tensile fatigue cracks in negative moment areas of the deck, and changing features each year suggested significant traffic abrasion. The annual inspection of 1975 found spots where the GK-250 mortar had spalled off and left the steel deck exposed. At these areas, it was discovered that the thickness of the mortar was 1/8 in. or less; traffic abrasion had removed approximately 1/8 in. of mortar per year. The rate of abrasion in the E815-V140 appeared to be less. In 1978, several bare areas in the Guardkote 250 mortar surfacing had enlarged in the south span. The north span epoxy mortar, though sustaining an undetermined amount of traffic abrasion, remained essentially intact.

Arrangements were made with domestic producers in 1980 to apply a Mobilplast system, used very successfully in Europe, as a wearing course. The original experimental epoxy wearing surface was removed and a 2-in. Mobilplast protection system applied.

Progress Past Year

A fourth electrical resistance survey and an inspection were made. This was done under a technical investigation of Mobilplast used as an overlay.

A report will be written and the project closed.

Salaries and Wages 1983: \$0

Title

71 G-180 - Effects of Deicing Salts on the Chloride Levels in Waters and Soil Adjacent to Roadways

Purpose

To study the effects of deicing salts on the chloride levels in water and soil adjacent to roadways, and to recommend remedial measures if environmental or health hazards are found to exist.

Scope

Long-term monitoring of chloride levels in water and soil adjacent to roadways both during and after the winter season by water sampling at selected groundwater wells and surface water sites. Salt usage and precipitation data are to be included for possible correlation. Additional test sites may be added as the study progresses.

Progress Past Year

Monthly water samples were obtained from 30 groundwater monitor wells located at four test sites along state trunklines. Additional water samples from selected streams and roadside ponds were also obtained monthly. A total of 525 samples were collected and tested for chloride content in 1983. Roadside soil samples were obtained at the monitor well locations in October of 1983 for late-year chloride content determination. Groundwater chlorides in 1983 showed no overall increase from those measured in 1982.

Planned Program for Coming Year

A continuation of the monthly monitoring of the groundwater wells and surface water sources is scheduled. Sampling of soil at the monitor well locations is scheduled for March or April of 1984 to measure soil chlorides at the time of maximum accumulation of deicing chlorides. The soil chloride data will be included in a project report.

Salaries and Wages 1983: \$7,985

Title

72 G-188 - Experimental Preformed Waterproofing Membranes for Concrete Bridge Decks

Purpose

To monitor and evaluate the application of three different sheet membranes applied to five widened and repaired structures prior to bituminous surfacing. Post-construction testing and long-term evaluation was to include visual inspection, resistance tests, and selected coring.

Scope

The initial work plan (No. 19) covered the use of three sheet membranes on five deck widening jobs on I 75 near Flint in the fall of 1973. A number of other membrane waterproofing jobs done subsequent to the 1973 projects have been added to the study. The long-term performance of these membrane jobs was to be evaluated by periodic inspections and selected testing.

Progress Past Year

Resistance tests were continued on deck waterproofing systems on five structures in the Lansing area. These include reinforced sheet systems and hot applied mixes with synthetic fibers. This was done under a technical investigation on related membrane systems.

Planned Program for Coming Year

It is planned to schedule final inspections on the initial 1973 projects on I 75 and selected membrane projects done since then. Results of these inspections and tests are to be assembled into a report for distribution late in the year or early 1985.

Salaries and Wages 1983: \$0

Title

73 G-197 - Investigation of Structural T's, Galvanized in Sections, in a Truss-Type Pedestrian Bridge (Work Plan No. 22)

Purpose

To evaluate performance and durability of galvanized open-section members for use in pedestrian bridge structures. The test structure is P01 of 52042 over US 41 southeast of Marquette, completed in 1972. The long-term corrosion protection of the galvanized coating was to be evaluated through periodic inspections.

Scope

The project is a Category 2 experiment carried out in cooperation with the FHWA as per MDOT Work Plan No. 22, which was developed by the Department. After construction of the test structure, the project was transferred to the Research Laboratory for follow-up surveys and reporting. The initial survey was covered by the Research Laboratory in the First Progress Report No. R-896 issued January 1974. The report lists several contemporary pedestrian bridges for comparison of subject bridge's main features.

Progress Past Year

None. No activity was scheduled.

Planned Program for Coming Year

An inspection trip is scheduled for 1984. It should be noted that due to other high priority projects, this trip may be delayed.

Salaries and Wages 1983: \$0

Title

74 G-205 - Pre-Engineering for Bridge Deck Rehabilitation

Purpose

This continuing project is to document and follow specific sampling, testing, and recommendations for particular deck repair projects programmed for major repair or widening contracts. This is to include jobs using thin bonded overlays or deck waterproofing systems.

Scope

The initial scope of this project was to cover data from special cores and corrosion cell tests on 32 Interstate structures scheduled for thin bonded overlays in 1975. Proposed limits on chloride content of the deck concrete and evaluation procedures of the FHWA initiated in 1974 prompted this open-ended study. Subsequent deck repair projects were added as they were programmed by the Design Division for repair contracts.

Progress Past Year

A total of 41 cores from four structures were tested for compressive strength and general condition prior to redesign. Standard rotohammer samples from 79 structures were processed by the Testing Laboratory prior to letting deck repair contracts.

Planned Program for Coming Year

Special cores for bridge deck overlay projects or for major reconstruction work will be processed as required.

Salaries and Wages 1983: \$52

Title

75 G-217 - Maintenance of Neoprene Sealed Concrete Pavements

Purpose

To develop a maintenance procedure for concrete pavements sealed with neoprene seals.

Scope

The project consists of maintaining a several-mile long section on I 69 in Calhoun County by utilizing new materials, methods, and equipment. It is a continuing project where new developments in concrete pavement maintenance can be applied and evaluated.

Progress Past Year

The test section was inspected to determine the present condition of the repairs and the extent of any new problems.

A joint condition survey was conducted on the remaining portion of I 69 in Calhoun and Branch Counties.

Planned Program for Coming Year

Spall repair utilizing newly developed materials will be conducted in the test section to evaluate the materials as possible alternates to the single material now being used.

Salaries and Wages 1983: \$1,340

Title

77 G-224 - Evaluation of Servicized Flex-Lok Filler for Pressure Relief Joints

Purpose

To evaluate the effectiveness of the subject material in performing the function of sealing pressure relief joints in concrete pavement against intrusion of water and incompressible materials.

Scope

Servicized Flex-Lok urethane foam filler was specified for pressure relief joints on construction Project F 29011-12241A, etc., which covers 50.9 miles of US 27 in Gratiot, Isabella, and Clare Counties. The installation and performance are to be monitored biannually for performance.

Progress Past Year

The final report was updated and is in the review stage.

Planned Program for Coming Year

The final report will be published.

Salaries and Wages 1983: \$0

Title

77 G-227 - A Research Study to Monitor the Deicing Chemical Pollution Prevention System of the MDOT Maintenance Garage at Reed City

Purpose

To monitor the effectiveness of deicing chemical containment procedures at the new maintenance facility at Reed City.

Scope

Containment of deicing chemicals at the location is to be monitored by continued sampling from groundwater wells placed at selected sites down-gradient from a brine retention lagoon, sand-salt storage pile, and salt storage shed. A supplemental study of salt leaching from winter maintenance sand-salt piles, bituminous-coated and uncoated, is included in this investigation. Periodic sampling of leachate from selected sand piles is planned.

Progress Past Year

A final report on the study was drafted to summarize the results of the five-year monitoring program. Final samples from the monitor wells and surface sites were obtained in February of 1983. Monitoring of the location has been assumed by the Maintenance Division.

Planned Program for Coming Year

Finalize report for distribution and close the project.

Salaries and Wages 1983: \$127

Title

77 G-230 - Development of Non-Proprietary Specifications for Inorganic Zinc-Rich Coating Systems

Purpose

The purpose of this study is to develop a workable specification for inorganic zinc-rich coatings which will assure us of quality products, ease of application, and long service life.

Scope

In this study, we plan to establish specifications for inorganic zinc-rich coating systems. This will involve determining applicable procedures for both performance and acceptance testing.

Progress Past Year

The fifth series of tests were started and will be completed in June 1984. Writing of a progress report continues. Special provisions were revised and issued for both the cleaning and painting of existing steel structures and for the shop coating of new steel beams.

Planned Program for Coming Year

The qualified product list will be updated based on results from the 1983 tests.

A sixth series of tests will be started.

Work will continue on a progress report.

Salaries and Wages 1983: \$12,901

Title

78 G-234 - Construction and Testing of an Instrument to Measure the Night Visibility of Traffic Paints

Purpose

To develop an instrument to measure the night visibility of traffic paints. Ideally, this will eliminate the subjective aspect of rating the field performance of traffic paints for subsequent purchases.

Scope

In this study we would develop a photometric method of evaluating both longitudinal and transverse traffic stripes. We would also compare our instrument data with our present evaluation program to ensure meaningful data, and an accurate correlation of results.

Progress Past Year

Progress has been much slower than expected due to technical problems in the data transfer unit of our latest model. We have attempted to measure stripes in other states with only limited success. Another factor that contributed to little progress was the cancelling of paint test stripes for 1983.

Planned Program for Coming Year

The instrument will continue to be used on our field performance stripes and its reliability improved.

Salaries and Wages 1983: \$4,934

Title

78 G-242 - Determination of Allowable Movement Ratings for Various Proprietary Bridge Deck Expansion Joint Devices at Various Skew Angles

Purpose

The purpose of this project is to determine the movement capabilities of proprietary bridge joint devices when installed at high skew angles so that they can be specified for use under conditions where the Department has been using the steel sliding plate design.

Scope

Four-foot sections of proprietary bridge expansion joint devices of the continuous sealing element type will be cycled in the laboratory to determine their limitations for movement in skew angles up to 60 degrees.

Progress Past Year

Eleven new or revised expansion devices were tested to determine their movement limitations. The results of the testing were transmitted to the Design Division for incorporation into their standards.

A second report covering the newly tested devices was prepared and is in the review stage.

Planned Program for Coming Year

A third testing phase will be scheduled if a sufficient number of devices are received for evaluation.

The second report will be finalized for distribution.

Salaries and Wages 1983: \$1,828

Title

79 G-245 - Procedures for Contract Maintenance of Neoprene Sealed Pavements

Purpose

To evaluate the developed procedures, materials, and specifications for use in contract maintenance of neoprene sealed pavements, and to determine the performance of liquid sealant in oversized joints spaced 71 ft apart.

Scope

A 12-mile section of I 75 between M 61 and Maple Ridge Rd in Arenac County has been selected for the planned work. On the basis of a recent survey, 1,435 joints require spall repair, 61 joints need resealing, and 27 crack repairs are needed.

Progress Past Year

Because of funding problems, the contract was postponed several times. Therefore, it was necessary to resurvey the project and adjust work quantities as needed. Specifications were also revised to reflect new developments in procedures and materials.

The FHWA agreed to participate in the project funding provided that all the neoprene seals were removed and the joints resealed. The proposal was revised to include 47,000 lineal feet of seal removal and replacement.

A contract was let in July 1983 and it is estimated that the work will be completed in mid 1984.

Research Laboratory personnel were at the project site to provide technical assistance to the contractor and Project Engineer and to determine if the specifications were adequate for the type of work being performed.

A second project site was surveyed and a job proposal was set up for a letting.

Planned Program for Coming Year

The work that has been completed on the first project will be evaluated after the freeze-thaw period.

The second project is scheduled to be let in March.

Research Laboratory personnel will be at both projects to provide technical assistance and to evaluate the work procedures.

A construction report will be drafted after the completion of the two projects.

Salaries and Wages 1983: \$10,411

Title

79 G-246 - Field Evaluation of Plural Component Pavement Marking Materials

Purpose

To establish cost-benefit data for the more durable plural component epoxy and polyester pavement marking materials compared to standard alkyd materials now used.

Scope

Select high traffic areas for contract application of significant quantities of epoxy and polyester pavement marking materials. Make field in-

spections and ultimately assess the relative cost effectiveness of these materials on both portland cement and bituminous concrete surfaces. The tests were to be evaluated for a three year period.

Two areas in Grand Rapids were selected by the Traffic and Safety Division; 28th St and US 131. Approximately 110,000 lin ft of markings were applied in August 1980.

Progress Past Year

Cursory inspections were made of test installations in the Grand Rapids area on 28th St and US 131. Much of the polyester striping on US 131 concrete was redone using regular fast dry traffic paint.

Planned Program for Coming Year

Conduct final inspections and reflectivity tests for final report to complete the project.

Salaries and Wages 1983: \$87

Title

83 G-260 - Evaluation of Silane Treated Glass Beads in Polyester Pavement Marking Paint

Purpose

To evaluate the effectiveness of Potters Industries, Inc. CP-01 silane bead treatment in maintaining better night visibility of polyester pavement marking paint.

Scope

Silane treated beads were specified on construction project FUG 84900-2077A, etc. which covers various urban areas in Districts 4 and 5. Adjacent contracts in Districts 6 and 8 using non-silane treated beads will be used for comparison.

Progress Past Year

Construction was completed in July and August 1983. Retroreflectivity measurements were made in areas of similar traffic densities for both silane treated beads and controls.

Planned Program for Coming Year

Retroreflectivity measurements will be made at three-month intervals.

Salaries and Wages 1983: \$2,605

PHOTOMETRY AND SPECTROCHEMISTRY UNIT

Title

71 G-182 - Investigation of Air Quality Test Equipment and Procedures

Purpose

Assemble equipment and develop procedures for acquiring air quality information as required in preparing environmental impact statements.

Scope

Review State and Federal air quality regulations and determine their applicability to transportation projects. Review the literature on and performance of commercially available instrumentation and purchase measuring equipment. Review the literature, review the experiences of other agencies and develop procedures for measuring air quality. Develop a data bank of meteorological and air quality data.

Progress Past Year

Federal and State air quality regulations were reviewed and a file maintained of material relevant to transportation. Information obtained from manufacturers and users was collected to keep current on instrumentation available to monitor air quality. Two mobile air monitoring laboratories operated full time in the field. Data banks for air quality data and meteorological data were expanded. Air quality data were supplied to the Bureau of Transportation Planning, and the Department of Natural Resources. A rough draft of the report was revised and edited.

Planned Program for Coming Year

Conduct air quality monitoring with the mobile units under other projects. Provide air quality data to the Bureau of Transportation Planning, and to the Department of Natural Resources. Maintain current information on instrumentation and methods available to monitor air quality. Keep current on information in State and Federal air quality regulations relating to transportation. Complete preparation of a report:

Salaries and Wages 1983: \$3,542

Title

73 G-192 - Evaluation of Glare Sources

Purpose

To provide data which can serve as a basis for legislation controlling glare sources.

Scope

Measure sources of glare as designated by citizen complaints and visual evaluation by Department personnel. Determine driver's visual task and determine luminance and luminance contrast necessary to perform the task. Develop criteria for specifying visual performance. Evaluate luminance of acceptable light sources. Propose basis for legislative control.

Progress Past Year

No complaints were received last year.

Planned Program for Coming Year

1) Negotiate with off right-of-way owners of glare sources for which complaints have been received.

2) Study drivers' reactions to glare sources by measuring vehicle performance of motorists on standardized visual tasks with standardized glare sources.

Salaries and Wages 1983: \$0

Title

73 G-196 - Experimental Tower Interchange Lighting (Federal Work Plans No. 21 and No. 31)

Purpose.

1) To determine maintenance factors for tower lighting; 2) to determine pavement illumination produced by tower lighting compared with design levels of pavement illumination, and with pavement illumination produced by conventional lighting; 3) to determine disability veiling glare of tower interchange lighting (roadway lighting mounted in tower clusters at heights above 50 ft) compared with conventional low-mounted interchange lighting; 4) to determine the need for underbridge lighting at interchanges; 5) to determine the aesthetic value of tower lighting; and, 6) to determine the value of tower lighting during inclement weather--fog, haze, sleet, snow, and rain.

Scope

Work Plan No. 31 of this project will evaluate the parameters of pavement illumination (illuminance) and brightness (luminance), and system disability glare in six interchanges in the Grand Rapids area before installation of tower lighting and after installation of tower lighting at six-month intervals up to 2-1/2 years. Work Plan No. 21 will investigate

pavement illuminance and system glare for two interchanges in the Detroit metropolitan area after tower lighting installation. The project will provide design criteria to the Utilities Design Section, and to the FHWA.

Progress Past Year

Little progress was made last year because of higher priority work. Revisions were made in research outline to accomodate different instrumentation.

Planned Program for Coming Year

- 1) Calibrate and test mobile instrumentation,
- 2) Record illuminance levels at the interchanges,
- 3) Record disability glare levels at the interchanges,
- 4) Complete progress report on evaluation of interchange lighting.

Salaries and Wages 1983: \$70

Title

73 G-200 - Experimental Settling and Oil Skimming Chamber

Purpose

To determine the quality with respect to sediment and oily material of water being discharged into Lake St. Clair from the storm sewer system serving I 696 between I 75 and I 94 in Oakland and Macomb Counties. Also, to determine the effectiveness of the settling and oil skimming chamber.

Scope

Records will be compiled of operating costs for the skimmer and of the volume of sediment removed when the chamber needs to be cleaned. These data will be assembled into an annual report for the Federal Highway Administration.

Progress Past Year

Records were compiled of operating costs, and sediment and petroleum spill cleanout activity. A letter report was sent to the Federal Highway Administration.

Planned Program for Coming Year

Compile records of operating costs and sediment collected. Report this information to FHWA.

Salaries and Wages 1983: \$89

Title

77 G-229 - Further Research on Reflectorized Flagger's Vests

Purpose

To provide answers to a request dated November 1, 1977, from R. E. Conner, Chief Traffic Control Systems Division, Office of Traffic Operations, FHWA, for further research into the areas of vest color and of a fully reflectorized vest. Investigation of the reflectorized STOP sign held by the flagger was also undertaken because the STOP sign visibility affected the vest visibility.

Scope

An industry-wide search is to be conducted in order to develop a yellow-orange reflectorized material which is similar to the current daytime fluorescent color or 'Blaze Orange' of traffic regulator vests.

Nighttime and daytime observations in both rural and urban lighting environments will be made of reflectorized vest patterns previously found to be effective and of a fully reflectorized vest with observers driving a vehicle. A STOP sign with much greater luminance than standard signs was evaluated.

Progress Past Year

A final draft report incorporating recommendations from all flagger vest studies was completed.

Planned Program for Coming Year

Complete three-page summary of report.

Salaries and Wages 1983: \$2,425

Title

78 G-235 - Air Quality Measurements for Movable Asphalt Plants for Recycling Paving Asphalt

Purpose

To determine if asphalt plants processing recycled asphalt paving can comply with Federal and Michigan particulate emission standards.

Scope

Several asphalt plant stacks will be monitored during successive construction seasons.

Progress Past Year

No requests to monitor asphalt plants were received and no further work was done on the project.

Planned Program for Coming Year

None.

Salaries and Wages 1983: \$620

SOILS AND BITUMINOUS SYSTEMS RESEARCH UNIT

Title

79 C-19 - Evaluation of Sprinkle Treatment for Improving Skid Resistance of Asphalt Surfaces

Purpose

The purpose of the experimental overlay construction is to evaluate the sprinkle treatment method of achieving adequate friction values on wearing surfaces in accordance with FHWA Demonstration Project No. 50. Sprinkle treatment is the relatively light application of precoated, high quality aggregate particles on the surface of the wearing course mat following laydown, and partial embedment during the compaction operation. This technique minimizes the use of high quality aggregate in areas where they are scarce or expensive. A savings in energy would also be realized from the reduction of long aggregate hauls.

Scope

An experimental test section, approximately five miles in length, was constructed using the sprinkle treatment method and its performance, measured by pavement friction levels, will be studied over a three-year period. The research project is to be completed in 1982.

Progress Past Year

Final friction measurements were made which show the sprinkle treatment to be more skid resistant than the control section.

A final report summarizing findings and recommendations was prepared (Research Report R-1223) in May 1983.

Planned Program for Coming Year

Project Completed.

Salaries and Wages 1983: \$1,927

Title

74 D-29 - Sulfur in Bituminous Mixtures

Purpose

The purpose of this experimental construction project is to evaluate the feasibility of using sulfur-asphalt mixtures for resurfacing highways.

Scope

Test sections were constructed as part of a 1976 resurfacing contract on M 18 in Gladwin County (Mb 26011-11032A). A process of blending hot liquid elemental sulfur with hot asphalt cement to form a sulfurasphalt (S/A) binder, developed by Gulf Oil Canada Ltd., was used to prepare paving mixtures for this project. Two different sulfur-to-asphalt ratios and two sulfur-asphalt binder levels were compared with adjacent sections of the same road which were paved with a conventional mixture.

Progress Past Year

Preparation of a final report on this project was delayed due to higher priority work.

Planned Program for Coming Year

Project will be completed with a final report.

Salaries and Wages 1983: \$4,260

Title

75 D-32 - Reclaimed Rubber-Asphalt

Purpose

To evaluate the benefits of reclaimed ground rubber when included in asphalt paving mixtures, with emphasis on the reduction of reflective cracking on resurfaced projects.

Scope

The study involves laboratory testing of engineering properties for several mixtures and a field test road incorporating different thicknesses and mix proportions. A five-year evaluation period is called for in the research proposal.

Progress Past Year

Final rut depths and friction measurements were made. Cores were obtained and tested for resilient modulus at two temperatures and three loading times.

Planned Program for Coming Year

Final report to be prepared.

Salaries and Wages 1983: \$2,000

Title

78 D-36 - Comparison of Cracked and Uncracked Flexible Pavements
in Michigan

Purpose

The purpose of this study is to analyze flexible pavements representing both unusually good and unusually poor performance in order to identify factors causing good and poor performance.

Scope

A total of 16 one-mile pavement sections, representing pavements throughout the upper and lower peninsula, are to be evaluated in pairs such that the design, specifications, traffic loading, age, and foundation conditions are the same--the only difference being the level of performance. Structural capacity of the pavements will be determined on the basis of Benkelman beam surface deflection data, the modulus of resiliency of the subgrade, and the drainage capacity of the pavement's foundation. The bituminous concrete will be tested to evaluate its fatigue, thermal cracking susceptibility, and resilient modulus characteristics. In addition, standard bituminous analyses will be conducted on all bituminous concrete samples collected. This project is being conducted as a joint study involving the Bituminous Technical Services Unit of the Testing Laboratory.

Rough draft reports dealing with engineering properties of the bituminous concrete, analysis of bituminous concrete aggregates, and structural foundation analysis have been reviewed, analyzed, appropriate data extracted for statistical analysis, and a statistical study completed preparatory to writing a final report.

Progress Past Year

Due to the priority of other work the final report on this project could not be prepared.

Planned Program for Coming Year

Effort will be made to assemble a final report and terminate this project.

Salaries and Wages 1983: \$548

Title

79 D-37 - Evaluation of Sulfur-Extended Asphalt for Bituminous Re-
surfacing Mixtures

Purpose

The purpose of this experimental construction project is to evaluate the feasibility of using sulfur-asphalt mixtures for resurfacing flexible highway pavements using softer asphalt.

Scope

Test sections were constructed as part of a 1979 resurfacing contract on M 99 in Calhoun County (Mb 13091-15321). The process of blending hot liquid elemental sulfur with hot asphalt cement to form a sulfur-asphalt (S/A) binder as developed by Gulf Oil Canada Ltd., was used to prepare paving mixtures for this project. Two different sulfur-to-asphalt ratios and two sulfur-asphalt surfacing thicknesses were compared with adjacent sections of the same road paved with a conventional mixture.

Performance evaluations will be made for several years and will include condition surveys (crack mapping), rut depth measurements, pavement friction values, and Benkelman beam deflection measurements. Prior to construction, mix proportions were determined in the Testing Laboratory. During construction, testing for compaction, asphalt content, temperature, and other investigative tests, were performed.

Laboratory tests are being performed on both the sulfur-extended asphalt (SEA) mixtures and conventional mixtures to compare fatigue life and low temperature cracking potential. Benkelman beam deflections were measured on the roadway before and after resurfacing so that field performance can be compared with performance as predicted by initial deflections and laboratory measured resilient modulus values. The comparison will be made through use of the CHEV 5L computer program for flexible pavement analysis. A five-year evaluation period is called for in the research project proposal. A progress report describing construction of this project was published (Research Report R-1129).

Progress Past Year

No field observations were scheduled for 1983. All laboratory testing is current.

Planned Program for Coming Year

Final field measurements will be made, the results analysed and a summary report prepared to terminate the study.

Salaries and Wages 1983: \$628

Title

79 D-38 - Evaluation of Plasticized Sulfur as a Binder in Flexible Pavement Resurfacing Mixtures

Purpose

The purpose of the study is to evaluate flexible pavement resurfacing mixtures composed of mineral aggregate combined with Sulphlex, a plasticized sulfur binder.

Scope

An experimental section of pavement overlay using the Sulphlex mixture was constructed. Laboratory mix designs were made to establish job control quantities. Laboratory tests were performed to measure resilient modulus and low temperature cracking potential, and performance is being monitored.

Performances of the test and control sections were monitored via friction and rut depth measurements, a crack survey and photographs. Two sets of cores were obtained, one for the FHWA and the others were tested for resilient modulus in the Research Laboratory. A progress report was submitted to the FHWA to comply with our Task Order agreement.

Progress Past Year

Performance of the test and control sections continued to be monitored via friction and rut depth measurements, a crack survey and photographs. Additional cores were obtained for the FHWA. Because of rapid disintegration of the Sulphlex, the test section has been programmed for removal and resurfacing in 1984.

Planned Program for Coming Year

A final report is to be submitted to the FHWA.

Salaries and Wages 1983: \$611

Title

80 D-39 - Feasibility of Paving Over Sylvax Patches

Purpose

To evaluate the feasibility of applying bituminous resurfacing over existing Sylvax patches.

Scope

A highway which was resurfaced in 1980 which had been patched with Sylvax is involved. Existing patch locations were logged and the condition of the patches noted. Performance evaluations will be made on a periodic basis after resurfacing. Cores will be obtained at selected patches after six months service to measure bonding and stability. The research project is scheduled for completion in 1983.

Paving over Sylvax patches was inspected, photographed, and coring was attempted. There were no signs of distress in the pavement over the patches but cores could not be obtained with the patch material attached. The Bituminous Technical Services Unit has developed a patching mix for the Department which is equivalent to Sylvax and can be obtained at a much lower cost. Trial of a small quantity (100 to 200 tons) of the Department's mix is planned.

Progress Past Year

A memorandum report summarizing project findings was submitted to complete the project.

Planned Program for Coming Year

Project has been completed.

Salaries and Wages 1983: \$0

Title

81 D-41 - Foamed Asphalt Sand Stabilization

Purpose

The purpose of this project is to develop experience and test data on stabilization of sand with foamed asphalt using mixed-in-place construction methods.

Scope

The existing shoulders of a 5.6 mile section of freeway in Muskegon County (Control Section FUR 71151-16044) consist of a seal coat placed on a sandy granular base course. The existing seal coat surface was pulverized, mixed with the sand base and stabilized to a depth of approximately 5 in. using foamed asphalt. This operation required a single pass stabilizer modified to permit the addition of water to the hot asphalt cement prior to the spray bar, in the mixing chamber. Water was added to the mixing chamber at a rate between 1 and 3 percent of the liquid bitumen volume. Total bitumen required was between 3 and 5 percent of the sand volume being stabilized. Modification of existing equipment was minimal for the operation.

Progress Past Year

Indirect tensile tests were completed on molded samples to determine rate of curing and ultimate strength of granular material stabilized with the foamed asphalt process, but the summary report was not completed.

Planned Program for Coming Year

Prepare a final report to complete the project.

Salaries and Wages 1983: \$83

Title

82 D-42 - The Effects of Coarse Aggregate on the Durability of Bituminous Concrete Mixtures

Purpose

To determine if bituminous concrete durability, as measured by its resistance to cracking, is significantly related to the tensile strength of the aggregate. If so, to develop the ability to determine, by test, the durability of bituminous concrete mixtures.

Scope

To determine if aggregate tensile strength is related to the tensile strength of bituminous concrete in such a way as to have practical significance. To establish a test method for indicating how much influence the selected aggregate will have on durability of the bituminous concrete product. To establish procedures that could be used to establish discount factors for aggregate, based on the aggregate's effect on durability of the bituminous concrete product.

Progress Past Year

This project was placed on 'hold' pending approval by the Division.

Salaries and Wages 1983: \$59

Title

83 D-43 - A Method of Determining the Angularity of Fine Aggregates and the Marshall Stability of Bituminous Concrete Mixtures

Purpose

To develop the capability of predicting bituminous mix stability on the basis of the gradation and angularity properties of the fine aggregate fraction of the mixture.

Scope

To develop a test procedure that can be used in the field or laboratory for the purpose of measuring the angularity properties of fine aggregate.

gates. And, to determine if fine aggregate angularity in combination with other commonly collected data can be used to predict the stability of bituminous mixtures.

Progress Past Year

Laboratory testing of the minus-4 fractions of bituminous aggregates was begun late in the year.

Planned Program for Coming Year

Continue laboratory testing of samples as time and laboratory help permit.

Salaries and Wages 1983: \$9,489

Title

83 D-44 - A Study of Compaction of Bituminous Mixtures with Pneumatic, Static, and Vibratory Rollers

Purpose

To investigate the effectiveness of pneumatic, steel, and vibratory steel rollers for compacting bituminous paving mixtures.

This research project was initiated at the request of the Engineer of Construction in a memorandum dated May 10, 1983. The memo stated that four situations exist where the degree of compaction of bituminous mixtures is less than desirable and this problem should be investigated with respect to the effectiveness of various types of rollers:

- 1) Resurfacing of rutted or potholed pavements,
- 2) Paving over unstable earth grade or sand subbase,
- 3) Paving over 4 in. of gravel base, and
- 4) Shoulder cross-section thicker than the roadway and placed in one pass

It was requested that item 4 be checked using only static steel rollers to determine whether or not special guidelines should be developed to ensure proper compaction, especially at the edge of the pavement.

Scope

Three types of rollers will be used, each at different specified locations, on five or more paving projects. Nuclear density measurements will be made in and between the wheelpaths for comparison of results achieved by each roller type. Measurements of rutting, mix temperature, air temperatures, and layer thicknesses will be made during construction.

The density of underlying layers will be measured prior to surfacing. Core samples will later be obtained to also measure density, thickness, and tensile strength in the laboratory.

Progress Past Year

Field measurements were made to complete item 4.

Planned Program for Coming Year

Field compaction measurements will be made to assess the effectiveness of the different rollers under conditions 1, 2, and 3.

Salaries and Wages 1983: \$2,375

Title

83 D-45 - Evaluation of the FHWA Asphalt Concrete Density and Temperature Monitoring Device

Purpose

To evaluate the usefulness, accuracy, precision, and reproducibility of two roller-mounted nuclear compaction devices, supplied by the FHWA.

Scope

The evaluation of two nuclear asphalt monitoring devices was conducted by the Research Laboratory under FHWA Basic Agreement DOT-FH-11-9211, Task Order No. 12. One device, the asphalt concrete density and temperature monitoring device (DMD) was a prototype constructed under contract (by Campbell Pacific) for the FHWA and included an infrared temperature sensor along with a nuclear density gage. The second device, also a roller-mounted unit, is a commercially available compaction gage (Seaman Nuclear) purchased by the FHWA for field evaluation. The second unit, called a DOR (density on the run) measures only density, with no temperature sensing capability.

Under terms of the Task Order, the devices were evaluated in the laboratory as well as in the field. Laboratory tests were performed on blocks of known density to verify calibration of the devices and to determine the effective volume of material being tested.

Field evaluation was conducted with the devices mounted on compaction rollers and involved comparisons with conventional nuclear gage values and core density results. Tests were conducted on a 6-in. thick lift and on a thinner, 1-in. lift.

Progress Past Year

The project was completed and a review draft of the final report was sent to FHWA for approval.

Planned Program for Coming Year

Final report will be revised to incorporate FHWA suggestions and then published.

Salaries and Wages 1983: \$7,315

Title

57 E-15 - Sodium Chloride Stabilization, M 46 (M 82), from Newaygo-Montcalm County Line West

Purpose

To investigate why this test road, an experimental salt stabilization project constructed in 1960, is performing well after 23 years of service.

Scope

The test road will be investigated as follows: the pavement is to be condition surveyed to determine the cause of existing distress; the pavement is to be load tested to determine the pavement's load carrying capacity; a roughness survey will be conducted to determine the pavement's present Riding Quality Index; and, salt content of the pavement foundation is to be determined so that the previously established relationship between performance and salt content may be verified.

Progress Past Year

All field and laboratory work was completed.

Planned Program for Coming Year

Prepare a summary report.

Salaries and Wages 1983: \$3,621

Title

68 E-42 - Evaluation of Component Layers in Bituminous Pavement Design

Purpose

To develop comparative thickness equivalency factors for asphalt- treated and untreated aggregate base course layers. A secondary purpose is to provide knowledge needed to develop rationally based design procedures.

Scope

Implement a laboratory testing procedure for determining rheologic properties of each pavement layer. Develop computer capability for stress and strain analysis for five or more layer systems. Determine rheologic properties for typical materials used in Michigan for constructing pavements. Develop theoretical equivalencies of bituminous stabilized and granular bases. Theoretical design curves for determining the thickness of bituminous concrete, black base, and granular base will be included. Benkelman beam deflection and rut depth measurement data from I 75 will be analyzed. Environmental effects on cracking characteristics will be investigated.

Progress Past Year

A summary report of this project was prepared.

Planned Program for Coming Year

With the publication of the summary report this project should be completed.

Salaries and Wages 1983: \$3,243

Title

75 E-54 - Use of Low Density Concrete as a Light Fill Material for Bridge Abutment (Work Plan No. 42)

Purpose

To determine the performance of a lightweight cellular (low density) concrete as a fill material to prevent further vertical movement in the area around a bridge abutment.

Scope

Approximately 3,500 cu yd of low density concrete was used to replace a portion of the existing backfill material for the east abutment of a bridge structure. Annual visual and instrument surveys are conducted to observe performance.

Progress Past Year

No work was done on this project during 1983. Except for long-term observation of the test sites to determine possible moisture increase or settlement of the lightweight fills, the project can be completed with a summary report.

Planned Program for Coming Year

If time permits, a summary report will be prepared.

Salaries and Wages 1983: \$60

Title

75 E-57 - Evaluation of Particle Index for Measuring the Influence of the Coarse Aggregate Fraction on Stability of Granular Mixtures

Purpose

To investigate the practical significance of being able to measure the geometric properties of the coarse aggregate fraction (+No. 4 sieve) of granular materials, and an attempt will be made to establish how significant are the influences of geometric properties on stability compared to the influence exerted by gradation and density.

Scope

The study is limited to literature review and supplemental laboratory study sufficient to indicate the potential of the Particle Index Test as a means of measuring geometric properties. To minimize variables in this study only the 1-in. +No. 4 sieve size fraction will be studied.

Progress Past Year

A summary report was printed and is under review by the Aggregate Acceptance Committee.

Planned Program for Coming Year

Pending any further suggestions by the Aggregates Acceptance Committee, no further work is planned on this project.

Salaries and Wages 1983: \$38

Title

75 E-59 - Comparative Study on Performance of Bituminous Stabilized Bases and Aggregate Bases (M 66 and M 20)

Purpose

To determine if there is any significant difference in the strength of the two base designs--aggregate base on M 20 and bituminous stabilized base on M 66.

Scope

Comparison of the strength of the two base layers will be made based on the elastic layer theory, the criteria of fatigue and rutting, and existing pavement condition surveys. The procedures will include the prediction of material characterization of the subgrade and bituminous concrete by using data from Benkelman deflection measurements, converted to 18 kip equivalent axle load repetitions. Remaining life expectancy of the pavements will be calculated based on future traffic projection and surface rut depth. Results will also be compared with Minnesota procedures.

Progress Past Year

No testing was done during 1983.

Planned Program for Coming Year

Although both types of test sections are in excellent condition, it is suggested that future testing be continued over a long-term period, as time or observed conditions warrant.

Salaries and Wages 1983: \$0

Title

75 E-60 - Use of Frost-Depth Indicators and Benkelman Beam to Determine When Load Restrictions Should be Lifted

Purpose

Research will be conducted in District 1 to formalize procedures for applying and lifting weight restrictions based on information provided by frost-depth indicators. In addition, this study will also provide a procedure for approving overload requests based on Benkelman beam deflection. The procedures developed in this study would be applicable Statewide.

Scope

The project includes study of seven one-mile sites in which frost depth, pavement surface deflection, climatological data and pavement foundation conditions were utilized to achieve the project's purpose.

Progress Past Year

A report of this project was prepared in which an additional season of field testing was suggested. This would depend on the availability of District 1 personnel to make the required measurements and the interest of the Department in establishing priority for such work.

Planned Program for Coming Year

None planned.

Salaries and Wages 1983: \$112

Title

81 E-62 - Evaluation of 'Enkamat' as an Aid to Stabilize a Cut Slope

Purpose

The purpose of this study was to evaluate the effectiveness of 'Enkamat' as a slope stabilization aid to prevent soil erosion and assist in the establishment of turf.

Scope.

A 300-ft long section of cut slope (1 on 1-1/2, approximately) along an I 94 exit ramp (82021-18643C1) was stabilized with Enkamat. This installation involved approximately 840 sq yd of Enkamat. Construction procedures were observed by Testing and Research personnel. The installation was inspected periodically after construction for signs of erosion, wash-out, slippage, or other problems.

Progress Past Year

Enkamat was installed on the test section in Wayne County. Condition of the section was observed and photographed during construction and again several months later.

Final condition was observed and photographed and a final report was prepared (Research Report R-1224). Project completed.

Salaries and Wages 1983: \$1,114

Title

83 E-64 - Demonstration Project of FHWA Field Permeability Testing Device

Purpose

To determine if the Field Permeability Testing Device submitted by the FHWA is suitable for non-destructive (FPTD) in situ testing of open graded base courses whose permeability should exceed 1,000 ft/day.

Scope

A construction project will be selected and approximately 10 lane miles of open graded base will be tested for permeability using the FPTD. At least 20 locations would be tested. Laboratory tests will be made of the test locations to determine if the in situ permeability corresponds to that obtained by laboratory constant head tests.

Progress Past Year

A project proposal was prepared and a site on M 21 selected for testing. However, the FHWA was unable to provide us with the permeameter they wanted tested.

Planned Program for Coming Year

When the permeameter can be delivered another test site will be selected and the project begun.

Salaries and Wages 1983: \$114

Title

82 G-258 - Further Evaluation of Prewetted Salt for Ice Control

Purpose

The purpose of this study was to evaluate the concept of prewetting rock salt with calcium chloride brine prior to winter maintenance ice control application.

Scope

Applications of both wet salt and conventional salt were made and compared during storms throughout the 1982-83 winter maintenance season. Equipment for prewetting the rock salt after it is loaded in the spreader trucks was supplied and installed by the Dow Chemical Co. at the Saginaw east side Maintenance Garage. Dow also furnished the prewetting brine. The effectiveness of the treatments were compared in terms of melting efficiency, amount of salt required, mechanical problems, and after-effects such as residual moisture and the resultant retention of blowing snow during the winter of 1982-83.

Progress Past Year

Although the 1982-83 winter season was relatively mild, the limited testing confirmed previous results showing little or no advantages from the use of pre-wetted salt under normal storm conditions. The product will be used on an "as needed" basis if desired by district personnel. The project was terminated by a letter to Dow Chemical Company from G. J. McCarthy.

Planned Program for Coming Year

None, project completed.

Salaries and Wages 1983: \$2,619

Title

82 G-259 - Evaluation of CMA as an Ice Control Agent

Purpose

The purpose of this study is to evaluate the effectiveness of calcium magnesium acetate (CMA) as an ice control chemical during typical winter maintenance operations in Michigan.

Scope

Applications of both CMA and rock salt will be made and compared during winter storm conditions. Application rates will be varied but will be in the range normally used for rock salt applications. Effectiveness will be compared with rock salt and will be judged by considering ice melting ability, prevention of snow pack, pavement friction levels, and handling and storage characteristics.

Michigan's work plan was approved at the National Pooled-Fund Conference and the Department is to receive 100 tons of CMA for field evaluation.

Progress Past Year

Applications of CMA and rock salt were made for comparison during several winter storms. Storage characteristics of CMA were observed during the 1983 spring, summer, and fall seasons. Friction levels were measured on an iced pavement surface after CMA application. Quarterly progress reports were submitted to FHWA in accordance with our Task Order contract. Although CMA melts ice and snow it has been less effective than rock salt especially during high snowfall rates.

Planned Program for Coming Year

Test applications will be continued until all CMA has been used (approximately 80 tons were carried-over to begin the 1983-84 season). A final report will be prepared as soon as the winter season is over.

Salaries and Wages 1983: \$12,356

RESEARCH SERVICES UNIT

Title

78 B-99 - Recycling of Concrete Pavement

Purpose

To investigate the feasibility of recycling portland cement concrete pavement into aggregate for producing new portland cement concrete pavement.

Scope

Methods of recycling concrete pavement are being evaluated and used as guidance in reconstructing portions of Michigan's roadway system.

Progress Past Year

A 5.7-mile length of dual 24-ft concrete roadway on I 94 was recycled into concrete for replacement pavement and shoulders. Field and laboratory tests are being made to evaluate the product.

Planned Program for Coming Year

Continue to evaluate I 94. Provide guidance and then monitor and evaluate further recycling projects.

Salaries and Wages 1983: \$20,485

Title

72 C-14 - An Evaluation of Mastic-Type Paving Mixtures for Resurfacing a Roadway and a Bridge Deck

Purpose

To determine whether mastic-type paving mixes could be successfully placed without using special construction equipment, and to evaluate the performance of the mastic surfaces.

Scope

Two different mastic-type surfaces were placed on a length of US 31 pavement south of Ludington and one of the mastic mixes was placed as part of a waterproof deck surface on a bridge on US 31. The two mastic mixes are known as Gussasphalt and Mastiphalt.

Progress Past Year

The bridge deck has been conventionally resurfaced and is no longer being observed. The pavement has served well for another year.

Planned Program for Coming Year

Complete final report.

Salaries and Wages 1983: \$0

Title

76 C-17 - Evaluation of Heater-Scarifier Methods for Recycling Asphalt Pavements

Purpose

To evaluate the use of a heater-scarifier in recycling the top 3/4 in. depth of a distressed asphalt pavement.

Scope

A five-mile length of I 75 was heater-scarified to a depth of 3/4 in. Chemical rejuvenator was added to increase the penetration of asphalt from its current 24 to at least 80. The rejuvenated material was resurfaced with a 250 lb/sq yd bituminous concrete mat.

Progress Past Year

Surveyed condition of pavement.

Planned Program for Coming Year

Prepare final report.

Salaries and Wages 1983: \$0

Title

39 F-7(14) - Performance of Postwar Pavements (Concrete Pavement Design)

Purpose

To evaluate the performance of concrete pavements built subsequent to World War II and recommend changes in design or construction practices where warranted.

Scope

The entire trunkline system of concrete pavements constructed after World War II are condition surveyed and used as sources of data for evaluating performance.

Progress Past Year

Nearly 1,400 lane miles of pavement were surveyed.

Planned Program for Coming Year

Continue surveys, investigate and report on problems of particular interest.

Salaries and Wages 1983: \$14,363

Title

65 F-82 - The Effects of Safety Studded Tires on Pavement Surfaces

Purpose

To evaluate the effects of studded tires on pavement.

Scope

Measurements were made of ruts worn in pavements throughout the State. Accident data related to tire studs have been analyzed, annual surveys of stud use were made, and legislation was promulgated regulating the use of studs.

Progress Past Year

Answered inquiries regarding law.

Planned Program for Coming Year

Evaluate new studs, if any are submitted by industry, for compliance with law. Respond to inquiries.

Salaries and Wages 1983: \$0

Title

75 F-147 - Pavement Riding Quality

Purpose

Conduct surveys with the Rapid Travel Profilometer to measure roughness or riding quality of Michigan pavements.

Scope

Conduct surveys and report results on all new construction and on past construction at 5, 10, 15, and 20-year service levels. Also tested are several research projects and special requests as called for by other personnel within the Department.

Progress Past Year

A total of approximately 5,600 lane miles were tested. This includes new construction, Research Projects, and completion of testing the entire Interstate system.

Planned Program for Coming Year

Continue with established program.

Salaries and Wages 1983: \$50,364

Title

43 G-23 - Compilation of Design and Construction Data for Concrete Pavement

Purpose

To make Testing and Research records from construction projects readily available for reference.

Scope

Organize, microfilm, and index Testing and Research records from construction projects.

Progress Past Year

Microfilming is currently completed for projects finalized during the 1980 construction year. Sorting is underway for records received from projects completed during 1981 and 1982 construction seasons.

Planned Program for Coming Year

Continue with established program.

Salaries and Wages 1983: \$6,763

Title

54 G-74 - Survey of Skid Resistance of MDOT Surfaces

Purpose

To conduct a program of pavement friction testing, interpretation, and research.

Scope

A systematic program of pavement friction testing Michigan's trunk-line system throughout its service life is being conducted. Data from the program are used to locate slippery areas, evaluate surface textures, and study materials.

Progress Past Year

Nearly 13,800 pavement friction tests were conducted throughout the State.

Planned Program for Coming Year

Continue established pavement friction test program.

Salaries and Wages 1983: \$40,830

Title

72 G-189 - Sources and Effects of Environmental Noise

Purpose

To investigate the various sources of transportation related noise and to determine their effects upon the environment.

Scope

This is a continuing research project which is intended to consist of a series of investigations into the varied aspects of vehicle-generated noise.

Progress Past Year

The Laboratory sent a representative to a three day, federally sponsored workshop on noise research. This workshop gave state DOTs, universities, and noise consultants the opportunity to suggest areas the FHWA might fund in highway-noise research. A revision of the FHWA STAMINA

2.0/OPTIMA program was adapted to the Department's computer system. Training was provided for new personnel in the Laboratory and in the Planning Division in the use of the program. Evaluation of the noise attenuation that exists at existing barriers built by the Department continued.

Planned Program for Coming Year

Continue collecting noise data from the field and analyze data in order to evaluate barrier noise attenuation.

Salaries and Wages 1983: \$4,728

Title

75 G-211 - Noise Level Inventory of Michigan Freeways

Purpose

To provide an inventory of the existing noise levels along all Michigan freeways. The resulting data base will provide the information necessary to determine the priorities of noise abatement projects along our freeways.

Scope

To catalog and rank the noise levels and respective land use categories in existence along all Michigan limited-access freeways.

Progress Past Year

Group II, eight sites have been selected and entered into the 1985 letting schedule.

Planned Program for Coming Year

All sites that had no residences built when freeway was built or widened (Priority 2) will be identified and moved in the inventory below sites where residences were built before the freeway was built or widened (Priority 1).

Salaries and Wages 1983: \$3,827

Title

77 G-225 - Rubberized Asphalt Stress Relieving Membrane

Purpose

To evaluate the effectiveness of asphalt-ground rubber stress absorbing membranes used as an interlayer and seal coat in preventing reflection cracking.

Scope

This project is part of a continuing search for an effective method for preventing reflection cracking. This method was developed in Arizona and its performance on Michigan pavements under our climatic conditions will be evaluated.

Progress Past Year

Second annual condition survey was completed. Performance of the asphalt rubber interlayer continues to show promise.

Planned Program for Coming Year

Conduct annual survey and evaluate performance if possible.

Salaries and Wages 1983: \$89

Title

78 G-232 - A Study to Develop a Roughness Rating System for Highway Railroad Grade Crossings

Purpose

To develop a roughness rating system that will describe the roughness of a railroad crossing in quantitative terms.

Scope

Pavement profiles of approximately 50 railroad crossings selected at random will be obtained. Using this information, a single number index of pavement smoothness will be calculated.

Progress Past Year

There was no progress due to higher priority work.

Planned Program for Coming Year

It is recommended that this project be closed - the need no longer exists.

Salaries and Wages 1983: \$0

Title

78 G-237 - Feasibility of Solar Power Installation for Railroad Grade Crossing

Purpose

To determine the feasibility of using solar energy to supply electrical power for railroad crossings.

Scope

This project will be confined to the evaluation of one solar-powered crossing using 16, 30-watt photovoltaic panels which will charge a 12-volt battery supply.

Progress Past Year

The system has been in operation for four years without failure. The solar collectors continue to supply sufficient energy to recharge the batteries for lights and gates.

Planned Program for Coming Year

Complete data analysis and prepare final report.

Salaries and Wages 1983: \$0

Title

78 G-240 - Evaluation of Shattering Existing Concrete Pavement Prior to Overlaying for Reducing Reflection Cracking

Purpose

This project is part of a continuing search for an effective method for preventing reflection cracking in bituminous overlays. This process has been used in Germany and on the Pennsylvania Turnpike.

Scope

To evaluate the effectiveness, in preventing reflection cracking, of creating structural discontinuities by shattering the existing concrete and adding a bituminous base course cushion to prevent transmission of movement from the underlying pavement into the overlay.

Progress Past Year

Construction was completed on the Research Project on US 23 near Dundee. Condition surveys were conducted on other experimental projects on US 2 and M 93.

Planned Program for Coming Year

Conduct initial survey on US 23, continue surveys on US 2 and M 93.

Salaries and Wages 1983: \$1,211

Title

78 G-244 - Determination of Michigan Reference Energy Vehicle Noise Emission Levels and Validation of the FHWA Highway Traffic Noise Prediction Model

Purpose

Determine the vehicle noise emission levels for automobiles, light trucks, and heavy trucks as a function of speed. Also, develop a computer program for the FHWA Noise Prediction Model (Report No. FHWA-RD-78-138) for use on the Department's B7700 time-share computer.

Scope

The work will consist of three phases: 1) determine reference noise levels; 2) develop computer program; and, 3) validate the computer model for Michigan traffic noise. Field data will be obtained over a range of vehicle speeds, types, and traffic volumes to determine reference noise emission levels and sufficient data to validate the model.

Progress Past Year

The final report was completed (Research Report R-1230). Approval was received from the FHWA to use results in STAMINA 2.0/OPTIMA program.

Planned Program for Coming Year

Project terminated.

Salaries and Wages 1983: \$271

Title

79 G-247 - Feasibility of Solar Energy for Hot Water Heating in Rest Areas

Purpose

Determine if solar hot water systems are practical for rest area buildings in Michigan. Determine the cost and energy savings associated with such systems and obtain experience on solar heating for use in other highway applications.

Scope

The Department is planning to modernize or expand approximately 12 rest area buildings. Solar hot water systems will be installed at each site where conflicts with trees or other structures are minimal. Installations will include different design concepts using liquid as well as air collectors. Three of the systems will include instrumentation to monitor the energy collected and resulting cost savings.

Progress Past Year

A valid set of data was obtained for the months of January through June. An interim on these data is in draft form. Assistance was given the Maintenance Division in analysis and repair of several problems that developed. A second solar hot water system was installed in the I 94 eastbound rest area, Calhoun County.

Planned Program for Coming Year

Data collection will continue in rest area on I 75 southbound, Bay County. Instrumentation will be installed in the Calhoun County rest area and data collection and analysis will begin. Interim report will be completed.

Salaries and Wages 1983: \$2,167

Title

81 G-255 - Automatic Weighing of Trucks

Purpose

To automatically weigh and record truck weights to see if the percentage of overweight trucks increase during periods of time when an operator is not present in the scale house.

Scope

This project will be confined to installing this system in one scale house and monitoring freeway traffic in one direction to determine compliance.

Progress Past Year

There was little progress due to higher priority work.

Planned Program for Coming Year

Finish installation, complete computer program and begin testing of system.

Salaries and Wages 1983: \$3,955

Title

82 G-257 - Experimental Use of Ice Detection System on Bridge Decks

Purpose

To determine if the Scan 16 System will provide a reliable means of predicting when slippery conditions will occur on bridge decks.

Scope

The project will be confined to evaluating the system at one freeway bridge deck for a period of two years.

Progress Past Year

First year's data collected and evaluated and an interim report was written and sent to FHWA. Some software revisions were made and a precipitation sensor was added.

Planned Program for Coming Year

Continue collecting data and write final report.

Salaries and Wages 1983: \$2,267

STRUCTURAL RESEARCH UNIT

Title

77 B-96 - Experimental 'Econocrete' Shoulder Construction, M 14 Near Wayne County Line, and I 69 Near Lansing

Purpose

To evaluate the construction and performance of econocrete shoulders on M 14 near the Wayne County line and on I 69 near Lansing. The econocrete mix on I 69 contains a cheaper peastone aggregate. The econocrete mix on M 14 incorporated cement reductions intended to provide compressive strengths of 3,000, 2,500, and 2,000 psi at 28 days age. Construction of the M 14 job was completed in the fall of 1978.

Scope

Approximately six miles of the experimental shoulders were built on M 14, in half-mile sections. The sections consisted alternately of, grade 35P (3,500 psi compressive strength) concrete for control, along with 3,000, 2,500, and 2,000 psi grade 30E, 25E, and 20E econocrete, respectively. The econocrete mixes utilized a locally available 20AA aggregate containing about 68 percent sand.

The I 69 installation includes shoulders on approximately three miles of rural freeway. The mix utilizes a locally available peastone aggregate and is designed at 3,500 psi compressive strength. Construction of about 20 percent of the project was completed in 1981. The remainder was built during the summer of 1982. The Structural Research Unit is responsible for performance evaluations on these projects. Materials Research covered mix evaluation and strength of materials placed.

Progress Past Year

Semiannual measurements were made on the M 14 installation. Inspections continue to show that cracks are beginning to form on the mainline pavement near the shoulder joint locations, and in the pavement opposite nearly every shoulder joint. It is evident that the strong intermittent keyway that locks the shoulder to the mainline pavement on this project has increased the amount of commutative cracking in the pavement. Standard plans for future installations, including the I 69 job, were revised to eliminate the keyway. No additional deterioration is evident at this time.

Summer and winter readings were recorded on the I 69 project, which is scheduled to be opened for traffic in spring of 1984.

Planned Program for Coming Year

Monitoring of joint width variations, elevation changes, and general pavement condition will continue.

Salaries and Wages 1983: \$2,566

Title

68 F-101 - Experimental Concrete and Bituminous Shoulders (Experimental Work Plan No. 4)

Purpose

To determine the relative costs and performance of the experimental shoulder designs.

Scope

An experimental portland cement concrete shoulder design, two experimental bituminous shoulder designs, and the standard (1970) shoulder for Interstate construction were installed in a test area on a rural freeway (I 69 south of Charlotte). Three sections, approximately 1/2-mile in length, of each type, were built. Only the outside shoulders were included in the experiment.

Progress Past Year

Winter and summer readings were completed and a condition survey made. Data were tabulated and are on file. Isolated problems at expansion joints in the concrete shoulders were noted previously. This past winter there was some frost heave at only one of these expansion joints. Inspection showed standard and full-depth bituminous shoulders deteriorating and sinking. The longitudinal shoulder-pavement joint in seal coated sections has been slurry-sealed by the Maintenance Division. Slurry sealing was not effective, deterioration is progressing. Several other bituminous locations have been wedged near the pavement edge. Some results from this project were included in Research Report R-1169 that was presented at the International Conference on Concrete Pavement Design, at Indianapolis, in April 1981, and was published as a Departmental Report in September 1981.

Planned Program for Coming Year

Perform biannual joint movement and elevation measurements of concrete shoulder sections. Make annual condition and photographic surveys. Tabulate, enter, and analyze data through the computer.

Salaries and Wages 1983: \$256

Title

*68 F-103 - Galvanized Steel Reinforced Concrete Bridge Decks

Purpose

To determine the feasibility of using galvanized reinforcement in Michigan bridge deck construction, and to evaluate the effect of galvanized reinforcement on the performance of laboratory specimens and full-scale bridge decks.

Scope

Twenty-nine test slabs 3 ft by 4 ft by 7-1/2 in. were cast in the Laboratory and subjected to outdoor exposure with periodic applications of salt. A 30 ft by 5-ft composite simulated deck section was cast in the field for similar treatment. One-half of the bars in the top mat were galvanized and the other half plain. Clear cover over the bars, and concrete mix were varied. Five experimental bridge decks were built, and approximately one-half of the top mat of reinforcement was galvanized on each deck.

Progress Past Year

Weekly treatment of the field exposure slabs was continued through the thirteenth winter. Extensive maintenance was performed at the field exposure site. Specimens with uncoated bars still have about four times as much spalling above the rebars as do those with galvanized bars. Weekly winter salting of the field exposure specimens continues. There is considerable cracking and deterioration of the slabs which is contributing to portions of the slabs "blowing off." Chloride is penetrating the cracks and the slabs are rapidly deteriorating. The five experimental bridge decks are now 11 years old. Field deck evaluations were not performed during the fall of 1983 because of other higher priority assignments. Quarterly reports on the project were prepared for the FHWA. The HP&R participation in this study has been extended through 1987. The first small 'hollow areas' near uncoated bars were reported during the evaluation five years ago, and two small hollow areas were found over galvanized bars on the Grand River Ave Bridge three years ago.

Field exposure specimens having 1/2-in. cover over the bars were dismantled last year. Rebar from the specimens is stored but will be cleaned of adherent concrete for evaluation of corrosive attack. The remaining specimens with 1-1/2 and 2-in. cover remain under treatment for future evaluation.

Planned Program for Coming Year

If time and staff allow, the following will be accomplished in 1984. Bars from field exposure specimens with 1/2-in. cover will be cleaned and evaluated. Cores from the experimental decks will be removed and analyzed. Weekly treatment of the remaining field exposure specimens

will continue through the winter. An inspection of bridge decks will be made. The project has been affected by higher priority work and lack of personnel.

Salaries and Wages 1983: \$2,404

Title

70 F-113 - Experimental Concrete Pavement Ramps (Experimental Work Plan No. 7)

Purpose

To determine the relative cost and performance of experimental non-reinforced ramps.

Scope

Experimental unreinforced ramp pavements were built on two interchanges having considerable differences in projected traffic volumes. Thickness of the aggregate base course was increased to 6 in. to provide additional support for construction machinery and slight additional strength to the pavement system. Black base was included at one site. Standard ramps were included for comparison.

Progress Past Year

A progress report was prepared for the FHWA. Faulting and joint opening measurements and profilometer surveys were completed. All data were reduced and tabulated. Poured joint seals have failed. Some faulting of joints has developed in the black base section of the I 475 interchange. General condition of the ramps is still good. No significant changes in rideability have occurred to date.

Planned Program for Coming Year

Work in 1984 will closely follow that of last year's. This is a long-range evaluation type project, and the general deterioration of the experimental installations has not yet begun. The project is scheduled for four more years.

Salaries and Wages 1983: \$532

Title

70 F-116 - Experimental Joint Spacing Project (Work Plan No. 10)

Purpose

To determine the relative performance of the experimental pavement types.

Scope

Experimental pavements having 71-ft 2-in., 57-ft 3-in., and 43-ft 4-in. slab lengths, were installed in an experimental area on I 75 between M 55 and the Roscommon County line. All experimental joints have load transfer, with plastic coated bars. Sections of standard pavement with 71-ft 2-in. slabs and uncoated steel dowel bars are included for comparison. Joints are sealed with preformed neoprene seals. The weight of the reinforcing mats is the same in all slab lengths. No expansion joints were placed in experimental areas, except those at bridges. Experimental pavements have chamfered joint grooves.

Progress Past Year

Repairs made shortly after construction are deteriorating. Concrete deterioration is present at the bottoms of the joints in all slab lengths. First stages of surface deterioration are beginning to appear in the form of D-Cracking and joint spalling. Roughness survey was completed. Rideability has not changed significantly. Winter and summer readings and surveys were not conducted in 1983 due to higher priority work and insufficient personnel.

Planned Program for Coming Year

This is a long-term evaluation and design differences are slight; therefore, we expect several more years of observation before having sufficient information available to issue a final report.

Salaries and Wages 1983: \$0

Title

72 F-126 - Experimental Concrete and Bituminous Shoulders (Work Plan No. 13)

Purpose

To determine the relative cost of improved shoulder designs.

Scope

Twenty-nine projects were selected for installation of improved shoulder designs, including 16 bituminous and 13 portland cement concrete.

Progress Past Year

No additional effort was made on this project due to higher priority work. These projects are still in relatively good condition, analysis should await observable deterioration.

Planned Program for Coming Year

At some time in the future qualitative performance condition surveys of some of the projects will be done. However, under present limitations on staff and budget, and the existence of other higher priority work, it is unlikely that any additional effort will be made on this project next year. Techniques of evaluation are being developed that will be useful in this project.

Salaries and Wages 1983: \$2,127

Title

*73 F-131 - Epoxy Resin Coated Reinforcing Steel

Purpose

To determine the feasibility of using epoxy coated reinforcement in Michigan bridge deck construction, and to evaluate the effect of epoxy coated reinforcement on the performance of laboratory specimens and experimental decks.

Scope

The project includes three epoxy coatings previously evaluated by the FHWA and NBS, in comparison with galvanized and uncoated steel. Small specimens for laboratory testing, slabs for outdoor exposure, and full-scale experimental decks are included.

Progress Past Year

Quarterly progress reports were prepared for the FHWA. Evaluation of laboratory specimens has been continued. Scheduled maintenance of field exposure specimens was completed. Field deck evaluations were not performed during the fall of 1983 because of other higher priority assignments. Salt treatment of field exposure specimens is being performed for the tenth winter. All decks are in excellent condition. Deterioration of experimental specimens is beginning to progress at a rapid rate. Computer programs have been completed to plot the corrosion data from the experimental decks.

Planned Program for Coming Year

Continue treatment and evaluation of the laboratory and field exposure specimens and experimental decks. Remove cores from the experimental bridge decks. Evaluate the cores for salt content and condition of the rebars. Project is up to date and on schedule.

Salaries and Wages 1983: \$2,805

Title

73 F-135 - Experimental Concrete Glare Screen (Work Plan No. 28)

Purpose

To determine the relative cost, performance, and durability of concrete and metal mesh type glare screen.

Scope

Approximately 1,000 ft of experimental concrete glare screen cast on existing concrete median barrier are in direct comparison with a similar installation of steel mesh. Subjective evaluations of other construction projects was added to compare the performance of other concrete glare screens, steel mesh glare screens, and glare screens integrally cast with the median barrier.

Progress Past Year

Final field performance evaluations were completed. Performance of the concrete screens has been considerably better than the metal mesh screens, from a damage and durability standpoint. Many mesh installations have been replaced by concrete.

Planned Program for Coming Year

Issue a final report.

Salaries and Wages 1983: \$1,325

Title

73 F-136 - Experimental Short Slab Pavements (Work Plan No. 34)

Purpose

To compare performance of several types of pavement systems.

Scope

Three experimental pavement types were installed at a rural freeway site (US 10 relocation north of Clare). Plain concrete slabs with and without load transfer, on three different types of base course, were installed for comparison with the standard Michigan pavements with load transfer and reinforcement. Three half-mile sections of each type were built. Asphalt-treated porous base, a more conventional bituminous base, and aggregate base course were placed on sand grade. All pavement sections are portland cement concrete, 9 in. thick.

Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made. Black base sections with no drainage show increasing signs of aggregate discoloration along the centerline and at joint intersections, and spalling at joint intersections is progressing. This type of deterioration is starting to occur in other sections as well. Cores from the joints in the black base sections showed concrete deterioration of the joint faces and the bottoms of the slabs to be proceeding rapidly. This is providing material which is being pumped under the leaving edges of the slabs and causing faulting which is now more than 3/4-in. at some locations. Sections on open graded drainage course are performing well as are the sections with load transfer on gravel base. Commercial traffic is light. Cores have been cut from this project and 40 other construction projects, for laboratory analysis related to durability or D-cracking. Approximately 333 cores have been taken, covering 13 different aggregate sources and ages of pavement ranging from 7 to 40 years. Laboratory work is in progress. Experimental edge drains were installed at several locations on the US 10 site. Rideability data show changes so small as to not be significant. Spalling of longitudinal centerline is becoming evident in both drainable and non-drainable sections. Staining is also becoming evident in the drainable A.T.P.M. sections.

Planned Program for Coming Year

Continue all experimental measurements and evaluations in the field, and laboratory work as well. This project will continue for many years.

Salaries and Wages 1983: \$15,373

Title

*75 F-144 - Bridge Girder Butt Welds, Resistance to Brittle Fracture, Fatigue, and Corrosion

Purpose

To evaluate electroslag and submerged-arc butt weldments for their fracture toughness, fatigue and corrosion properties, in two grades of steel commonly used in bridge construction.

Scope

Metallurgical and mechanical properties of the weldments were determined. Fracture toughness was measured by both Charpy and fracture mechanics type evaluations. Cyclic loadings determined fatigue crack initiation and propagation. Specimens were prepared for outdoor exposure.

Progress Past Year

All experimental work for the HPR project was completed previously. However, the HPR completion date has been extended one more year to allow for completion of the report. Duties and responsibilities within the Unit have been shifted to free the personnel necessary to complete this report. The initial evaluation of the five-year exposure specimens (urban and rural) was performed. The final report for the HPR phase of the project is in preparation.

Planned Program for Coming Year

The fatigue crack propagation studies will be continued during the coming year, along with chemical analysis work and some additional fracture toughness work as well, providing staff and equipment can be made available. Field investigations of existing bridges with electrosag weldments will continue if staff and funds permit. The HPR final report will be published and the remainder of the work is being carried on as a regular Michigan research project.

Salaries and Wages 1983: \$1,055

Title

75 F-150 - Experimental Project Concerning Joints in Concrete Pavement Repairs

Purpose

To develop data on the movement and relative performance of five different types of joint design details in order to choose suitable designs for future repair contracts.

Scope

This investigation includes the construction, instrumentation, and evaluation of a major concrete pavement repair contract on a deteriorated route (I 75 south of Flint), to compare the reaction and performance of slabs with various types of joints and seals.

Progress Past Year

The final report (R-1231) was issued July, 1983.

Planned Program for Coming Year

The project has been completed.

Salaries and Wages 1983: \$2,052

Title

77 F-153 - Static and Dynamic Properties of Anchor Bolts for Sign Supports

Purpose

To determine the effect of: 1) nut engagement on the static strength of typical anchor bolt assemblies; 2) closeness of fit of nut and bolt on the static strength of anchor bolt assemblies; and, 3) galvanizing on the fatigue strength of typical anchor bolts.

Scope

Two sizes of galvanized bolts are being evaluated at 0.25d, 0.50d, 0.75d, 1.0d, 1.5d, and 2.0d engagement where d is the nominal diameter of the bolt. Bolt diameters are 1-1/2 and 2 in. Anchor bolts are being evaluated statically and in fatigue, both plain and galvanized.

Progress Past Year

Stainless clad anchor bolts with rolled threads have been received for evaluation. Higher priority work and continued problems with the MTS machine prevented progress from being made on this project.

Planned Program for Coming Year

Conduct further fatigue evaluations pending completion of fatigue work on A-588 samples (78 G-241).

Salaries and Wages 1983: \$0

Title

79 F-157 - Field Inspection of Electroslag Welded Bridges for Weldment Flaws

Purpose

On March 14, 1979, the Department received a notice on "Federal Participation in Electroslag Weldment Inspection and Retrofitting," that included main-load-carrying members that are redundant as well as those that are non-redundant. Michigan has more than 125 such bridges in the Interstate system. This project was established to segregate time spent on such inspections for the purpose of obtaining any available Federal funds.

Scope

It is intended to work on inspection of the 125+ bridges, as time and staff permit, to evaluate the condition of the structural integrity of the electrosag butt weldments subject to tensile stress. Applicable non-destructive evaluation techniques will be used.

Progress Past Year

No significant effort was made on this project during the year because of higher priority projects and reductions in staff.

Planned Program for Coming Year

This project is a very long range undertaking, and will be worked on only as staff, equipment, and travel funds are available. Due to current restrictions, and reduced staff, it is questionable whether further work will be undertaken next year. However, an effort will be made to obtain preliminary data.

Salaries and Wages 1983: \$0

Title

82 F-160 - Stainless Steel Clad Reinforcing Bars in a Bridge Deck

Purpose

To gain some practical experience with supply, fabrication, and installation of stainless clad rebar in bridge decks, and to evaluate the performance of the decks in comparison with other decks having epoxy coated rebar.

Scope

A total of four single-span, urban Interstate bridges will be included in the evaluation. Two will have stainless clad rebar, and two will have epoxy coated rebar in the decks and safety walls. Decks with epoxy coated rebar will have two-stage construction with latex modified overlay, while decks with stainless bars will be built with a single lift, 3-in. cover of standard bridge deck concrete.

Laboratory experimentation will cover tensile and fatigue evaluations of the bars, as well as limited flexural work with reinforced concrete beams.

Progress Past Year

The research proposal was prepared and approved by the Engineering Operations Committee and the Federal Highway Administration. Speci-

fications were prepared, and the special requirements for the experiment were included in the plans for four structures by the Design Division. The structures are to be located at I 696 over the service road on the west side of I 75 (S01, S02 eastbound and westbound, and S03 of 63103). Contracts were awarded during the fall of 1982. Since that time, a steel supplier has requested and obtained approval to furnish solid stainless steel rebar in place of the stainless clad bar originally called for. Both stainless clad and solid stainless bars will be included in the laboratory phases of the work.

Experimental bridge decks with stainless steel and epoxy coated rebars were constructed during the summer of 1983. Instrumentation of decks consisting of making electrical connections to the rebar for future corrosion monitoring was completed prior to pouring of the decks. Observation of bridge deck pours was made; there were no major problems encountered.

Samples of stainless clad, solid stainless, and epoxy coated rebar were obtained for laboratory evaluations.

Bid prices for the job were as follows: uncoated rebar, \$.38/lb; epoxy coated rebar, \$.57/lb; and stainless rebar, \$2.00/lb.

Planned Program for Coming Year

Begin experimental laboratory work. Install junction boxes for instrumentation and make initial readings.

Salaries and Wages 1983: \$5,318

Title

74 G-207 - Sewage Treatment Systems at Freeway Rest Areas

Purpose

To develop methods of upgrading rest area sewage treatment systems to meet land treatment, disposal, and water control regulations.

Scope

To follow-up the development of this research project assigned to Michigan State University personnel.

Progress Past Year

Project evaluation work is complete. Final report from MSU was received and the project was closed (November 1983).

Planned Program for Coming Year

The project has been completed.

Salaries and Wages 1983: \$889

Title

78 G-241 - Effect of Corrosion on Bridges of Unpainted A588 Steel and Painted Steel Types

Purpose

To quantify the corrosion rates and total section loss due to corrosion on unpainted A588 steel bridges. To determine if any crevice corrosion is evident on steel bridge details and to investigate for possible corrosion-fatigue damage. To determine the integrity of paint systems applied over salt-contaminated steel.

Fatigue evaluation of specimens removed from bridges, also has been added to this project.

Scope

This investigation is aimed primarily at the nearly 500 bridges in Michigan that are constructed of unpainted A588 steel. Field investigations have revealed that salt leakage and spray from traffic have caused rapid deterioration of the unpainted steels.

The Department has terminated the use of unpainted steel.

A major problem is direct attack and crevice corrosion due to leakage of saltwater through the joints onto the beams. Spray from traffic below has been determined to cause more severe deterioration than previously noted. Accumulation of debris on the beams, capillarity of the rust coating, and lack of washing and drying cycles, also add to the problem.

In areas directly wetted by salt solution, the rate of attack is several-fold greater than on the structure in general, and in crevices subject to drainage the rate can be several-fold greater still. Additional work this year has allowed better quantification of the various environments.

Preliminary work on evaluation of painted structures was done. Paint loss on lower web and flange occurs in eight to fifteen years depending on severity of exposure.

Progress Past Year

Work was completed on the initial analysis of corrosion data, and the results were released in a memorandum. Major results of the statistical analysis indicate:

1) Traffic spray (from below) is, in general, corroding the first few exposed beams at a significantly worse rate (approximately twice the corrosion rate) than the remainder of the structure.

2) Newer structures exposed to traffic spray (8 years) appear to be corroding at a faster rate (approximately 1.5 - 2.0 times greater) than all structures for a given exposure environment.

Several structures have been more extensively examined and repeat corrosion loss measurements made. For the worst structure, corrosion losses on the lower portion of some beams were found to be in excess of 5 mils/year/surface and fatigue cracking was discovered in the fillet weld at one coverplate ending.

Fatigue testing has continued in the Structures Laboratory, but continued breakdowns of the aging MTS machines has severely limited progress. The fatigue program is about three-fourths completed. The results to date indicate a significant decrease in fatigue life with increased pitting and surface attack due to corrosion. Several of the worst specimens have shown reductions in fatigue category from A to C.

Planned Program for Coming Year

Experimental work on fatigue life will continue on the plates removed from the bridges in Detroit.

Data gathering and analysis will be continued as time permits. A formal report will be submitted for review and will be published.

Salaries and Wages 1983: \$15,714

Title

81 G-252 - Thetford Corporation "Cycle-Let" Recirculating Sanitary System

Purpose

To evaluate the performance of the Cycle-Let Recirculating Sanitary System for rest areas.

Scope

A Cycle-Let Model HU 1500 sanitary system, having a maximum capacity equivalent to 15,000 gallons per day of waste water, will be installed in the new rest area on I 96 eastbound, west of Jordan Lake Rd. in Ionia County. Performance, effectiveness, operation, and maintenance costs will be evaluated.

Progress Past Year

Specifications for the installation are ready for bids. The project letting was delayed until spring of 1984.

Planned Program for Coming Year

Letting scheduled for second quarter of 1984. Installation procedures to be monitored and evaluated during construction.

Salaries and Wages 1983: \$0

Title

81 G-256 - Evaluation of Strength and Durability of Guardrail Posts

Purpose

To document the condition of some older installations of wooden and steel guardrail posts; and periodically to evaluate the appearance and strength of unauthorized wood species posts in comparison with approved species.

Scope

The condition of posts was checked on 35 field locations of wooden posts 15 to 24 years of age treated with three different types of preservatives, and about 50 field locations of painted and galvanized steel posts about 20 years of age.

Posts of approved and unauthorized species were identified by the Soils and Materials staff in the Metro and Kalamazoo Districts, and samples are removed for strength testing in the Laboratory at intervals of approximately one year. Unauthorized species under consideration are of poplar. Pine posts are used as control, since they are of approved species.

Periodic condition surveys will be made by District Testing and Research staff on the unauthorized and control species.

Progress Past Year

Posts of unauthorized and control species continued to be sent into the laboratory from the Metro and Kalamazoo Districts. Evaluations of strength in static bending, loss of cross-section due to deterioration, moisture content, specific gravity, penetration of preservatives, and species determination were completed. Steel posts were also evaluated in the laboratory.

Inspection tools, methods, and training were furnished to Maintenance and Construction personnel and a statewide inspection program of wooden guardrail posts was undertaken.

A computer file of laboratory and field data of both steel and wooden guardrail posts was established. A sonic pole tester similar to that used by Detroit Edison for measuring telephone post deterioration was purchased.

Michigan Technological University established a sampling procedure for wooden guardrail posts throughout the state. Structural Research personnel coordinated the effort to transport these posts from the individual districts and MTU.

Michigan Tech also wrote a draft specification for wooden guardrail posts.

Planned Program for Coming Year

Continue a limited condition survey of wooden and steel posts in the field and evaluate the sonic pole tester.

Write progress report.

Salaries and Wages 1983: \$19,543

Title

82 G-259 - Evaluation of the Corrosive Effects of Calcium Magnesium Acetate on Structural Metals (Corrosion Phase)

Purpose

To evaluate, through laboratory experimentation, the corrosive effects of CMA on structural metals.

Scope

Various structural metals will be selected for corrosion testing. Identical specimens will be prepared for performance evaluation in both CMA and NaCl test solutions. An environmental test chamber will be fabricated to house separate CMA and NaCl baths. Specimens will undergo cyclic immersion in solution then exposure to drying (heat) and ultraviolet light.

Specimens will be visually evaluated and photographed at periodic intervals and tested for corrosion effects upon completion of the full test cycle. Results will be evaluated and comparisons made between metals exposed to CMA and those exposed to NaCl. Corrosive effects will be tabulated and summarized in a final report.

Progress Past Year

The environmental test chamber was designed and fabricated. Various structural metals were gathered and test specimens were machined. Higher priority work and reduced personnel caused the start of this project to be delayed.

Planned Program for Coming Year

Specimens will be photographed, cleaned, weighed and secured in the test chamber. Solutions of CMA and NaCl will be placed in tanks. The test will be initiated and evaluations will occur at three-month intervals. A progress report will be prepared. A formal report will be submitted for review in 1985.

Salaries and Wages 1983: \$12,356