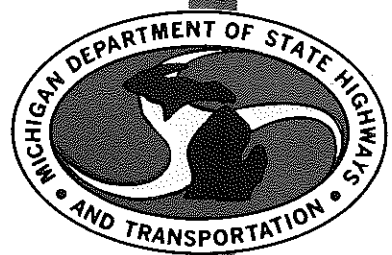
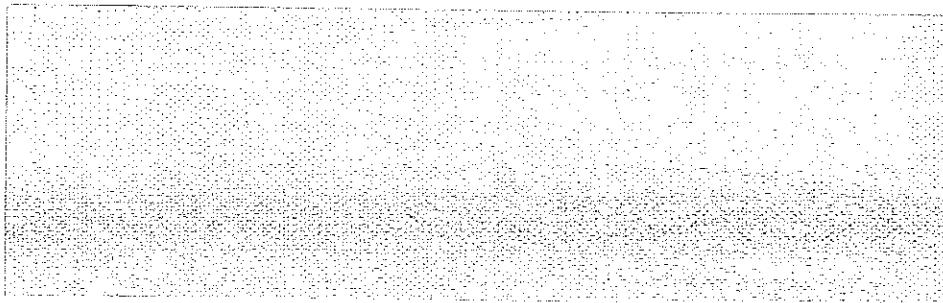


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ANNUAL REPORT OF ACTIVITIES OF  
THE MICHIGAN DEPARTMENT OF  
TRANSPORTATION RESEARCH LABORATORY



**TESTING AND RESEARCH DIVISION  
RESEARCH LABORATORY SECTION**



HE 28 M5 A56 c. 5  
Annual report of  
activities of the Michigan  
Department of Transportation  
Research Laboratory

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THE MICHIGAN DEPARTMENT OF  
TRANSPORTATION RESEARCH LABORATORY

Research Laboratory Section  
Testing and Research Division  
Research Report No. R-1112

Michigan Department of Transportation  
Hannes Meyers, Jr., Chairman;  
Carl V. Pellonpaa, Weston E. Vivian  
John P. Woodford, Director  
Lansing, March 1979

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## INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1978 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 eight 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 1978. 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, and projected activities for the coming year, for all active Departmental and Highway Planning and Research projects (H. P. & R. projects are denoted by an asterisk). The final section consists of a breakdown of salaries and wages expended for each project.

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 - 1978

Considerable time—particularly at the beginning of the year—was devoted to construction, installation, and trial runs of various pieces of equipment in the new Laboratory building. The aggregate wear track and the streetlight photometer were completed during the year, with the machine shop doing the bulk of the work, along with fabricating dozens of fixtures, safety devices, mounting brackets, repair parts, and many other custom jobs.

A load-strain study was conducted on the Mackinac Straits Bridge, in cooperation with the Design Division and the Bridge Authority. The study was conducted to confirm the feasibility of rail car transportation over the bridge; to gain additional insight concerning the overload capacity of the bridge; and to gather limited information concerning the effects of heavy commercial vehicles that use the bridge each day. Strain gages were placed at 49 locations; 14 on the suspension bridge between towers, and 35 on six approach spans at the very north end of the bridge. Experimental load was applied by an 11-axle, 74-tire rig, 80 ft long and 12 ft wide, loaded to 249,000 lb gross. This is the heaviest vehicle ever known to have crossed this bridge. Steel samples were removed from the beams at 13 locations. The strength of the steel in the beams sampled was found to be within specification, and stresses due to the experimental load vehicle were below the limiting values, indicating that from a structural-stress point of view, it would be feasible to haul 80-ton rail cars over the bridge. Many other factors, however, would have to be considered before such a policy is adopted.

As part of a program to explore smoother railroad crossings, 20 grade crossings using experimental types of surface material are now in service. Eleven of these were constructed this past year. Basically, five different types of material are in use: precast concrete, rigid polyethylene, steel reinforced rubber, steel, and a rubber-epoxy mix. Generally speaking, the experimental crossings have performed fairly well, except problems with precast concrete and rigid polyethylene have developed. Three of the latter crossings were replaced and two precast concrete crossings were recommended for replacement. We will continue monitoring these crossings, as well as incorporating other types of crossings into the program as they are developed.

The first paving project incorporating a new roughness specification was completed and tested this year. The new specification is based on Riding Quality Index and provides a bonus to the contractor for exceptionally smooth pavement, a penalty for rough pavement, and a range for average pavement where neither bonus nor penalty are assessed. The project constructed under the new specification, on US 31 in Berrien County, was measured by the Laboratory's Rapid Travel Profilometer and was in the average range, resulting in neither bonus nor penalty. It is hoped that such

a specification will provide an incentive for some extra care on the part of contractor personnel.

A number of projects involving bituminous paving were initiated during the year. A four-mile section using an asphalt-rubber membrane inter-layer was constructed on M 60 south of Battle Creek. The membrane, a mixture of asphalt cement and ground reclaimed tire rubber placed beneath a standard leveling and wearing course, may greatly reduce reflection cracking in the overlay. In another study of the 'reflection cracking' problem, a four-mile section of an old concrete pavement in Genessee County was used to test the effectiveness of placing a slurry seal emulsion over some longitudinal joints prior to paving with asphalt concrete.

A project was initiated involving comparison of cracked and uncracked bituminous pavements in an attempt to isolate the causative factors of good and bad performance. Sixteen one-mile pavement sections throughout the State are to be evaluated in pairs such that the design, specifications, traffic, age, and foundation conditions are the same—their only difference being the level of performance. The study will include the evaluation of asphalts with respect to temperature susceptibility and other viscoelastic properties.

Among the many services routinely provided by the Laboratory are a variety of statistical studies. Last year we engaged in various statistical evaluation activities, such as the analysis of aggregate wearing properties from the data collected on the wear track, assisted in designing procedures to evaluate mechanical versus hand-shake aggregate sieving, and designing a procedure to evaluate the Laboratory's noise prediction model. This group is also called upon to aid in the design of experimental procedures such as the sampling and analysis plans for bridges using A 588 steel, planning an experiment to evaluate the strength of galvanized anchor bolts for sign supports, and designed an experiment to evaluate the variation between plant and laboratory asphalt extraction tests. In addition to this, our statisticians produced a mathematical model predicting the risk of cross-median accidents when no median barrier is present, assisted in the development of Departmental specifications, and provided general statistical services to the Division.

Because of the increased Departmental interest in methods and machinery for the recycling of pavement materials, the Laboratory was requested to measure the particulate emissions from two portable asphalt plants processing up to 50 percent recycled material. Since this was a new facet of our air quality program, equipment had to be procured, personnel trained in an Environmental Protection Agency sponsored course, the gear calibrated, and the sampling scheduled. Two different plants were monitored and it was determined that it is indeed feasible to process the reclaimed material and stay within the desired air quality standards.

Occasionally, the Department finds it advantageous to use lightweight material as backfill at bridge abutments. Two bridge jobs have already been built using 'Elastizell,' a foaming agent that produces a lightweight cellular concrete. This year, a new material, 'Styropor,' was used to support the approaches to a bridge over the Tahquamenon River. Styropor, which consists chiefly of cement and styrene beads, will be monitored and compared with Elastizell, and any similar lightweight material that may be developed in the future.

Two techniques developed by the Laboratory, frost depth indicators and a field permeameter, were given an expanded role this year. Frost depth indicators have been used in the western half of the Upper Peninsula in order to determine when load limits should be imposed or lifted. At the request of other District Engineers, more indicators were installed in the rest of the Upper Peninsula and in the northern part of the Lower Peninsula. The field permeameter, and its associated test methods, was developed to rapidly and easily determine the drainability of subbase layers so that supplemental drainage can be added where necessary. The permeameter was developed and tested preliminarily last year, but this year it was used on a large Interstate reconstruction project where it was found to be most useful and effective.

A project was initiated to quantify the effects of corrosion on bridges of unpainted ASTM A 588 steel and painted steel. Preliminary results indicate that drainage of deicing chemicals greatly increases damage to beams, thus indicating that improved joint seals are needed, especially for skewed bridges. In line with this, the second phase of a project for evaluating bridge joint systems was begun. The use of systems without continuous length sealing elements has been discontinued, and evaluation of several proprietary continuous sealing element types has begun. Laboratory studies to determine movement parameters in skewed joints were initiated so as to further eliminate the use of steel sliding plate expansion dams.

Revision and implementation of new bridge paint specifications were made, and special programs were conducted to familiarize Department personnel and contractors with the changes. Lengthy field observations were conducted on several 1978 painting contracts to determine the workability of the specifications and to train inspectors. Equipment was purchased and installed in the Laboratory to enable us to establish performance requirements for maintenance coatings. The time consuming chore of coating the many test panels was started, coating products—both solvent base and water base—and application requirements are being tested.

The air quality monitoring van collected data at several locations to provide information for environmental impact statements. Construction of a second air monitoring vehicle was completed during the year. The vehicle emission computer program was updated to comply with current Environmental Protection Agency policy to use higher emission factors in



assessing the environmental impact of highway projects. Laboratory staff also updated the emission program used by the Bureau of Transportation Planning. A copy of the computer program for the CALINE II air pollutant dispersion model was furnished to the City of Detroit. A citizen complaint regarding particulate matter in the air west of Detroit was also investigated.

Laboratory evaluation of 'Kiwilite' reflective sheeting was completed. Suppliers furnishing materials that can conform with Department specifications were recommended for bidding purposes to the Department of Management and Budget. The resulting contract price is reported as the lowest in the U. S. and the lowest ever for the Department. Further developments in the reflecting sheeting area were the use of an infrared method for identifying various manufacturers' reflective sheeting to assist the Traffic and Safety Division in investigating defective signs. Counties and cities were also assisted, and the Federal General Services Administration solicited the Laboratory for our comments on their proposed reflective sheeting specifications.

The experimental field work on the development of preventive maintenance procedures for neoprene sealed pavements was completed. The joints on 7 miles of two-lane pavement were repaired using three different types of fast-setting mortars. The developed procedures have been accepted by the Department for contract work, and a 12-mile section of the I 75 freeway in Arenac County has been selected for the first contract covering this type of work. Joint spall repairs, open crack repairs, and replacement of non-functioning seals will be included in the contract proposal. In another project, over 12,000 lin ft of urethane foam pressure relief joint filler was installed in 1977 on US 27 between Ithaca and Harrison. In 1978, 3,000 lin ft were installed on I 96 in the Lansing area. Field inspections show that the material is performing well with no significant problems. This preventive maintenance procedure has been shown to significantly decrease the incidence of 'blow-ups' on older pavement.

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(January 1978 Through December 1978)

R-1077 - "Low Slump Portland Cement Concrete Bridge Deck Overlays,"  
(75 B-93). K. H. Laaninen.

This report describes the installation of bridge deck overlays using a low slump, cement-rich concrete on two structures—one in the Lansing area, one near Brighton. The purpose of the project, conducted in cooperation with the Federal Highway Administration, is to see whether the use of this overlay (the so-called 'Iowa Method') is an acceptable alternate to latex modified concrete for bridge deck overlays. The deck preparation, mixing, and curing are described, as are the on-site tests and the laboratory testing. In general, it was found that the low slump concrete was not easy to apply or finish, and the wet curing time was longer than for the latex modified concrete. The laboratory tests showed generally good results. It is anticipated that in about two years there will be sufficient data for a report to be issued on the field performance of the overlays.

R-1078 - "Evaluation of Sulfur-Asphalt Binder for Bituminous Resurfacing Mixtures," (74 D-29). J. H. DeFoe.

Some other research agencies have reported that the use of molten sulfur blended with hot asphalt as a binder for bituminous mixes has resulted in the use of less asphalt, lower mixing and placing temperatures, longer fatigue life, and reduced rutting as compared with conventional bituminous mixes. In order to evaluate this material under Michigan conditions, four quarter-mile sections of a resurfacing project were placed using two different ratios of sulfur-to-asphalt as a binder. Two adjacent sections, one at either end of the project, were used as a control. A conventional bituminous batch plant was used, but a special blending unit was required; this latter was supplied by Gulf of Canada, who also had their mobile air-monitoring unit on hand to make sure that air quality standards were met. No special problems were encountered in either the mixing or the placement of the experimental mixtures. Laboratory tests will be run on cores taken from the project and field evaluations, such as rut-depth and crack surveys, will be performed over the next five years. Performance evaluation reports will be issued as significant results develop.

R-1079 - "Second Progress Report on the Evaluation of Various Types of Railroad Crossings," (75 F-143). J. E. Simonsen

Michigan has been conducting an on-going research project in cooperation with the Federal Highway Administration for the investigation of various proprietary railroad crossing materials and designs. This report describes seven such crossings: T-Core, Fab-Ra-Cast, Steel Plank, Track-Span, Gen-Trac, Saf and Dri, and Parkco, and is the second progress

report issued on the project. Each of the crossing materials is described, as are the construction procedures for each. Seven criteria were used to evaluate the effectiveness of the crossings: surface wear, surface damage, alignment of units, fastening of units, fastening of rails, pavement/crossing joint, and crossing smoothness. Each of the experimental crossings are rated in the report. Since they've not been in service for a significant length of time, final evaluations are not possible at this time. However, certain general conclusions are drawn and a photographic appendix provides a visual look at some of the features of each type of crossing.

R-1080 - "Petrographic Analysis of Coarse Aggregate: Champion, Inc., Moon Lake Pit No. 22-4," (Testing Laboratory Sample No. 75 A-567). R. W. Muethel.

A sample of combined crushed and natural gravel 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 specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1081 - "A Report on the Cause of Deterioration of Sections of Flexible I 94 Pavement," (77 TI-433). E. C. Novak, Jr.

The Laboratory was requested to investigate a section of deteriorated pavement in order to help ascertain what rehabilitation method ought to be used. The pavement in question was surveyed to determine what sorts of deterioration were present, and samples of each pavement layer were collected for laboratory analysis. The conclusions from these laboratory analyses were passed along to the appropriate parties in the Department who will be directly involved with the pavement's rehabilitation.

R-1082 - "Annual Report of Activities of the Michigan Department of State Highways and Transportation Research Laboratory."

R-1083 - "Petrographic Analysis of Coarse Aggregate: Arthur #2 Pit No. 72-5," (Testing Laboratory Sample No. 75 A-912). R. W. Muethel.

A sample of natural gravel 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 specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1084 - "Petrographic Analysis of Coarse Aggregate: Champion, Inc., Dishneau Pit No. 52-1," (Testing Laboratory Sample No. 75 A-644). R. W. Muethel.

A sample of combined crushed and natural gravel 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 specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1085 - "Summaries of Michigan Pavement Skid Resistance: 1976 Test Program," (54 G-74). P. M. Schafer and P. T. Luce.

This year's annual survey reports the results of over 11,400 skid tests conducted throughout the state with the Department's skid test vehicles. New conventional portland cement concrete and new conventional asphaltic concrete pavements were given an initial testing in order to determine their degrees of slipperiness (coefficients of wet sliding friction). Friction levels were determined for both types of pavement projects after 5 and 10 years of service and reported herein. Additionally, skid tests are performed and reported upon for certain experimental resurfacing projects to monitor their effectiveness. Also included in the report are the results of skid tests at high accident locations, determined by the Traffic and Safety Division, to provide data as to whether slipperiness might be a factor. A section is included of skid data compiled at locations throughout the state by special request of other Divisions for their information. A final section of the report is devoted to special attention locations; those sites discovered during routine skid testing, that are found to be below a certain friction level. Although all skid test results are included in this report for the year 1976, the 'high accident,' 'special request,' and 'special attention' locations are reported out via letter immediately after testing to the concerned parties.

The data in this report were used to make Departmental decisions with respect to which pavement areas should receive a skidproof treatment or a resurfacing. The report also evaluates the durability and the frictional resistance to stopping for a number of experimental mixtures and various texturing procedures.

R-1086 - "Petrographic Analysis of Coarse Aggregate: U. S. Forest Service Pit No. 27-68," (Testing Laboratory Sample No. 75 A-1120). R. W. Muethel.

A sample of combined crushed and natural gravel 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 specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1087 - "Evaluation of Expansion Anchors, Self-Drilling, Torque-Type, and Stud-Type," (76 NM-508, 77 NM-514, 76 TI-380, 77 TI-431).  
M. A. Chiunti.

This report describes the testing of two types of proprietary expansion anchors, those which are self-drilling and those which require a predrilled hole. The anchors were tested against a slippage criterion, rather than ultimate load, since they are to be used for lane ties. Many anchors require some pull-out slippage to develop resistance, but slippage of a lane tie allows the joint to open. The report describes our standard method of testing expansion anchors, lists those approved for use as lane ties, and, as an appendix, summarizes the work that we have done in this area in the past.

R-1088 - "Use of Recycled Asphalt Surface Material in the Construction of a Bituminous Stabilized Base, I 75, Cheboygan County," (75 D-30).  
J. H. DeFoe and G. F. Sweeney.

The purpose of this study is to obtain additional information concerning the design of asphalt/aggregate combinations when stabilized in-place for reconstructing shoulders and bases. Conducted in cooperation with the Federal Highway Administration, the study emphasizes the use of existing base materials as well as the reclaiming of old asphalt surfaces and incorporating them into the resultant base layer. This report describes the construction of the recycled roadway with emphasis on equipment, operations, and materials. An 11-mile section of I 75 (northbound roadway) was recycled by pulverizing and stabilizing the existing bituminous pavement. The project was successfully constructed, with no undue difficulties arising, although a number of things were learned which should be incorporated in future recycling projects of this type. These are delineated in the report. A later report will present the physical characteristics of the resultant materials along with in-service performance evaluations.

R-1089 - "Evaluation of Monoslabs for Paving of Ditches and Service Drives," (74 NM-398). S. L. Purdy.

This report describes the installation of Monoslabs, a proprietary product of precast concrete, which is a slab containing holes in a waffle-like configuration. Backfill over the slabs allows for the growth of grass, yet the Monoslabs will reinforce the turf so that grass sodded areas can support light traffic. Two installations were made, one involving the latter use, providing a 'hidden' roadway across a grassy area, and another installation where Monoslabs were used to line a drainage ditch that was subject to severe erosion. Care must be exercised in installing the slabs, but they seemed to offer no great installation problems. Further reports will be issued after the installations have been monitored in service.

R-1090 - "Noise Study and Analysis, Cities of Allen Park, Dearborn Heights, and Taylor, Wayne County. Reconstruction of I 94 and M 39 Interchange (Addendum)," (74 TI-214).

This is a brief addendum to an earlier highway generated noise study (MDOT Research Report R-927) involving the subject area. The reason for this separate addendum is that a further alternative was added to the route location study. Based on the study described herein, recommendations are made to construct three noise barriers at the interchange area should this alternate (Scheme C) be constructed. Barrier heights, distances, etc., recommended for the site are included.

R-1091 - "A Computer Program for Computing Probabilities and Generating Random Variates for the Gamma, Normal, and Chi-Square Distributions and Its Applications to Highway Technology," (78 TI-485). Wen-Hou Kuo.

Because highway research and testing often require the simultaneous measurement of interrelated variables, a 'fast' computer program for generating multivariates (such as the gamma, normal, and chi-square considered here) would be desirable. This report provides an algorithm for writing such a computer program. The report also presents six practical examples (aggregate gradation distribution, aggregate sample size selection, aggregate product quality determination, median barrier collision probability, entrance ramp merging operation, and roadside vehicle inspection program) to point out the value of a computer program that generates normal and gamma variates. Listing of a FORTRAN computer program based on techniques presented in the report, together with users' instructions are included as an appendix.

R-1092 - "Air Quality Report for I 69 in Ingham, Clinton, and Shiawassee Counties," (78 AP-21(A)).

This report was prepared as part of the Environmental Impact Statement for this proposed route location. In accordance with Federal directives, the terrain and demography, meteorology, existing ambient air quality, and pollution estimates were all explored. Pollution estimates are based on a model which includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. The report concludes that no adverse environmental effects are to be expected.

R-1093 - "Petrographic Analysis of Coarse Aggregate: Paquin Gravel Co. #2, Pit No. 21-19," (Testing Laboratory Sample No. 78 A-758). R. W. Muethel.

A sample of crushed gravel 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 specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1094 - "A Statistical Analysis of Potential Relationships Between Selected Concrete and Aggregate Properties and Concrete Pavement Performance," (76 A-26). Wen-Hou Kuo.

After review of the initial draft of this report, a committee of Testing and Research personnel recommended that further data be incorporated into the study. The expansion of the study is underway and it is anticipated that the expanded report will be issued next year.

R-1095 - "Air Quality Report for Proposed Reconstruction of Interchanges at I 94 and Merriman Rd and I 94 and Middlebelt Rd," (78 AP-22(A)).

This report was prepared as part of the Environmental Impact Statement for this proposed route location. In accordance with Federal directives, the terrain and demography, meteorology, existing ambient air quality, and pollution estimates were all explored. Pollution estimates are based on a model which includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. The report concludes that no adverse environmental effects are to be expected.

R-1096 - "Condition of 'Elastizell' Lightweight Concrete Backfills After One Year in Place," (75 E-54). T. M. Green and E. C. Novak, Jr.

In 1976, the Pine River Bridge (M 29) and the Waiska River Bridge (M 28) were reconstructed using 'Elastizell,' a cellular concrete, as a lightweight fill for support of the bridge approaches. Construction details were described in two earlier reports (MDOT Research Reports R-1053 and R-1064) and this report describes the condition of the fills about one year after construction. Material samples were taken from the fill, and elevation readings made. In general, the material appears to be performing satisfactorily; the fills are of adequate strength, remain lighter than the design unit weight, are not absorbing water, and no serious settlement has been noted. No long-term conclusions are possible at this time, but sampling and testing will continue and subsequent reports are anticipated.

R-1097 - "Study of Latex Modified Concrete Deterioration on Wiard Rd Over US 12 (S04 of 81063)," (78 TI-508). M. G. Brown.

This letter report is in answer to questions involving the deterioration of a portion of the latex-modified overlay on the subject bridge (placed to repair surface deterioration due to a tanker fire). Cores were taken, and the results given in this report of the core testing. Recommendations are contained for the repair of this deterioration.

R-1098 - "The MDOT Circular Wear Track--Results of Preliminary Aggregate Polishing Tests: First Progress Report," (71 C-13). R. W. Muethel.

This report presents the results of preliminary aggregate polishing tests completed on the circular wear track which was developed to study the effect of simulated traffic polish on various aggregates for use in bituminous pavements. Our initial tests indicate that the polish resistance of aggregates can be readily differentiated by wear track testing, and that high-polishing carbonate aggregate can be blended with polish-resistant material to produce a composite aggregate which will provide acceptable polishing resistance. It is anticipated that a number of future reports will be issued based on wear track studies of aggregates and bituminous pavement specimens.

R-1099 - "Air Quality Measurements of Movable Asphalt Plants for Recycling Paving Asphalt," (78 G-235). J. T. Ellis.

Because of increased interest in developing methods for recycling pavement materials, some concern was raised as to whether the portable asphalt batch plants, used for recycling of bituminous pavement, might exceed either Michigan's or the Federal Government's particulate emission standards. A member of the Laboratory's staff attended a training course sponsored by the Environmental Protection Agency in the principles and techniques of measuring particulate emissions, and in turn instructed the rest of the personnel concerned with these matters. The proper equipment was purchased and initial measurements were performed on two different batch plants. At both plants, different recycled asphalt/virgin material ratios were used, and measurements taken of each. It is evident from the measurements that portable batch plants for recycling asphalt are capable of meeting both Michigan and Federal Standards; and, that there is a relationship between mix ratio (recycled to virgin) and particulate emissions (higher ratios generally result in greater concentrations of particulates). The two plants tested used different filtration systems (dry, and wet scrubber) and in these instances, the bag house system (dry) was found to be more effective. An appendix presents the procedure for planning and performing the stack test.

R-1100 - "Salt Degradation Study," (77 TI-427). L. T. Oehler.

A multivariate statistical analysis variance program was performed by W. H. Kuo to determine the effects of lake freighter transshipment of rock salt. It was determined that the major factors changing the gradation of shipments of salt was the loading, hydrating while in the boat's hold, and the unloading; the loading and unloading probably degrading the salt, while the hydrating makes it coarser. Two shipments were studied; in one the salt remained essentially the same, in a longer shipment it became slightly coarser.

R-1101 - "Investigation of Parking Ramp Leakage Through the Upper Level Slab at the Capitol Complex," (78 TI-447). H. L. Patterson.

Some surface deterioration of the concrete in the subject parking ramps has been noted and the Department of Management and Budget requested that the Laboratory investigate these and recommend suitable steps to be taken. The investigation showed various types of surface distress, and a program is included here for repairing the concrete floors, with the various techniques which would be preferred for the different types of deterioration.

R-1102 - "Traffic Signal Dimming Methods," (78 TI-489). J. D. Truax, G. M. Smith and M. H. Janson.

Dimming circuits have been used to reduce nighttime vehicular signal glare and can also provide reduced energy consumption. However, dimming by reducing the voltage to a lamp does effect lens color and intensity. This report, initiated at the request of the Traffic and Safety Division, measures lens color, transmission, and intensity of a signal lamp operating on each of three dimming circuits (diode rectifier circuit, a 3M photocell activated proportional automatic intensity phase-controlled switch, and a 'bucking' transformer) and compares them with MDOT requirements. Lens color and transmission were found to be satisfactory for all three circuits but lens intensity didn't conform with the requirements for either 12 or 8-in. signal lenses.

R-1103 - "Inspection of Low Slump and Latex Modified Overlays on I 94 in The Detroit Area," (57 B-39 and 75 B-93). M. G. Brown.

This report presents the results of an inspection of some Detroit area bridge decks by Laboratory and Construction personnel in response to reports of deck deterioration. The results showed that some of the decks in question did not warrant maintenance attention, though others in the area did. Recommendations were made for the repair of these decks.

LISTING OF NEW MATERIALS PROJECTS  
COMPLETED DURING THE YEAR

- 71 NM-295 - Hydron FX-15 Protective Sealant for Concrete
- 72 NM-326 - Spray Grip Skidproofing Application, US 24 at 10 Mile Road, Southfield
- 73 NM-373 - Mitsubishi International Corporation Reflective Sheeting
- 74 NM-394 - Burlington Glass Reinforcement for Asphalt (Burlington Glass Fabrics Co.)
- 74 NM-418 - Trim Built Paper Board for Sign Backing (Upson Co.)
- 76 NM-479 - Kiwalite Reflective Sheeting
- 76 NM-508 - Rawl Expansion Anchors and Shields
- 77 NM-514 - Silver King Self-Drilling Expansion Shield
- 77 NM-518 - Rust-Not Aluminum Protective Coating
- 77 NM-526 - Plastiroute Cold Applied Plastic Skidproof Reflectorized Traffic Paint
- 77 NM-528 - Syro Sound Absorbing Wall
- 77 NM-534 - 125 mm x 25 mm Corrugated Steel Pipe, ArmcoSteel Corp.
- 78 NM-547 - Corvel ECA-1440 Epoxy Coating for Bridge Reinforcing Steel
- 78 NM-550 - "AE Dispersed Black" Concrete Admixture for Giving Concrete Ability to Absorb Heat
- 78 NM-551 - Evazote 50-Ethylene Vinyl Acetate Foam Joint Filler Material
- 78 NM-556 - Herco Sound Absorptive Barrier
- 78 NM-557 - Oilless Bridge Bearings
- 78 NM-560 - NFS Industries Delineator Device
- 78 NM-562 - Macrometal (Iron and Cement) for Bridge Coverings and Highway Patching

LISTING OF TECHNICAL INVESTIGATIONS  
COMPLETED DURING THE YEAR

- 73 TI-193 - Air Quality Method for Cities and Counties
- 74 TI-199 - Air Quality Impact on M 29, Algonac
- 74 TI-214 - Noise Impact and Air Quality Impact, I 94/M 39 Interchange Reconstruction, Wayne County
- 74 TI-255 - Feasibility Study for Fast-Dry Paint Applicators
- 75 TI-296 - Snow-Free Sign Literature Search
- 75 TI-322 - Quality Assurance Plan for Reflective Sheeting
- 75 TI-324 - Skid Treatment for S-Curve on US 131, Grand Rapids
- 76 TI-343 - Investigation of Poor Joint Performance, I 75 East of I 475 (Transferred to 78 TI-461)
- 76 TI-349 - Profilometer Tests for Evaluating Traveling Stringline Bituminous Pavers
- 76 TI-356 - Deteriorated Sign Legends at Exit 55, I 96
- 76 TI-358 - Evaluation of Thermoplastic Pavement Marking Tape on Bituminous Surfaces
- 76 TI-375 - Extra Claim of Walter Toebe Co. on Deck Pour of X01 of 82291, I 275 Over C&O RR, South of Romulus
- 76 TI-380 - Frazer and Jones D-2 and D-3 Anchors
- 77 TI-389 - The Design and Construction of Lighting Systems for Kelsh-Plotter - Photogrammetry Section
- 77 TI-399 - Review of Airfield Pavement Evaluation and Condition Survey Report for Phelps Collins Air Base, Alpena, Michigan
- 77 TI-403 - Noise Analysis, I 275 at Castle Gardens
- 77 TI-404 - Noise Analysis, I 94 Near 10 Mile Road (Mrs. Caliguri)
- 77 TI-411 - An Investigation of Quasi-Elastic Modulus of Asphalt Concrete Layers

- 77 TI-415 - Feasibility Study for Hauling Railroad Freight Cars Over the Mackinac Bridge
- 77 TI-422 - 1979 License Plate Tests
- 77 TI-424 - Investigation of Vibration Complaint, R. Brown on M 14, Plymouth Township
- 77 TI-425 - Investigation of Ramp Pavement Distress, Erie Scales
- 77 TI-426 - Noise Problem Along I 96 at Portland (West Wind Mobile Home Park)
- 77 TI-428 - Noise Problem Adjacent to I 75/I 696 Interchange, Ferndale
- 77 TI-430 - Effect of Curing Compound on Pull-Out Resistance of Deformed Bars for Lane Ties
- 77 TI-431 - Pull-Out Resistance of Hilti Kwik-Bolts
- 77 TI-432 - Noise Barrier on West Side of I 275 Between 6 Mile and 7 Mile Roads
- 77 TI-433 - I 94 Berrien County Study of Failure of Flexible Surface
- 77 TI-434 - Investigation of Anchor Bolt Failures, Cantilever Sign Support Structures
- 77 TI-435 - Noise Study, M 14 at Beck Road (47255 Burning Tree Lane)
- 77 TI-438 - Specifications for Reclaimed Aluminum for Signs
- 77 TI-441 - Noise Investigation, I 96 at Richard Road, Lansing, Michigan
- 77 TI-442 - High Strength Bolts for Bridge Rail to Guardrail Connector
- 77 TI-443 - Stress Analysis of Michigan White Pine for Breakaway Sign Supports
- 77 TI-444 - Statistical Analysis of Deval and Los Angeles Abrasion Tests for Wear Properties of Aggregate
- 77 TI-445 - Evaluation of Shattering Existing Concrete Pavement Prior to Overlaying for Reducing Reflection Cracking (Transferred to 78 G-240)
- 77 TI-446 - Request for Barrier Extension, I 275 and 7 Mile Road, Melody Manor

- 78 TI-485 - Computer Program of Gamma, Chi Square, and Normal Distribution
- 78 TI-486 - Noise Investigation, Southwest Quadrant of I 75/M 39 Interchange
- 78 TI-490 - Noise Investigation on US 127 Between Saginaw and Lake Lansing Roads (Frondora Hills Subdivision)
- 78 TI-491 - Procedure Manual for Investigating Structural Damage from Construction Related Vibration AASHTO Subcommittee on Materials Task Group on Noise and Vibration
- 78 TI-494 - Noise Complaint Adjacent to Ford Road in Dearborn Heights
- 78 TI-495 - Noise Investigation, I 75 near Coolidge (Troy)
- 78 TI-496 - Noise Investigation, I 75 North of Outer Drive
- 78 TI-497 - Noise Investigation on Napier Road in Oakland County Between 6 and 7 Mile Roads
- 78 TI-498 - Noise Investigation, Square Lake Apartments, Telegraph Road, South of Orchard Lake Road
- 78 TI-499 - Noise Investigation, Highlands Cooperative, I 96 Between Logan and Cedar Streets
- 78 TI-501 - Noise Investigation, I 75, City of Rockwood (Transferred to 78 TI-527)
- 78 TI-503 - Noise Investigation, I 96 at Lamphere and Schoolcraft (Mrs. Ramelis) Detroit
- 78 TI-504 - Noise Investigation, US 27/US 10 Connector, Farwell (Mrs. Spalding)
- 78 TI-507 - Vibration Analysis of James Sayer House, 205 North Front Street (M 51) Dowagiac
- 78 TI-508 - Study of Latex Concrete Deterioration on Wiard Road Over US 12 (S04 of 81063)
- 78 TI-509 - Noise Investigation, I 75, Palte Subdivision, Forest View Village, Troy

- 78 TI-511 - Inspection and Analysis of Strength of Damaged Concrete Beams Repaired by Epoxy Grout, MCS 63012-10898A, Huron Street Bridge in City of Milford, Oakland County
- 78 TI-514 - Noise Investigation on I 94 Between Clippert and Monroe, City of Taylor
- 78 TI-524 - Brake Tests of A&E Dump Trucks
- 78 TI-525 - Noise Problem, I 75 Near Squirrel Road (Adams Square Sub-division) Bloomfield Hills
- 78 TI-527 - Noise Problem, I 75, City of Rockwood
- 78 TI-533 - Air Quality Measurements at M 14 Construction, Plymouth (Mr. R. L. Brown's Complaint)
- 78 TI-536 - Recommendations for Sealing Bituminous Deck Surface Cracking, Mackinac Bridge
- 78 TI-539 - Noise Study at Homes Fronting on I 96 South Service Drive, East and West of Telegraph Road
- 78 TI-540 - Low Slump High Density Concrete Maximum Density Study
- 78 TI-541 - Testing Auxiliary Support for Twin Post Hydraulic Floor Hoist



LISTING OF ACTION PLANS  
COMPLETED DURING THE YEAR

- 77 AP-18(A) - Air Quality Impact, M 51 Relocation in the City of Niles, Berrien County
- 78 AP-21(A) - Revision of Air Quality Report for I 69 from US 127 to Morrice
- 78 AP-22(A) - Air Quality Analysis, I 94 Merriman-Middlebelt Road Interchange, City of Romulus, Wayne County
- 78 AP-23(A) - Updating Air Quality Report, I 94 Widening-Wiard Road Interchange

## ACTIVE RESEARCH PROJECTS

### STATISTICAL ANALYSIS UNIT

#### Title

#### 76 A-26 - Statistical Analysis of Concrete Pavement

#### Purpose

To develop statistical models for concrete pavement performance prediction.

#### Scope

The scope of the investigation will be limited to currently available data, such as laboratory test results on coarse aggregate, condition survey data of concrete pavements, traffic volumes, and weather information.

#### Progress Past Year

Correlations of joint spalling with the freeze-thaw durability index were attempted without success. Moreover, correlations could not be found between the independent test variables such as deleterious content, etc.

#### Planned Program for Coming Year

Preparation of a draft work plan for a study which will compare the poorest performing 10 percent of concrete pavement projects with the best performing 10 percent. A complete case study of the best and poorest performers will be completed. All available information which could explain differences in these groups will be examined.

#### Title

#### 76 G-222 - Statistical Analysis of Aggregate Base Course Inspected by End Result Aggregate Specification

#### Purpose

The "End Result Aggregate Committee" recommended an in-place aggregate acceptance sampling plan based on the research results of the project "Aggregate Gradation Quality Control" (MDOT Research Report No. R-1021). This recommended acceptance sampling plan shall be used to accept or reject base aggregate for two construction projects (M 36021 and

I 50062). The purpose of this research program is to analyze the aggregate base course of these projects so that the major purpose of the recommended acceptance sampling plan (aggregate uniformity) can be evaluated.

#### Scope

An inspection plan to be used as a decision rule to accept or reject in-place aggregate.

#### Progress Past Year

The plan has been used experimentally in four construction projects.

#### Planned Program for Coming Year

Upon receipt of the data from these projects, we will conduct an analysis and make recommendations to the committee concerning the feasibility of the in-place acceptance sampling plan.

#### 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.

#### Progress Past Year

Literature review has been completed, proposal written and submitted to the Engineering Operations Committee which gave its approval.

#### Planned Program for Coming Year

Since it was determined that guardrail approach dimensions could not be accurately determined from road plans (due to safety improvements,

etc., since construction) field examination is planned so that bridge accident rates can be compared to approach guardrail rates. This comparison is intended to provide an assessment of the bridge pre-icing problem. These data together with accident data will be retrieved this year.

#### Title

#### 78 G-238 - Implementation of Modern Statistical Methods for Improving the Accuracy of Highway Laboratory and Field Data

#### Purpose

The end product will be a manual and computer program designed to bring engineers and scientists up to date on newly developed statistical estimation procedures. Benefits will be realized in the improved accuracy of test results taken from groups of samples and/or the reduction of test samples required to achieve desired precision.

#### Scope

Development of procedures for sample average improvements for aggregate testing, materials testing, accident estimates, skid tests, etc.

#### Progress Past Year

Completion of a proposal for Federal funding assistance.

#### Planned Program for Coming Year

Selection of application areas and investigation of accuracy improvement procedures for these areas. Begin work on manual and computer programs.

#### 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 skid test data for bituminous surfaces will be examined for correlations with design and construction variables.

### Progress Past Year

Review of available skid test data and preliminary examination of mix design variables.

### Planned Program for Coming Year

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

## 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 1978. 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.

### Progress Past Year

The first contract using Dylex 1186 latex on 11 structures on I 496 in Lansing was closely followed. Samples were taken at the job site from several days' pours for compressive and flexural strength and freeze-thaw durability. Some selected cores were taken to assess the overlay's bond strength.

Inspections were continued on latex overlay projects done in 1969 to 1976 and selected cores and corrosion cell tests were taken. Inspection was made of one large structure overlain in 1972 in Detroit with 1-1/4-in. latex concrete to assess repair areas for 1979 contracts.

### Planned Program for Coming Year

Complete laboratory testing of cores for chloride penetration and shear bond and finish assembly of these data with corrosion cell tests and visual inspections for report.

Closely monitor the initial use of Thermoflex 8002 under a repair contract on three structures in Lansing as was done on the Dylex contract in 1978.

Title

72 B-90 - Experimental Use of Water Reducers in Slip-Formed Concrete Pavement

Purpose

The use of water reducers was tried both with and without a slight cement reduction on a number of concrete paving projects. The fresh concrete was sampled, placing and finishing observed, and finished pavement properties evaluated. Tests were to evaluate rideability as well as strength and durability.

Scope

Portions of a number of paving projects by several contractors were selected in which to use water reducers with 6.0 and 5.6 sacks of cement per cubic yard. Extensive field sampling was done to evaluate strength and durability and profilometer tests were run to check riding qualities.

Based on the results of the extensive test data from seven projects paved in 1972 to 1974 the Department approved the use of water reducers in paving concrete with a slight reduction in cement. This usage in grades 35P and 30P concrete became part of the 1976 Standard Specifications (Table 7.01-1). The 5.6 sack/cu yd mix with water reducer, in lieu of 6.0 sacks of cement, was widely used across the state in paving concrete.

Progress Past Year

Repeat tests were completed on a number of mixes of 35P and 30P concrete with Type 1SA cement both with and without a water reducer. These tests had to be repeated with a new supply of 1SA cement when it was found the first sample was not uniform. All data were assembled for inclusion in a report.

Planned Program for Coming Year

The current list of approved water reducers will continue to be updated as new products are evaluated by the Testing Laboratory. A decision on the use of Type 1SA cement, at a reduction, with water reducers will be forthcoming on completion of analysis of all test data.

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.

## Progress Past Year

Results from fresh concrete test specimens from X01 and X03 of 82102 were reduced and tabulated. Test cores to evaluate the hardened concrete were cut horizontally from the substructure units and vertically full depth through the superstructure deck. Cores were cut in sections to determine compressive strength and assess consolidation.

## Planned Program for Coming Year

Test results from the core specimens will be reduced and tabulated. Reports will be written for both the pavement and bridge concrete application.

## 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 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.

#### Progress Past Year

The three subject structures on US 23 in northeastern lower Michigan were monitored during construction in the summer and fall of 1972. 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.

#### Planned Program for Coming Year

A report incorporating the data obtained during the inspections in 1977, tests of 1978, and the initial construction data, will be issued.

#### 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.

#### Progress Past Year

Additional structures were overlaid with low slump high density concrete overlays. These included 11 decks under two repair contracts and 8 new two-course structures on I 475 in Flint. The concrete density was checked by nuclear density gages using procedures developed by Testing and Research and Construction personnel. The post-construction report on the initial two structures overlain in 1975 was distributed as Research Report No. R-1077. Inspection was made of seven decks overlain in late 1977 and early 1978 on I 94 and reported in Research Report No. R-1103.

## Planned Program for Coming Year

A performance evaluation report of the first two projects in 1975 and selected 1977-78 projects will be issued combining data obtained from several inspections.

### Title

75 B-94 - Evaluation of Type 1SA Cement When Used with Water-Reducer Admixtures

### Purpose

To investigate the properties of this cement, and report on its characteristics, when used with and without a water reducer. Also, the curing properties of this type of cement at colder temperatures is to be evaluated.

### Scope

A series of tests was performed to compare properties of several grades of concrete made with Type 1SA and Type 1A cement with and without water reducers. Strength data were obtained at temperatures of 45 and 57 F to compare with normal temperature cure both with Type 1SA and 1A cements.

### Progress Past Year

Some repeat tests were completed using a fresh sample of 1SA cement when uniformity problems with the initial sample became evident. All test data on grades 35P and 30P were assembled for a report.

## Planned Program for Coming Year

Issue report with recommendations on using Type 1SA cement with and without water reducers. Cold weather limitations are also to be covered as indicated from the results of 45 and 57 F cure strength gain data.

### 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 econocrete pavement. About 1,200 ft of Ramp A was constructed with 8 in. of grade 35P concrete. The econocrete mix contained 305 lb of cement/cu yd, a water reducer, and a local 60-40 sand-gravel aggregate. The composite econocrete pavement consisted of two layers each of 4-in. depth; the lower layer being econocrete and the upper layer being grade 35P concrete. The construction of the composite econocrete pavement was closely monitored. Fresh concrete specimens of both econocrete 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 econocrete pavement and the grade 35P concrete pavement.

#### Progress Past Year

The initial report covering placement of the ramp concrete sections, including concrete test data, and inspection and coring data obtained in 1977 was finalized.

#### Planned Program for Coming Year

The above report is to be finished and distributed. Condition surveys, measurements of joint openings, slab movement, profilometer and load-deflection tests are to be continued.

#### 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 Wayne County line and I 69 near Lansing. The econocrete mix on I 69 will contain a cheaper peastone aggregate. The econocrete mix on M 14 incorporated cement reductions providing compressive strengths of 3,000, 2,500, and 2,000 psi at 28 days age.

#### Scope

It was proposed to pave three miles of the outside shoulders of M 14 in half-mile sections. The sections consisted of, alternately, grade 35P

concrete, 3,000, 2,500, and 2,000 psi grade "econocrete," or 30G, 25E, 20E, respectively. The econocrete mixes utilized a locally available 20AA aggregate containing about 68 percent sand.

The scope of the I 69 project using a local peastone gravel has not yet been determined.

#### Progress Past Year

Twelve sets of test specimens were made from the four different grades of shoulder concrete during paving on M 14 in September 1978. Testing of these for compressive and flexural strength and freeze-thaw durability has been completed as well as early shrinkage tests. These data are being assembled for inclusion in the initial report.

#### Planned Program for Coming Year

The above test data plus results of a field survey in the spring of 1979 are to be incorporated into an initial report later in the year. This will be in cooperation with the Physical Research Unit.

#### 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 of chloride per cu yd. 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 is proposed that latex modified concrete will 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 chloride per cu yd and the deck performance is to be compared to the fifth structure having an average of 1.6 lb chloride per cu yd.

## Progress Past Year

This study was initiated as a Category 2 project and Work Plan No. 64 was submitted and approved by the FHWA. Subsequently six more projects were added under the work plan since they also contained more than 4 lb chloride per cu yd. These projects are scheduled for letting in February to June 1979.

## Planned Program for Coming Year

It is planned to obtain initial corrosion cell tests and additional chloride tests as soon as the contractor starts deck preparation work in the spring. Samples and tests will be run on the fresh and hardened latex concrete mixture as it is placed. Selected tests and inspections are to be made after the overlay work is completed and at selected intervals for several years.

## Title

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

## Purpose

This project is to reevaluate 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 skid resistance of bituminous mixes and the economic factors involved in obtaining suitable aggregate in critical areas.

## Scope

Both bituminous concrete and bituminous aggregate skid 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.

## Progress Past Year

Reconstruction of the wear track in the new Testing and Research facility was completed. Samples of crushed gravel, sandy limestone, cherty limestone, sandstone, and slag have been obtained from selected sources for polishing tests. Wear track Series No. 9, nearing completion of testing at year's end, contains samples of crushed gravel. A review draft of

the first progress report on wear track tests, Series 1 through 8, was completed.

#### Planned Program for Coming Year

The Wear Track Committee has scheduled Series No. 10 to contain six blends of crushed gravel with selected sandstone blending agents. The tests are intended to evaluate the effectiveness of the blends in maintaining skid resistance during exposure to tire polishing.

Wear track Series No. 11 is scheduled to evaluate the effects of wear track polishing on samples of bituminous pavement. The Bituminous Section has scheduled the sampling of 8-in. diameter core specimens from selected pavements. The cores will be sliced and embedded in concrete mortar slabs for wear track polishing tests.

Wear track Series No. 12 is scheduled to continue the evaluation of selected crushed gravels, cherty limestone, slag, and blends of high-polishing limestone with sandstone anti-skid material.

A final draft of the first progress report is to be completed and distributed.

#### 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

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 skid tests are scheduled for a five-year period to monitor the long-term skid performance of the test pavements. Included in the study are supplemental insoluble residue determinations and petrographic analyses of the test aggregates.

### Progress Past Year

Measurement of the skid performance of the test pavement after one year of service was conducted by the Pavement Performance Group as requested. Preliminary insoluble residue analyses of the test aggregates have been completed.

### Planned Program for Coming Year

A preliminary report will be issued after completion of supplemental laboratory tests on the test aggregates.

Two-year skid tests of the test pavement will be requested. Field inspection of the test pavement is scheduled for mid-year.

### Title

72 F-128 - Evaluation of Various Bridge Deck Joint Systems

### Purpose

To evaluate the effectiveness of various types of bridge deck expansion joint systems covered by Category 2, NEEP Project No. 11.

### Scope

Field inspections are made of each installation at least twice annually to rate the systems for watertightness, durability, ride, noise, etc. These expansion joint systems are in both new structures and old structures under repair contracts.

### Progress Past Year

A final report was drafted and is being reviewed. This covers the installation and inspection data on eight types of expansion joints installed from 1971 to 1977.

### Planned Program for Coming Year

Since most joint systems covered under this study no longer qualify for Federal participation, the study is to be terminated upon publication of the final report.

The systems which will be of continuing interest will be followed under Research Project 78 F-154.

## 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, as pioneered by the State Highway Commission of Kansas, to similarly afflicted 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. To develop a procedure and the expertise to adapt the epoxy injection technique to the repair of concrete bridge deck delaminations. To successively inject on an annual basis the newly developing delaminations on a bridge deck to see if the deck can be returned to a condition of long-term functional stability. To annually inspect the bridge deck to determine if the procedure is achieving the desired results.

#### **Progress Past Year**

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 was carried out under an awarded development contract, and consisted of repairing the delaminations on four bridge decks that were in the initial stages of deterioration. Approximately half of the contract was completed in the fall of 1976 and the remainder was completed during the summer and fall of 1977. The third phase of this project was carried out in the summer of 1978 under a subsequent injection contract. The same bridges were again surveyed and all newly developed delaminations were injected. The deck of one of the subject bridges, westbound I 496 over the Red Cedar River (B02 of 33045A), featured a portion of the repaired area that was coated with a sealant to preclude the entrance of additional surface moisture and chlorides.

#### **Planned Program for Coming Year**

The effectiveness of this method, both with and without the benefit of a deck sealant application, will be evaluated with respect to extending the life



of the deck. This 1979 evaluation will either justify or terminate further work with this method.

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

Two new types were installed and a progress report was drafted on one of these types.

Planned Program for Coming Year

Continue surveillance of installations and write progress reports and recommendations as required.

Title

47 G-36(31A) - 1978 Supplemental Traffic Paint Performance Tests

Purpose

This project is the 1978 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 1979.

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 and evaluating them while the Research Laboratory is responsible for the laboratory work and the reporting.

#### Progress Past Year

Field tests were initiated in May 1978 including evaluation of silane coated beads. Improved methods of controlling the quality of stripe application were cooperatively worked out with the Traffic and Safety Division. Periodic ratings were made and a progress report was made to the Paint Committee in December 1978.

#### Planned Program for Coming Year

Ratings of the paints in field tests will continue until all paints have reached the limit of their useful lives. A final report will then be written.

#### Title

#### 49 G-50 - Study of Protective Coatings for Structural Steel

#### Purpose

To determine the potential merit of a variety of paint-type coatings for structural steel in construction and maintenance painting, by means of laboratory and field service tests.

#### Scope

As noted by the number, the project was initiated in 1949 and is meant to be continuing in order to evaluate the latest developments in paint coatings. The project has two phases, (a) evaluation of paint systems by laboratory techniques, and (b) field evaluation on actual structures of the best performing systems as determined previously in laboratory tests. Since the service life of a good paint system is more than 10 years, determining the merits of paints under phase (b) is lengthy and time consuming.

#### Progress Past Year

Extensive work has been done with the field inspections and the observing and training of inspectors. Problems that exist in the field have been documented and accelerated laboratory tests to determine the effects of these variations on the paint life have been started.

#### Planned Program for Coming Year

In order to better understand and resolve the problems encountered it is planned to once again observe the field application of coatings under 1979

structural painting contracts. We also hope to complete the laboratory tests started in 1978.

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 49 G-50. Revisions are generally cooperative with the using Division and are drawn-up to a Specifications Unit format.

Progress Past Year

The revision of specifications for cleaning and painting of structural steel was completed. A great deal of time was spent explaining these specifications to the contractors and the inspectors. How they were enforced in 1978 painting contracts and what areas need further revision were also documented.

Planned Program for Coming Year

We plan to continue in the inspector training program and to revise the specifications where necessary.

Title

60 G-102(2) - Evaluation of Aluminum Coatings on Guardrails

Purpose

To field evaluate the merits of subject hot-dip aluminum coating on steel beam guardrails.

## Scope

The Maintenance Division received and installed 40 subject guardrails and 12 standard galvanized controls at three locations (one Detroit and two Lansing) about mid-1970. The comparative performance was then to be monitored by us via periodic inspections.

## Progress Past Year

The one remaining installation on US 127 near Michigan Ave in Lansing (the other installations were previously removed because of modernization projects) was inspected December 30, 1977. Appearance at that time was inferior to that of the galvanized controls.

## Planned Program for Coming Year

Since there was only one installation to evaluate and this installation has shown significantly poorer appearance than the galvanized control, this study was closed.

## Title

62 G-113 - Evaluation of Galvanized Coatings on Highway Appurtenances

## Purpose

To determine the merits and performance of galvanized coatings on highway structural steel, with emphasis on appurtenances.

## Scope

The Department is specifying galvanized coatings on an increasing variety of highway hardware, from guardrails to bolts. Under this project, we are observing the performance of galvanizing in a variety of end-uses, i. e., bridge girders and diaphragms, girder-support hardware, guardrails and bridge railings, etc., as background information to be used in specifying protective coatings on highway steel.

## Progress Past Year

Since we have changed to biennial inspections, no work was done this year.

## Planned Program for Coming Year

Continue inspections of test installations.

Title

62 G-114 - Peeling of Paint on Treated Wood Posts

Purpose

The current phase of this project involves following the comparative resistance of peeling of the standard oil-based white paint vs. a latex paint on round wood posts of cable guardrail installations, maintenance repainted.

Scope

This project was reactivated in 1973 on request from the Maintenance Division to monitor the current phase, with field test installations in the Kalamazoo District. Their preference for use of a latex white paint has required our laboratory evaluation of several white latex formulas.

Progress Past Year

Due to the question of identification of the coatings on the installation in District 7 and the removal of the previous installations, further evaluation of any performance data would be of little value. This study was closed.

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

No new designs were submitted for approval. The exclusive use of the one-component polyurethane joint lubricant was discussed and should be incorporated in the 1979 Standard Specifications.

Planned Program for Coming Year

Evaluate new design sections as submitted.

## 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 in an aggressive area since the losses were higher than normal for the eight-year long tests. Because of the abnormality, the tests will be 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.

#### Progress Past Year

None, since no panels were scheduled for removal. However, a new research study (78 G-241) was initiated to plan and conduct a field survey of selected structures using A 588 weathering steel and A 36 to assess actual corrosion in areas of high salt usage and atmospheric contaminants.

#### Planned Program for Coming Year

The first series of panels will be removed in June for evaluation of rate of corrosion.

## 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 and annual inspections are made to determine long-term performance of the surface.

#### Progress Past Year

Epoxy mortar surfacing was applied during September and October of 1969 to a minimum thickness of 5/8 in. Guardkote 250 mortar was applied to the south half of the bridge and Epon 815-Versamid 140 mortar 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 has removed approximately 1/8 in. of mortar per year. The rate of abrasion in the E815-V140 appeared to be less. In 1978 several loss areas of the Guardkote 250 mortar had enlarged in the south span. The north span epoxy mortar, though sustaining an undetermined amount of traffic abrasion, remains essentially intact.

In early 1978, attention was drawn to a Mobilplast system as a possible orthotropic wearing course. The material has been used very successfully in Europe for that purpose.

#### Planned Program for Coming Year

A contract proposed to be let in June of 1979 will allow the newly licensed Koppers Company to supply the materials required to install the Mobilplast system on this deck. The epoxy mortar system on the north half will also be replaced to preclude additional maintenance work within the short term future.

Title

71 G-178 - Guardrail Wood Post Deterioration

Purpose

To determine the relative effectiveness of specification preservatives in minimizing decay, especially at ground line, on wood post supports for steel beam guardrails, via field inspections of installations.

Scope

The initial phase of the project covering preservative treatments allowed by past specifications was completed with Research Report No. R-954, which showed the water-borne treatment to be inferior. A current, secondary phase of the project endeavors to determine whether the current water-borne treatment (CCA) is superior to the former, superseded one (FCAP), and equivalent to the two organic-based treatments. The oldest known (CCA) treated posts are about 10 years old.

Progress Past Year

Surveys of the oldest CCA treated posts (10 years service) showed no significant decay.

Planned Program for Coming Year

Surveys will be made on an annual basis but on a very limited scale because of the very small number of individual posts shown to have significant decay.

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

Sampling from 30 roadside groundwater observation wells at four state-wide locations has been continued on a year-round basis. Accumulated chloride data have been periodically incorporated into chloride-level charts for the test locations.

#### Planned Program for Coming Year

Continued sampling from the roadside observation wells is scheduled. A progress report will be issued when the soil sample analyses are completed.

#### 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 inspections, 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

The use of preformed membranes was largely replaced in 1977-78 by the use of a hot mix membrane containing 5 percent asbestos as developed by Johns Manville. The application of Superseal 4000 hot applied membrane on one structure in Detroit was followed. A listing of projects including the initial five at Flint was being assembled at the year's end to complete field inspections early in 1979.

## Planned Program for Coming Year

Inspection and field testing of remaining unevaluated projects is to be completed for a summary report.

### Title

\*73 G-195 - Effectiveness of Neoprene Seals in Preventing Pavement Joint Deterioration

### Purpose

To determine whether there is sufficient penetration of deicing chemicals to cause joint deterioration; and the rate of concrete deterioration and chloride penetration if it proves to be significant.

### Scope

Joints on construction projects of different ages and geographical locations are cored annually to measure deicing chemical penetration and the amount of concrete deterioration. Samples of base materials are taken for permeability measurements.

### Progress Past Year

Chloride content data on concrete cores taken from 17 construction projects and data on permeability of base materials from the same locations were compiled. Freeze-thaw durability data on aggregate sources were also compiled.

Since less progress than anticipated was made on writing the final report, an extension to July 1, 1979 was requested and granted.

## Planned Program for Coming Year

Complete final report.

### 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 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

Since we have changed to biennial inspections, no work was done this year.

#### Planned Program for Coming Year

Continue inspections of test installations.

#### 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

Chloride data from 77 structures were transmitted in 1978. Sampling by coring has largely been replaced by the rotohammer method which was

instituted in early 1977. This field sampling was done by members of the Soils and Materials Section. Late in the year the routine chloride analysis testing and reporting was transferred to the Testing Laboratory Section.

#### Planned Program for Coming Year

Special deck cores will continue to be evaluated for strength and chlorides. These will largely be from decks covered with bituminous surfaces which negate the use of the delamination detector. Rotohammer samples will continue to be processed by the Testing Laboratory.

#### Title

74 G-210 - Bituminous Aggregate Resurfacing with High Shale Content Aggregate

#### Purpose

To evaluate the wear and durability of bituminous aggregate surfaces made with a particular high shale content material in the northern lower peninsula.

#### Scope

Laboratory wear tests and other related evaluations are to be run on the aggregate and bituminous aggregate surfacing containing high shale percentages. A comparison aggregate of intermediate shale content is also to be included.

#### Progress Past Year

A report incorporating the results of wear track tests completed on samples of high-shale and low-shale aggregates has been prepared (Research Report No. R-1098).

The resurfaced pavement containing the subject high-shale aggregate has been reevaluated by the Testing and Research Soils and Materials Section. Their findings including supplementary pavement friction tests have indicated that the shale content in question does not adversely affect serviceability or skid resistance. This study was closed.

#### Title

\*76 G-219 - Alternate, More Economical Repainting Systems for Structural Steel

## Purpose

To determine by service evaluation whether a bridge structural steel coating system based on SSPC-PS 8.01, Specification for a Thick-Film Rust Preventive, can provide comparable protection to the Department's currently specified four-coat system when applied as either a one or two-coat system at equivalent dry-film thickness.

Savings would be realized primarily by reducing the number of needed applications per maintenance recoating. Hazards involved in such maintenance operation would be reduced accordingly.

## Scope

This HPR project was initiated to study the feasibility of lowering the cost of maintenance repainting of bridge structural steel by use of a one-coat or two-coat paint system based on an auto underbody rust proofer formulation. The study utilizes a four-span grade separation structure, with its structural steel divided into four areas for the tests. One area was coated with the rust proofer in one coat, while another was coated in two coats. One of the remaining areas was coated with the Department's standard four coat system, while the other was coated with a promising two-coat test system based on an inorganic zinc-rich primer. The performance of the paint systems will be determined comparatively by continued inspections.

## Progress Past Year

Field inspections showed a few small areas in both the zinc-rich primed and the "rust preventative" coated areas where minor rust was visible. These appear to be caused by thin spots in the films in some cases and application of coatings over sand in others. An initial report covering paint application was prepared for review.

## Planned Program for Coming Year

Continue biannual inspections to monitor performance and finalize initial report for distribution.

## 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

Field inspections of over 12,000 lin ft installed in 1977 were made showing essentially no problems.

Little progress was made in resolving variations in density of material due to change in ownership of the manufacturing plant and moving of production facilities from Iowa to Wisconsin.

## Planned Program for Coming Year

Continue biannual inspections and attempt to resolve minor problems in quality control of density.

## 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

Sampling of groundwater from three observation wells and one artesian well at the Reed City facility was conducted on a monthly basis with bi-weekly samplings throughout the winter and spring months.

Leakage from the brine retention lagoon was detected in groundwater sampled in the lagoon vicinity. Results of chloride analyses were submitted to the District Maintenance Engineer. Supplemental samplings of groundwater were obtained to monitor the reduction of groundwater chlorides during remedial flushing of the lagoon preliminary to repair of the liner.

Samplings of run-off have been obtained from the bituminous coated sand-salt pile located at the Reed City facility. Initial chloride content of the stockpile was determined from a sampling of the treated sand.

Preliminary in-laboratory salt leaching tests were conducted on a small uncovered sand-salt stockpile. A procedure to simulate a bituminous coating for test sand piles has been suggested.

#### Planned Program for Coming Year

Sampling of groundwater from the observation wells is to continue on a monthly basis with biweekly samplings during the winter and spring months.

The retention lagoon will be monitored for possible leakage. Samples of lagoon water will be analyzed for chloride concentration.

The sand-salt stockpile will be resampled after the winter season to determine loss of salt content due to leaching.

In-laboratory salt leaching tests are scheduled to be conducted on small sand-salt test piles, uncovered and covered.

A preliminary report will be issued after completion of the chloride leaching tests.

#### Title

77 G-228 - A Study of Water Based Paint Systems for Protective Coatings for Steel Structures

#### Purpose

The overall purpose of this project is to provide optimum corrosion protection at the lowest cost and at the same time to eliminate the use of solvents for environmental and safety reasons.

#### Scope

In this study, we will start preliminary accelerated testing of current latex products and compare them directly with the paint systems currently

in use. Pending successful results of the laboratory phase, it is planned to implement the use of water based paint systems on selected field projects to be closely monitored.

#### Progress Past Year

The literature survey has been completed. Due to delays in obtaining test equipment and problems in maintaining necessary tolerances in preparation of test samples a semi-automatic sprayer was developed. After completion of the construction of this equipment the project can hopefully proceed as scheduled.

#### Planned Program for Coming Year

To complete the first phase of the accelerated test coating program.

#### 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 literature survey has been completed. Due to long delays in obtaining test equipment and the inability to maintain very close tolerances on the dry film thickness on the test panels, it has become necessary to construct a semi-automatic sprayer. Once this is complete, the project can then get back on schedule.

#### Planned Program for Coming Year

We plan to start and finish the first set of accelerated test coatings.



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

The preliminary reflectivity measurements on the laboratory prepared panels have been completed. In the process of securing parts for an experimental model, it was learned that an instrument much like our proposed design was available on the market. This instrument was to be submitted by the manufacturer for our evaluation.

Planned Program for Coming Year

To evaluate the reflectivity instrument and, depending upon the results, decide the best course of action; that is, whether it would be better to purchase an instrument or continue the development of our own instrument.

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

Samples and information were requested from manufacturers.

## Planned Program for Coming Year

It is anticipated that the testing will begin in early 1979 and that initial recommendations will be subsequently transmitted to the Design Division. A final report, including test results on any additional systems which may become available, will be issued by January 1980.

## Title

### 78 G-243 - Experimental Use of KP-N for Preserving Wood Guardrail Posts

## Purpose

The Environmental Protection Agency has questioned the safety of the current copper chrome arsenate wood preserving treatment. Since it is imperative that our guardrail posts be preserved, we are to determine the effectiveness of the most environmentally safe product, KP-N, on selected field projects.

## Scope

As requested by the New Materials Committee, a new product manufactured in Sweden (KP-N) will be specified and observed on three projects to be completed during the fall of 1979. Along with these projects we will install test stakes in six areas around the state and document their performance over a 10-year period.

## Progress Past Year

The specifications for KP-N treated guardrail posts have been completed, and incorporated into three project proposals.

## Planned Program for Coming Year

The selection and securing of test sites, the placement of stakes, and the observation of the treating process will be done this year following the letting of contracts on the three selected projects.

## SPECTROCHEMISTRY AND PHOTOMETRY UNIT

### Title

73 D-28 - Evaluation of Wet Bottom Boiler Slag for Bituminous Shoulder Wearing Courses, I 94 in Dearborn Heights

### Purpose

To determine if wet bottom slag can impart a significantly darker appearance to the shoulder thus improving the visual contrast between the shoulder and the pavement.

### Scope

The scope of this investigation is to evaluate photometrically the visual contrast between the shoulder and the pavement resulting from use of wet bottom slag in the bituminous shoulder mix.

### Progress Past Year

The day and night pavement-shoulder visual contrast was measured and evaluated.

### Planned Program for Coming Year

The daytime and nighttime luminance of the shoulder and pavement will be measured. Values for visual contrast will be computed, analyzed, and compared with the visual contrast values from the previous year.

### 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 transport 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 as issued and a file was maintained of material relevant to transportation. Information was obtained from manufacturers and user agencies on analyzers available to monitor air quality. Construction of a second air monitoring unit was completed. The air monitoring van was in service for all but two weeks during the year. Sites were monitored near proposed I 475 in Flint, the I 96/M 39 interchange, the I 94/M 39 interchange, and near I 94 and Middlebelt Rd (Metro Airport). Two automatic battery operated bag samplers were obtained and used to collect air samples near M 14 construction for carbon monoxide analysis at the van. These samplers will collect up to 24 samples unattended over periods of up to four days. The data banks for air quality were updated and expanded.

## Planned Program for Coming Year

Continue air monitoring with two mobile units. Expand the air quality data bank, and update the meteorological data bank. Maintain current information on State and Federal air quality regulations relating to transportation. Keep informed on equipment available to monitor air quality. Close out the project with a report on the equipment built and the procedures developed.

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

## Progress Past Year

A 60 by 30-ft advertising sign at Davison and I 96 in Detroit which was illuminated by nine 400-watt streetlight fixtures attached to the sign was evaluated for glare impact on the average driver. Both visual and instrumental observations showed that the sign would not distract the motorist

from the driving task. The driver's task was defined as the visual ability to follow the painted edge stripe on the pavement.

#### Planned Program for Coming Year

Complaints which are received from motorists concerning light sources such as advertising lights or illuminated areas such as signs which cause discomfort or difficulty with the driving task will be individually evaluated. The recommendations for remedies will be sent to the Division of Traffic and Safety for action on the complaints.

Because research has defined the procedures for computing glare levels but not the methods for evaluating the impact of glare sources on the driver's task a study will be conducted to determine the level of glare at which glare becomes intolerable to the typical driver. The study will consist in general, of observers driving through a curving course while confronted with a glare source. The drivers will attempt to follow a reflectorized paint stripe at various levels of glare in a dark rural situation and in a lighted urban environment.

The results of the study will be used to determine maximum tolerable levels of glare which could be legislated.

#### Title

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

#### Purpose

1) To determine maintenance factors for tower lightings. 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. 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.

#### Progress Past Year

Data from the Grand Rapids and Detroit interchanges were evaluated. The data were accurate in the highly illuminated areas of the roadway but imprecise in the crucial low illumination portions. Zero drift and processing problems in the measurement system apparently caused some of the loss of accuracy. The equipment used was designed for laboratory use, not rugged field use, and had no provision for checking data output in the field. A more advanced data system has been ordered which will provide for data scanning in the field as well as broad range measurement capability.

#### Planned Program for Coming Year

Assemble the components for the data acquisition system and calibrate system in area of Research Laboratory. Evaluate illumination and glare at the tower lighting interchanges.

#### 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 which has been built to remove sediment and oily materials from the storm sewer water.

#### Scope

The study is planned in three phases. Phase I provides for manual sampling of the water entering and exiting the skimmer chamber after completion of construction, but before the associated highway is open to traffic. Phase II is a continuation of Phase I after the highway is open to traffic. Phase III is an extensive program, using automated sampling equipment, designed to study the system after traffic on the highway and operation of the skimmer chamber has stabilized.

### Progress Past Year

The storm sewer has not been completed and little water entered the pump house. No water samples were analyzed.

### Planned Program for Coming Year

Proceed with Phase I of the project as permitted by available water traversing the system.

### Title

75 G-214 - Forward Antiglare Screen Evaluation - Category 2 Experimental Project (Work Plan No. 43)

### Purpose

To determine the suitability of the forward antiglare screen installed on concrete median barrier for general use.

### Scope

Evaluate oncoming vehicle headlamp glare prior to, and after, installation of the antiglare screen at two locations; I 94 over the Dequindre Yard and on M 39 from Village Rd to the Penn Central Railroad in Wayne County.

### Progress Past Year

None.

### Planned Program for Coming Year

If glare screen is installed, glare will be evaluated and videotaped.

### Title

77 G-229 - Reflectorized Flagman Vest

### 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.

## 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.

## Progress Past Year

Many manufacturing sources and suppliers of fabric and reflectorized materials have been contacted but none have a stock material of the proper yellow-orange color. One manufacturer was willing to develop such a material and offered to share development costs.

## Planned Program for Coming Year

Obtain suitable materials and conduct nighttime evaluations of flagman vests in the field.

## 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

Equipment was obtained and personnel were trained in approved EPA methods for stack sampling. Two movable asphalt plants were evaluated for particulate emissions when 10 to 50 percent recycled paving was being processed. A report was prepared (R-1099) on the work completed.

## Planned Program for Coming Year

Measure particulate emissions from several asphalt plants while different percentages of recycled material are being processed.



Title

78 G-236 - Effects of Box Culvert Length on Fish Migration

**Purpose**

To determine the effect of culvert illumination levels as altered by culvert length on fish migration patterns.

**Scope**

Various culverts in the Upper Peninsula will be evaluated for interim illumination and for migration of fish.

**Progress Past Year**

A literature search revealed no references concerning light measurements inside culverts. A summary of the literature concerning the effect of culverts on fish movement was prepared.

**Planned Program for Coming Year**

The project is inactive pending a decision on whether to proceed with proposed work.

## SOILS RESEARCH UNIT

### Title

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

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 elimination of long aggregate hauls.

### 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.

### Scope

An experimental test section, approximately 5 miles in length, will be constructed using the sprinkle treatment method and its performance, measured by skid resistance, will be studied over a three-year period.

### Progress Past Year

Contract documents for construction of the test section have been prepared for advertising.

### Planned Program for Coming Year

The experimental section will be constructed on US 23 at Rogers City. Construction procedures will be documented, materials sampled and tested, and a construction report prepared. Skid tests and speed gradients will be established as soon after construction as practical.

### Title

#### 68 D-26 - Evaluation of Nuclear Methods for Asphalt Testing

### Purpose

The purpose of this work plan is to outline procedures for continuing the study with the added provision for evaluating nuclear soil gages as well as a nuclear gage manufactured specifically for measuring the asphalt content of bituminous mixtures.

## Scope

This study will consist of laboratory and field evaluation of both a Troxler Model 2226 Asphalt Content Gage and a Troxler Model 2401 Soil Density-Moisture Gage which may also be suitable for measuring asphalt content. The Model 2226 Asphalt Content Gage will be evaluated for accuracy and adaptability to job control by the Bituminous Technical Service Unit of the Testing Laboratory, in accordance with the work plan they have prepared which includes a preliminary study of the accuracy and precision of the instrument, followed by field evaluation on selected paving projects.

## Progress Past Year

This project was completed with the publication of MDOT Research Report No. R-1076.

## 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 sulfur-asphalt (S/A), binder has been developed by Gulf Oil Canada Ltd. and will be used to prepare paving mixtures for this project. Two different sulfur to asphalt ratios and two sulfur-asphalt binder levels will be compared with adjacent sections of the same road which will be paved with a conventional mixture.

## Progress Past Year

A progress report describing construction of the test sections was published, "Evaluation of Sulfur-Asphalt Binder for Bituminous Resurfacing Mixtures," Research Report No. R-1078.

## Planned Program for Coming Year

Laboratory tests will be made on all samples for fatigue life and temperature susceptibility. Performance of the road will be monitored by rut depth measurements and cracking surveys.

A second experimental construction project will be planned providing a suitable flexible pavement site can be found.

## Title

### 75 D-30 - Recycling of Asphalt Pavement

#### Purpose

The objective of this study is to evaluate the overall applicability and effectiveness of this specific recycling technique for rehabilitation of flexible pavements characterized by extensive cracking and roughness.

#### Scope

Altogether, 31 miles of I 75 freeway is to be rehabilitated in Otsego and Cheboygan Counties. Of this mileage, 11 miles of northbound roadway is to be recycled by mixed-in-place stabilization procedures, and will involve pulverizing, blending and compacting 254,000 sq yd of shoulder base and pavement materials.

#### Progress Past Year

A progress report describing the experimental construction was published, "Use of Recycled Asphalt Surface Material in the Construction of a Bituminous Stabilized Base, I 75, Cheboygan County," Research Report No. R-1088.

#### Planned Program for Coming Year

Core specimens will be tested for physical properties and annual condition surveys will be made.

## 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 will involve laboratory tests of engineering properties for several mixtures and a field test road incorporating different thicknesses and mix proportions.

### Progress Past Year

Construction of the leveling course involving reclaimed and ground rubber was completed. The paving season ended before the wearing course could be paved.

### Planned Program for Coming Year

Construction of the experimental test sections will be completed and a progress report prepared.

### Title

77 D-33 - Effectiveness of Infrared Joint Heaters for Bituminous Pavements

### Purpose

To determine the effectiveness of infrared joint heaters as currently used and to develop procedures for more effective use.

### Scope

The study will be conducted on several resurfacing projects during the 1977 construction season. The study may be continued if data collected indicate that additional information is needed. Variables to be measured in the study include layer thicknesses, mixture temperature, paver speeds, heater output, and ambient conditions of temperature and wind velocity.

Effectiveness of the joint heaters will be measured by the degree of compaction achieved in the vicinity of the joint as compared with compaction nearer the center of the paved lanes. Tensile strength distributions will also be measured in the vicinity of the joint. The Indirect Tensile Test will be used to test cores taken from the overlay and on either side of the joint.

### Progress Past Year

Field measurements were completed for all five test projects and cores obtained for density and tensile strength analysis. Delay in setting up testing equipment prevented completion of laboratory evaluations.

### Planned Program for Coming Year

Laboratory testing of all cores will be completed and a final report prepared.

## 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 Testing and Soils Research Units.

#### Progress Past Year

The project proposal was prepared and approved. The test sites were selected and field testing of four of the sites has been completed. The laboratory testing has not yet been started.

#### Planned Program for Coming Year

Complete the field testing phase of the project and begin laboratory testing of samples.

## Title

### 57 E-15(2) - Sodium Chloride Stabilization - M 28 East of Bruce Crossing

#### Purpose

The objective in this project is to evaluate the effects of adding sodium chloride to a base course aggregate in a concentration much greater than is conventionally used and to compare salt-treated bases with untreated bases.

## Scope

Sodium chloride in concentrations of 40 lb/ton of base course aggregate were used to stabilize two 1/2-mile test sections of a 24-ft bituminous paved roadway. Performance of these sections will be compared with that of alternating adjacent sections in which untreated aggregate is used in the base, and with sections constructed containing 12 lb/ton of salt, a concentration used as standard on the rest of this contract. Evaluation of the test sections will be made by field and laboratory compaction tests, laboratory measurement of base and subbase strength, frost susceptibility studies, and periodic rut depth measurements of the finished road surface over a five-year period.

## Progress Past Year

All of the data obtained on this project were analyzed and a summary report prepared for publication. No advantage could be found from increasing salt treatment of aggregate to 40 lb/ton. Although the project is substantially completed, it is felt that inspection and rut depth measurements should continue, on a limited basis, during the next five years or so to see if any radical changes develop in the test sections.

## Planned Program for Coming Year

Publish and distribute summary report. Measure seven-year rut depths of the test sections.

## 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

Implementation of a laboratory testing procedure for determining rheologic properties of each pavement layer. Develop computer capability for stress strain analysis of five or more layer systems. Determine rheologic properties of typical materials used in Michigan for constructing pavements. Develop theoretical equivalencies, based on AASHTO failure criteria, of base course materials, i. e., bituminous stabilized and gravels.

The final phase will be verification of theoretical equivalencies developed by this study.

#### Progress Past Year

Condition surveys and Benkelman beam deflection measurements were made at the project test sites and cores obtained for laboratory study of fatigue and structural properties of the bases. The black base sections continue to show more cracking than do the untreated aggregate sections. In addition to the original test sections, a 6 mile badly cracked black base section of I 75 just south of the test sections is now included in our study. Observations to date indicate that the cracked surface condition is not due directly to the black base, which in all cases was sound, but to stripping of the leveling and binder courses which were wet. This condition could be caused by water being trapped in the binder course over the relatively impervious black base.

A report is being prepared outlining a procedure for determining bituminous concrete and base thicknesses for flexible pavement design. The report develops the assumption that load-related failure of flexible pavements take place in the form of surface rutting and cracking rather than by subgrade rutting.

#### Planned Program for Coming Year

Performance of black base pavements of I 75 will continue to be studied. Sample cores obtained during the past year will be tested in the laboratory using MTS cyclic load applications as well as by standard bituminous testing methods.

The report concerning procedures for determining bituminous concrete and base thickness for flexible pavement design will be completed.

#### Title

68 E-43 - Evaluation of Open-Hearth Slag

#### Purpose

To determine the feasibility of using open-hearth and basic oxygen slags for base and subbase aggregates; specifically, to develop specifications and inspection testing procedures to assure adequate quality.

#### Scope

The project will require a review of all available information concerning existing projects constructed with these materials. Tests will be performed attempting to correlate heaving with particle size gradation, chemical



composition (especially lime content), moisture absorption, and freezing. Where possible, these characteristics will be studied at particular locations before and after heaving.

#### Progress Past Year

Extensive repairs were made to CRC areas of I 75 which included the test sections of open hearth slag base. Studies were made during these repairs which showed nothing to indicate that the slag bases contributed in any way to the deteriorated area.

#### Planned Program for Coming Year

This project will be completed with the preparation of a summary report.

#### Title

71 E-49 - Development of Soil Support Values and Coefficients of Relative Strength of Michigan Highway Soils

#### Purpose

To develop a method for calculating the soil support values of subgrade soils used in Michigan and use the method for assigning typical values to soil groups, enabling the Department to more fully implement the AASHTO Interim Guide for the Design of Flexible Pavements. In addition, to develop a method to calculate strength coefficients of Michigan pavement materials.

#### Scope

Originally the project was to be conducted in the laboratories of the Research Laboratory using triaxial tests developed for the equivalency studies under Research Project 68 E-42. During 1975, however, the project was expanded, through a contract with Michigan State University, to develop additional testing methods and procedures for relating soil support values to measured soil properties. The laboratory results will be correlated with field test site data to check the method developed for calculating soil support values. Tests will include cyclic triaxial, conventional triaxial and CBR, using cohesionless soils, supplemented by tests to determine the behavior of asphalt concrete, base and subbase materials under repeated loading. An in-depth study of existing multilayer elastic solutions and finite element techniques will be made to determine the test best suited for meeting project objectives.

## Progress Past Year

After review of the research report submitted by MSU summarizing their work to determine the soil support value of sands, another contract was given to MSU to do similar work applicable to cohesive soils. Field test sites were selected and pertinent tests and sampling were performed by the Soils Research Unit for use by MSU in their laboratory and field correlation studies.

## Planned Program for Coming Year

Field sampling and testing will be continued as required by MSU, and should be completed during the year. Assist MSU, if requested, in suggestions and analysis pertinent to the data developed in their laboratory.

## Title

### 74 E-53 - Development of a Field Permeability Test

## Purpose

To develop a reliable field permeability test, easy to use in the field, and comparable to, for example, the standard density test in speed and simplicity of operation.

## Scope

Limited to development of such a field test and its evaluation through trial field use.

## Progress Past Year

The field permeameter test equipment was loaned to District personnel for use during reconstruction work of I 75 in Wayne County. They reported the test to be easy to use, effective in identifying poorly drained subbase and speedy enough to prevent delays to the contractor. It was found that many subbase drains were needed.

A project on M 66 was selected as being suitable for a controlled evaluation of the test equipment.

## Planned Program for Coming Year

Conduct a controlled field evaluation of the permeameter equipment in accordance with the proposal for the project.

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 will be used to replace a portion of the existing backfill material for the east abutment of this bridge structure. Annual visual and instrument surveys will be conducted to observe performance.

Progress Past Year

Research Report No. R-1096, describing the condition of the two Elastizell Lightweight concrete backfills after one year in place, was published. The condition of the lightweight concrete and the abutments were found to be satisfactory. It was decided that measurements of the Elastizell moisture contents would be made every two years rather than on the planned annual basis.

Planned Program for Coming Year

Field inspections of the two sites will be made to determine the condition of the Elastizell fill and to check for any settlement of the approach fills or lateral movement of the abutments.

Title

75 E-55 - Evaluation of Cold-Mix Emulsion Black Base at the Secondary Complex

Purpose

To determine the handling, construction, and performance of a cold-mix black base in relationship to conventional black base construction.

Scope

A cold-mix base will be included as part of a black base construction using normal construction procedures so that a performance evaluation can be made under typical traffic and environmental conditions.

## Progress Past Year

No change has been noted in the test section during the past year. Several cores were taken for examination and testing in the laboratory.

## Planned Program for Coming Year

Periodic observations of field performance of the test sections will be continued and cores will be tested in the laboratory.

## 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

Due to the higher priority of other projects and the development of new testing procedures in the laboratory, work on completing this project has been delayed. Also, it is felt that to properly complete the project, other work being conducted—in which relationships between geometrical and other basic properties of aggregates and pavement performance are being studied—should be considered.

## Planned Program for Coming Year

Information developed during this project will be reviewed in the light of other projects now underway, which should result in methods for relating geometric properties to pavement performance and allow specification limits to be established on a rational basis. This information should be reported during 1979.

## Title

### 75 E-58 - Relationship Between Pavement Performance and Subsurface Drainage Conditions

#### Purpose

To determine if the subsurface drainage condition of a flexible pavement's foundation can be related to pavement performance characteristics.

#### Scope

Test sites are limited to the flexible pavement portion of US 27 and I 75 where traffic volumes and pavement design are very uniform but performance varies from excellent to poor, and to M 82 where considerable information from a previous project was available for correlation studies. The study is preliminary in nature, intended to provide a basis for future study of flexible pavement performance and its relationship with the engineering properties of its several layers.

#### Progress Past Year

Base samples from a test site on M 82 were tested for permeability. Subbase samples have yet to be tested.

#### Planned Program for Coming Year

Efforts will be made to complete the laboratory testing phase of this project. However, due to the higher priority of other projects and the backlog of samples to be tested, it is probable that work on this project will proceed slowly during 1979.

## Title

### 75 E-59 - Comparative Study on Performance of Bituminous Stabilized 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 for M 20 and bituminous stabilized base for M 66.

#### Scope

Benkelman beam measurements will be conducted on comparable sites of these two pavements. Comparison of the strength of the two base layers

is to be made based on the life expectancy of the pavements as calculated from the surface deflection data.

#### Progress Past Year

Benkelman beam deflection surveys were made at each test site during the spring break-up period (mid-March to late April) and again in mid-October when the pavements were considered to be at their most stable unfrozen condition. Undisturbed subgrade samples were collected to determine subgrade modulus of resiliency at the test sites.

#### Planned Program for Coming Year

Samples collected from the subgrade of the test area will be tested using MTS cyclic load procedures for determining modulus values. Using procedures developed for Research Project 68 E-42, the load carrying capacity of the test sections will be evaluated.

#### Title

75 E-60 - Use of Frost Depth Indicators and Benkelman Beams 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 will include study of up to 12 one-mile sites in which frost depth, pavement surface deflection, climatological data and pavement foundation conditions will be utilized to achieve the project's purpose.

#### Progress Past Year

All field and laboratory testing for the project was completed. Fourteen additional frost depth indicators were installed in District 2, and six in District 4.

Procedures for evaluating the effect of overloaded vehicles on the pavement performance were completed, as were procedures for determining when load restrictions could be lifted. Preparation of the report concerning overload studies was delayed due to increased time spent for analysis of the data obtained.

## Planned Program for Coming Year

Complete reports for evaluating overload capacity of flexible pavements and the determination of the load carrying capacity of each test section during the spring break-up period.

### Title

75 G-215 - Pavement Feedback System

### Purpose

To establish a computerized, retrievable compilation of historical data and updated information on existing pavement systems for use in shaping decisions affecting optimum utilization of highway materials, overlays, upgrading.

### Scope

The original description of the scope needed a slight revision after consultation was made with personnel from the Data Base Management Section of Computer Services Division. The availability of new software for data management and the fact that other highway data inventories have since been built within the Department are making it possible to now plan on a more extensive program, perhaps Statewide, even with the initial compilation of the historical file.

### Progress Past Year

While waiting for the eventual resumption of file compilations for this project, several computer programs that have to do with pavement design and performance and/or prediction of failures or loss of serviceability were studied, namely PDMAP (Probabilistic Distress Models for Asphalt Pavement), COLD (Computation of Low Temperature Damage), and VESYSIIM (Viscoelastic System II, Modified). The purpose was to determine the principal input items and how these are obtained, whether from the records, from the laboratory, or from field sampling.

### Planned Program for Coming Year

Complete the list of required data and have Data Base Management start on the files.

Prepare layouts of the various reports which would be useful to management or other users, and submit them to the Computer Services Division.

If the files are completed before the year is over, we will try the system on a limited basis so that improvements, changes, and additions can be made before extensive implementation.

### Title

76 G-221 - Investigating the Feasibility of Implementing "SAMP-6" in Michigan Flexible Pavement Design

### Purpose

To determine if the model for systems analysis of pavements developed in Texas for NCHRP Project 1-10 is applicable to Michigan flexible design methods.

### Scope

Since the results of model calculations are summarized as feasible designs in order of increasing total cost (initial construction, maintenance, overlays, etc. less salvage value), the sensitivity of total cost to variations in soil support value, asphalt layer strength coefficient, percent commercial vehicles, estimated number of 18-kip equivalents of traffic load per thousand commercial vehicles, and other governing parameters, will be analyzed. Input for the sample problem accompanying the model will be used for testing sensitivity during the first phase, then parallel procedures will be applied to chosen sections of existing flexible pavements in Michigan during the second phase.

### Progress Past Year

The structural module of VESYSII was examined after it had been converted into the Burroughs 7700 and was running correctly, meaning that the runs were yielding the same output as shown on the documentation which accompanied the sample data. It was determined that VESYSII uses a completely different approach to pavement design than SAMP 6, and, therefore, the VESYSII structural module cannot be worked into SAMP 6. VESYSII uses the rational method besides employing a range of values (as opposed to point values) for inputs which are likely to vary in the Laboratory or in the field.

### Planned Program for Coming Year

To finish the project by preparing a report to show feasibility or non-feasibility of implementing SAMP 6 in Michigan pavement design. The report will contain the results of multiple computer runs made with the SAMP 6 program to test the sensitivity of the results to variations in soil support value, layer strength coefficient, and 18-kip equivalent factors.



## PHYSICAL RESEARCH UNIT

### Title

#### 78 B-99 - Recycling of Concrete Pavement

### Purpose

To investigate the economics, construction problems, and performance of recycled concrete pavement.

### Scope

Many miles of concrete pavement have served beyond their design lives and now need treatment. It is planned to select a concrete pavement, crush it, replace it with a new concrete made by reusing the crushed materials as aggregate.

### Progress Past Year

Project was approved as an FHWA Demonstration Project.

### Planned Program for Coming Year

Select an appropriate pavement and recycle it.

### 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 surfaces were inspected, pavement friction measurements were made, however, little progress was made on preparation of the final report due to higher priority work load.

## Planned Program for Coming Year

Prepare final report.

### Title

73 C-16 - Performance Evaluation of Trinidad Asphalt Cement for Bituminous Pavement

### Purpose

To assess the relative performance of Trinidad asphalt cement compared with conventional 85-100 penetration grade asphalt in bituminous concrete mixtures.

### Scope

To compare the qualities and properties of the asphalt concrete mixes and their service performance under traffic and weather conditions at an experimental site covering 4.9 miles of four-lane divided highway; compile and analyze field data in terms of surface compaction, skid resistance, riding quality, and surface durability in resisting long-term cracking, deformation, and other pavement failures; discuss construction problems, if any; and compile and compare construction costs.

### Progress Past Year

Crack surveys conducted, summarized, and reported.

## Planned Program for Coming Year

Continue field inspections and crack surveys.

### 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 5 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

Project was inspected.

#### Planned Program for Coming Year

Continue observations and pavement condition surveys.

#### Title

77 D-34 - Asphalt Pavement Recycling by the Heat Transfer Method

#### Purpose

The purpose of this study is to develop expertise in recycling, by the Heat Transfer Method, a mixture consisting of equal parts of the existing bituminous surface and the existing gravel base. Such a recycled mix must meet acceptable standards for a base course and must be produced without causing the asphalt mixing plant to emit air pollutants which exceed State or local standards.

#### Scope

A 3.5 mile length of the eastbound roadway of I 94 will be recycled. The roadway is in Berrien County. The existing roadway includes three lanes, each 12 ft wide, together with an inside shoulder 3 ft wide and an outside shoulder 9 ft wide. On the pavement, a 5-in. thick bituminous concrete mat lies on an 11 in. thickness of compacted gravel. The shoulders consist of a 2.5-in. bituminous concrete mat over an 8-in. thickness of compacted gravel. The full width, including shoulders, will be recycled.

The material will be processed through a conventional asphalt mixing plant and will be used as a base course. It will be surfaced with wearing and leveling courses placed at a rate of 120 and 130 lb/sq yd, respectively.

#### Progress Past Year

A 3.5 mile length of eastbound I 94 in Berrien County was successfully recycled through a conventional asphalt mixing plant.

#### Planned Program for Coming Year

Leadership of the project has been transferred to the Testing Laboratory which will assume the responsibility for observing and reporting as

appropriate. The Research Laboratory may occasionally be requested to provide certain support services, such as condition survey, pavement friction testing, profiling, etc.

#### Title

##### 77 D-35 - Drum Mixer Recycling of Asphalt Pavement

#### Purpose

To determine if a crushed asphalt pavement can be successfully processed through a drum mixer without causing excessive air pollution; and, to evaluate the properties and performance of the recycled mix.

#### Scope

A length of pavement 22 ft wide and about 7.2 miles long will be recycled through a drum mixer. The pavement is located on M 57 east of Greenville between Berridge Rd and M 66 in Montcalm County.

#### Progress Past Year

A 7.2 mile length of M 57 east of Greenville was successfully recycled as bituminous wearing course by use of a drum mix plant. A report of this work was prepared by the Testing Laboratory.

#### Planned Program for Coming Year

Leadership of the project has been transferred to the Testing Laboratory which will assume responsibility for observing and reporting as appropriate. The Research Laboratory may occasionally be requested to provide certain support services, such as condition surveys, pavement friction testing, profiling, etc.

#### 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

Condition surveys were made of pavement as scheduled.

## Planned Program for Coming Year

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

## 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 4 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

Measurements and observations of the performance of the bar mat test sections and of the mesh reinforced sections that were converted to essentially a jointed pavement by repairing with undowelled repairs, were made semiannually. The bar mat section continues to give good performance after 20 years of service. The repairs on the mesh sections are performing satisfactorily to date. Steel specimens were examined after removal from the repair areas and tensile tests were conducted. Results indicate that corrosion of the steel is taking place, but at a varying degree from bar to bar across the pavement section.

## Planned Program for Coming Year

The bar mat sections will continue to be monitored for signs of failure due to corrosion and for general performance. The undowelled joints will be measured semiannually to evaluate their performance. The problem of slab faulting will be checked and measured if severe faulting is noted visually.

### 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 6 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

Semiannual measurements on movements at end anchors and at crack openings were taken on the bar mat reinforced section. Inspection of the pavement revealed 181 locations needing repair on the mesh reinforced section and 32 locations on the bar mat section were found to need repair. The locations on the mesh section were recommended for undowelled repairs, whereas those on the bar mat section were recommended for dowelled repair. Cores taken through cracks on the bar mat section revealed that the steel had fractured due to corrosion at 12 locations. Repair recommendations were accepted by the Engineering Operations Committee.

## Planned Program for Coming Year

Measurement of end anchorage movement and crack openings will continue on the bar mat section. If the repair contract work is to be done, instrumentation of selected joints will be made to determine their performance.

### 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 by using 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

The performance of the pavement was observed by conducting twice-a-year inspections. Special attention was given to detect signs of corrosion of the steel, wide cracks, spalls, and construction joint problems. Repairs totaling 5,860 sq yd were made on the pavement section from M 39 to Gratiot Ave. Examination of the repair areas revealed separation of the concrete at the steel level and rusting of the reinforcement. A survey in late December revealed numerous new failures, on the same section, totaling about 3,500 sq yd. Considerations are being given to removal and replacement of long sections of pavement because of the numerous failures occurring in certain areas.

## Planned Program for Coming Year

Semiannual inspections will be continued to check on the performance of the pavement and the repairs. Should replacement of long sections be approved, specifications concerning this type of work will be written.

## 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 are 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

Annual stud use surveys were made.

### Planned Program for Coming Year

Evaluate new studs, if any are submitted by industry, for compliance with pavement wear rules.

### Title

67 F-95 - Evaluation of Acme Load Transfer Devices

### Purpose

Evaluate Acme assemblies with respect to load transfer capability, joint movement restraint, joint deterioration, and corrosion of load transfer unit. Also, to determine the feasibility of using a two-part dowel assembly in construction joints.

### Scope

The test section is located on M 52 south of Owosso and consists of about one mile of pavement containing Acme assemblies and one mile of standard pavement with steel dowels used for comparison purposes. Eight construction joints contain the new type of dowel bar assembly.

### Progress Past Year

Joint width measurements were taken on a summer-winter basis. Annual surveys of transverse crack formation and of joint deterioration were conducted.

### Planned Program for Coming Year

Monitoring of joint width variations, crack formation, and joint deterioration will continue, but on an every other year basis. Samples of dowel bars may possibly be removed for corrosion analysis.

A progress report will be prepared.

### 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. 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 an inspection made. Data were tabulated and are on file. Inspection showed standard and full-depth bituminous shoulders deteriorating and sinking, no new problems with concrete shoulders. Longitudinal joint in seal coated sections have been sealed by Maintenance Division.

## Planned Program for Coming Year

Make semiannual evaluations as in the past. A progress report detailing additional deterioration of bituminous sections is anticipated.

## 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 x 4 ft x 7-1/2 in. were cast in the Laboratory and subjected to outdoor exposure with periodic applications of salt. A 30 ft x 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 eighth winter. Routine maintenance was performed at the field exposure site. Field inspections, "corrosion-cell" readings and delamination detector surveys were completed on the five experimental decks. All data were tabulated and records updated. Quarterly reports on the project were prepared for the FHWA. The first "hollow areas" were detected in the ungalvanized portion of some decks.

## Planned Program for Coming Year

It is anticipated that next year coring will be performed to verify the existence of fracture plane separation in the hollow areas and to observe the condition of galvanized and plain reinforcing bars. The project has been kept up to date and on schedule.

## Title

### 68 F-104 - Plastic Coated Dowels for Pavement Joints

## Purpose

Evaluate plastic coated dowels with respect to load transfer capability, joint movement restraint, joint deterioration, and corrosion of dowel.

## Scope

The test section is located on M 52 south of Owosso and consists of 10 consecutive joints containing plastic coated dowels manufactured by Republic Steel Corporation.

## Progress Past Year

Semiannual joint width measurements were taken and crack formation and joint deterioration surveys were conducted.

## Planned Program for Coming Year

Monitoring of joint width variations, crack formation, and joint deterioration will continue, but on a biennial basis. Samples of dowel bars may possibly be removed for corrosion analysis.

A progress report will be prepared.

Title

69 F-111 - Construction and Performance Evaluation of Mixed-In-Place Bituminous Stabilized Shoulder

Purpose

Evaluate the use of different bituminous materials for mixed-in-place stabilization of existing shoulders.

Scope

Five different bituminous materials were used to stabilize about 42 lineal miles of shoulder on I 75 near Flint.

Progress Past Year

A final inspection of the experimental shoulders was made.

Planned Program for Coming Year

Prepare final report.

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. Standard ramps were included for comparison.

Progress Past Year

A progress report was prepared for FHWA. Faulting and joint opening measurements and profilometer surveys were completed. All data were reduced and tabulated. Poured joint seals have failed. General condition of ramps is still good.

## Planned Program for Coming Year

Next year's work will closely follow that of last years, as this is a long-range evaluation type project.

### Title

#### 70 F-114 - Broomed Concrete Pavement Surfaces

### Purpose

Develop, construct, and evaluate new methods of texturing new concrete pavements.

### Scope

Develop or procure equipment for texturing concrete pavements during construction. Evaluate performance of the treated surface.

### Progress Past Year

Experimental textured sections were tested with the Department's pavement friction measuring units. Texturing specifications were prepared and approved for use.

## Planned Program for Coming Year

Continue monitoring experimental textured surfaces and make specification and design recommendations as appropriate.

### 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 a test 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 plain 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

A progress report was prepared for FHWA. Condition and roughness surveys and summer and winter joint movements were recorded. All data were reduced and tabulated. Repairs made shortly after construction are deteriorating. General condition of the roadways is still good.

#### Planned Program for Coming Year

Next year's work will be very similar to the work outlined above for last year. This is a long-range evaluation; therefore, we expect several more years of observation before having sufficient information available to issue a final report.

#### Title

70 F-118 - Development of Procedures for Replacing Joints in Concrete Pavements

#### Purpose

To develop procedures for replacement of distressed joints with permanent type repairs that can be opened to traffic within a few hours after installation.

#### Scope

A total of 100 lane repairs were made: 20 on westbound I 96 between Lowell exit and Thornapple River in Kent County; 40 on east I 96 also between Lowell exit and Thornapple River; and, 40 on westbound temporary I 69 just west of the M 52 intersection in Shiawassee County. Various repair lengths, joint types, and both precast and cast-in-place repairs are included in the study.

#### Progress Past Year

Data on changes in elevation between old and new slabs and on joint width variations at the repairs were obtained annually. The repairs continue to perform satisfactorily. Inquiries concerning longitudinal cracking of fast set repairs resulted in surveys of contract repairs on two freeway

routes. Results indicated only a small percentage of repair slabs crack longitudinally.

#### Planned Program for Coming Year

Annual measurements of joint width variations and of joint faulting will be made. A survey of fast set repairs made within the past five years will be made to determine the amount of longitudinal cracking that occurs during service. This work will be done under Research Project 78 TI-542.

#### Title

71 F-122 - Experimental Pressure Relief Joints, US 23 North of M 36

#### Purpose

To evaluate the performance of pressure relief joints placed at variable spacing.

#### Scope

Ten ethafoam pressure relief joints were placed, with spacing varied from approximately 400 to nearly 4,000 ft. Foam was placed in the joints without precompression, during the spring of the year. Joints were instrumented for measurement of closure.

#### Progress Past Year

Condition surveys were completed on the pressure relief area and the adjacent control section. Summer and winter joint readings were made, and data were reduced. The most recent survey showed approximately 70 percent more repairs in the unrelieved control section than in the section where the pressure relief joints were installed. There have been no joint failures within 400 ft of a pressure relief joint.

#### Planned Program for Coming Year

Since virtually all the provided expansion space has been used, it is anticipated that the project will be terminated after this summer's evaluation.

#### Title

72 F-123 - Comparative Field Study of Joint Repair Techniques to Reduce Blowups

## Purpose

To evaluate the merit of preventive maintenance of concrete pavements to eliminate blowups.

## Scope

Approximately 7 miles of US 127 between Mason and Leslie were selected for this project. The southbound roadway was pressure-relieved by installing precast slabs, cast-in-place repairs, or relief joints at selected locations. The northbound roadway is used as a control section.

## Progress Past Year

Semiannual measurements of relief joint movements were made. Annual inspections of joint spall deterioration on both roadways were conducted. Records on full-depth repairs conducted on the northbound roadway indicate no new repairs were made and none have been made in the pressure-relieved southbound roadway during the five years since this study was initiated.

## Planned Program for Coming Year

Measurements of relief joint movements, inspection of joint deterioration, and blowup surveys will be continued. A survey of fast set repairs on numerous projects will be made to determine if joint faulting is a problem.

## 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

A progress report was prepared for the FHWA. Costs of all scheduled projects have been evaluated.

## Planned Program for Coming Year

If time permits, perform a qualitative condition survey of some of the projects.

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 slip-formed 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

Semiannual condition surveys were made to check the performance of slipformed CRC pavements. Special studies were made of longitudinal cracking in CRC pavements, of failures of WF beam joints, and of punch-out type failures. WF beam joints were discontinued for use in favor of anchor lugs which are now used, except in sandy soils where a six-expansion joint relief section is to be used. A procedure for checking the performance of WF beam joints was developed.

Planned Program for Coming Year

Continue periodic surveys to monitor the performance of this type of pavement. Investigation of longitudinal cracking and associated punch-out type failures will continue. Also, continue to check on construction procedures when the need arises, and assist Design and Construction Divisions in preparing plans and specifications.

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 prepared for FHWA. Evaluation of laboratory specimens has been resumed after being stored for approximately one year due to move. Initial condition, delamination detector and corrosion cell surveys performed on three experimental bridge decks. Salt treatment of field exposure specimens being performed for fifth winter. All decks and experimental specimens still are in excellent condition.

## Planned Program for Coming Year

Continue treatment and evaluation of the laboratory and field exposure specimens and experimental decks. Project is up to date and on schedule.

## 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 is in direct comparison with a similar length of mesh. Subjective evaluation of another construction project was added at the request of the FHWA.

## Progress Past Year

A progress report was prepared for the FHWA. A survey of concrete glare screen on I 94 showed some distress of contraction joints caused by the rebar being carried through the joint. Performance of the concrete screens has been considerably better than the metal mesh screens from a damage and durability standpoint.

## Planned Program for Coming Year

Survey condition of experimental glare screens, and report any significant developments.

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. 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 courses were placed on sand grade.

Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made. No deterioration of this relatively new highway has been noted.

Planned Program for Coming Year

Continue all experimental measurements and data reduction.

Title

74 F-138 - Review of Special Permits for Overloaded Vehicles

Purpose

Structurally analyze the effects of overloads on pavements to determine whether a special permit should be given for moving such overloads.

Scope

Requires an engineering analysis of stresses induced in the pavement system by extreme loads.

Progress Past Year

One request was received and responded to.

Planned Program for Coming Year

Requests will be responded to as they come in.

Title

74 F-139 - Study of Laminations and Other Rolling Flaws in Structural Steel Plates and Shapes

Purpose

To explore, document, and aid in the determination of acceptability of plates and shapes containing rolling flaws.

Scope

Work on this project is done only when one of the welding inspectors finds evidence of flaws in material delivered for girder fabrication. Therefore, the scope is somewhat indeterminate, depending upon the occurrence of such flaws in the steel purchased by fabricators.

Progress Past Year

Several consultations were held with welding inspectors, a few specimens were prepared and polished to determine the extent of flaws, and some field checks were made for extent of delamination type flaws in existing bridge beams.

Planned Program for Coming Year

Continue to respond to any requests for assistance from the welding inspection group.

Title

74 F-140 - Maintenance Procedures to Prevent Blowup of Concrete Pavement Joints

Purpose

To develop procedures for preventive maintenance of concrete pavements to delay the occurrence of joint failure due to compressive stress, and to try to prevent joint blowups.

Scope

Procedures for rating pavement joints and selecting locations for joint replacement or installation of pressure relief joints were developed. These concepts were applied on approximately 80 miles of divided highway. Pressure relief joints and adjacent joints and cracks were instrumented at 10 locations on I 696 and 16 locations on I 75.

## Progress Past Year

Joint condition surveys were conducted on the preventive maintenance project on US 27 from Ithaca to Clare and are being evaluated. Surveys were also conducted on five other projects containing pressure relief. Many projects continue to be completed utilizing pressure relief in joint repair contracts. We continue to supply design squads with joint location information for use in preparing joint repair contracts. No violent blowups requiring emergency repairs have been reported in the preventively treated projects.

## Planned Program for Coming Year

Continue monitoring pressure relief joint movements and performance.

## 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. Initially, 10 crossings and three new materials were included. Thirty-six new crossings and four new materials have been added since the study was initiated.

## Progress Past Year

Eleven new crossings were constructed: four Gen-Track, one Saf and Dri, two Parkco, four Steel Plank. Construction of the new crossings were observed and evaluation surveys of completed crossings were made. Three T-Core crossings were replaced, and two Fab-Ra-Cast crossings were recommended for replacement.

## Planned Program for Coming Year

Observation of the construction of authorized crossings will be made and evaluation data obtained on new as well as on previous year's installations.

## 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 will be determined. Fracture toughness will be measured by both Charpy and fracture mechanics type evaluations. Cyclic loadings will determine fatigue crack initiation and propagation. Specimens will be prepared for outdoor exposure.

#### Progress Past Year

All of the weldments required for the project have now been obtained. The weldments have been evaluated for flaws using both X-ray and ultrasonic nondestructive evaluation techniques. The fracture toughness evaluation program is well under way and the fatigue crack propagation program has been initiated. Corrosion samples from various types of "self-weathering" weldments in A 588 steel have been prepared for installation beneath a bridge in Detroit where an adverse corrosion atmosphere exists.

#### Planned Program for Coming Year

The fracture and fatigue programs should be completed over the coming year. Field investigation of existing electroslagwelded structures will search for the presence of flaws, fatigue cracks, and corrosion problems.

## Title

### 75 F-147 - Pavement Riding Quality

#### Purpose

Conduct surveys with the Rapid Travel Profilometer to measure the 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.

### Progress Past Year

A total of 500 lane-miles of newly constructed concrete and bituminous roadways were tested. Pavement surfaces associated with seven research projects were also tested and reported. Included in the new construction tested was the first project to incorporate the recently developed roughness specification.

### Planned Program for Coming Year

Continue with established survey procedures. More projects are expected to be let this year incorporating the roughness specification.

### 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, to compare the reaction and performance of slabs with various types of joints and seals.

### Progress Past Year

Scheduled faulting and movement measurements completed and surveys performed. Poured joint seals have failed, otherwise repairs are still in good condition.

### Planned Program for Coming Year

Continue to take readings, compile data, and perform condition surveys.

### Title

76 F-151 - Field Evaluation of Guardrail to Bridge Rail Connection

## Purpose

To evaluate the strength of cast-in-place and drilled-in anchors for securing guardrail end shoes to New Jersey and concrete parapet type bridge rails.

## Scope

Thirty-six anchorages will be loaded to failure; including cast-in-place "spiders," self-drilling flush-type anchors, and taper-bolt inserts set at two different distances from the end of two different types of concrete bridge rail.

## Progress Past Year

This project was closed with a summary letter report containing the results of the study. Based upon the results of this study, changes were made in the design of the anchorage. Construction of subsequent new installations and retrofits were done with the improved design. Since implementation of the results of this study have been made, no formal report will be prepared.

## 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

It is intended that two sizes of galvanized bolts be 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 will be 1-1/2 and 2 in. Anchor bolts will be tested in fatigue, both plain and galvanized.

## Progress Past Year

Static loading tests to determine the effect of nut engagement were performed on 1-1/2-in. diameter samples supplied by Central Warehouse. Additional samples for evaluation were ordered from the manufacturer. Samples expected to arrive in early 1979.

#### Planned Program for Coming Year

Complete static and fatigue testing. Issue report.

#### Title

78 F-155 - Load Distribution and Stress Measurements on the Mackinac Bridge

#### Purpose

To determine the reaction of the bridge to an applied overload; to determine the magnitude and distribution of stresses in the instrumented spans; to check the amount of composite action exhibited at a few strategic locations; to determine whether overloads applied by hauling rail-freight cars on a special truck-transporter would be detrimental to the bridge; and to gather some information concerning the stresses caused by heavy commercial vehicles that use the bridge daily.

#### Scope

Strain gages were applied at 49 locations on the structure; on two-span and four-span continuous bridges at the far northern end and on a two-span continuous portion of the suspension bridge, between towers. Loading was applied by an 11-axle, 74-tire, 80 ft long, 12-ft wide vehicle, loaded to 216,000 and 249,000 lb. Steel samples for determination of strength and impact resistance were removed from 14 locations.

#### Progress Past Year

Instrumentation and field work completed. Majority of data reduction, analysis, and report have been completed. Steel strengths were found to be within specification, and applied stresses due to the load vehicle were well within allowable limits.

#### Planned Program for Coming Year

Finish data reduction, analysis, and report.

#### Title

78 F-156 - Conenco Pot Bearings for Zilwaukee Bridge

#### Purpose

To document the long-term performance of the Conenco pot bearings.



## Scope

Conenco bearings are to be installed at 150 locations on the proposed concrete structure.

## Progress Past Year

Project plans reviewed and work plan issued.

## Planned Program for Coming Year

It is not anticipated that any time will be spent on this project until the time that the bearings are delivered to the site.

## Title

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

## Purpose

To conduct a program of skid testing, interpretation, and research.

## Scope

A systematic program of skid testing Michigan's trunkline 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

Over 12,000 skid tests were made throughout the State.

## Planned Program for Coming Year

Continue skid testing program.

## Title

54 G-74(5) - High Accident Areas (For Traffic Research) (Survey of Skid Resistance of MDOT Surfaces)

## Purpose

To skid test areas where accidents on wet surfaces are disproportionately high.

### Scope

All areas on the State trunkline system are under observation.

### Progress Past Year

About 85 locations were made and reported on.

### Planned Program for Coming Year

Continue program.

### 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

Several literature reviews were made in order to keep the Department's noise analysis and abatement effort at the current state-of-the-art level. A proposal was prepared and submitted for approval encompassing an implementation and validation program for the new FHWA traffic noise level prediction model.

### Planned Program for Coming Year

Incorporate and implement new FHWA noise level prediction model into the Department's operational noise analysis program.

### Title

72 G-190 - Improvement of Techniques for Handling Experimental Data

### Purpose

To develop continually improved data processing techniques (programming and hardware) for the Laboratory.

## Scope

This is a continuing project to design and develop programs or construct instruments for all Laboratory Units.

## Progress Past Year

Development of a digital acquisition system using auto-ranging techniques to obtain data from 16 strain gage locations. Design of an instrument to provide a non-contact measurement of displacement for the Rapid Travel Profilometer. Development of a system to measure ground vibration caused by pile drivers and vehicular traffic.

## Planned Program for Coming Year

Continue to develop new instruments or computer programs as required.

## 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 extended to include land treatment at four rest areas; odor and aerosol studies at an experimental site.

## Planned Program for Coming Year

Monitor project evaluations and subsequent progress reports as submitted.

## Title

75 G-211 - Noise Level Inventory of Michigan Freeways

## Purpose

To provide an inventory of the existing noise levels along all Michigan limited-access 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

The Department surveyed all sites identified as having an L10 83 dbA or greater noise level.

## Planned Program for Coming Year

Implement noise abatement measures for these sites and begin processing the next worst group in the inventory.

## Title

75 G-212 - Non-Discharge Recirculating Sewage System for Freeway Rest Areas

## Purpose

To evaluate Chrysler Recirculating Sewage System for use at rest areas.

## Scope

To cooperate and participate in the proposed experimental installation of a Chrysler Aqua-Sans Recirculating Sewage System for the I 275 rest area (southbound) 58171, north of Monroe.

## Progress Past Year

Aqua-Sans unit inspected and tested.

## Planned Program for Coming Year

Complete inspection and evaluation procedures; write interim report.

Title

75 G-213 - Erosion Control and Turf Establishment on Roadside Slopes

Purpose

To assess the relative performance of three methods of turf establishment and erosion control under field conditions.

Scope

To provide assistance for evaluating the comparative performance of these methods; for determining the most feasible and economical way of controlling erosion; and for establishing roadside turf on selected projects.

Progress Past Year

Project completed and final report under review by Construction Division.

Planned Program for Coming Year

Complete final report and close project.

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 joints on 7 miles of two-lane concrete pavement were restored to their intended function by repairing groove spalls. Three types of mortar were used. Evaluation surveys of previously repaired pavement sections were conducted. The procedures were accepted by the Department and a

12-mile section of I 75 in Arenac County has been selected for contract repairs.

#### Planned Program for Coming Year

In cooperation with the Design Division a proposal for a contract on the I 75 section will be prepared for bids in June. Observation of the repair work will be made. Evaluation of the experimental repairs will be continued.

A final report on the experimental phase of the work is planned.

#### Title

77 G-225 - Evaluation of Effectiveness of Asphalt Rubber Interlayer and Seal Coat in Preventing Reflection Cracking

#### Purpose

To evaluate the effectiveness of asphalt-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

Construction was completed on a 4-mile experimental installation of the asphalt-rubber stress absorbing membrane as an interlayer.

#### Planned Program for Coming Year

A report on the construction phase is being prepared. Condition surveys will be conducted and compared to preconstruction surveys to evaluate performance. A project utilizing asphalt rubber as a seal coat is being planned for the coming construction season.

#### Title

78 G-232 - Development of 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

Thirty railroad crossings were profiled from a list of 130 local locations using a Rapid Travel Profilometer.

## Planned Program for Coming Year

The recorded profile data will be processed to obtain digital profiles for each railroad crossing. From this information a "mean squares" value will be calculated to obtain a measure of performance for the overall crossing, the approach pavement, leaving slab, and the crossing materials.

## 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 requirements for the size of the solar array and battery capacity have been determined using data on the availability of solar radiation at the site. Solar panels, voltage regulators, battery box, and railroad signal equipment have been ordered.

## Planned Program for Coming Year

Install rail crossing safety equipment, control sensors, and solar equipment. Design, construct, and install instrumentation to monitor the flow of power within the system. Evaluate the durability of photocells, amount of time during which electrical energy can be produced, the adequacy of reserve battery capacity, and gather data on system maintenance problems.

### 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. This process has been used in Germany and on the Pennsylvania Turnpike.

### Scope

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

### Progress Past Year

Work plan submitted and approved by Engineering Operations Committee.

## Planned Program for Coming Year

Locate test site and initiate construction project.

### Title

78 G-241 - Effect of Corrosion on Bridges of Unpainted A 588 Steel and Painted Steel Types

### Purpose

To quantify the corrosion rates and total section loss due to corrosion on unpainted A 588 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.

### Scope

This investigation is aimed primarily at the over 600 bridges in Michigan that are constructed of unpainted A 588 steel. Field investigations have revealed that some adverse environments and salt leakage have caused rapid deterioration of the unpainted steels.

### Progress Past Year

The project was initiated in late October 1978. Some preliminary data were gathered showing significant loss of section due to accelerated corrosion on unpainted bridge members.

### Planned Program for Coming Year

The majority of the proposed field investigation will hopefully be completed in the coming year. Laboratory work will be carried out to evaluate the ability of various paint systems to perform on salt-contaminated steel.

## RESEARCH LABORATORY SALARIES AND WAGES

Starting in January 1979, the Department's computer has been keeping track of the salaries and wages for the employees of the Research Laboratory so that we can obtain an accurate record of the areas of research where those monies have been spent. Salaries and wages are by far the greatest cost factor in these studies and, therefore, we implemented this phase of the program first. Prior to January, an Activity Time Schedule had been prepared by each employee which showed the projects worked on during each two-week period. However, it was not possible without the use of the computer to tabulate these costs biweekly into the cost for each research project. However, during 1978 the Research Laboratory worked with the Computer Services Division to develop the present system. Our latest tabulation of costs per research project is for the January 8 to October 13, 1978 period (about nine months). These project costs will be valuable in several ways; for review of projects, attempting to promote studies which are most cost-effective, prioritizing projects, etc.

SALARIES AND WAGES  
RESEARCH LABORATORY PROJECT COSTS  
January 8, 1978 to October 13, 1978

Research Project Number	Research Project Title	Costs
76 A-26	Comparison of Laboratory Tests with Field Performance of Aggregates	\$ 7,448.69
57 B-39	Use of Latex Concrete in Restoration of Bridge Structures	\$ 15,632.30
72 B-90	Experimental Use of a Water Reducer in Slip-Form Con- crete Pavement	-0-
72 B-91	Evaluation of Pozzolanic Cement in Concrete on Riding Quality of Slip-Form Paving	4,345.58
72 B-92	Experimental Bridge Deck Surfacing Methods 1) Revibrated Concrete 2) Bonded Conventional Overlay 3) Bonded Latex Mortar Overlay	240.67
75 B-93	Low Slump Concrete Overlay for Bridge Decks (Iowa Mix)	3,459.54
75 B-94	Study of Type IS-A Cement with Water Reducer	153.03
76 B-95	Experimental "Econocrete" Ramp Construction	150.72
77 B-96	Experimental "Econocrete" Shoulders	3,025.98
78 B-98	Experimental Resurfacing of Chloride Bridge Decks With Latex Modified Concrete	90.02
78 B-99	Recycling of Concrete Pavement	423.80
	Total	\$ 27,521.64
71 C-13	Study of Aggregate and Mix Requirements for Durable and Skid-Resistant Bituminous Concrete	\$ 6,791.11
72 C-14	Evaluation of Gussasphalt Surfacing Material	-0-
73 C-16	Experimental Trinidad Asphalt Resurfacing	1,103.57
76 C-17	Evaluation of Heater Scarifier Methods for Recycling Asphalt Pavements	116.62
77 C-18	* Evaluation of the Performance of Bituminous Wearing Course Containing Arenaceous Limestone	300.16
78 C-19	Evaluation of Sprinkle Treatment for Improving Skid Re- sistance of Asphalt Surfaces	732.64
	Total	\$ 9,044.10
68 D-26	Evaluation of Nuclear Gage for Bituminous Concrete Test- ing	-0-
73 D-28	Experimental Evaluation of Wet Bottom Slag for Bituminous Wearing Course for Shoulders	\$ 167.99
74 D-29	Sulfur in Bituminous Mixtures	5,452.72
75 D-30	Recycling of Asphalt Pavement, I 75, Indian River South	3,086.73
75 D-32	Reclaimed Rubber in Asphalt Paving Mixes	5,415.82
77 D-33	Effectiveness of Infra-Red Joint Heaters for Bituminous Pavement	3,140.64

Research Project Number	Research Project Title	Costs
77 D-34	Asphalt Pavement Recycling by the Heat Transfer Method	\$ 1,890.32
77 D-35	Drum Mixer Recycling of Asphalt Pavement	2,295.76
78 D-36	Study of Good and Poor Performing Flexible Pavements	5,800.05
78 D-37	Evaluation of Sulfur Extended Asphalt for Bituminous Resurfacing Mixtures	-0-
	Total	\$ 27,250.03
57 E-15	Sodium Chloride Stabilization, M 46, From Newaygo-Montcalm County Line West	\$ 1,181.20
68 E-42	Evaluation of Component Layers in Bituminous Pavement Design	12,741.55
68 E-43	Feasibility of Open Hearth Slag for Bases	2,925.76
71 E-49	Development of Soil Support Values and Coefficients of Relative Strengths of Michigan Highway Soils	2,992.14
72 E-50	Performance of Drains in Concrete Shoulders - I 69, Butterfield and Ainger Road Interchanges	-0-
73 E-52	Developing Laboratory Procedures for Nuclear Soil and Asphalt Gages	-0-
74 E-53	Development of a Field Permeability Test	1,161.39
74 E-54	Use of Low Density Concrete as a Light Fill Material to Reduce Road Settlement	2,516.21
75 E-55	Evaluation of Black Base at Canal Road Secondary Governmental Complex	206.56
75 E-57	Evaluation of the Particle Index for Measuring the Influence of Coarse Aggregate Fraction on Stability of Granular Mixtures	143.92
75 E-58	Relationship Between Pavement Performance and Subsurface Drainage Conditions	1,655.04
75 E-59	Comparative Study on Performance of Bituminous Stabilized Bases, M 60 and M 20	8,954.72
75 E-60	Use of Frost Indicators and Benkelman Beams to Determine when Load Restrictions should be Lifted	16,085.85
	Total	\$ 50,564.34
39 F-7(14)	Performance of Postwar Pavements (Concrete Pavement Design)	\$ 9,541.52
57 F-46	Continuously Reinforced Test Project, I 96, M 66 to Portland	707.61
59 F-53(1) and 53(2)	Deck Repairs, B01 of 59022 (M 57 Over Flat River, Greenville) (Sealant Coatings for Bridge Decks)	-0-
60 F-58(2)	Forming Contraction Joints with Hollow Plastic Temp. Filler, I 96 East of M 99	-0-
61 F-64(1)	Continuously Reinforced Pavement (Seaway Freeway-Fisher Freeway)	4,015.28
65 F-82	The Effects of Safety Studded Tires on Pavement Surfaces	958.41
67 F-95	Evaluation of Acme Load-Transfer Devices	708.69
68 F-101	Concrete Shoulder Construction	1,641.27
68 F-103	Galvanized Reinforcing Steel in Concrete Bridge Decks	2,897.29
69 F-104	Plastic-Coated Dowels for Pavement Joints	64.47

Research Project Number	Research Project Title	Costs
69 F-105	Effects of Transverse Sawcutting PCCP on Reflection Cracking	-0-
69 F-111	Construction and Performance Evaluation of Mixed-In-Place Bituminous Stabilized Shoulder	\$ 50.24
70 F-113	Non-Reinforced Concrete Pavement Ramps	1,360.27
70 F-114	Broomed Concrete Pavement Surface	171.60
70 F-116	Experimental Joint Spacing Project	760.16
70 F-118	Development of Procedures for Replacing Joints in Concrete Pavements	2,454.74
71 F-122	Experimental Pressure Relief Joints, US 23 North of M 36	94.08
72 F-123	Comparative Field Study of Joint Repair Techniques	240.54
72 F-126	Experimental (Type 1) Concrete and Bituminous Shoulders	26.95
72 F-128	Evaluation of Various Bridge Deck Joint Systems	2,154.93
73 F-129	Evaluation of Slipform Paving Methods for CRCP	5,302.25
73 F-131	Epoxy Coated Rebars for Bridge Decks	3,906.89
73 F-135	Experimental Concrete Glare Screen, I 696	88.12
73 F-136	Experimental Short Slab Pavements	832.70
74 F-138	Review of Special Permits for Overloaded Vehicles	-0-
74 F-139	Laminations and Other Rolling Flaws in Structural Steel Plates and Shapes	329.15
74 F-140	Maintenance Procedures to Prevent Blowup of Concrete Pavement Joints	9,313.31
74 F-141	Epoxy Injection for Concrete Repair (Kansas Method)	6,344.81
75 F-142	Predesign Evaluation of Pavement Serviceability	-0-
75 F-143	Evaluation of Various Types of Railroad Crossings	7,639.72
75 F-144	Bridge Girder Butt Welds - Resistance to Brittle Fracture and Corrosion	18,892.78
75 F-145	Rehabilitation of Old Concrete Pavement, US 2	225.08
75 F-146	Steel Analysis for Statewide Inventory of Trunkline Structures	1,016.18
75 F-147	Pavement Riding Quality	11,788.07
75 F-148	Pavement Roughness for Non-Reinforced Ramps and Service Roads	-0-
75 F-149	Experimental Project for Variable Spacing of Expansion Joints	-0-
75 F-150	Experimental Project Concerning Joints for Concrete Pavement Repairs	1,932.76
76 F-151	Experimental Testing of Guardrail to Bridgerail Connection	1,066.53
77 F-152	Calibration and Correlation of Response-Type Road Roughness Measuring Systems	300.16
77 F-153	Static and Dynamic Properties of Anchor Bolts for Sign Supports	1,259.12
78 F-154	Evaluation of Promising Proprietary Bridge Deck Expansion Joint Device	2,120.44
78 F-155	Live Load Study of Mackinac Bridge	37,906.26
	Total	\$138,112.38

Research Project Number	Research Project Title	Costs
43 G-23	Compilation of Design, Construction Data for Concrete Pavement	\$ 4,039.69
47 G-36	Glass Beads for Pavement Marking (Investigation of Reflective Traffic Marking Materials and Methods)	5,475.64
49 G-50	Study of Protective Coatings for Structural Steel	5,640.24
59 G-50(6)	Topcoat Paint Peeling on Structures	
51 G-54	Revision of Standard Specifications for Reflectorized Signs and Reflective Materials	1,623.36
54 G-73 or (3)	Investigation of Traffic Control Devices	20.50
54 G-74	Survey of Skid Resistance of MSHD Surfaces	46,506.45
54 G-74(5)	High Accident Areas (For Traffic Research )	
57 G-87 or (1)	Revision of Existing Paint Specifications	8,543.18
60 G-102(2)	Evaluation of Aluminum Coated Bolts for Bridge Railing Posts	-0-
62 G-114	Peeling of Paint on Pressure Treated Posts	50.24
62 G-116 or (3)	Extruded Neoprene Joint Sealer, Including I 96 from Waverly Road to M 99	926.88
62 G-122	Use of Low-Alloy Steels in Highway End-Uses	274.86
67 G-157	Evaluation of Bridge Deck Surfacing for Orthotropic Bridge on I 496, Crietz Road	195.92
71 G-177	Estimation of Quantities of Bituminous Resurfacing by Computer Simulation	6,021.96
71 G-178	Survey of Wood Guardrail Post Deterioration	257.40
71 G-180	Effect of De-Icing Salts on the Chloride Levels in Waters Adjacent to Roadways	9,238.21
71 G-182	Investigation of Air Quality Test Equipment and Procedures	46,522.94
72 G-188	Experimental Preformed Waterproofing Membranes for Concrete Bridge Decks	50.24
72 G-189	Sources and Effects of Environmental Noise	9,093.22
72 G-190	Improvement of Electronic Techniques for Handling Experimental Data	1,206.07
73 G-192	Glare Criteria for Advertising Signs	22.32
73 G-195	Effectiveness of Neoprene Seals in Preventing Pavement Joint Deterioration	424.96
73 G-196	Tower Lighting Evaluation I 696 and I 75 Interchange	1,073.84
73 G-197	Evaluation of Galvanized Structural Steel Protection of Bridges	-0-
73 G-198	Specification Revisions for Street Lighting	333.38
73 G-199	Investigation of Performance of Neoprene Joint Seals of Several Manufacturers	-0-
73 G-200	Evaluation of Water Quality Resulting from I 696 Skimmer Tank	35.11
74 G-205	Pre-Engineering for Bridge Deck Rehabilitation	16,857.54
74 G-207	Rest Area Sewerage Systems	832.32
74 G-210	Bituminous Aggregate Resurfacing with High Shale Content Aggregates	-0-
75 G-211	Noise Level Inventory of Michigan Freeways	5,113.67
75 G-212	No Discharge Recirculating Sewerage System for Freeway Rest Areas (I 275 Rest Area North of Monroe)	1,360.80

Research Project Number	Research Project Title	Costs
75 G-213	Modified Procedures for Erosion Control and Turf Establishment on Roadside Slopes	\$ 905.76
75 G-214	Experimental Installation of Forward Glare Screen, I 94 and M 39	320.66
75 G-215	Pavement Feedback System	5,721.12
75 G-217	Maintenance of Neoprene Sealed Concrete Pavements	11,818.12
76 G-219	Alternate More Economical Repainting Systems for Structural Steel	312.02
76 G-221	Investigating the Feasibility of Implementing "SAMPL 6" in Michigan Flexible Pavement Design	5,819.28
76 G-222	Statistical Analysis of Aggregate Base Course Inspected by End Result Aggregate Specification	1,365.67
76 G-223	Statewide Accident Prediction Model	552.47
77 G-224	Evaluation of Urethane Pressure Relief Joints, US 27 Ithaca to North of Clare	1,323.85
77 G-225	Rubberized Asphalt Stress Relieving Membranes	8,470.11
77 G-226	Evaluation of Factors Affecting Snow Drifts	151.20
77 G-227	Salt Monitoring - Reed City Maintenance Garage	1,639.55
77 G-228	A Study of Water Based Paint Systems for Protective Coatings for Steel Structures	145.34
77 G-229	Further Research on Reflectorized Flagmen's Vests	4,016.85
77 G-230	Development of Non-Proprietary Specifications for Inorganic Zinc-Rich Coating Systems	2,232.30
77 G-231	Means of Preventing Bridge Deck Icing Phenomenon	1,020.11
78 G-232	A Study to Develop a Roughness Rating System for Highway Railroad Grade Crossings	1,975.45
78 G-233	Evaluation of Materials for Seal Coat Applications	280.80
78 G-234	Construction and Testing of an Instrument to Measure the Night Visibility of Traffic Paints	723.89
78 G-235	Air Quality Measurements for Movable Asphalt Plants for Recycling Paving Asphalt	7,193.06
78 G-236	Effects of Box Culvert Length on Fish Migration	2,427.82
78 G-237	Feasibility of Solar Power Installation for Railroad Grade Crossing	-0-
78 G-238	Implementation of Modern Statistical Methods for Improving the Accuracy of Highway Laboratory and Field Data	816.93
78 G-239	Comprehensive Analysis of Skid Resistance Data	15.49
78 G-240	Evaluation of Shattering Existing Concrete Pavement Prior to Overlaying for Reducing Reflection Cracking	161.28
78 G-241	Effects of Corrosion on Bridges of Unpainted A 588 Steel and Painted Steel Types	450.93
	Total	\$231,601.00
	NEW MATERIALS	\$ 33,393.76
	TECHNICAL INVESTIGATIONS	\$141,096.63

Research Project Number	Research Project Title	Costs
75 AP-5(A)	Air Quality Impact, I 69/US 127 to East Clinton County Line	\$ 86.25
77 AP-14(A)	Air Quality, M 51 Relocation - City of Niles	2,066.56
77 AP-14(N)	Noise Impact, M 51 Relocation - City of Niles	247.56
77 AP-15(A)	Air Quality, M 53 Corridor Study, 8 Mile to I 696 Macomb County	37.52
77 AP-16(A)	Air Quality, Control Section 82081 M 153 (Ford Road) Widening From I 275 to Venoy Road	291.46
77 AP-19(A)	Air Quality Impact at Ambassador Bridge Rest Area	213.97
78 AP-21(A)	Revision of Air Quality Report for I 69 From US 127 to Morrice	640.48
78 AP-22(A)	Air Quality Analysis I 94 Merriman-Middlebelt Road Interchange, City of Romulus, Wayne County	2,987.27
78 AP-23(A)	Updating Air Quality Report I 94 Widening-Wiard Road Interchange	314.11
	Total	\$ 6,885.18
	Sick Leave, Annual Leave, Holiday	
ACCTG	Acceptance Testing	\$ 43,059.30
ADOVD	Administrative Overhead	200,439.71
CODIV	Consultations with Other Divisions	7,262.89
C0000	Department and National Committees	5,295.34
DCTEO	Development and Construction of Test Equipment	14,557.00
MSRLE	Maintenance, Servicing, and Repair of Laboratory Testing Equipment	46,795.37
PGOTR	Publications and Graphics for Other Testing and Research Sections	5,988.14
RTL00	Review of Technical Literature	17,796.22
SPEC0	Review of Specifications	7,502.24
	SUMMARY TOTAL	\$1,012,290.58