

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



**TESTING AND RESEARCH DIVISION  
RESEARCH LABORATORY SECTION**

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

Research Laboratory Section  
Testing and Research Division  
Research Report No. R-1187

Michigan Transportation Commission  
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## INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1981 calendar year. By better informing Department personnel of these activities, we hope to implement the research which is being conducted, and to integrate our research findings into Department practice.

The report is divided into seven sections. The first section outlines some of the highlights of the past year's research. Section two consists of a general index of reports and projects. Section three contains abstracts of all Research Reports published during 1981. The fourth section contains a list of New Materials projects completed during the year, the fifth section is a listing of Technical Investigations completed during the year, and the sixth section lists the Action Plans completed during the year. The seventh section lists the title, purpose, scope, progress past year, projected activities for the coming year, and salaries and wages for 1981, for all active Departmental and Highway Planning and Research projects (H. P. & R. projects are denoted by an asterisk).

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

## RESEARCH HIGHLIGHTS - 1981

A report was completed, to be published in 1982, concerning the five-year performance of the first preventive maintenance contracts on 279 lane miles of I 75 and I 696. This project was intended to see what effect certain preventive maintenance procedures (primarily joint repair and added expansion space for pressure relief) had on the prevention of blow-ups on older pavements. The evaluation showed that the intended five-year extension period had passed without requiring emergency repairs by use of these methods. Major differences in the performance of the various projects were determined, and seem to be related primarily to the quality of the coarse aggregate used in concrete mixes.

Also in the area of maintaining and prolonging the lives of our pavements, the Laboratory has been testing several types of tied pavement joints between pavement joint replacement areas (new concrete) and the existing pavements at either end of the repair. The project is included in the Federal Highway Administration's National Experimental and Evaluation Program (NEEP) as a 'Portland Cement Concrete Pavement Joint Restoration and Rehabilitation' project. The first stage of the project was completed last summer; namely, construction of two types of tied joints to ascertain the feasibility of using them. The study concluded that these methods were of practical applicability, and it is now planned to construct and test the experimental joints on a high commercial volume route. The third stage of the study, construction of non-faulting joint repairs on a contract basis, is scheduled for 1983.

In our quest for new paving materials, 'Sulphlex,' a plasticized sulfur compound, was used to replace asphalt cement for an experimental resurfacing project on M 54 in Genesee County. This was one of seven experimental projects sponsored throughout the country by the Federal Highway Administration in an effort to find suitable substitutes for the petroleum derivatives now used in the construction of highways. We have also continued to evaluate the pavement recycling projects that the Department has installed over the past four years.

Six years ago, the Department installed some shoulders whose bituminous wearing course was constructed by using wet-bottom slag, thus resulting in a darker color which contrasted with the pavement in the hopes of providing better shoulder/pavement delineation. Using telephotometry techniques from the driver's position, the day and night visual contrasts between these shoulders and the pavement were measured, and it was found that after six years, the shoulder was still perceptibly darker than the pavement, providing adequate delineation of the shoulder for motorists.

The use of a superplasticizer in fast-set concrete mixes containing calcium chloride as a set accelerator was tested in the Laboratory to determine if its use would increase concrete workability without sacrificing early strength. A field trial is planned for 1982, since the laboratory work showed that the mix workability was improved, and about a 20 percent reduction in cement may be possible without early strength reduction, providing the curing temperature is held at about 100-degrees Fahrenheit. Samples of a mix of low-slump high-density concrete with a superplasticizer added, and some without the additive, are being tested in the laboratory to determine concrete properties. This type of mix was used on a bridge deck overlay in Detroit, and the workability of the mix was improved, thereby making the finishing operations easier and producing a smoother riding deck. Research on these promising admixtures is continuing.

In order to provide the various services required of the Research Laboratory, we are continually keeping abreast of new developments in equipment and research techniques. New instrumentation in our structures laboratory, called acoustic emission monitoring equipment, has been obtained for the non-destructive evaluation of the growth of flaws in metals. This equipment is able to 'hear' the sound emitted by spreading flaws in parts subjected to stress, and to locate the flaws in the parts. This is valuable in research related to fatigue in weldments and metal structures. Fatigue failures originate as extremely tiny cracks and grow larger with repeated loading. This equipment is able to identify the existence of flaws long before they are large enough to be found by more conventional techniques.

In the area of sign material technology, gas chromatographic and infrared spectrophotometric procedures were developed which permit identification of the manufacturer of reflective sheeting removed from signs, even after several years of weathering and deterioration in the field. A simple humidity chamber procedure was also developed to evaluate high-intensity reflective sheeting as to whether it would wrinkle after application to a sign face and exposure to the elements.

Our soils engineers and technicians succeeded in modifying repetitive loading equipment so that axle load weights and configurations, encountered in highway use, can be duplicated in the laboratory for testing pavement surfacing and base layers.

In cooperation with the Tuscola and Saginaw Bay Railroad, a solar-powered railroad crossing signal has been installed. The grade crossing, located on M 15 south of Vassar, is a 500-watt solar voltaic array designed to charge six 12-volt batteries. The electrical energy stored provides

power for flashers and bells, and operates the safety gates. The system has the capacity to power these devices for 15 days without sunshine, and in the event that sufficient power is unavailable, a utility connected battery charger will recharge the system. The system was monitored by an independent electronic recording system, and this indicated that the solar powered gear worked flawlessly on solar power, never having to resort to the back-up recharging system.

Our Statistical Analysis Unit has been engaged in studying in-place gradation testing procedures for 22A aggregate. The analyses have shown that 'sequential' acceptance plans could reduce testing by as much as 40 percent, with very little increase in decision risk to the Department. The proposed procedure would make continued testing of available field samples contingent on early results. The same approach should be feasible in other areas of acceptance testing. In another project, statistical procedures have been developed which improve the overall accuracy of lists of numerical estimates such as averages, proportions, etc. These procedures are particularly useful to any type of priority decision making which requires such lists. Depending on numerical reliabilities, relative rankings of skid coefficients, accident rates, roughness indices, etc., can shift dramatically when revised according to these procedures.

The Laboratory continued to provide its services to other Divisions and agencies as requested, including air quality analyses of the area of the Lodge Freeway running beneath Cobo Hall in Detroit, in highway maintenance garages, and at interchange sites where complaints have been registered. Several airport beacon lamps were checked against Federal standards (the results being given at the annual Engineering Conference of the Michigan Aeronautics Commission) and reference standards provided to the Wayne County Road Commission for calibrating their portable sign photometer. Vibration and elevation monitoring was undertaken of 50-year old high-voltage power transmission towers adjacent to the new Saginaw River bridge at Zilwaukee during pile driving for the new bridge piers, and a variety of other investigations utilizing the specialized expertise of Research Laboratory personnel and equipment were performed during the year.

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ABSTRACTS OF RESEARCH REPORTS  
(January 1981 Through December 1981)

- R-1158 - "The Relationship of Aggregate Durability to Concrete Pavement Performance, and the Associated Effects of Base Drainability," (73 F-136). C. J. Arnold

Two different types of bituminous-stabilized base were used on the experimental section of US 10 near Clare; one very porous and free-draining, the other a dense, impervious base. After about four years, faulting (up to nearly 3/4 in.) was prevalent in the impervious base sections. It was found that water in considerable quantity was entering through the pavement/shoulder joint and, once it entered, had nowhere to go, leaving the pavement, during wet periods, in a 'bath tub' environment. Coring showed that the joint faces and bottom of the pavement slab were deteriorating by deep scaling of the mortar fraction. This debris was being pumped by traffic traversing the roadway because of the captive water between the pavement and the base. Moreover, these same sections of impervious base also showed preliminary signs of the D-cracking phenomenon at less than four years of age. Another project, of about 20 years age and using the same coarse aggregate source was studied. On one portion of the project, the coarse aggregate had been blended with a higher quality material, and showed marked superiority over the non-blended section. It is clear that D-cracking is becoming a problem in Michigan, and further research is suggested in identifying the aggregate sources that are susceptible to it, instigating the necessary corrective action, and developing more rapid test methods for identifying such susceptible material.

- R-1159 - "Petrographic Analysis of Coarse Aggregate: Salem Gr. Construction Co. Pit No. 63-65 (Testing Laboratory Sample Nos. 80 A-1089, 1090, 1092, and 1093)." R. W. Muethel

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

- R-1160 - "Final Report of Research Project 75 E-55, Evaluation of Cold-Mix Emulsion Black Base at the Secondary Complex," (75 E-55). L. T. Oehler

This FHWA Category 2 experimental project involved placing an MS-2S emulsified asphalt cold-mix black base on the same job as a 'conventional'

black base (treated with a hot-mix penetration grade bitumen) in order to compare them. Serious construction problems were encountered, as it was almost impossible to dry the MS-2S mixture to a point where adequate stability could be obtained. Various efforts at stabilization were not altogether successful and about half of the material was eventually removed and replaced. Although there are many applications where emulsions may be useful, its use as a base stabilization agent is not practical unless further developmental work is done.

R-1161 - "Weatherability of Map Displays," (80 TI-695).

Because of fading maps, displayed in highway rest areas, accelerated weather testing of an unfaced map, and a map encapsulated in plexiglas, was performed at the request of the Department's Technical Services Division. It was found that the plastic-encased map would last a much longer time than an unfaced map with respect to fading. A less expensive encapsulating material was also suggested.

R-1162 - "Airport Beacon L-801A Photometric Test," (81 TI-726).

Lamps from the Capital City Airport beacon were tested for intensity and intensity distribution. A method for estimating the effective intensity of rotating beacons was applied. Results indicated that the lamps, as submitted, have intensity and intensity distribution deficiencies.

R-1163 - "Annual Report of Activities of the Michigan Department of Transportation Research Laboratory."

R-1164 - "Evaluation of Timber Piles from Fort St Bridge," (80 TI-722).  
C. J. Arnold and M. A. Chiunti

At the request of the Attorney General's office, samples of timber piling from the fender system of the Fort St bascule bridge were evaluated. This was initiated because a frieghter struck the piling cluster, and an opinion was requested as to the soundness of the pilings. The various tests performed are described in the report, which concludes that the pilings were in sound condition.

R-1165 - "Simplified Technique for Traffic Noise Level Estimation," (72 G-189). F. W. Harwood and M. E. Scarlata

This report is primarily intended for use by cities and counties in the State for predicting noise levels at sites very near to at-grade roadways carrying low speed, low volume traffic. It provides state-of-the-art values

based upon Federally recommended noise prediction procedures in tabular form. This report replaces an earlier one (MDOT Research Report No. R-946, December 1974) and substitutes the currently used ' $L_{eq}$  dbA' traffic noise level values for the older ' $L_{10}$  dbA' levels.

R-1166 - "Air Quality Report for M 275 in Oakland County," (80 AP-31A).

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 that includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. Total pollutant burden for the alternates is also given. The estimated concentrations of carbon monoxide, including existing background, at all receptor sites for both alternates of the proposed project are within Federal air quality standards.

R-1167 - "American Decal Reflective Sheeting," (78 TI-493). M. H. Janson

This manufacturer's reflective sheeting has been considered an approved material, but had not been tested for a number of years. Samples of white, yellow, orange, green, and red—both pressure sensitive and heat activated—were requested from the manufacturer. Tests applicable to Type 2 reflective sheeting (adhesion, cold shock, flexibility, liner removal, luminance wet, impact, shrinkage, solvent, peeling, water immersion; and both initial luminance, color, and reflectance, and luminance, color and reflectance after 1,200 hours of artificial weathering) were performed. The results are discussed in this report and presented in tabular form.

R-1168 - "Field Evaluation of 3M and American Decal Reflective Signing Materials," (78 TI-493). J. D. Truax, G. M. Smith, and M. H. Janson

This report presents the results of a field evaluation of two different brands of Type 2 engineering grade reflective sheeting. Measurements were taken soon after installation in 1972 and the signs were under observation until they were replaced in 1980. Six years of weathering resulted in little significant effect on luminance for either material, and a casual observer would probably notice little difference after dark. Significant peeling was noted on the 3M material, which rendered its daytime appearance poorer than the Adcolite.

R-1169 - "Jointed Concrete Pavements: Design, Performance, and Repair," (68 F-101, 70 F-113, 70 F-116, 71 F-122, 73 F-136, and 74 F-140). C. J. Arnold, M. A. Chiunti, and K. S. Bancroft

Background information is presented concerning the performance and problems related to postwar pavements with 99-ft reinforced slabs, load transfer, and base plates under the joints. Newer pavements have been designed with successively shorter slab lengths and still use load transfer and reinforcement. An experimental installation having extreme variations in drainability is discussed and the effects of base drainage on the performance of the concrete pavement as well as the inter-relationships with aggregate quality are demonstrated. Highly variable performance with changes in coarse aggregate source is shown as well. Pavement joint faulting due to rearrangement of fine base materials is shown. The effects of pressure build-up in older pavements is discussed, along with strategies for pressure relief, experimental pressure relief projects, preventive maintenance, and the development of techniques for locating pressure relief joints and installing joint filler. A rating system is presented for evaluation of joint condition, selection of joints for replacement, and determination of the rates of deterioration of various sections of roadway. A few details of concrete shoulder design and some examples of compatible slab length considerations are suggested along with brief comments on corrosion resistant load transfer dowels.

R-1170 - "Summaries of Michigan Pavement Friction Measurements - 1979 Test Program," (54 G-74). P. M. Schafer

This year's annual survey reports the results of over 13,800 pavement friction tests conducted throughout the State with the Department's pavement friction test vehicles. New conventional portland cement concrete and new conventional asphaltic concrete pavements were given an initial testing in order to determine their pavement frictions in terms of coefficients of wet sliding friction. Friction levels were determined for both types of pavement projects after five, ten, and fifteen years of service and reported herein. Additionally, an inventory of pavement friction results on both concrete and bituminous pavements constructed before 1963 is included, as well as pavement friction tests on certain experimental resurfacing projects intended to monitor their effectiveness. Also included in the report are the results of friction tests at high-accident locations, determined by the Traffic and Safety Division to indicate priorities for resurfacing. A section is included of pavement friction 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 whose coefficients of wet sliding friction might require some priority

action. Although all pavement friction test results for 1979 are included in this report, the High-Accident, Special Request, and Special Attention locations are reported out via letter immediately after testing to the parties concerned. It should be noted that these 1979 results are the last to utilize our old friction coefficient numbers. Next year's (1980) results will use the new standardized 'FN' number.

R-1171 - "Concrete Pavement Performance Problems and Foundation Investigation of I 75 from the Ohio Line Northerly to the Huron River," (80 TI-669). J. E. Simonsen and E. C. Novak, Jr.

This report deals with the results of surveys conducted to establish the extent of cracking on the subject pavement and checking concrete cores for concrete strength and condition of steel reinforcement, as well as to determine the performance of the pavement's foundation. In essence, the investigation revealed that the major cause seemed to be inadequate drainage of the base and subbase. Following the recommendations of this report, the Department installed edge drains along the poorer drainage areas.

R-1172 - "Petrographic Analysis of Coarse Aggregate Extracted from Bituminous Pavement Cores, M 55, Control Section No. 83021, 16035A," (78 TI-510). R. W. Muethel

A sample of coarse aggregate which was extracted from bituminous pavement cores was submitted to the Research Laboratory's Materials Research Unit for petrographic analysis. The general petrographic composition of the material is included in this report, as are observations of the condition of the individual lithologies.

R-1173 - "Surface Texture Measurements by the Putty Impression Method," (54 G-74). C. A. Zapata

In negligence cases involving wet pavement skidding accidents and alleging hydroplaning, equations relating water depths to such factors as rainfall intensity, cross-slope, drainage path, and surface texture have been used by some plaintiffs. This report investigates the relative precision of texture depth measurements as used in the Texas Transportation Institute model for estimating water depths. This limited testing, done in the laboratory where conditions are to be expected to be less susceptible to variations than in the field, showed testing errors in texture measurements by the putty impression method can result in 20 to 200 percent variations in the calculated values of water depth obtained by the TTI equation. It is recommended that a field testing program be initiated to establish

practical limits for sampling and testing error in texture depths as measured by the putty impression method.

R-1174 - "Petrographic Analysis of Coarse Aggregate: Wallace Stone Co. Pit No. 32-4 (Testing Laboratory Sample No. 81 A-843)," (78 TI-510). R. W. Muethel

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

R-1175 - "An Inventory of Traffic Noise Levels Along Limited Access Freeways in Michigan," (75 G-211). M. E. Scarlata and F. W. Harwood

An inventory of the noise levels in the residential areas along Michigan's limited access freeways is reported herein. Its purpose is to provide guidance for decisions on noise abatement projects. A total of 3,326.6 roadway frontage miles (each mile of freeway having two miles of roadway frontage) were physically inventoried, and the noise levels they are experiencing are given in the report. The cost of applying noise abatement procedures along the areas where it is reasonable and feasible to do so is estimated at over 152 million dollars; the State's share being nearly 30 million dollars.

R-1176 - "Petrographic Analysis of Crushed Stone Coarse Aggregate: Michigan Foundation Pit No. 82-6 (Testing Laboratory Sample No. 81 A-462)," (78 TI-510). R. W. Muethel

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

R-1177 - "Airport Beacon L-801A Photometric Test," (81 TI-726).

Two airport beacon lamps were tested for intensity and intensity distribution. A method for estimating the effective intensity of rotating beacons was applied. Results reported here indicate that the lamps have intensity deficiencies but they can provide acceptable effective intensities.

R-1178 - "A Study of Seasonal Variation in Pavement Conditions by Means of Benkelman Beam Deflection and Frost Depth Measurements," (75 E-60). R. C. Mainfort

This reports upon a pilot study, conducted at seven sites in the Upper Peninsula, to check the feasibility of using frost depth indicators and Benkelman beam deflection measurements for determining when springtime load restrictions should be lifted from roadways. Development of such procedures should provide a more positive method for evaluating pavement support conditions during and immediately following the spring thaw and furnish information for evaluating overload requests. A method developed by the Minnesota Department of Highways was used for measuring and evaluating seasonal variation in the deflection of the test areas. In general the findings of this project were encouraging, but it is to be continued in order to evaluate and compare any changes from year to year that might affect results.

R-1179 - "PCC Pavement Joint Restoration and Rehabilitation," (79 F-159). J. E. Simonsen, F. J. Bashore, and A. W. Price

This is the initial report on the development of a transverse joint repair procedure under the FHWA NEEP Project 27. The report describes two types of tied joint for use between existing and new concrete pavement slabs that can be constructed rapidly without extensive hand labor and when used in conjunction with a doweled joint at the center of the repair provides necessary load transfer, thus eliminating faulting. Both types of joint were tied with No. 6 bars, cemented with an epoxy grout, into holes drilled into the faces of the existing slabs; the difference being that to provide necessary shear strength, one type utilized a 1/4-in. step sawed into the existing slab faces at about mid-slab depth, the other type used the epoxy binder to coat the vertical end faces of the slabs. The repairs proved feasible and it is now intended to proceed with a major repair project using tied joints with load transfer.

R-1180R - "Fasign Reflective Sheeting," (80 TI-707). M. H. Janson

Samples of white, red, orange, yellow, green, and blue reflective sheeting—both pressure sensitive and heat activated—were submitted by the manufacturer for testing. Tests applicable to Type 2 reflective sheeting (adhesion, cold shock, flexibility, liner removal, luminance wet, impact, solvent resistance, peeling, water immersion; and both initial luminance, color, and reflectance, and luminance, color and reflectance after 1,200 hours of artificial weathering) were performed. The results are discussed in this report and presented in tabular form.

R-1181 - "Kiwalite Reflective Sheeting," (80 TI-674). M. H. Janson

Samples of white, red, orange, yellow, green, and blue reflective sheeting—both pressure sensitive and heat activated—were submitted by the manufacturer for laboratory evaluation. Tests applicable to Type 2 reflective sheeting (adhesion, cold shock, flexibility, liner removal, luminance wet, impact, solvent resistance, peeling, water immersion; and both initial luminance, color, and reflectance, and luminance, color and reflectance after 1,200 hours of artificial weathering) were performed. The results are discussed in this report and presented in tabular form.

R-1182 - "Air Quality Measurements of Movable Asphalt Plants for Recycling Paving Asphalt (Interim Report for 1981)," (78 G-235).  
J. T. Ellis

Stack samples were taken from two movable asphalt plants that were processing 50:50 recycled-to-virgin material. One plant used a baghouse filter exhaust system, the other used a wet scrubber system. It was found that the plant using the baghouse filter met Federal air quality standards for particulate emissions; the plant using the wet scrubber, however, did not. The need for modification of the wet scrubber systems is indicated.

R-1183 - "Final Report, Evaluation of 'Monoslabs' for Paving Ditches and Service Drives," (74 NM-398). J. H. DeFoe

'Monoslabs,' precast concrete paving blocks, were used experimentally as a ditch lining and as a paving for a lagoon service drive in a rest area. These 24 x 16 x 5-in. blocks have a waffle-like configuration. Erosion has undercut those used in the ditch and after four years has resulted in severe faulting and collapse of the Monoslabs in the bottom of the ditch. As a paving material for the service drive the Monoslabs continue to provide a firm driving surface showing no sign of deformation or distress.



LISTING OF NEW MATERIALS PROJECTS  
COMPLETED DURING THE YEAR

- 72 NM-318 - "Cerex" Spunbound Nylon for Retarding Reflection Cracking in Overlay (Chemstrand Research Center, Inc.)
- 74 NM-398 - "Monoslabs" for Temporary Roads, Shoulder Erosion Control
- 74 NM-411 - Allied SS-40 Fence Pipe (Allied Tube and Conduit Corp.)
- 75 NM-435 - Fasson Reflective Sheeting
- 76 NM-487 - HMC-1000 Solid State, Fixed Time Traffic Controller (Honeywell, Inc.)
- 76 NM-488 - HMP-140 Microprocessor Based Freeway Ramp Controller (Honeywell, Inc.)
- 76 NM-489 - HIFU-100 Communications Interforce Unit (Honeywell, Inc.)
- 76 NM-490 - HSC-150 Traffic Controller (Honeywell, Inc.)
- 76 NM-491 - HSC-100 Traffic Controller (Honeywell, Inc.)
- 76 NM-492 - HMP-190 Microprocessor Based Intersection Traffic Controller (Honeywell, Inc.)
- 79 NM-591 - Brick/Master System (Decorative Brick)
- 79 NM-598 - Sylvax 818 Manhole Casting Epoxy
- 80 NM-611 - "Xypex Concentrate" for Waterproofing Concrete
- 80 NM-621 - Intergard EAA001/EAA002, Intergard EPA130/EPA131, Interchlor LPA012; Protective Coatings (International Paint Co.)
- 80 NM-622 - Protective Coatings, Acti-Thane MC, Acti-Thane HC, and H-704 Primer Acti-Thane LS, Neoprene, Pliogard LS (Saran Protective Coatings Co.)
- 80 NM-623 - "Glasbord" for Sign Backing Material
- 81 NM-627 - "Genack" Joint and Crack Seal

- 81 NM-628 - "Quantacote" Plastic Protective Coating
- 81 NM-630 - Plastic Dowel Caps for Concrete Expansion Joints
- 81 NM-631 - "Pro Hyd" Protective Coating; Water Reducible Acrylic Mastic
- 81 NM-635 - Bethlehem Load Indicator Bolts
- 81 NM-636 - Harco PNT Non-Overlay Bridge Deck Cathodic Protective System
- 81 NM-637 - Reflexite A/C 1000 Reflective Sheeting
- 81 NM-638 - Universal Primer for Metal Structures
- 81 NM-639 - Rust Transformer (A. W. Chesterton Co.)

LISTING OF TECHNICAL INVESTIGATIONS  
COMPLETED DURING THE YEAR

- 72 TI-126 - Improving Skid Resistance by Use of Tennant Machine and Pavement Grooving
- 76 TI-365 - Investigation of Causes and Development of Remedies for New Asphalt Pavements Which are Slippery
- 78 TI-499 - Noise Investigation: Highlands Cooperative, I 96 Between Logan and Cedar Sts
- 78 TI-500 - Vibration Monitoring of Transmission Towers During Pile Driving Operations; Zilwaukee Bridge
- 78 TI-512 - Bridge Cores (B02 and B03 of 23092) for Determination of Compressive Strength and Cement Content
- 78 TI-519 - Experimental Work on Development of an Airport Runway Light Indicating Approximate Location on Runway
- 78 TI-544 - Tests of Water in Film Processors; Photo Services Building
- 79 TI-552 - Transport System for T. V. Sewer Inspection Equipment, I 696, Detroit
- 79 TI-563 - Load Test Evaluation of Structural Beam Walker for MIOSHA Specification Conformance
- 79 TI-622 - Additional Investigation of Pavement Problems on I 275
- 79 TI-624 - Cement Determination for Three Beam Ends, Project No. 33071-03772
- 79 TI-628 - Low Concrete Strength on Project No. 50111-14207
- 80 TI-634 - Greyhound Bus Suit
- 80 TI-667 - Field Sampling of Structural Concrete for Quality Control
- 80 TI-669 - Concrete Pavement Performance Problems, I 75 from the Ohio Line Northerly to the Huron River
- 80 TI-674 - "Kiwalite" Reflective Sheeting

- 80 TI-686 - Engineering Review of Woodward Ave Corridor Light Transit Railroad
- 80 TI-689 - Noise Investigation, Pursell Residence Between Territorial Rd and M 14
- 80 TI-695 - Weatherability of Map Displays
- 80 TI-702 - Steel Sampling and Analysis of Impacted Bridge S02 of 82191; Woodruff Rd Over I 75
- 80 TI-703 - Testing of Watertight Coaxial Cable Splices
- 80 TI-706 - Effect of Form Coating on Epoxy Bond, Zilwaukee Bridge
- 80 TI-707 - Evaluation of Avery International (Fasson) Reflective Sheeting
- 80 TI-719 - Computer Prediction for Local Government Noise Studies
- 80 TI-721 - Design Speed and Side Friction Factor on Concrete Pavement; Brown Rd, Oakland County
- 80 TI-722 - Investigation of Broken Cluster Piles for Fort St Bridge
- 80 TI-723 - Profilometer Measurement for Smoothness on Projects MBR 79011-18192A, MB 16022-17366A, and MB 71031-17407A
- 80 TI-724 - Noise Investigation on I 96 Between Telegraph Rd and Lahser Rd (Rep. Leland)
- 81 TI-725 - Friction Tests and GM Profilometer Survey of Merriman and Eureka Rds for Wayne County
- 81 TI-726 - Sealed Beam Lamp Testing for L-801A Airport Beacon
- 81 TI-729 - Pavement Surface Improvement for I 94 from Wyoming to Gratiot
- 81 TI-730 - Air Quality Monitoring of Lodge Freeway Under Cobo Hall
- 81 TI-731 - Noise Investigation, I 75 Monroe County, Stoney Creek Rd (Donald Webb)
- 81 TI-733 - Noise and Air Pollution on I 94 Near I 696 Interchange, St. Clair Shores

- 81 TI-734 - Icing of Bridge Decks on Curves
- 81 TI-735 - Vibration Investigation of Richard Powell Residence; I 94,  
Paw Paw
- 81 TI-736 - Noise Investigation; I 696, East Inkster
- 81 TI-738 - Carbon Monoxide Testing at Brighton Maintenance Garage
- 81 TI-739 - Feasibility of a Noise Barrier at I 96 and US 23, Brighton  
(Mr. and Mrs. John A. Erickson)
- 81 TI-740 - Noise Barrier Request Adjacent to Harold's Driving Range  
and Riverbank Fairway Estates, City of Southfield
- 81 TI-741 - Noise and Air Pollution on I 94 Near I 696 Interchange, South-  
east Quadrant (Mr. and Mrs. James Schiro)
- 81 TI-742 - "Rawl" Steel Drop In Expansion Anchors
- 81 TI-743 - Investigation of Beam Guardrail Damage, US 2 and US 41  
North of Escanaba
- 81 TI-744 - Carbon Monoxide Monitoring of Main St Garage, Lansing
- 81 TI-746 - Noise Investigation on I 94 at Thirteen Mile Rd, Roseville
- 81 TI-749 - Limit Switches for Poweray Infrared Asphalt Heaters
- 81 TI-750 - Zilwaukee Pool Electrical Switches
- 81 TI-751 - Noise Investigation, I 696 at Schoenherr Rd (Edward Wiland,  
13795 McKinley, Warren)
- 81 TI-752 - City of Ann Arbor Sidewalk Concrete Problems
- 81 TI-753 - "PK" Nails for Fastening Traffic Recorder Hose
- 81 TI-756 - Investigation of Plaster Cracking in Home of Mr. and Mrs.  
Patrick Thornton, 701 Memorial Rd, Houghton
- 81 TI-757 - Use of Methylene Chloride in Paint Stripping Operations
- 81 TI-758 - Noise Investigation on M 53 in Vicinity of Dresden Village  
Subdivision, Sterling Heights (Mrs. Rose Cline)

- 81 TI-759 - Noise Study on I 96, Southeast Quadrant of I 96 and Cascade Rd, Grand Rapids
- 81 TI-760 - Noise Study Along I 75, South of Nine Mile Rd in Hazel Park (Mrs. Ernest Stiles)
- 81 TI-761 - Noise Study; I 75 Forest View Village Subdivision in Troy
- 81 TI-763 - Noise Investigation; I 75, Troy (Gilda Fox)
- 81 TI-767 - Emergency Repair of Bridge S01 of 72014, US 27, 2.5 Miles North of M 55
- 81 TI-768 - Noise Investigation at I 96/I 275 Interchange (Mrs. William Mozurkewick)
- 81 TI-769 - Steel Sampling on X01 of 82052, US 24 Over Railroad, 4.5 Miles North of Flat Rock
- 81 TI-770 - Noise Investigation; I 75 and 11 Mile Rd, Madison Heights
- 81 TI-772 - Statistical Analysis of Loop Performance, SCANDI Project
- 81 TI-774 - Determination of Speed and Stopping Characteristics of Pokerino Machine for Attorney General's Office
- 81 TI-779 - Evaluation of Devine's Lighting "Wal-Pak" Unit
- 81 TI-780 - Simpson vs. Michigan Department of Transportation, Court of Claims No. 7239

LISTING OF ACTION PLANS  
COMPLETED DURING THE YEAR

80 AP-29(A) - Air Quality Monitoring at M 43 in Kalamazoo County; Job  
No. 00555

80 AP-31(A) - Air Quality Monitoring - M 275 West Oakland County; Job  
No. 12311

## STATISTICAL ANALYSIS UNIT

### 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

Data from four experimental projects have been examined as to the feasibility of the program. Most analysis, charts, etc., have been completed.

### Planned Program for Coming Year

Completion of analysis together with development and recommendation of sequential acceptance testing plans designed to reduce laboratory testing costs with minimal impact on testing risk. Completion of final report.

Salaries and Wages 1981: \$1,026

### 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

Approximately 200 bridges have now been examined and accident statistics, surface conditions, times, locations, etc., have been recorded. Sufficient data now exist to support the conclusion that pre-icing is most likely to occur during a period extending from mid-November to about January 1. While it can be present at any time of the remaining winter, the risk factor declines sharply after January 1.

A probability model has been developed which closely follows seasonal changes in pre-icing risk. This model uses accident statistics to estimate the relative frequency of dry and icy surface conditions as this frequency changes with season. Also, statistical relationships between bridge accidents and current temperature and precipitation conditions have been established. A final report is in progress.

#### Planned Program for Coming Year

Completion of final report.

Salaries and Wages 1981: \$30,066

#### 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, pavement friction tests, etc.

#### Progress Past Year

1. Development of General Estimation Procedures in Traffic Area. Estimation procedures have been developed for using accident records together with supplemental information such as traffic volumes and roadway characteristics, to improve estimates of accident rates and severities. These procedures can be used for the purpose of detecting hazardous locations and optimal allocation of safety improvement funding. Also these procedures can be used to improve estimates of traffic counts (or volumes) for the purpose of improving traffic signal systems.

2. Development of General Estimation Procedures in the Area of Highway Maintenance and Construction. Applications of these procedures have been developed for the following two areas:

a) Improvement of skid number estimates for the purpose of setting more efficient pavement resurfacing programs.

b) Improvement of estimates of aggregate gradation (percent passing various sieve sizes and percent loss-by-washing) for the purpose of setting specification limits and determining proper testing methods.

3. A draft of the final report has been completed for submittal to the FHWA.

#### Planned Program for Coming Year

None. Upon review and approval by the FHWA, issue final report.

Salaries and Wages 1981: \$17,059

Title

78 G-239 - Comprehensive Analysis of Skid Resistance Data

Purpose

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

Scope

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

Progress Past Year

None.

Planned Program for Coming Year

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

Salaries and Wages 1981: - 0 -

Title

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

Purpose

1. The end product will be a manual which contains relevant theory and procedures such as tables, charts, and computer programs for estimating the percentage of material falling within specifications.

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

Scope

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

Progress Past Year

Theoretical work is complete.

Planned Program for Coming Year

Continue work on estimation procedures, computer programs, and development of examples.

Salaries and Wages 1981: \$4,711

Title

80 G-250 - Evaluation of Michigan's Roadside Hazard Removal Manual

Purpose

To prepare a methodology for evaluation of Michigan's roadside hazard removal manual which was prepared for the Department by Asplundh Associates.

Scope

Analysis, design and manual evaluation using field accident data recorded both before and after implementation of the manual by several selected counties.

Progress Past Year

Preliminary examination of roadside accidents, their dates, times of day, etc.

Planned Program for Coming Year

Project cancelled at Federal level.

Salaries and Wages 1981: \$478

## MATERIALS RESEARCH UNIT

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

A report draft of the initial decks done with Arco Dylex 1186 and Thermoflex 8002 is in the final review stage.

### Planned Program for Coming Year

An inspection of the 11 decks using Dylex 1186 and three using Thermoflex 8002, as well as some older selected decks with Dow Modifier A, is to be made. This will include visual inspections and selective delamination and half-cell surveys and coring for chloride determinations.

Salaries and Wages 1981: \$790

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 and 1979 Standard Specifications (Table 7.01-1). The 5.6 sack/cu yd mix with water-reducer, in lieu of 6.0 sacks of cement, has been widely used across the state in paving concrete.

Progress Past Year

Due to the continuing work load and higher priority assignments, the project was not closed.

Planned Program for Coming Year

Complete a report to finalize the project although results of the study have been implemented in the Standard Specifications.

Salaries and Wages 1981: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

The draft of the final report was completed for the M 14 bridge application. It makes a qualified recommendation for the inclusion of Type 1P-A cement in both substructure and superstructure bridge concrete.

Planned Program for Coming Year

With the printing of the final report, this project should be terminated.

Salaries and Wages 1981: \$2,926

Title

72 B-92 - Experimental Bridge Deck Surfacing Methods

Purpose

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

Scope

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

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

Progress Past Year

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

Planned Program for Coming Year

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

Salaries and Wages 1981: - 0 -

Title

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

Purpose

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



## Scope

Determine the effectiveness of low slump high density overlays in rehabilitating spalled and chloride contaminated bridge decks. For this purpose two projects on I 96 were selected to monitor and evaluate this system. Long-term performance will be evaluated by periodic inspection and testing. In 1977 the low slump high density overlays were used both for deck repair and on new two-course construction as an alternate to latex modified concrete. Additional structures were overlayed in 1978 with low slump high density concrete overlays. These included 11 decks under two repair contracts and eight new two-course structures on I 475 in Flint.

## Progress Past Year

The performance of the two I 96 projects was checked by conducting a delamination survey, recording crack patterns, and taking half-cell readings. An experimental deck overlay using low slump high density concrete containing a superplasticizer was placed this summer on Winchester Ave over I 75 in Detroit. Samples of the fresh concrete with and without the superplasticizer were made at the site for later testing in the laboratory. Normal field tests on the concrete were also conducted and the construction operations observed.

## Planned Program for Coming Year

The data obtained on the two I 96 projects to date will be analyzed and reported. A brief report describing the construction operations and concrete properties of the superplasticized concrete deck overlay will be issued.

Salaries and Wages 1981: \$4,809

## Title

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

## Purpose

To investigate 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

A rough draft of a report on the use of Type 1SA cement in grades 35P and 30P concrete with and without a water-reducer was in final review late in the year.

## Planned Program for Coming Year

Finalize the report and distribute to close the project during the first quarter.

Salaries and Wages 1981: - 0 -

## Title

76 B-95 - Experimental "Econocrete" 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 econocrete mix in the lower half of the slab. This econocrete 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/cu yd of cement, 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

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

#### Progress Past Year

The planned performance evaluation and the final reporting on this type of ramp pavement were not done due to higher priority work assignments.

#### Planned Program for Coming Year

A survey is scheduled and the results, as well as previously gathered data will be included in a final report.

Salaries and Wages 1981: - 0 -

#### Title

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

#### Purpose

To evaluate the construction and performance of econcrete shoulders on M 14 near Wayne County line and I 69 near Lansing. The econcrete mix on I 69 is proposed to contain a cheaper peastone aggregate. The econcrete mix on M 14 incorporated cement reductions intended to provide compressive strengths of 3,000, 2,500, and 2,000 psi at 28 days age.

#### Scope

About three miles of the outside shoulders of M 14 were paved in 1978 in half-mile sections. The sections consisted of, alternately, grade 30P concrete, 3,000, 2,500, and 2,000 psi grade "econcrete," or 30E, 25E, 20E, respectively. The econcrete mixes utilized a locally available 20AA aggregate containing about 68 percent sand.

Almost three miles of I 69 north of Lansing was to utilize peastone aggregate in the concrete shoulders of the dual roadway in 1981 and 1982.

## Progress Past Year

About 20 percent of the 66,360 sq yd of concrete shoulders was poured late in 1981 but was not sampled by laboratory personnel.

## Planned Program for Coming Year

Samples of the concrete shoulder pours are to be taken for strength and durability tests, and all of these initial data are to be included in a construction report.

Salaries and Wages 1981: \$556

## Title

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

## Purpose

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

## Scope

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

This study was initiated as a Category 2 project and Work Plan No. 64 was submitted and approved by the FHWA. Since the project was initiated, 41 more structures have been approved for inclusion in the study. Four were added in 1978, 17 in 1979, 8 in 1980, and 12 through November 1981. All of these structures were found to contain more than 4 lb/cu yd of chloride in portions of their deck.

## Progress Past Year

Ten decks were selected for evaluation on the basis of their high chloride content and because closure of lane would not inconvenience the traffic. The corrosion condition of these decks was checked by taking half-cell readings and a delamination test was also done. Crack patterns were recorded for each deck. In all cases, only the outside lane of multiple lane decks was evaluated and only one lane of a two-lane, two-way traffic deck was subjected to the tests.

## Planned Program for Coming Year

The deck evaluation will continue where traffic conditions permit closing a lane for evaluation. If time permits all decks overlaid will be subjected to a visual inspection and the placement of the overlays on some decks may be observed. A brief report dealing with our 1981 evaluation program will be written.

Salaries and Wages 1981: \$7,737

## Title

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

## Purpose

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

## Scope

Voluntary field test arrangements with the Bidwell Co. were secured in an existing contract to construct a six-span bridge to carry relocated Francis Rd over I 69 about two miles northwest of Lansing. It was originally intended that the machine be used to provide consolidation for three or more of these spans during the 1981 construction season. Subsequent to its construction, concrete cores will be used to evaluate the machine's

effectiveness in comparison to cores from spans placed and finished by conventional means and equipment.

#### Progress Past Year

Originally, the Francis Rd deck was scheduled to be placed during the construction season of 1981, but inadvertent delays moved the construction date to the spring of 1982. However, a long stretch of unusually mild late fall weather allowed the contractor to place four of the six spans. Unfortunately, this modification of plans precluded the demonstration of the machine.

#### Planned Program for Coming Year

The demonstration will be planned for next spring on either the two remaining spans or another bridge in the same vicinity. When temporary ramps to the decks are in place, cores will be taken to evaluate the consolidation characteristics of the concrete.

Salaries and Wages 1981: \$1,870

#### Title

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

#### Purpose

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

#### Scope

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

## Progress Past Year

Wear track Series Nos. 14 and 15 were completed during 1981. Aggregates tested included crushed gravels, quarried carbonates, steel furnace slag, and uncrushed gravel.

Weartrack Series No. 16 containing siliceous limestone, crushed concrete, and blends of control limestone with blast furnace and steel furnace slags was started but not completed by the end of 1981.

Test methods incorporating the wear track data and aggregate petrographic composition were developed to derive an aggregate wear index (AWI) for rating aggregates according to traffic polishing resistance. The AWI has been implemented on an experimental paving project on M 33 (Project Mbr 16051, Job No. 17367A) in Cheboygan County. The new "Supplemental Specifications for Bituminous Mixtures Classified by Stability" have been written to include an AWI requirement for quarried limestones for use as coarse aggregate in wearing course mixtures.

## Planned Program for Coming Year

An interim progress report to present the results of wear track Series Nos. 13, 14, and 15 is to be completed.

Wear track Series No. 17 to contain blends of crushed and uncrushed gravel has been scheduled to evaluate the effect of various percentages of uncrushed material upon the polishing resistance of aggregates.

Salaries and Wages 1981: \$14,313

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

Four-year trailer pavement friction tests were conducted on the test pavements in mid-summer. The tests indicate that the sandy limestone test section is maintaining a slightly higher resistance to polishing than the control gravel test section.

## Planned Program for Coming Year

Five-year trailer pavement friction tests will be requested. An on-site inspection of the test pavements and a review of pavement performance is scheduled. A report of findings is to be completed.

Salaries and Wages 1981: - 0 -

## Title

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

## Purpose

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

## Scope

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



### Progress Past Year

Inspection of the pavement shows that the 23 year old bar mat reinforced sections continue to give good service. One previous construction joint repair failed and was repaired with bituminous material. In the mesh reinforced section the undowelled concrete repairs continued to perform satisfactorily. A few more failures have occurred and were repaired with bituminous material. Crack spalls as well as spalls along the pavement centerline joint were filled with bituminous material this fall.

### Planned Program for Coming Year

Periodic surveys will be made to note surface condition and monitor the performance of previously constructed repairs.

Salaries and Wages 1981: \$114

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Repairs on both roadways were made in 1981. On the eastbound roadway the repairs were undowelled but were all reinforced because the pavement thickness is only 8 in. The repairs on the westbound roadway were also reinforced and tied to the existing pavement and dowelled expansion joints installed in the center of each repair. Initial joint width readings of these joints were made shortly after the construction was completed.

## Planned Program for Coming Year

Joint width openings of the dowelled expansion joints on the westbound roadway will be measured winter and summer to determine seasonal, as well as permanent changes in joint openings. These data should help in determining the expansion space needed in CRC pavement to provide pressure relief when the continuity of a pavement of this type can no longer be maintained.

Salaries and Wages 1981: - 0 -

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Concrete repairs re-establishing the pavement continuity were made south of the Rouge River. In addition, bituminous temporary repairs were done on the entire I 75 CRC pavement section by maintenance forces. Inspection of both repair types indicate that new deterioration develops next to the repairs. The 1/4 mile of bituminous overlay placed on the southbound roadway north of the Rouge River in the fall of 1980 continues to give good service.

## Planned Program for Coming Year

The pavement will be inspected periodically to check on the repairs' performance and to note any new surface deterioration or failures caused by fracture of the steel reinforcement.

Salaries and Wages 1981: \$1,764

## 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

Longitudinal cracking on I 196 and US 31 appears to have stabilized, but spalling along the cracks has developed. On I 275 the increase in longitudinal cracking was less than the previous year. The cracks in some areas appear to have opened somewhat over the years and slight faulting and spalling have occurred. Nearly 2,500 lin ft of cracks were routed and sealed with a silicone sealant to determine the feasibility of sealing this type of crack. Only a few new punch-outs have occurred and these, as well as previous ones, are being maintained with bituminous patching. Wide-flange beam failures were noted on I 96 and I 275. In both locations the beams were removed prior to their interference with traffic.

## Planned Program for Coming Year

Surveys will be conducted periodically to monitor the pavements' performance with respect to continued increase in longitudinal cracking and formation of new punch-outs. The performance of silicone sealed cracks will also be evaluated.

Salaries and Wages 1981: \$5,316

## Title

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

## Purpose

To adapt the bridge deck epoxy injection concept used on bridges in Kansas to similarly 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. A procedure and the expertise are to be developed to adapt the epoxy injection technique to the repair of concrete bridge deck delaminations. Injection on an annual basis of newly developing delaminations on a bridge deck are to be made to see if the deck can be returned to a condition of long-term functional stability, and annual inspections conducted of the bridge deck to determine if the procedure is achieving the desired results.

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

## Progress Past Year

Higher priority work precluded additional work on this project.

## Planned Program for Coming Year

Hopefully decks can again be inspected, delamination graphs analyzed, and final report started.

Salaries and Wages 1981: \$103

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Twelve crossings were reconstructed using experimental surface materials during 1981; one Gen Trac, two Cobra X, two Saf and Dri, and seven Parkco. The total crossings under study is now 68, with several of these having multiple tracks. The yearly inspection showed some problems with the Gen Trac field units wearing into the ties in the traffic wheelpath areas. The Steel Plank crossings of the early design tend to work loose in the wheelpaths of the highway traffic, and one Parkco crossing experienced broken pads and one fractured cable because of failure in the crossing foundation.

### Planned Program for Coming Year

The installation of experimental surface material will be observed, when possible. Each of the experimental crossings will be inspected once during the year and special inspections of crossing performance problems will be made as requested. A fifth progress report will be issued.

Salaries and Wages 1981: \$5,079

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

A progress report was not issued as planned. Instead, any problems noted with a particular device were brought to the attention of the appropriate MDOT Divisions and manufacturer so that revisions could be made in a more timely manner.

Standard details and installation procedures have been worked out with the manufacturers for five expansion dam systems, with two others very near final acceptance. These standard details provide a clear set of installation instructions and eliminate the necessity of reviewing shop drawings for each expansion dam installation.

Two new expansion dam systems were installed on nine structures this construction season.

## Planned Program for Coming Year

We will continue surveillance of present installations and the installation of two new devices, and write a progress report.

Salaries and Wages 1981: \$13,229

Title

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

Purpose

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

Scope

Different types of tied joints will be tested in the Laboratory, and promising ones are planned for testing in the field.

Progress Past Year

The Department joined the FHWA in a NEEP project concerning the repairs of concrete pavements. Consequently, the project was expanded to a three-year, three-stage project. Stage 1, a feasibility study to determine the practicality of constructing repairs tied to the existing slab and having a dowelled expansion joint in their centers, was completed this summer. Eight lane repairs were constructed using two different types of tied joints—one with a step saw-cut at the repair end limits and one using an epoxy to help obtain early shear strength. Both types of joints contained No. 6 tie bars set in epoxy mortar in holes drilled into the end faces of the repairs. Based on construction and early performance data (Research Report R-1179) Stage 2 of the project was approved.

Planned Program for Coming Year

An addendum to the project work plan, covering Stage 2 of the project, will be prepared. In addition to tied joints, dowelled contraction joints will be utilized. Also, a few inverted T-repairs will be tried and retrofitting faulted repairs with dowels will be investigated. The repairs are planned for installation on a route carrying heavy commercial traffic to test their performance under the most severe conditions.

Salaries and Wages 1981: \$20,565

Title

47 G-36(34) - 1981 Supplemental Traffic Paint Performance Tests

## Purpose

This project is the 1981 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 1983.

## Scope

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

## Progress Past Year

Field tests were initiated in July 1981 including two whites and two yellows from each of four producers. Periodic ratings were made and will be continued until each paint has reached the end of its useful life as defined by ASTM D 713. A progress report was made to the Paint Committee in December of 1981.

## Planned Program for Coming Year

Rating of the paints in field tests will continue until all paints have reached the limit of their useful lives. A final report will be made to the Paint Committee including recommendations as to eligibility of paints for 1983 purchases.

Salaries and Wages 1981: \$11,381

## 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

The evaluation of the effects of field deviations from specifications was documented. Accelerated test panels were prepared and the testing program continued.

## Planned Program for Coming Year

We plan to continue field inspection of coating systems and continue to determine the effect of deviation from specifications under this project.

Salaries and Wages 1981: \$1,139

## 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 Specification Unit format.

### Progress Past Year

The establishment of an inspector training program has started with the first sessions scheduled for the spring of 1982. As with other years, some 'one time only' revisions were processed.

### Planned Program for Coming Year

Continue development and conduct first school. Also 'one time only' specification revisions will continue under this project.

Salaries and Wages 1981: \$497

### 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

One new seal design was evaluated but not approved.

### Planned Program for Coming Year

Evaluate new design sections as submitted.

Salaries and Wages 1981: \$871

### Title

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

## Purpose

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

## Scope

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

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

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

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

## Progress Past Year

The second set of panels were removed from the Armory roof and the structure over the Lodge freeway. These were shipped to the producer after visual examination in the laboratory. It should be noted that another research study (78 G-241) is being conducted to assess actual corrosion in

areas of high salt usage and atmospheric contaminants for both A 588 and A 36 steel structures.

#### Planned Program for Coming Year

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

Salaries and Wages 1981: \$970

#### Title

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

#### Purpose

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

#### Scope

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

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

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

#### Progress Past Year

A second electrical resistance survey was made that indicated some loss of resistance over the initial survey made within a month of the completion of the application. It was not known whether this represented a deterioration or simply the maturing of the initial condition.

#### Planned Program for Coming Year

A third electrical resistance survey and visual inspection will be made, conclusions drawn, and final report started.

Salaries and Wages 1981: - 0 -

#### 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 11 years old.

#### Progress Past Year

Due to higher priorities no work was done on this project.

## Planned Program for Coming Year

Make inspections of selected installations as time permits.

Salaries and Wages 1981: \$56

### 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 statewide locations has continued. Sampling frequency has been maintained on a monthly basis. Chloride content of the water samples has been determined and tabulated.

### Planned Program for Coming Year

A review draft of progress report on sampling from 1976 through 1981 is to be completed.

Continued sampling from the 30 groundwater observation wells and surface water sampling sites is scheduled on a monthly basis.

Salaries and Wages 1981: \$6,897

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

Resistance tests were run on deck waterproofing systems on five structures in the Lansing area. These include reinforced sheet systems and hot applied mixes with synthetic fibers.

Planned Program for Coming Year

With the help of other T&R and District personnel, it is planned to schedule final inspections on the initial 1973 projects on I 75 and selected membrane projects done since then. Results of these inspections and tests are to be assembled into a report for distribution late in the year or early 1983.

Salaries and Wages 1981: \$545

Title

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

Purpose

To evaluate performance and durability of galvanized open-section members for use in pedestrian bridge structures. The test structure is

P01 of 52042 over US 41 southeast of Marquette, completed in 1972. The long-term corrosion protection of the galvanized coating was to be evaluated through periodic inspections.

#### Scope

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

#### Progress Past Year

An inspection was completed, indicating the bridge is performing well.

#### Planned Program for Coming Year

An inspection trip is scheduled for 1984.

Salaries and Wages 1981: \$169

#### 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

The Testing Laboratory continued to process the standard rotohammer deck samples for chlorides and transmitted the results of tests on 57 structures in 1981. The Research Laboratory only processed special 4-in. deck cores for visual appraisal, compressive strength, and in some cases, chloride content on a few structures having bituminous overlays.

### Planned Program for Coming Year

It is anticipated that there will be only a small number of special cores for bridge overlay projects to process in 1982 as the Testing Laboratory will continue to do the standard drill samples.

Salaries and Wages 1981: \$103

### 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 annual evaluation survey shows that about 10 percent of the spall repairs have failed, the replaced expansion joint neoprene seals are performing excellently, and the PVC hot-poured seals have failed in adhesion to the groove walls. In addition to the spall repair failures, new spalls have developed on some of the neoprene sealed joint grooves.

### Planned Program for Coming Year

A survey will be conducted this winter to update the condition of the repaired joints. This information will be used to determine the maintenance

requirement to bring the joints back to their as-constructed condition. It is anticipated that an arrangement can be made with the Maintenance Division to conduct required repairs on the nine-mile long experimentally maintained freeway section.

Salaries and Wages 1981: \$3,219

### 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 rustproofer 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 rustproofer 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 were made in the second and fourth quarters.

Planned Program for Coming Year

Make final inspection and write report.

Salaries and Wages 1981: \$91

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. A final report was drafted.

Planned Program for Coming Year

Complete final report.

Salaries and Wages 1981: \$987

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 the observation wells was conducted on a monthly basis. Samples of water were also obtained from the retention lagoon and sand pile sump.

Bimonthly reports of chloride test results were distributed.

A review draft of a progress report has been completed and revised to include the 1980 chloride test results and lagoon-pumping records.

## Planned Program for Coming Year

A progress report to present the results of the study through 1981 is to be completed.

Sampling of the test wells, retention lagoon, and sand pile sump are scheduled to continue on a monthly basis.

Bimonthly reports of chloride test results will be distributed.

Salaries and Wages 1981: \$1,327

## 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

To date, we have not found a system in the accelerated tests that has performed well enough to merit further consideration. This has been confirmed by the Steel Structure Painting Council's data.

## Planned Program for Coming Year

Due to a lack of promising products, we plan to cancel this project this year.

Salaries and Wages 1981: - 0 -

## 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

Testing of the third series of tests are well underway. These will be completed in June of 1982. Assuming the Department chooses to use zinc-rich coatings we will have a standard specification for the 1983 printing of the Standard Specification manual. Due to the inconsistency of a

small portion of the test, we will be duplicating these tests this year thus delaying the final report.

#### Planned Program for Coming Year

It is planned to continue to test various systems since the forthcoming specification will be a performance specification. We also hope to establish the minimum performance levels that will be used for acceptance of a coating system. A report on this project is scheduled for 1982.

Salaries and Wages 1981: \$19,832

#### 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 initial instrument continued to perform well and as expected. A new improved model was almost completed with the bulk of the remaining work involving programming the computer to handle the data.

#### Planned Program for Coming Year

Test and use new instrument both in our performance evaluations and in a FHWA sponsored project in cooperation with Ohio and Pennsylvania.

Salaries and Wages 1981: \$18,203

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

Due to scheduling problems with the test equipment and knowing that at least two new devices would be introduced in the current year, testing of new devices was delayed until 1982.

Planned Program for Coming Year

Samples representing seven devices have been received and prepared for testing. These seven devices will be evaluated during the first part of the year and a report written to cover these devices and those previously evaluated in Research Report No. R-1144.

Salaries and Wages 1981: \$1,716

Title

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

Purpose

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

## Scope

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

## Progress Past Year

Because of FHWA non-participation in this type of work, the planned contract for 1981 was put 'on hold.' However, the Department's Engineering Operations Committee decided that the work should be done using Michigan funds.

## Planned Program for Coming Year

If contract is let, Research personnel will be at the job site to work with the project engineer and obtain data pertinent to evaluation of the repairs.

Salaries and Wages 1981: \$2,070

## Title

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

## Purpose

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

## Scope

Select high traffic areas for contract application of significant quantities of epoxy and polyester pavement marking materials. Make field inspections and ultimately assess the relative cost effectiveness of these materials on both portland cement and bituminous concrete surfaces.

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



### Progress Past Year

Periodic inspections were made of test installations in the Grand Rapids area on 28th St and US 131.

### Planned Program for Coming Year

Periodic field inspections will continue to determine ultimate effective life of the test materials and their relative cost effectiveness.

Salaries and Wages 1981: \$995

## PHOTOMETRY AND SPECTROCHEMISTRY UNIT

### Title

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

### Purpose

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

### Scope

Evaluate photometrically the visual contrast between the shoulder and pavement resulting from the use of wet bottom slag in the bituminous shoulder mix.

### Progress Past Year

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

### Planned Program for Coming Year

Write report covering the six years of evaluation of the shoulder visibility.

Salaries and Wages 1981: \$862

### Title

71 G-181 - Investigation of Air Quality Test Equipment and Procedures

### Purpose

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

### Scope

Review State and Federal air quality regulations and determine their applicability to transportation projects. Review the literature on and

performance of commercially available instrumentation and purchase measuring equipment. Review the literature, review the experiences of other agencies and develop procedures for measuring air quality. Develop a data bank of meteorological and air quality data.

#### Progress Past Year

Federal and State air quality regulations were reviewed as issued and a file maintained of material relevant to transportation. Information obtained from manufacturers and users was used to keep current on instrumentation available to monitor air quality. Guidelines from the U. S. Environmental Protection Agency were used to maintain quality control for air quality data added to the Department's data bank. Three mobile air monitoring laboratories operated in the field to obtain data at eight sites. Data banks for air quality data and meteorological data were updated and expanded. Air monitoring data were supplied to the Bureau of Transportation Planning, and the Department of Natural Resources. A draft of most of the material for this project report was prepared.

#### Planned Program for Coming Year

Conduct air quality monitoring with three mobile units. Expand the air quality data bank. Provide air quality data to the Bureau of Transportation Planning. Maintain current information on State and Federal air quality regulations relating to transportation. Keep current information on instrumentation and methods available to monitor air quality. Prepare a report on the equipment assembled and the procedures developed.

Salaries and Wages 1981: \$25,496

#### Title

73 G-192 - Evaluation of Glare Sources

#### Purpose

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

#### Scope

Measure sources of glare as designated by citizen complaints and visual evaluation by Department personnel. Determine driver's visual task and

determine luminance and luminance contrast necessary to perform the task. Develop criteria for specifying visual performance. Evaluate luminance of acceptable light sources. Propose basis for legislative control.

#### Progress Past Year

None.

#### Planned Program for Coming Year

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

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

Salaries and Wages 1981: \$51

#### Title

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

#### Purpose

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

#### Scope

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

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

#### Progress Past Year

In order to improve the zero photocell and eliminate drift in the data acquisition system's reference system, a remote controlled cover for the photocells was designed and constructed.

#### Planned Program for Coming Year

- 1) Program the floppy disk computer system (H-11).
- 2) Record illuminance levels at the interchanges.

Salaries and Wages 1981: \$1,067

#### 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 pumphouse. No water samples were analyzed.

## Planned Program for Coming Year

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

Salaries and Wages 1981: \$100

### Title

#### 77 G-229 - Further Research on Reflectorized Flagman's Vests

### Purpose

To provide answers to a request dated November 1, 1977, from R. E. Conner, Chief Traffic Control Systems Division, Office of Traffic Operations, FHWA, for further research into the areas of vest color and of a fully reflectorized vest.

### 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

- 1) A progress report recommending a reflectorized yellow 'stick-man' figure was sent to the MUTCD subcommittee on traffic control devices.
- 2) The Phase II study with 30 observers was completed comparing a simplified chevron-shape and pattern with the stick-man pattern as well as five colors comprised of a brighter Reflexite material than used in Phase I.
- 3) A Phase III study with nine observers was conducted to evaluate:
  - a) Effect of reflectorized strips on the side of the flagger vest in addition to a reflectorized pattern on the frontal portion of the vest

because of a field survey which showed that traffic regulators generally stand sideward to the traffic flow.

b) Comparison of a Reflexite reflectorized polycarbonate stop sign with a 3M engineering grade reflective sheeting stop sign held by the traffic regulator.

#### Planned Program for Coming Year

Write final report.

Salaries and Wages 1981: \$8, 272

#### 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 modified to improve operation and calibrated to EPA standards. Two asphalt plants were monitored for particulate emissions when recycled paving was being processed. A report on the work was prepared.

#### Planned Program for Coming Year

Measure particulate emissions from several asphalt plants while recycled material is being processed, and report the results.

Salaries and Wages 1981: \$4, 961

## SOILS AND BITUMINOUS SYSTEMS RESEARCH UNIT

### Title

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

### Purpose

The purpose of the experimental overlay construction is to evaluate the sprinkle treatment method of achieving adequate friction values on wearing surfaces in accordance with FHWA Demonstration Project No. 50. Sprinkle treatment is the relatively light application of precoated, high quality aggregate particles on the surface of the wearing course mat following lay-down, 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.

### Scope

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

### Progress Past Year

Annual pavement friction measurements were made, which continued to show the sprinkle treatment to be more skid resistant than the control section.

### Planned Program for Coming Year

Conduct friction level tests and observe condition of the surface. A final report will be published.

Salaries and Wages 1981: - 0 -



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, developed by Gulf Oil Canada Ltd., was used to prepare paving mixtures for this project. Two different sulfur-to-asphalt ratios and two sulfur-asphalt binder levels were compared with adjacent sections of the same road which were paved with a conventional mixture.

Progress Past Year

Performance was monitored. Testing has been delayed due to shortage of personnel and the assignment of additional projects of higher priority. The 30 percent sulfur test sections continue to perform well.

Planned Program for Coming Year

Condition surveys will be continued to evaluate performance. Laboratory tests should be completed and a final report prepared.

Salaries and Wages 1981: \$481

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 which show extensive cracking and roughness.

## Scope

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

## Progress Past Year

The annual condition survey was performed. Laboratory test data were summarized and the analysis of deflection basins was started.

## Planned Program for Coming Year

The physical properties of the recycled material will be summarized in a final report along with structural analysis results and final performance evaluations.

Salaries and Wages 1981: \$497

## Title

75 D-32 - Reclaimed Rubber-Asphalt

## Purpose

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

## Scope

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

## Progress Past Year

Rut depth and pavement friction measurements were made on test sections constructed in 1979 on M 46 in Saginaw County. Laboratory testing of road materials was continued but delayed because of a shortage of laboratory technicians.

## Planned Program for Coming Year

Laboratory tests should be completed. Annual condition surveys and pavement friction measurements will be made.

Salaries and Wages 1981: \$1,943

### 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 Unit of the Testing Laboratory.

### Progress Past Year

Field and laboratory testing was completed. Rough draft reports dealing with engineering properties of the bituminous concrete, analysis of the bituminous concrete aggregates, and structural foundation analysis have been completed. A review committee was formed to coordinate preparation of a single report on this project.

## Planned Program for Coming Year

Complete all the individual reports and prepare a single final report of the project findings.

Salaries and Wages 1981: \$22,804

### Title

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

### Purpose

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

### Scope

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

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

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

## Progress Past Year

Laboratory testing was continued to assess fatigue life and low temperature characteristics. Analysis of deflection basins was started to determine structural characteristics.

## Planned Program for Coming Year

Laboratory tests should be completed and structural analyses performed to compare sulfur-extended-asphalt sections of roadway with the conventional control sections, with respect to service life. Comparisons of thermal cracking potential will also be made. Work has been delayed because of higher priority assignments.

Salaries and Wages 1981: \$5,667

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

A test section of Sulphlex was paved on M 54 in Genesee County. Samples of Sulphlex binder and paving mixture were obtained for laboratory testing. Initial performance observations and friction tests were made. Laboratory tests of resilient modulus, thermal contraction coefficient, penetration and viscosity were completed. A progress report describing construction and test results is being prepared.

### Planned Program for Coming Year

A construction progress report will be prepared and performance evaluation will continue.

Salaries and Wages 1981: \$9,068

#### Title

#### 80 D-39 - Feasibility of Paving Over Sylvax Patches

#### Purpose

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

#### Scope

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

#### Progress Past Year

The resurfaced highway was inspected for signs of distress in the areas of the Sylvax patches. No distress or deformation was evident.

### Planned Program for Coming Year

The bituminous resurfacing at the patches will be inspected and photographed. Cores will be obtained to measure bonding and stability.

Salaries and Wages 1981: \$114

#### Title

#### 80 D-40 - Direct Blending of Sulfur and Asphalt for Bituminous Paving Mixtures

## Purpose

To evaluate the feasibility of directly blending hot molten sulfur and asphalt cement without the use of mechanical blending mills as used in previous sulfur-asphalt projects.

## Scope

Several miles of freeway shoulders are to be surfaced with sulfur-asphalt mixtures prepared by direct blending methods. Sulfur-to-asphalt proportions ranging from 5 to 30 percent sulfur will be tried.

## Progress Past Year

A project scheduled for 1981 was selected, US 23 in Livingston County (CS 47014-17384). The sulfur-asphalt portion of the project was deleted.

## Planned Program for Coming Year

None. Project discontinued.

Salaries and Wages 1981: \$930

## Title

81 D-41 - Foamed Asphalt Sand Stabilization

## Purpose

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

## Scope

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

Total bitumen required was between 3 and 5 percent of the sand volume being stabilized. Modification of existing equipment was minimal for the operation.

#### Progress Past Year

Stabilization operations were observed and photographed. Samples of mixture were tested in the laboratory for uniformity of asphalt dispersion, gradation, and strength development during curing.

#### Planned Program for Coming Year

Laboratory tests will be completed and field performance measurements made.

Salaries and Wages 1981: \$3,487

#### Title

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

#### Purpose

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

#### Scope

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



### Progress Past Year

Due to the departure of S. S. Kuo, the project leader for this work, the project has not been completed as planned. Cracking and rutting surveys were continued and data assembled for preparation of a final report. This work is being correlated with that of Research Project 75 E-59.

### Planned Program for Coming Year

Effort will be made to complete this project with a summary report.

Salaries and Wages 1981: \$6,358

### 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

The MSU study was completed and a final report furnished the Department. Further work undertaken in this area will be handled as a new project.

### Planned Program for Coming Year

None. Project completed.

Salaries and Wages 1981: \$745

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Additional fill samples were collected and laboratory testing of these samples has been completed. There were no apparent changes in the fills from the previous year checked.

### Planned Program for Coming Year

Continue checking the performance of the two Elastizell projects and prepare a report on their current status.

Salaries and Wages 1981: \$2,864

Title

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

Purpose

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

Scope

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

Progress Past Year

A final report summarizing research findings concerning the Particle Index Test and the Grading Index concept has been prepared and is being reviewed.

Planned Program for Coming Year

Complete project with a final report.

Salaries and Wages 1981: \$6,271

Title

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

Purpose

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

## Scope

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

## Progress Past Year

Deflection studies conducted during the fall show that the pavement foundation softened considerably as a result of an unusually heavy rainfall. This indicates that additional study of spring foundation conditions should be made since all previous spring studies were conducted during years of mild spring conditions. A rough draft report has been prepared on the findings of this study to date.

## Planned Program for Coming Year

Conduct at least four pavement surface deflection studies during the traditionally recognized spring break-up period and analyze the data to observe the relationship between frost depth and pavement load carrying ability. These data will be compared with results obtained during previous years when spring conditions were relatively mild.

A progress report will be prepared.

Salaries and Wages 1981: \$15,827

## Title

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

## Purpose

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

## RESEARCH SERVICES UNIT

### Title

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

### Purpose

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

### Scope

Because of severe financial constraints, projects selected for recycling have been postponed or a less expensive treatment chosen. If possible, new efficient methods for removing concrete will be required.

### Progress Past Year

Sections of US 23 and M 50 were chosen for recycling but put aside because of money problems. The Department provided technical support for a concrete recycling project on a street in the City of Wyoming. Department representatives also actively participated in a concrete recycling seminar conducted by the University of Michigan and a national seminar by the Transportation Research Board.

### Planned Program for Coming Year

Monitor local government work to encourage concrete recycling.

Salaries and Wages 1981: \$7,630

### Title

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

### Purpose

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

## Scope

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

## Progress Past Year

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

## Planned Program for Coming Year

Complete final report.

Salaries and Wages 1981: - 0 -

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

Surveyed condition of pavement.

## Planned Program for Coming Year

Prepare final report.

Salaries and Wages 1981: \$11

Title

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

Purpose

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

Scope

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

Progress Past Year

Nearly 2,300 lane miles of pavement were surveyed.

Planned Program for Coming Year

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

Salaries and Wages 1981: \$20,895

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

Answered inquiries regarding law.

Planned Program for Coming Year

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

Salaries and Wages 1981: \$86

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 surfaces continue to be monitored with the Department's pavement friction measuring units.

Planned Program for Coming Year

Project to be closed with continued monitoring followed under Project 54 G-74 as a test area.

Salaries and Wages 1981: - 0 -

Title

75 F-147 - Pavement Riding Quality

Purpose

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



## Scope

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

## Progress Past Year

A total of 1,835 lane miles of bituminous and concrete pavements were tested. This includes new construction, repeat testing, research projects, and special requests.

## Planned Program for Coming Year

Continue with established program.

Salaries and Wages 1981: \$40,997

## Title

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

## Purpose

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

## Scope

A systematic program of pavement friction testing Michigan's 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

Nearly 17,600 pavement friction tests were conducted throughout the State.

## Planned Program for Coming Year

Continue established pavement friction test program.

Salaries and Wages 1981: \$92,224

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. The FHWA STAMINA 1.0 program was adapted to the Department's computer system for use by Testing and Research and other Divisions in the Department. A graphics software program was added to the FHWA program to produce a plan and profile drawing of the noise site.

Planned Program for Coming Year

Incorporate and implement a new FHWA noise prediction program into the Department's computer system. Improve graphics program so that noise site is displayed in smaller scale and with greater clarity.

Salaries and Wages 1981: \$16,130

Title

75 G-211 - Noise Level Inventory of Michigan Freeways

Purpose

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

Scope

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

### Progress Past Year

The Department has surveyed all sites identified as having an  $L_{10}$  between 80 and 83 dbA.

### Planned Program for Coming Year

Implement noise abatement measures for Group I sites that were identified in 1979. Select Group II, approximately eight sites, and write report to submit to FHWA for funding approval.

Salaries and Wages 1981: \$11,740

### Title

77 G-225 - Rubberized Asphalt Stress Relieving Membrane

### Purpose

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

### Scope

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

### Progress Past Year

First annual condition survey was completed. Performance of the asphalt rubber interlayer is promising.

### Planned Program for Coming Year

Conduct annual survey and evaluate performance if possible.

Salaries and Wages 1981: \$420

Title

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

Purpose

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

Scope

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

Progress Past Year

There was no progress due to higher priority work.

Planned Program for Coming Year

Using recorded data and digital profile computation techniques, develop a procedure for ranking crossings. An index similar to that used for rating pavements is anticipated.

Salaries and Wages 1981: - 0 -

Title

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

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 monitor system used to monitor energy flow has been in operation for two years. Data for the first year have been compiled. Data collected include: energy from solar cells, energy stored, energy shunted to ground (batteries fully charged), energy consumed, battery temperature, and ambient temperature. Data collected during the second year are now being compiled.

### Planned Program for Coming Year

Complete data analysis and prepare final report.

Salaries and Wages 1981: - 0 -

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Construction was completed on the research project on US 2 at Thompson. Also completed were similar projects on US 2 at M 117 and M 93 in Grayling which will also be followed.

### Planned Program for Coming Year

Conduct initial condition surveys.

Salaries and Wages 1981: \$2,260

Title

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

Purpose

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

Scope

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

Progress Past Year

The field measurements have been completed.

Planned Program for Coming Year

Complete data analysis of field measurements. Write report of noise levels obtained and submit report to the FHWA with a request to use results in the FHWA computer model.

Salaries and Wages 1981: \$670

Title

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

Purpose

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

## Scope

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

## Progress Past Year

One system has been installed in a rest area building. The system consists of four roof-mounted collectors using liquid for heat transfer, storage tank, and controls. The system will be placed into operation when the building is opened to the public.

## Planned Program for Coming Year

Temperature sensors and water flow meters will be installed and system performance monitored and recorded for two years.

Salaries and Wages 1981: \$30

## STRUCTURAL RESEARCH UNIT

### Title

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

### Purpose

To evaluate the construction and performance of econocrete shoulders on M 14 near the Wayne County line and 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. Construction of the M 14 job was completed in the fall of 1978. Construction on I 69 was started in 1981, and will be completed in 1982.

### Scope

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

The I 69 installation includes shoulders on approximately three miles of rural freeway. The mix utilizes a locally available peastone aggregate at 3,500 psi compressive strength. Construction of about 20 percent of the project was completed in 1981.

### Progress Past Year

Semiannual measurements have been made on the M 14 installation. Early inspections showed that cracks were beginning to form on the mainline pavement near the shoulder joint locations, and now there is a crack in the pavement opposite nearly every shoulder joint. It is evident that the strong intermittent keyway that locks the shoulder to the mainline pavement on this project has increased the amount of commutative cracking in the pavement. Standard plans for future installations, including the I 69 job, have been revised to eliminate the keyway. No additional deterioration is evident at this time. No experimental work has been done on I 69.



## Planned Program for Coming Year

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

Salaries and Wages 1981: \$556

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Winter and summer readings were completed and a condition survey made. Data were tabulated and are on file. Inspection showed standard and full-depth bituminous shoulders deteriorating and sinking, no new problems with concrete shoulders. The longitudinal shoulder-pavement joint in seal coated sections has been slurry-sealed by the Maintenance Division. Slurry sealing was not effective, deterioration is progressing. Several other bituminous locations have been wedged near the pavement edge. Some results from this project were included in Research Report R-1169 that was presented at the International Conference on Concrete Pavement Design, at Indianapolis, in April 1981, and was published as a Departmental Report in September 1981.

## Planned Program for Coming Year

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

Salaries and Wages 1981: \$1,182

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

Weekly treatment of the field exposure slabs was continued through the eleventh winter. Routine maintenance was performed at the field exposure site. Specimens with uncoated bars still have about four times as much spalling above the rebars as do those with galvanized bars. Field inspections, 'corrosion cell' readings and delamination detector surveys were completed on the five experimental decks that are now nine years old. All data were tabulated and records updated. Quarterly reports on the project were prepared for the FHWA. The first small 'hollow areas' near uncoated bars were reported during the evaluation three years ago, and two small hollow areas were found over galvanized bars on the Grand River Ave Bridge last year. This year's survey showed about 10 sq ft of hollow areas on the Grand River Ave Bridge, over both uncoated and galvanized bars.

### Planned Program for Coming Year

Field exposure specimens with 1/2-in. cover have been removed from treatment and will be disassembled to determine the condition of the bars. Weekly treatment of the remaining field exposure specimens will continue through this winter as will yearly inspections of bridge decks. The project has been kept up to date and on schedule.

Salaries and Wages 1981: \$11,019

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

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

### Planned Program for Coming Year

Next year's work will closely follow that of last year's, as this is a long-range evaluation type project, and the general deterioration of the experimental installations has not yet begun.

Salaries and Wages 1981: \$2,205

Title

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

Purpose

To determine the relative performance of the experimental pavement types.

Scope

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

Progress Past Year

A progress report was prepared for FHWA. Roughness and condition surveys were completed and recorded. Repairs made shortly after construction are deteriorating. Concrete deterioration is present at the bottoms of the joints in all slab lengths. First stages of surface deterioration are beginning to appear in the form of D-cracking and joint spalling. Rideability has not changed significantly.

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

Salaries and Wages 1981: \$1,181

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 a variable spacing.

## Scope

Ten 'ethafoam' pressure relief joints were placed in 1971, 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

There was little change in joint width readings from 1980 to 1981. Joints are tightly closed and faulting has developed, but general condition is still good. The relief space that was added has provided blow-up protection in the area treated, for a total of 10 years. Results of this project were included in Reports R-1169 and R-1185. Report R-1185 will be considered to be the final report for this project.

## Planned Program for Coming Year

The project is closed.

Salaries and Wages 1981: \$267

## 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. No additional effort was made on this project due to higher priority work. (These projects are still relatively new, analysis should await observable deterioration.)

## Planned Program for Coming Year

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

Salaries and Wages 1981: - 0 -

## Title

\*73 F-131 - Epoxy Resin Coated Reinforcing Steel

## Purpose

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

## Scope

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

## Progress Past Year

Quarterly progress reports were prepared for the FHWA. Evaluation of laboratory specimens has been continued. Scheduled maintenance of field exposure specimens was completed. Yearly condition, delamination detector, and corrosion cell surveys were performed on three experimental bridge decks. Salt treatment of field exposure specimens is being performed for the eighth winter. All decks and experimental specimens still are in excellent condition. Computer programs are in progress to plot the corrosion data from the experimental decks.

#### Planned Program for Coming Year

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

Salaries and Wages 1981: \$4,072

#### 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

This project has seen no activity during the past year. It is being continued as a long term evaluation of the performance of the concrete glare screen, but since all concrete installations are relatively new, no planned series of activities exists. Performance of the concrete screens has been considerably better than the metal mesh screens, from a damage and durability standpoint. Many mesh installations have been replaced by concrete.

#### Planned Program for Coming Year

Survey condition of experimental glare screens, and issue a final report, if time and staff permit.

Salaries and Wages 1981: - 0 -

#### Title

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

#### Purpose

To compare performance of several types of pavement systems.

## Scope

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

## Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made. Black base sections with no drainage show increasing signs of aggregate discoloration along the centerline and at joint intersections, and some spalling at joint intersections. This type of deterioration is starting to occur in other sections as well. Cores from the joints in the black base sections showed concrete deterioration of the joint faces and the bottoms of the slabs to be proceeding rapidly. This is providing material which is being pumped under the leaving edges of the slabs and causing faulting which is now more than 3/4-in. at some locations. Sections on open graded drainage course are performing well as are the sections with load transfer on gravel base. Commercial traffic is light. Cores were cut from this project and 17 other construction projects, for lab analysis related to durability or D-cracking. The total number of cores was about 180, covering 11 different aggregate sources. Laboratory work is in progress. Experimental edge drains were installed at several locations on the US 10 site.

## Planned Program for Coming Year

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

Salaries and Wages 1981: \$18,904

## Title

74 F-140 - Maintenance Procedures to Prevent Blow-Up 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 blow-ups.



## 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

Yearly condition survey and biannual measurements were performed. Results of data tabulation are as follows:

It was obvious from earlier results that there were significant differences in the performance of the various construction contracts included within the limits of evaluation.

In general, the pressure relief joints have closed to near their capacity. Much of the expansion and contraction is occurring at open cracks, with some joints frozen. Pressure relief joints where filler was lost are inoperative as far as pressure relief is concerned. A final report for the project (R-1185) has been prepared and is ready for publication.

After six years of service since preventive maintenance was done, some of the sections are badly in need of repair. However, no emergency repairs have been required. It was concluded that the type of deterioration is the same on all projects, although the amount is quite different. The cause is aggregate durability or D-crack deterioration.

## Planned Program for Coming Year

Publish the final report. The project is complete.

Salaries and Wages 1981: \$6,191

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

All experimental work for the HPR project was completed previously. However, the HPR completion date has been extended one year to allow for completion of the report. Initial work on crack propagation and fatigue was done during the past year, and additional non-destructive evaluation of specimens was done as well.

## Planned Program for Coming Year

The fatigue crack propagation studies will be continued during the coming year, along with chemical analysis work and some additional fracture toughness work as well. Field investigations of existing bridges with electroslog weldments will continue if staff and funds permit. The initial set of field exposure specimens (five years exposure) will be removed and evaluated. The HPR final report will be issued, and the remainder of the work is being carried on as a regular Michigan research project.

Salaries and Wages 1981: \$7,691

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

Scheduled faulting and joint movement measurements were completed and surveys were performed. A condition survey of the entire project was completed. Poured joint seals have come loose in places, unsealed joints continue to fill and 'grow.' Many neoprene seals have been lost from expansion joints. Some faulting is developing, preliminary analysis of the data indicates that expansion and contraction repair joints perform equally poorly as far as faulting is concerned. Work on the report is in progress.

## Planned Program for Coming Year

Continue to take readings, compile data, and perform condition surveys. Analyze data and publish a report.

Salaries and Wages 1981: \$5,027

## Title

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

## Purpose

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

## Scope

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

## Progress Past Year

Dynamic evaluations have been completed on all scheduled specimens, including galvanized, plain, or "galvanized-and-then-stripped" specimens.

In all cases the fatigue life of the plain or stripped specimen has been at least twice as long as that of the corresponding galvanized specimens,

with a 95 percent confidence level in the resulting data. Therefore, it appears evident that the galvanized coating increases fatigue cracking.

#### Planned Program for Coming Year

Issue a report of findings.

Salaries and Wages 1981: \$617

#### Title

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

#### Purpose

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

#### Scope

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

#### Progress Past Year

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

#### Planned Program for Coming Year

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

Salaries and Wages 1981: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Project evaluation work is complete. Awaiting final report from MSU.

Planned Program for Coming Year

Final report to be issued and reviewed.

Salaries and Wages 1981: \$81

Title

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

Purpose

To evaluate Aqua-Sans Recirculating Sewage System for use at rest areas.

Scope

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

Progress Past Year

Experimental work completed. Final report being drafted.

## Planned Program for Coming Year

Final report.

Salaries and Wages 1981: \$2,709

### Title

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

### Purpose

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

### Scope

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

### Progress Past Year

The Department has terminated the use of unpainted steel.

Research Report R-1155 was published, covering uncoated guardrail. Reports were prepared and presented to AISI and the Northwest Bridge Engineers Conference.

Corrosion loss data have been gathered from additional field sites, including remeasuring some sites after a known time interval. More accurate data on actual exposure time have been obtained.

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

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

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

Additional link plates have been obtained from a repair job in Detroit. Specimens have been prepared and fatigue experiments are in progress in the Laboratory.

Finite element routines have been developed for application in the fatigue-related portions of the project. Additional work in this area is continuing.

A draft report covering progress on the project has been prepared.

#### Planned Program for Coming Year

Additional observations and measurements will be made, as staff and time permit.

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

Data gathering and analysis will be continued. The progress report will be submitted for review and will be published.

Salaries and Wages 1981: \$30,444

#### Title

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

#### Purpose

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

## Scope

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

## Progress Past Year

Specifications for the installation are ready for bids, which are scheduled for January 1982.

## Planned Program for Coming Year

Monitoring and evaluating installation procedures for the facility scheduled for construction in 1982.

Salaries and Wages 1981: \$2,342

## Title

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

## Purpose

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

## Scope

The condition of posts will be checked on approximately 60 projects, including wooden posts of about 5 to 25 years of age, treated with four different types of preservatives; as well as painted and galvanized steel posts.

Posts of approved and unauthorized species will be identified in Metro and Kalamazoo Districts, samples will be removed for strength testing in the Laboratory, at intervals of approximately one year. Unauthorized species under consideration are basswood and two types of poplar. Pine posts will be used as control, since they are of approved species.



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

#### Progress Past Year

A rating system for the laboratory-conducted condition surveys of older posts has been developed and field inspections have begun. Fixtures for strength-testing the posts have been revised and set up.

Posts of unauthorized and control species have been selected and tagged in Metro and Kalamazoo Districts. Posts have been removed from Kalamazoo District and sent in to the Laboratory. Samples also have been obtained of posts that had been removed from service due to deterioration, in the Grand Rapids District.

#### Planned Program for Coming Year

Conduct bend-to-failure tests on posts submitted to the Laboratory.  
Continue condition surveys of the various installations of older posts.  
Compile and evaluate data.

Salaries and Wages 1981: \$3,125