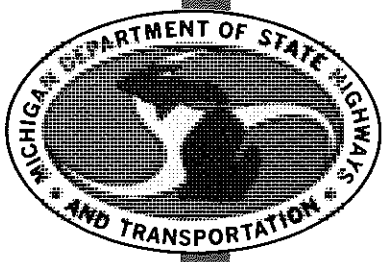
ANNUAL REPORT OF ACTIVITIES OF THE MICHIGAN DEPARTMENT OF TRANSPORTATION RESEARCH LABORATORY



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-1139

Lansing, March 1980

CONTENTS

INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1979 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 1979. 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 costs for 1978-1979, 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.

As a result of a feasibility study by Michigan State University, the Department, with Federal support, has undertaken a project to supply solar and wind-generated energy to a highway information and rest area building. The Department-designed, earth-sheltered building, to be constructed in 1980, will include numerous methods of energy generation and conservation. About 50 percent of the energy requirements of the building will be generated from a 40-kilowatt a-c wind turbine generator, a 15-kilowatt d-c wind turbine generator, a 5-kilowatt voltaic array, and a 234 cu ft thermal wall with heat storage. Sensors will be included to monitor energy generation and consumption together with environmental sensors to measure wind velocity, solar radiation, and temperature. Significant energy flow rates and weather information will be publicly displayed on an interpretive panel located in the building. At three other rest areas, solar collectors are being installed to supplement energy requirements for hot water heating.

A second test section was constructed for evaluating the performance of a sulfur-extended asphalt for resurfacing pavements. In this method, hot sulfur is blended with hot asphalt cement to form a paving mixture requiring less asphalt, which is now a critical petroleum material. Other bituminous test sections were constructed to evaluate the use of reclaimed rubber as an additive to asphalt cement in an effort to produce a more durable material, less susceptible to reflection cracking.

The Laboratory continued to be active in the area of air quality monitoring with two air quality monitoring units collecting data at several locations. These data were provided to the Bureau of Transportation Planning, Michigan Department of Natural Resources, and the Southeast Michigan Council of Governments. A trailer and instruments for constructing a third air monitoring unit were obtained, and the unit will be put in the field this spring. The Laboratory hosted a Federal Highway Administration seminar on air pollution modeling at Detroit Metro Airport which was attended by State, city, and county transportation planners and air quality specialists, and also operated an Environmental Protection Agency display engine at the State Fair to show the effects of emission control equipment. The engine was equipped with exhaust analyzers to show the effect of an out-of-tune engine or an inoperative catalytic converter on the amounts of carbon monoxide, hydrocarbons, and nitrogen oxides emitted.

As an aid in judging the performance quality of traffic paint striping, an instrument has been developed at the Laboratory to measure the reflectance of pavement paint stripes. The portable hand-held unit utilizes a three-digit liquid crystal display to indicate the reflectance of measured striping relative to a laboratory sample. Measurements can now be made during daylight hours, thus avoiding hazardous night testing using subjective evaluations.

In our on-going experimentation to discover improved maintenance procedures, we have been working on procedures for maintaining neoprene sealed concrete pavements. An experimental section on I 69 has been undergoing evaluation and specifications have been prepared for a contract on I 75 in Arenac County utilizing the methods and materials that have shown satisfactory performance on the I 69 section. The I 75 contract is planned for letting in the spring of 1980. Joint spalls on 12 miles of freeway will be repaired with fast-set mortar, defective seals will be replaced, and cracks with fractured reinforcement will be repaired.

'End result' aggregate acceptance sampling plans have been used on four construction projects during the past two years. The technical and operational aspects of the plans have been successful. Based on this exment, the end-result specification appears to be feasible and beneficial to the Department.

In the area of highway safety, new designs of wide-angle reflectors for concrete barrier walls, reflectors for replacing centermount delineators on curves, and curb-top reflectors were evaluated. A barrier wall delineator was developed in the Laboratory and a manufacturer has begun producing it. Retro-reflective brightness of school crossing guard vests was evaluated and recommendations for vest design were prepared. A significant development was made in the technique of measuring such retro-reflective materials in that the equipment was redesigned and fabricated which allows one man, rather than two, to operate the equipment for the test.

The Laboratory has developed a mathematical model which compares the risk of cross-median collisions to median barrier accidents for any combination of median width, vehicle speed, and barrier type. Computer trials with this model will allow engineers to compute accident trade-offs before barrier installation. For most highway situations the model indicates that barrier installed in medians wider than about 30 ft result in more accidents and injuries than the barrier-free alternative.

The evaluation program of experimental railroad grade crossing surface materials now includes a total of 46 crossings. Of these, 26 were installed this past year. The crossing materials currently being evaluated are: rigid polyethylene, steel reinforced rubber, steel, and a rubber-epoxy mix. Two precast concrete crossings and three polyethylene crossings have been or are being replaced because of poor performance. Otherwise the experimental crossing materials are performing satisfactorily.

Our Federally funded research project on bridge welding has yielded some significant advances in the measurement of the fracture toughness of electroslag and submerged arc weldments. Knowledge of the weldment

fracture toughness allows the estimation of the maximum size flaw that can be tolerated at a given stress intensity in a bridge structure without failure. Significant decisions have been made concerning the structural integrity of bridges in service based on our research results.

An investigation of the condition of a non-redundant electroslag welded major railroad bridge in Detroit showed the weld metal to have very low toughness, and also confirmed that defects exist in some of the welds. The end result of the investigation was a Departmental contract to bolt-splice the welds subjected to tensile stress.

Investigation of the condition of unpainted A 588 steel bridges led to recommendations that resulted in a moratorium on the use of such steel in the unpainted condition in heavily salted or industrially polluted environments.

The test road the Department constructed near Clare, Michigan, continues to provide data on new construction methods. Performance evaluations have shown the deleterious effects of impervious base materials on the concrete pavements, and also has shown the excellent performance to date of the short slab, no-load transfer pavements placed on 'super draining' asphalt treated porous base materials.

INDEX TO RESEARCH REPORT ABSTRACTS AND
ACTIVE RESEARCH PROJECTS

R-1104 - "Air Quality Report for M 51 Relocation, Berrien County," (77 AP-14A).

This report was a revision of an earlier one (R-909R) and was prepared as part of the Environmental Impact Statement for this proposed route location. In accordance with Federal directives, the terrain and demography, meteorology, existing ambient air quality, and pollution estimates were all explored. Pollution estimates are based on a model which includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. Also included is additional information for three receptor sites, two schools and a playground, and a total pollutant burden analysis. The report concludes that no adverse environmental effects are to be expected.

R-1105 - "Air Quality Report for US 31, Berrien County," (73 TI-183).

This report was a revision of an earlier one (R-899R) and was prepared as part of the Environmental Impact Statement for this proposed route location. In accordance with Federal directives, the terrain and demography, meteorology, existing ambient air quality, and pollution estimates were all explored. Pollution estimates are based on a model which includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. Also included is additional information for five receptor sites, four schools and a boy scout camp, and a total pollutant burden analysis. The report concludes that no adverse environmental effects are to be expected.

R-1106 - This report on median barriers was withheld in order to pursue further research.

R-1107 - "Evaluation of Sodium Chloride for Stabilizing an Aggregate Base Course (M 28 East of Bruce Crossing)," (57 E-15(2)). R. C. Mainfort.

This report comments on the results, after five years, of a project to evaluate the effect of adding different quantities of sodium chloride as a stabilizing agent for base course aggregates. Seven experimental sections were laid-out using 0, 12, and 40 lb of rock salt per ton of aggregate. After five years, all test sections are performing satisfactorily. No problems were encountered with the construction of the sections, higher densities were obtained with the salt treatments, and laboratory determinations

of the resilient modulus of samples showed no significant trend of results between the three types of section. Should salt be used as a construction aid for base compaction, it appears that the present specification value of 6 lb/ton of aggregate is satisfactory; but, because of mixing problems, and the low cost of rock salt, a value between 6 and 12 lb/ton should be acceptable.

R-1108 - "Stress Measurements and Load Distribution on Selected Portions of the Mackinac Bridge," (78 F-155). C. J. Arnold and W. D. Bullen.

This study was intended to confirm the feasibility of transporting railroad cars over the Mackinac Straits Bridge on a special vehicle (and to gain additional insight concerning the overload capacity of the structure). The critical, or most highly stressed, portions of the bridge were calculated, and strain gages were applied at 49 different locations. Strains were measured, and associated stresses calculated, as loads were applied by an experimental 11-axle, 74-tire, 80 ft by 12-ft, 249,000-lb vehicle. Calculations indicated that the proposed railcar transporter would cause only about 3/4 as much stress as the experimental vehicle, and that it would not stress the floor system of the suspension bridge as highly as does the 77-ton commercial vehicle legal in Michigan. Additionally, steel specimens removed from 13 locations on the instrumented spans determined that the strength of the steel exceeded specifications. The report concluded that the bridge is capable of carrying 80-ton railroad cars on the proposed railcar transporter vehicle. This conclusion, however, is related only to the physical strength of the bridge and the stress distributions that occur. It is not a recommendation that such a program be necessarily undertaken, as there are many other factors that must be considered.

R-1109 - "Summaries of Michigan Pavement Friction Measurements: 1977 Test Program," (54 G-74). P. M. Schafer.

This year's annual survey reports the results of over 10,300 pavement friction tests conducted throughout the State with the Department's pavement friction test vehicle. 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 5 and 10 years of service and reported herein. Additionally, pavement friction tests are performed and reported upon for certain experimental resurfacing projects 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 1977 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.

R-1110 - "Astro Optics Delineators," (78 NM-559). M. H. Janson.

This report describes the laboratory evaluation of four types of reflective delineators manufactured by the Astro Optics Corp. The types submitted were for: center mounting on delineator posts (Model 001), mounting on concrete barriers (Model B-1), one similar to the former but fitted for mounting in guardrails (Model GR-1), and for mounting on raised curbs (Model CM-1). Photometric, color, seal, and heat or warping tests were conducted in the laboratory, and the materials used were identified. Results showed that the manufacturer can produce a satisfactory product if quality control is improved. It was recommended that all of the above models be evaluated under field conditions.

R-1111 - "NFS Industries Delineators," (78 NM-560). M. H. Janson.

This report describes the laboratory evaluation of a reflective delineator manufactured by NFS Industries. It can be used either as a replacement for our center mount delineators, or mounted on barrier walls. Photometric, color, seal, and heat or warping tests were conducted in the laboratory, and the materials used were identified. Results showed that the manufacturer can produce a satisfactory product if quality control is improved. It was recommended that the delineator be evaluated under field conditions, particularly in ramp and horizontal curve areas.

R-1112 - "Annual Report of Activities of the Michigan Department of Transportation Research Laboratory."

R-1113 - "Evaluation of Various Types of Railroad Crossings: Third Progress Report," (75 F-143). J. E. Simonsen.

Michigan has been conducting an on-going research project in cooperation with the Federal Highway Administration to investigate various proprietary railroad crossing materials and designs. This report describes seven such crossings: T-Core, Fab-Ra-Cast, Steel Plank, Track-Span, Gen-Trac, Saf and Dri, and Parkco, and is the third progress report issued on the project. Each of the crossing materials is described, as are the construction procedures for each. Seven criteria were used to evaluate the effectiveness of the crossings: surface wear, surface damage, alignment of units, fastening of units, fastening of rails, pavement/crossing joint,

and crossing smoothness. Each of the experimental crossings are rated in the report. On the basis of observations of the test crossings, two (T-Core and Fab-Ra-Cast) did not prove suitable for crossings having traffic volumes at the magnitude experienced, and the Department has suspended the use of these crossing types. The remaining five continue to perform satisfactorily up to this time. Due to the relatively short length of time these crossings have been in service, further reports will be forthcoming on their conditions as time passes.

R-1114 - "A Study to Monitor the Deicing Chemical Pollution Prevention System at the Reed City MDOT Maintenance Garage: Preliminary Report," (77 G-227). R. W. Muethel.

This study was initiated to evaluate the Department's revised Pollution Incident Prevention Plan (PIPP) guidelines for deicing salt and treated sand storage and handling at maintenance facilities. The Reed City garage was selected as a monitoring site since it was designed to incorporate the measures recommended in the PIPP guidelines. The study involves the use of test wells to monitor possible groundwater salt contamination from stockpiled maintenance storage facilities. At the same time, saltwater run-off was to be studied on a salt-treated sandpile on a long-term basis. The results of this preliminary report are somewhat inconclusive, since a rupture was discovered in the liner of the lagoon designed to collect any saltwater run-off; moreover, an unusually severe winter necessitated the use of the salt-treated sandpile that had been intended for long-term observation. The liner has been repaired, an auxiliary sandpile deposited for long-term observation, and the sampling program will be continued.

R-1115 - "Performance Evaluation of Non-Reinforced Ramps," (78 TI-528). L. T. Oehler.

At the request of the Engineering Operations Committee, the Laboratory conducted a survey of all non-reinforced freeway ramp pavements (a total of 16 interchanges, consisting of 63 non-reinforced ramps and 5,813 individual slabs were surveyed). On the basis of our visual inspection of the non-reinforced ramps, it appears that base problems and/or heavy or frequent traffic have caused the cracks to develop. Therefore, unless better ways are found to ensure that the base is compatible with a non-reinforced slab, it is suggested that the use of reinforcement be required. The Department is now reinforcing all ramp pavements.

R-1116 - "Anti-Glare Screen Median Fence," (69 NM-241). J. D. Truax and G. M. Smith.

The intent of this project was to evaluate the headlamp glare-reducing effectiveness of a conventional chain-link fence for roadway medians, and to compare this with an expanded metal anti-glare screen made by the Niles

Expanded Metal Co., and currently in use. Laboratory and field observations showed that because of the rather large median widths required (15 ft for the screen, 20 to 25 ft for the chain-link fence) for either of these materials to be effective as an anti-glare device, they would be more suitable for rural than urban applications.

R-1117 - "Effectiveness of Infrared Joint Heaters for Bituminous Pavements," (77 D-33). J. H. DeFoe.

The weakest point in bituminous pavement is often the longitudinal joint between adjacently paved lanes. This is because of lower density at the edge of the first lane paved which is due to lack of confinement at the edge during compaction rolling, and lower tensile strength due to cooling of the material at the edge of the first lane by the time the second lane is rolled. If two pavers can work in echelon, allowing both lanes to be paved and rolled at the same temperature, the problem is alleviated. However, in the case of two-lane pavement, one lane is generally required to be paved at a time in order to allow maintenance of traffic. To rectify this, it has been the practice of the Department to require the pavers to be equipped with infrared joint heaters, which heat the cooled edge of the first lane at the time of paving the adjacent lane. Because the effectiveness of this technique has been questioned, this study was initiated. Measurements and observations made in the course of this study showed that the infrared joint heaters do not alleviate the zone of low density, low tensile strength, regardless of paver speed or ambient temperature, and the use of these heaters as currently specified should be discontinued. Possible alternative solutions might be to confine the joint during compaction of the first lane, pave both lanes at once, or cut away the low density, low tensile strength zone before paving the second lane.

R-1118 - This report on median barrier installation was withheld in order to pursue further research.

R-1119 - "Development of Base Layer Thickness Equivalency," (68 E-42). S. S. Kuo.

The purpose of this study is to establish a 'thickness equivalency' of the base layer on the basis of elastic layer theory and limiting strains at critical locations in the pavement (the horizontal tensile strain at the bottom of any asphaltic layer and the compressive strain at the top of the subgrade). Control of these strain values provides control over the ability of the pavement to resist fatigue cracking and subgrade failure. The CHEV 5L computer program was used to calculate all critical strains in this study. The determination of appropriate modulus values for computer input parameters in bituminous concrete, black base, and subgrade soils is discussed. The moduli of granular base and subbase materials are determined from

subgrade modulus by stress-dependent concepts, which consider the modulus of a base or subbase layer to be a function of the modulus of the layer below it. With the use of computer data obtained from models of two standard Michigan flexible pavement sections subjected to three different 18-kip equivalent axle load repetitions, thickness equivalency curves were developed. These should be able to be used to design the thickness of a granular or asphalt-treated base which will satisfy the strain restrictions in a flexible pavement section with known bituminous concrete and subgrade moduli. Procedures for designing theoretical thickness combinations of granular base and black base pavements are also presented as design alternatives in this report. The equivalency charts may also be used to determine if a black base is needed in a pavement section, or whether one may be substituted for a granular base (black bases have an economic advantage only when the subgrade is weak), and they may be used for predicting the remaining years of performance life in an existing flexible pavement.

R-1120 - "Continuously Reinforced Concrete Pavement in Michigan: A Historical Summary," (61 F-64, 57 F-46, and 73 F-129). J. E. Simonsen.

This report is a summary and survey of Michigan's 20-year experience with continuously reinforced concrete pavement (CRCP). It discusses the design, construction, types of failure, maintenance, and current condition of Michigan's CRCP. Although there are many attractive features about such pavement, and advances have been made over the years in its design and construction, CRCP is sensitive to construction-related problems, it requires a firm, uniform base support to prevent premature failures, its reinforcement will eventually corrode and fracture will occur across the entire lane or roadway, and it is more difficult to maintain than conventional jointed concrete pavement. The most disturbing fact is that the reinforcement will rust through (an Appendix with photographs is devoted to rebar corrosion). Once this occurs, it appears necessary to convert to a jointed pavement or saw the CRCP into short slabs and apply a bituminous overlay. All this considered, the report concludes that it would appear better to construct a conventionally reinforced pavement to begin with, and the report recommends discontinuing CRCP in Michigan, at least until economical corrosion protection of the reinforcement can be developed.

R-1121 - "Evaluation of Various Bridge Deck Joint Sealing Systems: Final Report," (72 F-128). F. J. Bashore, D. E. Branch, and A. W. Price.

Since 1972, in cooperation with the Federal Highway Administration, Research Laboratory personnel have been evaluating eight different bridge expansion joint seal systems installed on over 250 bridges (totalling more than 350 joint installations). There are three general types of seal under

examination: metal-reinforced polychloroprene pads, metal-supported and anchored modular polychloroprene compression seals, and metal-supported and/or anchored polychloroprene or EPDM continuous elements. Each joint has been inspected twice yearly to determine its general appearance and condition, ride and noise qualities, movement, damage, and debris intrusion. The report includes a complete description of the rating system used, detailed descriptions with drawings and photographs of each joint seal system, and a discussion of the good and bad features of each system after a number of years of observation. In general, the report concluded that all the systems provided a more watertight seal than the 'conventional' steel sliding plate system used in the past; however, each has its own serious problems. The report recommends that the metal-supported and anchored polychloroprene compression seals not be used, since our experience has shown them incapable of providing a watertight joint, and that if any of the other systems are to continue to be used, certain precautions outlined in the report's conclusions should be observed.

R-1122 - "Effectiveness of Neoprene Seals in Preventing Concrete Pavement Contraction Joint Deterioration," (73 G-195). F. J. Bashore and A. W. Price.

This project, a Highway Planning and Research project performed in cooperation with the Federal Highway Administration, involved taking over 200 cores from contraction joints sealed with compressible seals on 17 construction projects over a period of four years in order to determine the amount and rate of deterioration of the concrete at the bottom of the joint. Seal performance was rated, chloride content of the concrete was determined, and drainability of the base material was rated. The study indicated that the neoprene seals perform well in preventing the entry of incompressibles but permit the entry of liquids into virtually all joints to some degree. Deterioration of the concrete at the bottom of joints is occurring, but at a relatively low rate for most projects. The data indicated that most of the deterioration occurred during the first five years and shows little significant change for the following years. Several modifications in design, construction, and maintenance of concrete contraction joints are suggested.

R-1123 - "Alternate, More Economical Repainting Systems for Bridge Structural Steel: First Progress Report," (76 G-219). F. J. Bashore and A. J. Permoda.

This Highway Planning and Research project, conducted in cooperation with the Federal Highway Administration, is intended to evaluate coating systems that might prove more economical, yet as durable, as our current four-coat system. The report discusses the application of a 'high build' petroleum-based wax coating which is to be evaluated in the field in both one and two-coat applications. It is intended that future observation will

determine whether the fewer coat application, necessarily a lower cost repainting system, can give protection comparable with our four-coat system when applied at an equivalent film thickness of 5+ mils. The possible protection advantage of applying the 'high build' coating system at a 10-mil dry film thickness was also to be evaluated. The objectives of this test application were somewhat negated by the inability of the painter to apply a uniform thickness with spray equipment. Three months after the coatings were applied late in 1976, rusting was evident in areas scattered throughout the entire half of the structure where this type coating was applied. The contractor subsequently returned to correct the film-deficiency areas and, in addition, applied an additional coat to the entire half of the structure. This resulted in average film thicknesses of 12 mils and 17 mils, respectively, for the areas where one and two coats were intended, compared to the specified minimum of 6 mils and 10 mils, respectively. These coatings will continue to be monitored, and reported upon at a later date.

R-1124 - "A Study to Evaluate the Performance of Bituminous Wearing Course Containing Sandy Limestone: Preliminary Report," (77 C-18). R. W. Muethel.

In testing the polishing characteristics of carbonates on the Laboratory's indoor wear track, it was noted that the samples of arenaceous (sandy) carbonates exhibited only slightly less resistance to polishing than crushed gravel, suggesting that this material might serve as a satisfactory substitute for the latter as bituminous wearing course aggregate. This report describes the construction and constituents of a three mile bituminous concrete resurfacing project; with over 3/4 of a mile containing a special sandy limestone aggregate, the remainder being a control section using a conventional crushed gravel aggregate mix. A detailed petrographic analysis is included as an Appendix. Visual inspections, initially and after one year, and test results from Michigan's pavement friction test unit were made. The pavement is performing satisfactorily, and continued future observations will allow us to draw more conclusive results as the pavement wears.

R-1125 - "Performance Evaluation of 'Mirafi 140' Fabric as Overlay Reinforcement to Control Reflection Cracking," (77 TI-398). C. A. Zapata.

This study, conducted in cooperation with the Federal Highway Administration, was conducted to see whether this plastic fabric, installed between an existing concrete pavement and an asphalt overlay, would reduce reflection cracking. A conventional resurfacing project was selected, and 330 ft of 'Mirafi 140' fabric were included as a test section, to evaluate its performance in terms of reflection cracking reduction, laydown and bonding practices, labor, equipment and inspection required, maintenance, and

construction costs as compared with the conventionally performed part of the project. In general, the fabric was installed without any major field problems, and the resurfacing work including paving operations, control practice, and workmanship was satisfactory throughout the experimental project. After two years, the Mirafi section has shown little or no resistance to reflection cracking; however, seasonal crack surveys and field inspections will continue for at least two more winters to complete the evaluation.

R-1126 - 'Investigation of Pavement Problems on I 275," (79 F-158).

As a result of unusual development of longitudinal cracking and 'punch-out' failures—small sections of concrete which are 'punched' into the base or broken apart by traffic—pavement surveys were made, soil samples taken, and construction materials were reviewed. On the basis of field observations and test data obtained during this investigation, it is concluded that the concrete and subgrade are not factors contributing to the formation of longitudinal cracks. Although the exact mechanism responsible for the cracking was not determined, it is concluded that the primary causes are poorly drained bases and subbases, blocked drainage paths, and frost susceptible bases. Recommendations are presented based on the results of the report, and some limited crack sealing studies were included.

R-1127 - "Texturing Existing Concrete Pavement," (78 TI-537). P. T. Luce.

One of the problems that texturing or profile planing of existing concrete pavements using milling or percussive type cutters is the spalling that occurs at vertical planes, particularly along transverse joint faces. This project investigated a suggested solution to the problem that consisted of: complete removal of the joint seal material, refilling joints and open cracks with a fast-set mortar, texturing the surface continuously, resawing joints to remove the mortar, and replacing the joint seal material. A site was selected, and a field trial of the method proved to be successful; after one year's time, the joint seal remains satisfactory. A disadvantage of this method is the high cost resulting from all the handwork necessary, and less expensive methods should continue to be sought.

R-1128 - "Investigation of Pavement Heaving on Bridge Approaches, I 275," (79 TI-562). E. C. Novak, Jr.

This investigation was undertaken because six bridges had pavement approach slabs that heaved as much as 2 in. above the bridge decks, under freezing conditions, and dropped below the deck level after thawing. Laboratory and field investigation showed that the frost susceptible layer was the slag base material, which was the dominant contributor to the heaving.

It was recommended that this slag base be removed and replaced with a free draining material such as 6A or 9A gravel.

R-1129 - "Evaluation of Sulfur-Asphalt Binder Bituminous Paving Mixtures: Progress Report," (79 D-37). J. H. DeFoe.

In an earlier project (MDOT Research Report R-1078) an existing, jointed portland cement concrete pavement was overlayed with a sulfur-asphalt mixture. Because of the potential benefits of the use of sulfur—conservation of asphalt cement, reduction in mixture cost, and extended pavement life—it was decided to schedule another test project, this time involving the overlay of an existing bituminous pavement. The latter project is the subject of this report which discusses the materials, construction techniques and problems, and makes some general observations concerning installation. There were a number of problems in the construction of the overlay that are discussed and, as with the earlier project involving rigid pavement, the merits of the pavement surface itself can only be judged after long-term performance evaluation.

R-1130 - "Application for Federal Financial Participation in Traffic Noise Barrier Construction: Michigan Statewide Traffic Noise Level Inventory - Group I," (75 G-211).

The purpose of this report is to describe and justify approximately 27,000 lin ft of traffic noise barrier along selected segments of US 23, I 75 and I 94, for which Federal funding participation is requested. The site selection was based upon data contained in the MDOT Noise Level Inventory (Research Reports R-1013 and R-1013A) rather than on the basis of direct citizen complaint or request. Federal funds can be granted under a provision which is included in the law which provides for funding of noise abatement measures for freeways constructed before the FHWA freeway noise standards were put into effect.

R-1131 - "Stimsonite Delineators," (78 NM-588). G. M. Smith.

This report describes the laboratory evaluation of a reflective delineator, 'Stimsonite 962.' Photometric, color, seal, and heat or warping tests were conducted in the laboratory and the item proved to be satisfactory on these counts. An experimental barrier wall installation can be recommended, with the reservation that because they protrude some 2-1/2 in. from the barrier wall, their service life is expected to be limited being highly susceptible to impact damage.

LISTING OF NEW MATERIALS PROJECTS COMPLETED DURING THE YEAR

71 NM-287 - "Petro-Set" Emulsion for Preserving Bituminous Surfaces

72 NM-358 - "Radgrout-H" for Concrete Bridge Deck Patching (Radiation Technology Division)

75 NM-421 - "Tigercrete" for Patching and Repairing Concrete

76 NM-499 - LDP-6 Plastic Delineator Post (American Highway Products)

77 NM-515 - "Maclite 7200" Reflective Plastic Sheeting (Morgan Adhesives Co.)

77 NM-517 - Acme Fiberglass Dowels

77 NM-523 - "Prismo Plastix HR" Cold Extruded Thermoplastic for Traffic Marking

78 NM-555 - Delugrip Bituminous Design System, High Friction Surface

78 NM-559 - Astro Optics Delineators

78 NM-560 - NFS Industries Delineator Device

78 NM-564 - "Tirecade" for a Type I Barricade (Energy Absorption Systems, Inc.)

79 NM-570 - "De-Raseal" Protective Rubber Coating for Metal (Automotive Chemical Products, Inc.)

79 NM-571 - H.P.S. Rectangular Luminaire - ITT

79 NM-578 - "Calcium Chloride Free Concrete Admixtures"

79 NM-579 - "Set Seal" Concrete Masonry Waterproofing

79 NM-584 - Fusion Bonded Coated Guardrail and Overhead Sign Facing

79 NM-585 - Spencer Floating Bearings for Bridges

79 NM-590 - "Conwed" Preformed Expansion Joint Filler

79 NM-597 - Swaveflex Reflective Devices

LISTING OF TECHNICAL INVESTIGATIONS COMPLETED DURING THE YEAR

73 TI-183 - Air Quality Study on US 31, Glendora Road to I 96, Berrien County

73 TI-186 - Specifications for Diamond Saw Blades (Reopened October 30, 1978)

74 TI-219 - Air Quality Impact for Construction of a M 37/US 131 Connector, North of Grand Rapids

77 TI-429 - Construction of Terminal Monitor for Computer Services

78 TI-451 - Air Monitoring in Vicinity of I 475 in Flint (Control Section 25132)

78 TI-454 - Statistical Analysis of 1978 Bituminous Concrete Extraction Results

78 TI-457 - Assistance in Updating Air Pollution Emission Model

78 TI-475 - Unusually High Skid Coefficient for Concrete with Fine Aggregate from Pit 63-7

78 TI-487 - Noise Investigation Along I 75 Near Outer Drive, Northern Part of Lincoln Park

78 TI-488 - Air Quality Monitoring at the I 96/M 39 Interchange in Detroit

78 TI-489 - Test of Twelve Inch Traffic Signal Dimming Methods

78 TI-502 - General Motors Corp., Road Requirements Study

78 TI-505 - Design of Water Deflector Detail for A 588 Steel Bridges

78 TI-513 - Non-Destructive Testing and Steel Sampling of X06 of 82123, Wayne County

78 TI-515 - Noise Investigation, Davison-Lodge Interchange

78 TI-517 - Noise Abatement Recommendation for Riverfront Development I 75 in Flint

78 TI-518 - Cromwell Vibration Complaint—Cromwell and Telegraph

78 TI-524 - Brake Tests of A&E Dump Trucks

78 TI-528 - Performance Evaluation of Non-Reinforced Ramps

78 TI-529 - Noise Analysis, I 275 and I 94 in Romulus

78 TI-530 - Noise Analysis, M 30 Between Snow Road and Outer Drive, Dearborn

78 TI-534 - Noise Analysis, I 75 (Chrysler Freeway) at Cameron, Between Winchester and Remington. (Request for noise barrier, Mr. Roy Long)

78 TI-544 - Tests of Water in Film Processors—Photographic Services Building

78 TI-545 - Fracture of Cable to Pole Clamp for Cable Supported Signs

78 TI-546 - Investigation and Recommendations for Abutment Movement Eastbound and Westbound I 94 over Pelham Road in Wayne County (S17 and S18 of 82022)

79 TI-551 - Skid Tests for Macomb County on Mound Road

79 TI-554 - Noise Problem, I 75/West Road, Woodhaven, Michigan

79 TI-555 - Cement Analysis, S26 of 25132, 06577A

79 TI-556 - Freezing Characteristics of Hydro-Cell Cushion Liquids

79 TI-559 - Noise and Vibration Investigation, Southbound I 75 Between Livernois and Springwells

79 TI-561 - Reflectivity Evaluation of Bicentennial License Plates

79 TI-562 - Investigation of Pavement Heaving on Bridge Approaches on I 275 (I 58171-06463A)

79 TI-568 - Study of Vibration Problems at Denniston Home During Pavement Breaking, 4090 Overlea Lane, Bloomfield Hills, Michigan, 48013

79 TI-569 - Noise Investigation, 28606 Rhelda Drive, Brownstone Township, Trenton, Michigan

79 TI-570 - Brightness Measurements on School Crossing Guard Vests

79 TI-571 - Noise Investigation, I 94, McBridge to Wayne Road, Wyndclift Estates, Romulus, Michigan

79 TI-572 - Recommendations for Preventing Moisture in Sand at Bottom of Energite Impact Attenuators

79 TI-573 - Pavement Performance of I 69 East of Perry and West of Durand, Eastbound Roadway

79 TI-575 - Alleged Vibration Damage to Mrs. M. Zirbas House (624 Lathrop, Lansing) Due to Traffic on I 496

79 TI-576 - Adhesion Testing of Reclaimed Aluminum Sign Blanks

79 TI-579 - Condition Survey of Steel Guardrail Posts, I 69 from Charlotte to Indiana Line

79 TI-580 - Investigation of Ramp Pavement Failure, Westbound I 94, Rawsonville Rest Area, Wayne County

79 TI-581 - Construction of Traffic Simulation Pulse Generator

79 TI-582 - Noise Investigation, George Czekey Residence, Southeast Quadrant of I 275 and 5 Mile Road

79 TI-587 - Noise Investigation on M 104 in Spring Lake, Ottawa County (Mr. Dick Gilson)

79 TI-590 - Tests on Gunite Mortar for Capitol Complex Sculpture Project

79 TI-592 - Investigation of Vibrations Due to Pavement Removal, US 24 Reconstruction; Quarton Road West to Maple

79 TI-593 - Vibration Investigation Due to Pavement Removal, Telegraph Road/Lone Pine/Long Lake Section

79 TI-594 - Concrete Core Study, A&E Addition, Marshall

79 TI-596 - Noise Investigation, Southeast Quadrant of I 94 and I 275 (Mrs. Edgar Killingbeck)

79 TI-599 - Vibration Monitoring on Telegraph Road South of Lone Pine Road

79 TI-601 - Structural Analysis of MT 640 and MT 650 Transmission Cases

79 TI-604 - Investigation of Post Failure of Salt Shed, Mason Garage

79 TI-605 - Constructing Water Level Detectors for Department of Natural Resources

79 TI-609 - Recommendations Concerning Condition of Guard Posts and Steel Beam Guardrail on I 75 in Bay and Arenac Counties from M 13 Connector North of Bay City Northerly 39.7 Miles to M 33 Near Alger

79 TI-610 - Sign Face Material Identification for City of Dearborn

79 TI-617 - Investigate Pavement Failure at "E. Upson" Rest Area

79 TI-623 - Noise Investigation, Lake Orion, Michigan, Clarkston Road (Mr. and Mrs. L. Wolf)

79 TI-625 - Alleged Damage to Ellis Home Due to Truck Vibrations

79 TI-627 - Analysis of Gasoline in Diesel Fuel

LISTING OF ACTION PLANS
COMPLETED DURING THE YEAR

77 AP-14A - Air Quality, M 51 Relocation—City of Niles, Berrien County

77 AP-15A - Air Quality, M 53 Corridor Study, 8 Mile to I 696, Macomb County

77 AP-17N - Noise Impact, US 12 One-Way Pair, City of Dearborn, Wayne County

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

Test results for four construction projects have been received and evaluated with favorable results.

Planned Program for Coming Year

Two to three additional projects are being set up with double lot size. This means that the relative sample size will be cut in half. A determination of the feasibility of this sample size is expected.

Cost 1978-1979: $4,708

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

Fifty bridges have been identified, examined for length of approach guardrail and also examined for accidents for the period 1971-1978. All accident records pertaining to these bridges have been retrieved and relevant material such as surface conditions, time of day, nature and location of accident has been tabulated. Preliminary comparison of approach and bridge accidents indicates that icy bridge decks generate about three times as many accidents as expected. Moreover, these excess accidents appear most likely during late fall and early spring.

Planned Program for Coming Year

Another 75 bridges will be examined and their accident records tabulated. Analysis will proceed to establish potential relationships between pre-icing and season, time of day, geography, and bridge type.

Cost 1978-1979: $16,578

Title

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

Purpose

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

Scope

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

Progress Past Year

All theoretical work has been initiated. One useful estimation procedure has been found. Program is now in the process of using simulated as well as field data to test the estimation procedure.

Planned Program for Coming Year

Completion of theoretical work, development of applications models and manual.

Cost 1978-1979: $5,017

Title

78 G-239 - Comprehensive Analysis of Skid Resistance Data

Purpose

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

Scope

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

Progress Past Year

Computer retrieval of all bituminous sections for which skid test data are available.

Planned Program for Coming Year

Assembly and correlation of relevant mix design and environmental variables with skid numbers.

Cost 1978-1979: $2,369

Title

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

Purpose

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

Scope

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

Progress Past Year

The first use of Thermoflex 8002 latex emulsion on a state project was monitored on I 496 in Lansing. Only half of the three structures—the eastbound decks—were completed late in the year before closing down for the winter. Due to loss of personnel and other high priority work, processing of selected cores and some field inspections of other overlay projects were not completed.

Planned Program for Coming Year

Finish the sampling and inspection of the Thermoflex project on the westbound decks in Lansing. Assemble all data and prepare initial report. Complete two-year inspections and report on the 11 Dylex structures overlain in 1978. Continue field inspections on other selected latex overlay projects.

Cost 1978-1979: $20,256

Title

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

Purpose

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

Scope

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

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

Progress Past Year

The use of water reducers in grade 35S concrete with the same cement reduction as 35P, to 5.6 sacks/cu yd, was incorporated into the 1979 Standard Specifications. Laboratory test data on the use of Type 1SA cement with and without water-reducer was summarized for a report.

Planned Program for Coming Year

Close out the project with a report containing the data on Type 1SA cement and also a summary of all earlier data on grades 35P and 30P concrete.

Cost 1978-1979: - 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.

Progress Past Year

A performance inspection of the experimental portion of the I 275 paving project was completed and a rough draft of the final report is nearing completion.

Test results from the concrete cores of the bridge application were reduced and tabulated.

Planned Program for Coming Year

The I 275 paving project report will be completed and a report will be written on the bridge concrete evaluation.

Cost 1978-1979: $17,704

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.

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 loss of personnel, 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.

Cost 1978-1979: $241

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 8 new two-course structures on I 475 in Flint.

Progress Past Year

No additional projects were done with LSHD concrete since all overlay projects have been of the latex modified concrete type. The LSHD concrete is no longer listed as an alternate to the latex modified concrete overlays.

Planned Program for Coming Year

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

Cost 1978-1979: $4,302

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 assembled but not typed final. Later data on tests cured at 45 F and 57 F were also included.

Planned Program for Coming Year

Finalize the report and distribute to close the project.

Cost 1978-1979: $269

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 of cement/cu yd, a water-reducer, and a local 60-40 sand-gravel aggregate. The composite econocrete pavement consisted of two layers each of 4-in. depth; the lower layer being econocrete and the upper layer being grade 35P concrete. The construction of the composite econocrete pavement was closely monitored. Fresh concrete specimens of both econocrete and grade 35P concrete were obtained and tested in the laboratory. Future inspections and testing were to include coring, measurements of joint openings, slab movement, profilometer, load-deflection and condition surveys of both the composite econocrete pavement and the grade 35P concrete pavement.

Progress Past Year

Final typing of the report was delayed to include tests on cores and profilometer tests run in 1979 on all four ramps in the Shelby Rd interchange.

Planned Program for Coming Year

Profilometer tests and condition surveys are to be run early in the year to be included in the report for final typing and distribution.

Cost 1978-1979: $151

Title

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

Purpose

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

Scope

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

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

Progress Past Year

The report on this project was delayed pending the drilling of 24 cores from the four basic mixes involved. The cores were obtained late in the year and testing was started.

Planned Program for Coming Year

A report will be finalized and distributed to include all construction data, tests on field samples, results of subsequent coring, and field inspection data.

Cost 1978-1979: $8,972

Title

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

Purpose

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

Scope

It 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 chloride per cu yd and the deck performance was to be compared to the fifth structure having an average of 1.6 lb chloride per cu yd.

This study was initiated as a Category 2 project and Work Plan No. 64 was submitted and approved by the FHWA. Subsequently, nine more projects were added under the work plan since they also contained more than 4 lb chloride per cu yd. These projects are scheduled for letting in February to June 1979 and into 1980.

Progress Past Year

Deck preparation, latex modified concrete overlay placement, and corrosion cell tests before and after overlay, were monitored and tested on the five decks in the Livingston County project and also on portions of nine decks of a Macomb County project on I 94.

Planned Program for Coming Year

Selected portions of decks containing high chlorides and repaired in 1980 are to be monitored during and after construction. An initial progress report is to be prepared later in the year.

Cost 1978-1979: $2,841

Title

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

Purpose

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

Scope

Both bituminous concrete and bituminous aggregate pavement friction data were reexamined 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

A final draft of the first progress report of wear track tests, Series 1 through 8, was completed and distributed in March, as Research Report No. R-1098.

Wear track Series No. 9 containing samples of selected crushed gravels was completed. Wear track Series No. 10 containing blends of crushed gravel with selected sandstone blending agents was completed. The wear track series scheduled as No. 11 to evaluate the effects of wear track polishing on samples of bituminous core specimens was not tested due to poor durability of preliminary specimens subjected to trial wear track polishing. The wear track series scheduled as No. 12 containing selected crushed gravels, cherty limestone, slag, and blends of high-polishing limestone with sandstone anti-skid material was redesignated as wear track Series No. 11 and completed.

A review draft of an interim progress report on wear track Series 9 through 11 was completed. This will be distributed as Research Report No. R-1132.

The wear track friction tester was converted from usage of a smooth tread test tire to a grooved tread tire due to discontinuation of smooth tread tires by the supplier. Correlation pavement friction tests have been conducted.

Planned Program for Coming Year

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

Wear track Series No. 12 is scheduled to test blends of high-carbonate gravel with non-carbonate gravel anti-skid material.

A summary report covering all tests with blended aggregates including possible implementation will be prepared.

Cost 1978-1979: $19,785

Title

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

Purpose

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

Scope

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

Progress Past Year

A preliminary report was completed and distributed in July under Research Report No. R-1124.

Two-year trailer pavement friction tests were conducted on the test pavements in July, and indicated satisfactory pavement friction coefficients.

Planned Program for Coming Year

Three-year trailer pavement friction tests will be requested. Field inspection of the test pavement is scheduled for mid-year.

Cost 1978-1979: $1,633

Title

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

Purpose

To adapt the bridge deck epoxy injection concept, as pioneered by the State Highway Commission of Kansas, to similarly afflicted Michigan

bridges, and to evaluate the permanence of this type repair by long-term evaluation.

Scope

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

Progress Past Year

The first phase of this project was done as a joint voluntary venture between a contractor and the Department in 1975 to develop a procedure by which a bridge deck, in early stages of deterioration, could be restored to its original integrity without resorting to costly chipping and patching. The second phase of this project was carried out under an awarded development contract, and consisted of repairing the delaminations on four bridge decks that were in the initial stages of deterioration. Approximately half of the contract was completed in the fall of 1976 and the remainder was completed during the summer and fall of 1977. The third phase of this project was carried out in the summer of 1978 under a subsequent injection contract. The same bridges were again surveyed and all newly developed delaminations were injected. The deck of one of the subject bridges, westbound I 496 over the Red Cedar River (B02 of 33045A), featured a portion of the repaired area that was coated with a sealant to preclude the entrance of additional surface moisture and chlorides. Inspection of the subject bridge decks in September 1979, revealed that several new delaminations had developed. Most occurred adjacent to areas successfully injected in 1978, others occurred 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.

Planned Program for Coming Year

The effectiveness of this method, both with and without the benefit of a deck sealant, appears to be temporary at best. Subsequent inspections this year and next will provide a basis for a more comprehensive evaluation.

Cost 1978-1979: $6,955

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

Three new types of expansion dams were installed with a total of five under evaluation. The Standard Plan was revised twice in an effort to improve upon the installation practices and accessory materials used for installation.

Planned Program for Coming Year

Continue surveillance of installations and write a progress report.

Cost 1978-1979: $14,752

Title

47 G-36(32A) - 1979 Supplemental Traffic Paint Performance Tests

Purpose

This project is the 1979 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 1980 and 1981.

Scope

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

Progress Past Year

Field tests were initiated in May 1979 including two whites and two yellows from each of three producers to better ensure that there would be an adequate number of eligible paints. Also included were three different samples of silane-treated glass beads. Periodic ratings were made and a progress report was made to the Paint Committee in December of 1979.

Planned Program for Coming Year

Ratings of the paints in field tests will continue until all paints have reached the limit of their useful lives. A final report will be written including recommendations as to eligibility of paints for 1981 purchases.

Cost 1978-1979: $13,411

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

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

Planned Program for Coming Year

It is hoped that the field work will be limited to emergency and special problem situations. In place of field observations, more time will be spent in the establishment of an inspector and/or applicator certification program. The series of laboratory tests that were completed in 1979 have been greatly expanded. These tests will be completed in late 1980 with a major report scheduled for mid-1981.

Cost 1978-1979: $11,969

Title

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

Purpose

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

Scope

Work under this project entails revision of standard Department painting specifications and also writing specifications for experimental paint systems scheduled for field service tests. Technical background information is often obtained from work under Research Project 49 G-50. Revisions are generally cooperative with the using Division and are drawn-up to a Specifications Unit format.

Progress Past Year

The enforcement of specifications in the field has been thoroughly observed and documented. Much time was again spent in explaining specifications to the contractors and inspectors. Areas that need further clarification were also documented.

Planned Program for Coming Year

An inspector certification program is being set up. As in other years, there are always unique situations that require "one time only" revisions. This work will continue under this project.

Cost 1978-1979: $18,512

Title

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

Purpose

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

Scope

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

Progress Past Year

Due to the importance of work in other areas, no work was done this year.

Planned Program for Coming Year

Continue inspections of test installations.

Cost 1978-1979: - 0 -

Title

62 G-116 - Extruded Neoprene Joint Sealer

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

Evaluate new design sections as submitted.

Cost 1978-1979: $2,621

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 normal for the eight-year long tests. Because of the abnormality, the tests will be continued

with Phase 2 panels. Since the producer did not submit the new test panels until mid-December 1976, all were exposed on the Detroit Armory roof on December 17, 1976.

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

Progress Past Year

The first set of panels was removed in July 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.

Planned Program for Coming Year

No work is scheduled for this specific project on panel tests since the next panel removal is scheduled for 1981. 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.

Cost 1978-1979: $784

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.

Progress Past Year

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

In early 1978, attention was drawn to a Mobilplast system as a possible orthotropic wearing course. The material had been used very successfully in Europe. Arrangements were made with domestic producers to implement its application, but a proposal let out for bids in 1979 failed to attract any bidders.

Planned Program for Coming Year

The local contractors who had shown interest in the 1979 proposal were interviewed, their problems considered, and the proposal revised to eliminate their objections. The revised proposal, which will resurface not only the Creyts Rd bridge but also two area concrete decks, will again be let out for bids in early 1980.

Cost 1978-1979: $1,280

Title

71 G-178 - Guardrail Wood Post Deterioration

Purpose

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

Scope

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

Progress Past Year

Due to time limitations, no significant progress has been made.

Planned Program for Coming Year

Since the 1978 data showed so little decay, no work is planned until 1981 when another inspection is scheduled.

Cost 1978-1979: $257

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 on a monthly to biweekly basis. Chloride content of the water samples has been determined and tabulated.

Planned Program for Coming Year

A review draft of a progress report on sampling from 1976 through 1979 is to be completed.

Continued sampling from the 30 roadside groundwater observation wells is scheduled on a monthly basis.

Tentative plans include several supplemental test wells at selected locations of greater lateral distance from the roadways to measure the dissipation of deicing chlorides.

Cost 1978-1979: $22,946

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

Due to the loss of personnel and load of other high priority projects, field inspections and tests on the subject structures were not made.

Planned Program for Coming Year

With the addition of new 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 1981.

Cost 1978-1979: $50

Title

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

Purpose

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

Scope

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

Progress Past Year

After evaluation of the test data and considering the present work load, it was decided that triannual inspections would be sufficient, especially in the early years of the life of the bridges.

Planned Program for Coming Year

An inspection trip is scheduled.

Cost 1978-1979: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

The Testing Laboratory continued to process the standard rotohammer deck samples for chlorides and transmitted the results of tests on 138 structures in 1979. The Research Laboratory only processed special 4-in. deck cores for visual appraisal, compressive strength, and, in some cases, chloride content. Samples from 13 structures of this latter type were processed.

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 1980 as the Testing Laboratory will continue to do the standard drill samples.

Cost 1978-1979: $19,835

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

An initial progress report, Research Report No. R-1123, covering application was distributed. Field inspections were made in the second and fourth quarters.

Planned Program for Coming Year

Continue biannual inspections to monitor performance.

Cost 1978-1979: $1,268

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.

Planned Program for Coming Year

Continue biannual inspections and prepare progress report.

Cost 1978-1979: $2,020

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 downgradient 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 continued on a monthly to biweekly basis. The retention lagoon was sampled for chloride content on a monthly to biweekly basis. Sampling of leachate from the sand-salt stockpile was terminated due to removal of the material for winter maintenance use in February. Resampling of the sand-salt stockpile for salt loss was not possible due to removal of the stockpile. In-laboratory salt leaching tests on a small test pile of salt-treated sand were completed. A preliminary report, Research Report No. R-1114, was completed and distributed in April. Supplemental memorandum letters were distributed regarding the pollution prevention system. The treated sand test pile was reestablished and sampled for initial salt content prior to the 1979-80 winter. Sampling of leachate from the sand pile was resumed.

Planned Program for Coming Year

Sampling of groundwater from the observation wells is scheduled to continue on a monthly to biweekly basis. Sampling from the retention lagoon and sand pile sump are scheduled to continue on a monthly to biweekly basis. The sand-salt stockpile is scheduled to be resampled at the end of the winter maintenance season to measure the salt loss during storage.

Cost 1978-1979: $6,535

Title

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

Purpose

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

Scope

In this study, we will start preliminary accelerated testing of current latex products and compare them directly with the paint systems currently in use. Pending successful results of the laboratory phase, it is planned to implement the use of water-based paint systems on selected field projects to be closely monitored.

Progress Past Year

The first series of test panels have been completed. The results were not very promising in that none of the systems performed nearly as well as the solvent-based systems.

Planned Program for Coming Year

We are still looking for a good water-based system or at least the best of the available systems. In view of the fact that the solvent-based systems are performing so well, chances of finding a comparable water-based system appear slim at this point.

Cost 1978-1979: $1,316

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 first set of test panels has been completed.

Planned Program for Coming Year

Due to the interesting results of the first set of test panels, we plan to greatly expand the number of products tested, duplicate the 1979 results, and better control the experimental conditions. Once this is completed, we hope to write a report sometime in mid-1981.

Cost 1978-1979: $11,296

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

An instrument has been built. We are in the process of evaluating its performance against the visual observations made on this year's test stripes.

Planned Program for Coming Year

Since the initial results are so promising, we plan to continue to develop the instrument to allow us to roll the retro-reflectometer across a stripe and obtain a continuous readout. If the results are as anticipated, we plan to computerize the data and write a program to analyze it.

Cost 1978-1979: $2,386

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

A testing frame was constructed and evaluation of joint devices initiated in November.

Planned Program for Coming Year

Testing of systems currently being used by the Department will be completed in early 1980. A report of recommended parameters for movements at the various skew angles will be transmitted to the Design Division as soon as possible.

Cost 1978-1979: $5,555

Title

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

Purpose

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

Scope

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

Progress Past Year

There have been so many problems in obtaining the KP-N from Sweden, no posts were treated and it appears that the manufacturer has lost interest in marketing this product. It was also learned that the EPA seems to be taking a much softer stand on CCA treated posts.

Planned Program for Coming Year

In view of the information collected this past year, no work is planned and it appears the project will be cancelled.

Cost 1978-1979: $383

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.

Progress Past Year

Two areas in Grand Rapids were selected by the Traffic and Safety Division; 28th St and US 131. Approximately 130,000 lin ft of markings would be applied.

Planned Program for Coming Year

It is anticipated that markings will be placed in selected areas. Periodic field inspections will be made.

Cost 1978-1979: $118

PHOTOMETRY AND SPECTROCHEMISTRY UNIT

Title

73 D-28 - Construction and Evaluation of Wet Bottom Slag Bituminous Shoulders, I 94 at Dearborn Heights

Purpose

To provide delineation of the shoulder by means of a darker aggregate than that in the lane paving.

Scope

Annually evaluate pavement-shoulder visual contrast, day and night.

Progress Past Year

The luminance of the shoulder and pavement were measured and the luminance contrast computed.

Planned Program for Coming Year

Remeasure the shoulder and pavement luminance.

Cost 1978-1979: $662

Title

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

Purpose

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

Scope

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

Progress Past Year

Federal and State air quality regulations were reviewed as issued and a file was maintained of material relevant to transportation. Information obtained from manufacturers and users was used to keep current on analyzers available to monitor air quality. Two mobile air monitoring laboratories were in the field for all but a few days during the year. Most sites monitored were in southeastern Michigan, but one site northeast of Lansing was also monitored for four months. Data banks for air quality data were updated and expanded. An outline for the project report was drafted.

Planned Program for Coming Year

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

Cost 1978-1979: $118,563

Title

73 G-192 - Evaluation of Glare Sources

Purpose

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

Scope

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

Progress Past Year

Glare from an off-road source, a parking lot light, was evaluated.

Planned Program for Coming Year

Continue development of quantitative criteria for evaluating impact on driver vision of various types of glare sources. Evaluate glare complaints as complaints are received.

Cost 1978-1979: $22

Title

73 G-196 - Experimental Tower Interchange Lighting (Federal Work Plan Nos. 21 and 31)

Purpose

To determine maintenance factors for tower lighting. To determine pavement illumination produced by tower lighting compared with design levels of pavement illumination, and with pavement illumination produced by conventional lighting. 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. To determine the need for underbridge lighting at interchanges. To determine the aesthetic value of tower lighting. To determine the value of tower lighting during inclement weather—fog, haze, sleet, snow, rain.

Scope

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

Progress Past Year

A computer was purchased in order to remedy defects experienced with previous data acquisition equipment, such as inaccuracy at low light levels and zero drift.

Planned Program for Coming Year

Complete construction of data acquisition system and measure glare, pavement illumination, and luminance at the interchanges.

Cost 1978-1979: $1,424

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

Cost 1978-1979: $59

Title

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

Purpose

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

Scope

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

Progress Past Year

None.

Planned Program for Coming Year

An installation of glarefoils on the Rouge River Bridge (I 75) between Schaefer Rd and Fort St will be evaluated for prevention of headlight glare. The glarefoils at the two locations listed under scope were never installed.

Cost 1978-1979: $516

Title

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

Purpose

To develop a recognizable and attention-getting reflectorized pattern shape and color for flagman vests. Also, to conduct an industry search for an appropriate reflectorized orange which is similar in color to the currently recognized color code.

Scope

An industry wide search will be conducted in order to develop a yellow-orange color for reflectorized materials which is similar to the daytime fluorescent yellow-orange color generally used for flagman vests. Observers will make subjective evaluations of various flagman vests by comparing pairs of vests worn by flagmen. The observers will be making the comparisons while driving an automobile toward the vest at night in both an urban and rural lighting environment.

Progress Past Year

A newly developed reflectorized as well as fluorescent yellow-orange material was obtained.

Observers viewed various shapes of reflectorized patterns at night, in fog, and in twilight.

A draft of a progress report was completed.

Planned Program for Coming Year

1) Observers will view various colors of reflectorized flagman vests in urban as well as rural situations.

2) Development of an illuminated hand-held STOP sign will begin.

Cost 1978-1979: $15,311

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. Three movable asphalt plants were monitored for particulate emissions when recycled paving was being processed. A report on the work has been drafted.

Planned Program for Coming Year

Measure particulate emissions from several asphalt plants while recycled material is being processed.

Cost 1978-1979: $14,389

Title

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

Sprinkle treatment is the relatively light application of precoated, high quality, aggregate particles on the surface of the wearing course mat following laydown, and partial embedment during the compaction operation. This technique minimizes the use of high quality aggregate in areas where they are scarce or expensive. A savings in energy would also be realized from the elimination of long aggregate hauls.

Purpose

The purpose of the experimental overlay construction is to evaluate the sprinkle treatment method of achieving adequate friction values on wearing surfaces in accordance with FHWA Demonstration Project No. 50.

Scope

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

Progress Past Year

An experimental section was constructed on US 23 at Rogers City. Tests were conducted which indicated higher friction levels for sprinkle treatment than for comparative conventional sections.

Planned Program for Coming Year

A progress report describing construction will be published. Annual pavement friction measurements will be made along with visual inspection for durability.

Cost 1978-1979: $2,051

Title

74 D-29 - Sulfur in Bituminous Mixtures

Purpose

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

Scope

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

Progress Past Year

Laboratory testing of pavement cores was started to determine fatigue life and low temperature cracking potential. Testing has been delayed due to equipment development and shortage of personnel.

Planned Program for Coming Year

Annual condition surveys will be made to evaluate performance. Laboratory tests should be completed.

Cost 1978-1979: $10,065

Title

75 D-30 - Recycling of Asphalt Pavement

Purpose

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

Scope

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

Progress Past Year

The annual condition survey was performed. Laboratory tests were made to determine resilient modulus. Deflection measurements were made to permit fatigue life analysis based on elastic layer theory.

Planned Program for Coming Year

The physical properties of the recycled material will be summarized in a progress report along with the structural analysis results.

Cost 1978-1979: $6,966

Title

75 D-32 - Reclaimed Rubber-Asphalt

Purpose

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

Scope

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

Progress Past Year

Paving of the wearing course was completed. Initial rut depth and pavement friction measurements were made. Laboratory testing of road materials was started but delayed because of the need for equipment development and 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.

Cost 1978-1979: $8,329

Title

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

Purpose

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

Scope

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

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

Progress Past Year

Project was completed. A final report, "Effectiveness of Infrared Joint Heaters for Bituminous Pavements," Research Report No. R-1117 was published in May 1979. Infrared joint heaters were found to be ineffective.

Planned Program for Coming Year

Project completed.

Cost 1978-1979: $6,668

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 sampling was completed at all but one test site and laboratory testing of samples was begun. The scope of the project was reduced to include only nine test sites instead of the sixteen as planned.

Planned Program for Coming Year

Complete the field testing, which includes Benkelman beam deflection measurements and all laboratory testing. Those principal investigators, to whom various portions of the work were assigned will each prepare a report of his findings. These will be summarized in a single final report.

Cost 1978-1979: $18,292

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 asphalts.

Scope

Test sections will be 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., will be used to prepare paving mixtures for this project. Two different sulfur to asphalt ratios and two sulfur-asphalt surfacing thicknesses will be compared with adjacent sections of the same road which will be 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 will be determined in the Testing Laboratory. During construction, testing for compaction, asphalt content, temperature, and other investigative tests, will be performed by Testing and Research personnel. Supervision and inspection of construction will be handled by Construction Division personnel in the usual manner.

Laboratory tests will be performed on both the sulfur-extended asphalt (SEA) mixtures and conventional mixtures to compare fatigue life and low temperature cracking potential. Benkelman beam deflections will be 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 the use of the CHEV 5L computer program for flexible pavement analysis.

Progress Past Year

Test sections were constructed. Deflection measurements were made before and after resurfacing with the experimental mixture. Cores were obtained and laboratory testing was started to assess fatigue life and low temperature characteristics.

Planned Program for Coming Year

Laboratory tests will 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.

Cost 1978-1979: $19,302

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 aggregates combined with Sulphlex, a plasticized sulfur binder.

Scope

Two half-mile long experimental sections of pavement overlay using the Sulphlex mixtures will be constructed over both rigid and flexible bases on M 37 in Kent County as part of a 1980 resurfacing project, Mb 41043-17379. Two control sections of conventional overlay mixture will be included as part of the experiment. Laboratory mix designs will be made to establish job control quantities. The structural quality of the road will be measured prior to resurfacing and again after the experimental resurfacing to determine fatigue life and rutting potential. Laboratory tests will be performed to measure resilient modulus and low temperature cracking potential.

Progress Past Year

A research proposal was prepared and a construction project selected. A progress report (review draft) has been submitted which describes construction of the test sections.

Planned Program for Coming Year

An experimental section will be paved. Laboratory mix design and pavement core samples will be tested for physical characteristics.

Cost 1978-1979: $440

Title

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

Purpose

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

Scope

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

Progress Past Year

Seven-year rut depth measurements were obtained which showed no relative change in the performance of the test areas. A final report was published, "Evaluation of Sodium Chloride for Stabilizing an Aggregate Base Course" (Research Report No. R-1107) which formally completes this project. Observation of the test sections will be continued on a non-scheduled basis, to check for any abrupt changes in performance.

Planned Program for Coming Year

Project completed.

Cost 1978-1979: $3,411

Title

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

Purpose

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

Scope

Implementation of a laboratory testing procedure for determining rheologic properties of each pavement layer. Develop computer capability for stress strain analysis of five or more layer systems. Determine rheologic

properties of typical materials used in Michigan for constructing pavements. Develop theoretical equivalencies, based on AASHTO failure criteria, of base course materials, i.e., bituminous stabilized and gravels. The final phase will be verification of theoretical equivalencies developed by this study.

Progress Past Year

Research Report No. R-1119, "Development of Base Layer Thickness Equivalency" was completed which includes thickness equivalency charts developed to determine thickness relationships between granular and black base for equivalent pavement performance. This information when correlated with available field test information obtained from this project should allow successful completion of project objectives.

Planned Program for Coming Year

Field data and samples obtained from the two test sections of this project will be analyzed and examined on the basis of relationships developed in Research Report No. R-1119. The results obtained will be presented in a final report for the project.

Cost 1978-1979: $23,684

Title

68 E-43 - Evaluation of Open-Hearth Slag

Purpose

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

Scope

The project will require a review of all available information concerning existing projects constructed with these materials. Tests will be performed attempting to correlate heaving with particle size gradation, chemical composition (especially lime content), moisture absorption, and freezing. Where possible, these characteristics will be studied at particular locations before and after heaving.

Progress Past Year

Characteristics of open hearth slag were determined along with those of other aggregates included in the base materials study under Research

Project 79 F-158, "Investigations of Pavement Problems, I 275." The slag material was found to be more frost-susceptible than the other aggregates tested, confirming previous laboratory findings. Modification of required gradations for slag bases may relieve this problem and recommendations for this will be included in the final report of this project.

Planned Program for Coming Year

When our portion of the I 275 foundation study is completed any results pertinent to open hearth slag will be incorporated in a final report of the slag project which should be published during 1980.

Cost 1978-1979: $3,294

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

Assisted MSU personnel in the selection and inspection of several sites in the Lower Peninsula where flexible pavements were constructed on clayey subgrades. Field sampling was completed and laboratory testing at MSU is in progress.

Planned Program for Coming Year

Laboratory testing at MSU should be completed and a final report prepared.

Cost 1978-1979: $7,976

Title

74 E-53 - Development of a Field Permeability Test

Purpose

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

Scope

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

Progress Past Year

The construction project selected to evaluate the permeability test—M 66, 4.4 miles from Phelps Rd to north County Line—was begun in September 1979. As planned, the permeability tests were to be made by Construction Division personnel (with minimal assistance from Research Laboratory personnel) in order to determine how well the new procedures would fit into construction operations. Unfortunately the Construction Division now does not have sufficient personnel to perform the tests, so this operation falls back on Testing and Research personnel. For this reason the primary objective of the M 66 research work cannot be met.

Planned Program for Coming Year

The M 66 field work will be completed and a report prepared. Whether the permeability test, performed under Testing and Research direction, will satisfy the Construction Division is a matter of conjecture at this time.

Cost 1978-1979: $3,082

Title

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

Purpose

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

Scope

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

Progress Past Year

The 'Elastizell' fill at the Waiska River bridge site was checked for settlement and movement of the adjoining abutments. The fill appeared to be stable and in satisfactory condition. Time did not permit inspection of our other Elastizell installation at St. Clair.

Planned Program for Coming Year

Continued inspection of the two Elastizell projects will be made to check for possible settlement of the fills or lateral movement of the abutments and to determine if there has been any significant moisture pick-up by the fills.

Cost 1978-1979: $2,585

Title

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

Purpose

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

Scope

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

Progress Past Year

No change has been noted in the test section during the past year.

Planned Program for Coming Year

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

Cost 1978-1979: $207

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

All laboratory testing was completed and a supplementary report was begun describing part of the project information, which will be used as part of a Committee responsibility. This report contains information that can be used to simplify the particle index test and points out the importance of the proper identification of the physical properties of those materials retained on the No. 4 sieve.

Planned Program for Coming Year

The supplemental report will be completed and, depending on priority of other projects, effort will be made to complete the final report for this project.

Cost 1978-1979: $1,320

Title

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

Purpose

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

Scope

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

Progress Past Year

Due to the priority of other assignments, there was no progress on this project during the past year.

Planned Program for Coming Year

Complete the permeability testing of subbase samples obtained from M 82 and, if time permits, prepare a final report for the project.

Cost 1978-1979: $1,665

Title

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

Purpose

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

Scope

Benkelman beam measurements will be conducted on comparable sites of these two pavements. Comparison of the strength of the two base layers is to be made based on the life expectancy of the pavements as calculated from the surface deflection data.

Progress Past Year

Benkelman beam deflection measurements were made at each test site during the spring break-up period (mid-March to late April) and again in mid-October when the pavements were considered to be at their most stable, unfrozen condition. Undisturbed subgrade and disturbed granular subbase and base samples were collected to determine their resilient modulus.

Planned Program for Coming Year

Samples collected from each site will be tested using MTS cyclic loading procedures for determining their modulus values. These modulus values will be compared with those interpreted from Benkelman beam deflection data using procedures developed in other studies. The load carrying capacity (life expectancy) for existing pavements will be evaluated according to the results shown in Research Report No. R-1119.

Cost 1978-1979: $14,427

Title

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

Purpose

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

Scope

The project will include study of up to 12 one-mile sites in which frost depth, pavement surface deflection, climatological data and pavement foundation conditions will be utilized to achieve the project's purpose.

Progress Past Year

A report on this project is in preparation but has not been completed due to the completion of higher priority projects. Supplemental information, concerning the load carrying capacity of flexible pavement systems, was consolidated into a proposed report which is now being reviewed.

Planned Program for Coming Year

Final reporting of this project should be completed which will conclude the immediate project. Assistance will still be provided to the Districts in the installation of frost-depth indicators and in the use of data to determine overload capacities of pavements.

Cost 1978-1979: $44,071

Title

75 G-215 - Pavement Feedback System

Purpose

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

Scope

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

Progress Past Year

No significant progress on the project was made during the past year. A request for an overall pavement management system has been made by

Department management and a brief outline for such a system prepared. At a meeting to discuss pavement management procedures it was decided to include this project in a more comprehensive study to be submitted to the Engineering Operations Committee for discussion.

Planned Program for Coming Year

A preliminary outline for a pavement management procedure suitable for Michigan will be prepared and submitted to the Engineering Operations Committee for discussion. The future of work in this area will be determined at that time.

Cost 1978-1979: $12,752

Title

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

Purpose

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

Scope

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

Progress Past Year

Work on this project was held in abeyance pending studies to check other available systems which might be more applicable to Michigan conditions and procedures.

Planned Program for Coming Year

This project, as such, will be discontinued and the work incorporated into the pavement management study proposed under Research Project 75 G-215.

Cost 1978-1979: $11,386

Title

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

Purpose

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

Scope

Approximately six miles of the experimental shoulders were built on M 14, in half-mile sections. The sections consisted 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 scope of the I 69 project using a local peastone gravel has not yet been determined.

Progress Past Year

Twenty locations were instrumented shortly after construction for the purpose of monitoring joint movement and elevation changes. Semiannual measurements have been made. Inspections showed that cracks were beginning to form on the mainline pavement near the joint locations. Roadway opened to traffic in the fall of 1979.

Planned Program for Coming Year

Concrete strength data, joint opening measurements, and the results of a field survey are to be incorporated into an initial report. Monitoring of joint width variations, elevation changes, and crack formation will continue.

Cost 1978-1979: $8,972

Title

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

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

Prepare final report.

Cost 1978-1979: - 0 -

Title

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

Purpose

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

Scope

To compare the qualities and properties of the asphalt concrete mixes and their service performance under traffic and weather conditions at an experimental site covering 4.9 miles of four-lane divided highway; compile and analyze field data in terms of surface compaction, skid resistance,

riding quality, and surface durability in resisting long-term cracking, deformation, and other pavement failures; discuss construction problems, if any, and compile and compare construction costs.

Progress Past Year

Crack surveys conducted, summarized, and reported annually.

Planned Program for Coming Year

Continue field inspections and crack surveys.

Cost 1978-1979: $5,361

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

Project was inspected.

Planned Program for Coming Year

Continue observations and pavement condition surveys.

Cost 1978-1979: $132

Title

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

Purpose

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

Scope

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

Progress Past Year

Condition surveys were made of pavement as scheduled.

Planned Program for Coming Year

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

Cost 1978-1979: $14,729

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

Measurements and inspections of the performance of the bar mat reinforced sections show that these sections continue to give excellent service.

To date, only two failures have occurred—one at a construction joint and one at a lap in the reinforcement. The mesh reinforced sections are now essentially jointed pavements because repairs of failures are relatively closely spaced. Measurements of joint movements show that the average seasonal joint movement for repairs spaced from 100 to 500 ft apart was 7/16 in.; for those spaced 500 to 800 ft apart, it was 3/4 in.; and for repairs spaced over 800 ft it was also 3/4 in. The average permanent joint closure recorded for these spacing intervals was 1/16 in., 1/4 in., and 3/8 in., respectively. Faulting of the undowelled repair slabs has not as yet developed to the point where it requires remedial action.

Planned Program for Coming Year

The performance of the bar mat sections will be monitored for surface deterioration and for failures due to corrosion of the reinforcement. Joint movements at repair slabs will be measured semiannually in order to determine when additional expansion space will be needed and to obtain information on permanent increases of different length sections of CRC pavement.

Cost 1978-1979: $2,447

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

Measurements of end anchorage movement indicate that very little seasonal movement occurs at the anchorages. Crack openings of five consecutive cracks vary from 0.036 to 0.071 in. after 17 years of service. A contract for repair of the eastbound roadway with undowelled repairs and for dowelled repairs on the westbound roadway is nearly complete.

Planned Program for Coming Year

Measurements of end movements and crack openings will be phased out. Repair operations on the westbound roadway will be observed to determine the feasibility of installing dowelled joints in CRC pavements. The performance of these repairs will be monitored for a few years after construction.

Cost 1978-1979: Cost included in 61 F-64(1).

Title

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

Purpose

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

Scope

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

Progress Past Year

Inspections indicate that the pavement on depressed sections continues to fail. The failures apparently are caused by the slab separating at the steel level and then the top layer breaks apart under traffic. On the remaining sections the pavement performs much better with only a few failures occurring. Repairs are currently underway on I 75 north of the Rouge River and a contract for repairs south of the river is planned for letting in the spring of 1980.

Planned Program for Coming Year

The performance of the pavement as well as of the repairs will be observed periodically. Signs of corrosion of the steel reinforcement—formation of wide cracks—will be noted.

Cost 1978-1979: $11,430 - includes 61 F-64.

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 from public regarding law.

Planned Program for Coming Year

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

Cost 1978-1979: $1,228

Title

67 F-95 - Evaluation of Acme Load Transfer Devices

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

The collected data will be analyzed and a final report will be written.

Cost 1978-1979: $1,347

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 an inspection made. Data were tabulated and are on file. Inspection showed standard and full-depth bituminous shoulders deteriorating and sinking, no new problems with concrete shoulders. The longitudinal joint in seal-coated sections has been slurry-sealed by Maintenance Division. Several other bituminous locations will need repair soon.

Planned Program for Coming Year

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

Cost 1978-1979: $3,050

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 ninth winter. Routine maintenance was performed at the field exposure site. Specimens with uncoated bars have about four times as much spalling above the rebar as do those with galvanized bars. Field inspections, 'corrosion cell' readings and delamination detector surveys were completed on the five experimental decks. All data were tabulated and records updated. Quarterly reports on the project were prepared for the FHWA. The first small 'hollow areas' which were reported during last year's evaluation were not evident during the most recent survey. Bridge decks have not yet begun to show significant deterioration.

Planned Program for Coming Year

It is anticipated that coring will be performed to observe the condition of galvanized and plain reinforcing bars. Weekly treatment of field exposure specimens will continue as will yearly inspections of bridge decks. The project has been kept up to date and on schedule.

Cost 1978-1979: $6,676

Title

68 F-104 - Plastic Coated Dowels for Pavement Joints

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

The collected data will be analyzed and a final report will be written.

Cost 1978-1979: $64

Title

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

Purpose

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

Scope

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

Progress Past Year

A final inspection of the experimental shoulders was made.

Planned Program for Coming Year

Prepare final report.

Cost 1978-1979: $1,392

Title

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

Purpose

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

Scope

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

Progress Past Year

A progress report was prepared for FHWA. Faulting and joint opening measurements and profilometer surveys were completed. All data were reduced and tabulated. Poured joint seals have failed. Some faulting of joints has developed in the black-base section of the I 475 interchange. General condition of ramps is still good.

Planned Program for Coming Year

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

Cost 1978-1979: $3,041

Title

70 F-114 - Broomed Concrete Pavement Surfaces

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

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

Cost 1978-1979: $343

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 surveys were completed and recorded. Repairs made shortly after construction are deteriorating. Concrete cores were removed from joints of each different slab length to check the condition of the load transfer dowels. Plastic-coated dowels remain in very good condition, plain dowels are beginning to show some localized corrosion in the area of the joint faces. Concrete deterioration was present at the bottom of the joint in all slab lengths.

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; therefore, we expect several more years of observation before having sufficient information available to issue a final report.

Cost 1978-1979: $1,795

Title

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

Purpose

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

Scope

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

Progress Past Year

Annual measurements of elevation between old and new slabs and semi-annual measurements of joint width changes were made. The repairs continue to perform satisfactorily. The pavement itself is deteriorating extensively and contract repairs between the experimental repairs were done.

Planned Program for Coming Year

Since new repairs have been made between the experimental ones, the movement at the experimental repair joints will be affected and, therefore, is planned to be discontinued. Elevation readings, which are not affected, will be continued.

Cost 1978-1979: $4,134

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, 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

Little change in width readings from 1978 to 1979. Joints are tightly closed and faulting has developed, but general condition is still good. The relief provided has provided blow-up protection in the area treated.

Planned Program for Coming Year

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

Cost 1978-1979: $864

Title

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

Purpose

To evaluate the merit of preventive maintenance of concrete pavements to eliminate blow-ups.

Scope

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

Progress Past Year

Semiannual measurements of relief joint movements were made. Annual inspections of joint spall deterioration on both roadways were conducted. Records on full-depth repairs conducted on the northbound roadway indicate no new repairs were made but three have been made in the pressure-relieved southbound roadway during the past year.

Planned Program for Coming Year

Information gathered on the performance of the pressure-relieved sections will be evaluated and a final report issued.

Cost 1978-1979: $384

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 on this project due to higher priority work.

Planned Program for Coming Year

If time permits, qualitative performance condition survey of some of the projects will be done.

Cost 1978-1979: $347

Title

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

Purpose

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

Scope

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

Progress Past Year

Periodic condition surveys of slipformed CRC pavements were made. The results show I 196 is in excellent condition. US 31 is also in excellent condition except for one project where about 2,000 ft of longitudinal cracking has occurred. On I 94, a few punch-out failures have developed and one more wide-flange beam failure occurred. The I 96 and I 696 CRC pavements are both in good condition.

Longitudinal cracking on I 275 continued to increase in amount. The Engineering Operations Committee approved the Research Laboratory's recommendation that a moratorium be placed on the building of CRC pavement, primarily because of corrosion of the reinforcement.

Planned Program for Coming Year

Condition surveys of slipformed CRC pavement will continue on a periodic basis. The Research Laboratory will work with the Design Division in preparing contracts for repairs and crack sealing on I 275.

Cost 1978-1979: $19,638

Title

*73 F-131 - Epoxy Resin Coated Reinforcing Steel

Purpose

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

Scope

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

Progress Past Year

Quarterly progress reports prepared for FHWA. Evaluation of laboratory specimens has been resumed after being stored for approximately one year due to move. 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 sixth winter. All decks and experimental specimens still are in excellent condition.

Planned Program for Coming Year

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

Cost 1978-1979: $8,013

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 FHWA.

Progress Past Year

A progress report was prepared for the FHWA. Performance of the concrete screens has been considerably better than the metal mesh screens from a damage and durability standpoint. Many metal mesh screen installations have been replaced by concrete.

Planned Program for Coming Year

Survey condition of experimental glare screens, and issue a final report.

Cost 1978-1979: $304

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.

Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made. Coring was performed at joints with and without load transfer devices. Cores through the load transfer devices showed the epoxy coatings to be performing 'fair' to 'good.' Cores also showed deterioration of the bottom of the joints on the 71-ft slabs, but not the short slabs. Black base sections with no drainage also show early signs of aggregate discoloration along the centerline and at joint intersections. Cores from the joints in the black base sections showed concrete deterioration of the bottom of the slab to be proceeding rapidly, providing material which is being pumped under the leaving edge of the slabs and causing faulting. ATPM sections are performing very well. Commercial traffic is light.

Planned Program for Coming Year

Continue all experimental measurements and evaluations.

Cost 1978-1979: $6,466

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 semiannual measurements were performed. Results of data tabulation are as follows:

I 696 - 43 lane miles. Joint spalling increased 13 percent in the past two years and stands at 70 lin ft/lane mile. No new repairs have been made and no additional pressure relief joint seals have been lost (19 percent out).

I 75 north - 128 lane miles. Joint spalling has increased 41 percent in the past two years and stands at 156 lin ft/lane mile. No new repairs have been made, pressure relief joint filler missing has increased from 16 percent two years ago to 19 percent this past fall. In addition, 36 lin ft/lane mile of spalled cracks have developed.

I 75 south - 108 lane miles. Joint spalling has increased 41 percent in the past two years and stands at 65 lin ft/lane mile. Thirty-one lane joint repairs, nine lane crack repairs plus 15 lane patches with bituminous have been made since 1976. Pressure relief joint filler loss has stayed constant at 25 percent. In addition, 22 ft/lane mile of crack spalling has developed.

In general, the pressure relief joints have closed to near their capacity. Much of the expansion and contraction is occurring at open cracks, with joints frozen. Joints where filler was lost are inoperative as far as pressure relief is concerned.

Planned Program for Coming Year

Continue monitoring pressure relief joint movements and performance. Prepare a report of findings to date concerning preventive maintenance procedures.

Cost 1978-1979: $19,348

Title

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

Purpose

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

Scope

This is an open-ended Category 2 project. Initially, ten crossings and three new materials were included. Sixty new crossings and four new materials have been added since the study was initiated.

Progress Past Year

Twenty new crossings were constructed: eleven Gen-Track, two Saf and Dri, three Parkco, two Steel Plank, and two Track-Span. Construction of the new crossings were observed and evaluation surveys of completed crossings were made. A third progress report (R-1113) was issued.

Planned Program for Coming Year

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

Cost 1978-1979: $16,869

Title

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

Purpose

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

Scope

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

Progress Past Year

The fracture toughness testing is nearly completed on the electroslag and submerged arc weldments. Valid measurements of the fracture toughness parameter, K_{IC} (ASTM E-399) have been achieved on the electroslag weldments. A new type of toughness specimen has been developed to test the submerged-arc weldments which are considerably tougher than electroslag, and cannot be evaluated in the same way. Corrosion specimens have been placed under the Eight Mile Rd bridge over US 10 in Detroit. Considerable experimentation has been done in the nondestructive evaluation of electroslag weldments; including radiography, ultrasonics, and the application of Acoustic Emission Monitoring to electroslag welds during welding.

Planned Program for Coming Year

The fatigue crack propagation studies will be conducted during the coming year. Field investigations of existing bridges with electroslag weldments will continue. The HPR final report will be issued in July 1980, although work on the project will probably continue beyond that date.

Cost 1978-1979: $65,367

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 1,100 lane miles of bituminous and concrete pavements were tested. This includes new construction, research projects, and special requests.

Planned Program for Coming Year

Continue with established program.

Cost 1978-1979: $46,729

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 movement measurements were completed and surveys were performed. Poured joint seals have failed, unsealed joints beginning to fill and 'grow.' Some neoprene seals have been lost from expansion joints. Some faulting developing, but no trends evident that are related to project variables.

Planned Program for Coming Year

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

Cost 1978-1979: $3,347

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

All samples were received and all static tests completed by March 1979. Steel strength was less than specified. Dynamic evaluations have been completed on five 2-in. diameter galvanized samples, five 2-in. diameter plain samples, and five 1-1/2-in. diameter galvanized samples. Galvanized specimens break at considerably fewer cycles, but it presently appears that this may be due to the fact that they cannot be tightened (due to thread galling), rather than to any inherent effect of the galvanizing on the steel.

Planned Program for Coming Year

Perform additional fatigue evaluations. Issue report.

Cost 1978-1979: $4,058

Title

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

Purpose

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

Scope

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

Progress Past Year

Completed data reduction, analysis and issued final report (Research Report No. R-1108).

Planned Program for Coming Year

Project is completed.

Cost 1978-1979: $44,274

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

Over 12,000 pavement friction tests were made throughout the State.

Planned Program for Coming Year

Continue pavement friction testing program.

Cost 1978-1979: $120,957 - includes 54 G-74(5).

Title

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

Purpose

To conduct pavement friction tests at areas where accidents on wet surfaces are disproportionately high.

Scope

All areas on the State trunkline system are under observation.

Progress Past Year

About 36 locations were tested and reported on.

Planned Program for Coming Year

Continue program.

Cost 1978-1979: Included in 54 G-74.

Title

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

Purpose

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

Scope

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

Progress Past Year

Project extended to include one more rest area for evaluation. An MSU fourth quarterly report has been published.

Planned Program for Coming Year

Monitor project evaluations and subsequent progress reports as submitted.

Cost 1978-1979: $1,637

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 southbound I 275 rest area (58171) north of Monroe.

Progress Past Year

Aqua-Sans unit inspected and tested, and evaluation procedures completed.

Planned Program for Coming Year

Complete final report and close project.

Cost 1978-1979: $6,745

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

Evaluation surveys of the joints being maintained indicated that 7 percent of the spall repairs are not performing satisfactorily. Specifications for contract work of this type were prepared on the basis of the data collected on the experimental project.

Planned Program for Coming Year

Observations of the performance of the experimental maintenance procedures will be continued. New development in this area of maintenance will be carried out under Research Project 79 G-245.

Cost 1978-1979: $20,308

Title

77 G-225 - Rubberized Asphalt Stress Relieving Membranes

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

Plans were completed for a project, scheduled to be let in March 1980, to incorporate an asphalt-rubber stress absorbing membrane interlayer on approximately three miles of M 55 west of Cadillac. The membrane will be placed over flexible pavement instead of concrete which proved unsuccessful in 1978.

Planned Program for Coming Year

Construct experimental installation on M 55 west of Cadillac.

Cost 1978-1979: $15,061

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

Profiles were obtained from each grade crossing during several seasons of the year. Photographs were also taken to provide a visual condition of the crossing.

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.

Cost 1978-1979: $3,483

Title

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

Purpose

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

Scope

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

Progress Past Year

A 500-watt 12-volt d-c array was installed at a grade crossing in Vassar, Michigan. The electrical supply system consisting of the solar array, voltage regulators, and battery storage will provide all power necessary for signal and control operations. A laboratory designed system is being used to monitor the energy flow throughout the system.

Planned Program for Coming Year

Continue to monitor energy generation, consumption, and operation of the system. A report will be prepared after one year of operation.

Cost 1978-1979: $2,882

Title

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

Progress Past Year

The FHWA prediction model for highway noise was written for use on the Department's computer. Equipment necessary for measurement of vehicle speed has been purchased.

Planned Program for Coming Year

Prepare a field procedure for obtaining noise data. This work will include site selection, sampling procedure and data storage, and retrieval programs. After completion of field measurements, data will be analyzed to obtain required parameters for the FHWA computer model and its subsequent validation.

Cost 1978-1979: $3,933

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

The Design Division with assistance from the Research Laboratory has been involved in the preparation of a contract proposal for the proposed maintenance work. A letting date is planned for this spring.

Planned Program for Coming Year

Research personnel will be on the project to assist the project engineer and contractor in carrying out the maintenance procedures. Also, data in

the construction phase of the work will be recorded, and evaluation of the repaired joints will begin.

Cost 1978-1979: $2,682

Title

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

Purpose

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

Scope

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

Progress Past Year

A contract for the installation of a solar liquid collector and data monitor system has been let. Installation is planned for the spring of 1980.

Planned Program for Coming Year

After completion of the system, monitor its operation for one year. A report will be prepared detailing such items as initial cost, maintenance requirements, and system performance.

Cost 1978-1979: $174

Title

79 G-248 - Esthetic Treatment of Concrete Noise Abatement Walls

Purpose

To improve the appearance of concrete noise abatement walls by adding a brick veneer surface to the highway and property owners sides of the wall.

Scope

It is planned to install approximately 34,000 sq ft of brick veneer on noise walls installed in the City of Flint, Michigan. The veneer treatment, together with painting and use of form liners on other sections of noise abatement walls, will be evaluated objectively and subjectively.

Progress Past Year

Walls are to be installed during the 1980 construction season.

Planned Program for Coming Year

Observe construction procedures and evaluate such items as wetness or dryness of concrete wall during application, workmanship, and environmental hazards. After completion, attitudes of adjacent property owners towards the noise barrier will be obtained.

Cost 1978-1979: - 0 -