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-1163

Michigan Transportation Commission
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INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1980 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 1980. 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 1980, for all active Departmental and Highway Planning and Research projects (H. P. & R. projects are denoted by an asterisk).

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

RESEARCH HIGHLIGHTS - 1980

In 1965, the pavement friction test program was expanded to include routine testing of all trunkline surfaces. Previously, only high-accident areas, experimental surfaces, and special request tests were conducted. The expanded program included all projects greater than 1/2-mile in length which were completed commencing with the 1963 construction year. Repeat testing for these projects was scheduled at five-year intervals. In 1979, the program was again expanded to include existing trunkline surfaces constructed prior to 1963. During the 1979 and 1980 test years, nearly 600 of these older projects were tested. This essentially completes the goal of being able to provide pavement friction data for all existing trunkline surfaces within the most recent five-year service period. All friction test data are stored in a computer file for fast and efficient access. In July of this year, a new reporting unit, 'Friction Number' (FN), was implemented. This new unit is the result of calibration and correlation studies conducted at the Federal Regional Reference Center in East Liberty, Ohio. The studies were initiated to provide a standard unit of measurement on a national basis. The correlation resulted in FN being a slightly smaller value than previously reported (SN_W) values. Previously reported SN_W values remain valid and can be converted to the new standard FN unit using available conversion tables.

Vehicle noise enforcement training courses for local government police officers were conducted by Laboratory personnel at the State Police Academy in May, June, and October of this year. A total of 41 vehicle noise enforcement kits were assigned to police departments around the state and an additional seven kits were loaned to small local police departments. A total of 96 enforcement officers from Michigan communities have completed the training course and were awarded certificates attesting to their training. To date, 35 of our 42 largest cities have trained personnel and equipment to deal with the problems of noisy vehicles. An attempt was made in the training sessions to convey a sense of the gravity of the problem and the urgent need for vehicle noise abatement. A survey of participating police departments is planned to determine their problems and ascertain their success in enforcing vehicle noise levels.

A third air monitoring unit was completed. Air monitoring was carried out at ten sites in the southern lower peninsula. Several of the sites were monitored during the high carbon monoxide season (October through February) and also during the low carbon monoxide season (March through September) to discover how large the seasonal effects would be. The Federal Highway Administration and the Michigan Department of Natural Resources wish to utilize the highest expected background levels of carbon monoxide in

our Environmental Impact Statements. The data obtained from the mobile units were shared with the Bureau of Transportation Planning and the DNR. A third generation, improved air pollutant dispersion model, CALINE III, was obtained from the Federal Highway Administration and made operational on the Department's computer. The new model will handle more complex situations (up to 19 links simultaneously) and yields more accurate estimates of pollutant concentrations near transportation facilities than previous models. Additional exhaust stack sampling for particulate matter was carried out on plants processing recycled asphalt material to see whether they were meeting air quality standards.

A report was published describing the construction and performance to date of a thin layer of high quality aggregate embedded into the surface of a bituminous pavement during compaction operations to improve the skid resistance and durability of the pavement surface. This application, known as 'sprinkle treatment,' provides a quality surface at a much lower cost in material and energy use than does the standard surface construction. To date, the surface is performing satisfactorily and provides more skid resistance than does the corresponding control sections of conventional construction.

Additional investigation of the performance of unpainted bridge steels has resulted in the termination of their use in Michigan. An interim report was published, giving background, information from selected bridges, and reasoning behind the recommendations that were made. Another report, relating specifically to unpainted guardrail, was also prepared. Corrosion loss data have been collected for more than 50 unpainted bridges. New link plates and hanger pins were built in the Laboratory to replace the plates and pins at 11 locations on the bridge at 8 Mile Rd and I 75. Maintenance forces removed the old pins and plates, the areas behind the plates were cleaned and painted, and the new plates, pins, and bearings were installed. The old plates were brought back to the Laboratory where they will be used for experimental work related to coatings and fatigue.

All of the experimental work has been completed for the three-year study of fracture resistance of electroslag and submerged arc welds in ASTM A36 and A588 steels. The final report is in preparation. Electroslag welds were found to be more susceptible to fatigue and fracture. As a result of this project and the one that preceded it, these weldments are no longer allowed for areas of tensile stress or stress reversal on structures in Michigan.

A continuing investigation of the experimental concrete pavement on US 10 relocation north of Clare has resulted in additional information of

interest. Performance of the roadway to date underscores the importance of good drainage beneath the pavement. Sections placed over impervious base have shown early signs of deterioration, while others on free-draining base perform much better. Associated work related to this project and other freeway pavements in the area, has shown the effects of certain types of coarse aggregates in the concrete on the development of 'D-cracking,' a type of freeze-thaw generated pavement deterioration which begins at the joints.

A small-scale research project has been initiated to develop methods for constructing a non-faulting joint between existing and new concrete to be used when repairing a concrete pavement. Several methods will be tested in the laboratory and the most promising of these will be recommended for field testing.

In its ongoing effort to provide the latest facilities and instruments, the Laboratory's photometric range has been revamped to allow one, instead of two-person operation of both ends of the range. Also, a new projector with a 1,200-watt tungsten halide lamp was installed permitting more accurate measurements of low level reflectorized materials. An atomic absorption spectrophotometer was put into operation. This instrumentation provides the capability for analyzing diverse types of samples for most metals, even at very low concentrations. Planned applications include steel sample analysis, investigation of weldments in structural steel, minerals, and environmental samples.

In a continuing effort to provide effective year-round pavement markings on high volume roadways, large scale testing of polyester and epoxy pavement marking materials was begun in the Grand Rapids area on M 11 (28th St) and US 131. Approximately 55,000 lin ft of each material was applied in September 1980 and will be closely monitored for useful life. In the past, conventional materials—applied twice annually—have not maintained their effectiveness through the winter period in high traffic areas. Small scale tests have indicated that polyester and epoxies may provide effective delineation for up to two years or more.

INDEX TO RESEARCH REPORT ABSTRACTS AND
ACTIVE RESEARCH PROJECTS

R-1132 - "The Michigan Department of Transportation Circular Wear Track--Results of Supplemental Aggregate Polishing Tests, Interim Progress Report," (71 C-13). R. W. Muethel.

Results of Series 9, 10, and 11 aggregate polishing tests (the first 8 were reported in MDOT Research Report R-1098) were completed on the Laboratory's circular wear track and are reported upon here. These series include two samples of arenaceous carbonates—very sandy limestone and cherty, arenaceous dolomite; samples of glacial gravel from six sources; two blast furnace slag samples; six blends containing gravel plus sandstone from four selected sources; and, two blends containing a high-polishing limestone plus a sandstone anti-skid agent. The arenaceous carbonates recorded satisfactory to superior resistance to polishing. The glacial gravels containing approximately the same carbonate rock content recorded similar polishing values. Both slag materials recorded superior resistance to polishing. The blends of crushed gravel with sandstone, and limestone with sandstone indicated an increased polishing resistance with increased sandstone content.

R-1133 - "Precisions of the Aggregate Sample Splitter and Testing Method," (78 TI-483 and 79 TI-578). W. H. Kuo.

Statistical procedures are used in three experiments to test the accuracy of a Gilson sample splitter, and to compare a mechanical vs. 'hand' testing method for in-place aggregate inspection. It was found that the sample splitter was able to split a sample of aggregate into two subsamples such that their weight ratio is very nearly constant; and, although the gradations of the subsamples are slightly different, the differences are negligible relative to in-place aggregate uniformity. The testing precision of the 'hand' and mechanical methods were found to be very high relative to in-place aggregate uniformity. The gradation differences measured by the two methods are negligible based on laboratory samples; however, on field samples they are significant. It was concluded that the mechanical method degraded the aggregate more, and some further study is suggested.

R-1134 - "Evaluation of Sprinkle Treatment for Improving Skid Resistance of Asphalt Surfaces, A Progress Report,' (78 C-19). J. H. DeFoe.

In many areas of the State, limestone is the predominant source of aggregate, yet bituminous paving mixtures using this material are susceptible

to traffic polishing, which may result in lower pavement friction values. In order to obviate the expensive practice of hauling-in large quantities of higher quality aggregate, a 'sprinkle treatment' was applied. This consists of the application of 5 to 10 lb/sq yd of precoated, high quality aggregate particles, 1/2-in. nominal size, onto the surface of a wearing course with embedment achieved by the rolling operation. The project involves a four-mile portion of US 23 in Presque Isle County and was completed in June 1979. Periodic inspections and friction measurements are planned for the next few years.

R-1135 - "Reflectorized Traffic Regulator Vests, Progress Report," (77 G-229). M. H. Janson, G. M. Smith, and J. D. Truax.

This report was issued to disseminate the information so-far gathered on reflectorized flagmen vests. Observers made a series of subjective evaluations involving vests constructed of different materials, as well as different design configurations. The number of preferred configurations and materials has been reduced to a favored few. Further testing will concentrate on these designs and materials, and more subjective evaluations from moving vehicles will be conducted.

R-1136 - "Petrographic Analysis of Coarse Aggregate: County Road Comm. No. 3, Pit No. 17-62," (Testing Laboratory Sample No. 79 A-2280). R. W. Muethel

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

R-1137 - "Final Report on Joint Load Transfer Test Road to Evaluate Acme Load Transfer Assemblies, Plastic Coated Dowels, and End-of-Pour Construction Joint Assemblies," (67 F-95 and 68 F-104). J. E. Simonsen.

This project was conducted to determine the performance of plastic coated dowels and Acme load transfer assemblies (two-piece malleable iron casting) as compared to standard steel dowels, and also to evaluate the feasibility of using a two-part dowel in end-of-pour construction joints. The latter was approved in 1970, but dropped in 1976 in favor of a tied end-of-pour joint. Six factors were used as a basis of comparison of the load transfer assemblies; uniformity of joint movement, initial pull-out resistance, joint groove spalling, slabs with fractured steel, load transfer

effectiveness, and corrosion. On the basis of these factors, the Acme and plastic coated doweled joints performed better than standard steel dowels. Joints with Acme devices, however, developed faulting, so they proved to be unacceptable. The use of plastic coated dowels in new construction is encouraged.

R-1138 - "Experimental Evaluation of No-Discharge Recirculating Sewage System for Freeway Rest Areas (SB I 275, N of Monroe)," (75 G-212). J. W. Bastian, G. Horton, Jr., and C. A. Zapata.

This Category 2 project, conducted in cooperation with the Federal Highway Administration, investigates a recirculating sanitary system, installed in a rest area that was unsuitable for conventional disposal methods. This proprietary system, 'Aqua Sans,' uses an odorless, colorless, nontoxic mineral oil instead of water for a flushing medium, which is then cleansed and recirculated through the system. This report describes the initial performance of the system, which was found to be slightly less than adequate as originally planned. Further improvements of the system components are needed to make the system more efficient and economical, although the investigation indicates that the system can be used safely, and its continued operation will be monitored.

R-1139 - "Annual Report of Activities of the Michigan Department of Transportation Research Laboratory - 1979."

R-1140 - "Summaries of Michigan Pavement Friction Measurements - 1978 Test Program," (54 G-74). P. M. Schafer.

This year's annual survey reports the results of over 12,200 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 1978 are included in this report, the High-Accident, Special Request, and Special Attention locations are reported out via letter immediately after testing to the parties concerned. It should be noted that these are the 1978 results; the new standardized 'FN number' described in the "Highlights" Section will not be completely incorporated until the 1980 test results are published.

R-1141 - "Preventive Maintenance of Concrete Pavements: US 27 - Final Report," (72 F-123). J. E. Simonsen.

In 1972, a length of US 127 in Ingham County was selected to determine the feasibility of a preventive maintenance concept for concrete pavements, utilizing precast slabs, cast-in-place slabs, and relief joints coupled with pressure-grouting of existing joints (this latter procedure proved unfeasible, as reported in MDOT Research Report R-838). A selection procedure was developed in order to ascertain which joints should be replaced, and the location of pressure-relief joints (a 4-in. transverse joint cut through the slab and filled with ethafoam). Joints that were replaced used both a cast-in-place and a precast slab technique, with an expansion space at each end of the slab. The use of these pressure relief techniques on the southbound roadway prevented blow-ups from occurring for a six-year period. Spalling of the joints on the pressure relieved pavement continued to increase at nearly the same rate as on the non-relieved northbound pavement. The procedure used to select deteriorated joints for replacement was found to be 83 percent accurate in comparison to the joint failures that occurred on the control pavement.

R-1142 - "Interim Report on Effects of Corrosion on Bridges of Unpainted A588 Steel and Painted Steel Types," (78 G-241). J. D. Culp and G. L. Tinklenberg.

Throughout the 1970's, high-strength low-alloy steels were used in fabricating our bridges. These steels would presumably develop a slight patina of corrosion which would act as a protective coating, preventing further rust after its formation, and thus removing the necessity of initial painting or future maintenance repainting. Investigations described in this report have revealed that A588 steel is not exhibiting the resistance to corrosion that was initially anticipated. The steel in the unpainted condition is continuing to corrode in the typical Michigan highway environment; the primary reason is attributed to the use of deicing salt on our highway system. Saltwater running off the roadway comes in contact with the steel by leakage through the bridge deck joints and by spray thrown up by traffic. Based on the findings of this research, the Department has placed a moratorium on the use of this material in bridge applications. It has also been

found that some unique problems exist concerning the painting of these 'weathering steel' bridges, and research is continuing in the Laboratory concerning the best coating material, and methods of preparation and application for these bridges.

R-1143 - "Investigation of Popout Problems on M 14," (80 TI-649). L. T. Oehler.

An area of the subject highway had been called to our attention as containing a number of popouts in the concrete. An investigation showed that they were not of such extent to significantly affect the integrity of the pavement. Recommendations for patching parts of the area with a fast-set mortar are included.

R-1144 - "Determination of Allowable Movement Ratings for Various Proprietary Bridge Deck Expansion Joint Devices at Various Skew Angles," (78 G-242). F. J. Bashore, A. W. Price, and D. E. Branch.

Michigan specifies single element, continuous length, elastomeric strip sealing devices for virtually all new and reconstructed bridge expansion joints. Generally, these devices are not installed at a 90-degree crossing angle (0-degree skew); however, the manufacturers' movement ratings are based on a 90-degree angle. No guidelines, except some general theoretical and intuitive ones, existed and the Department's Design Division requested that the Laboratory establish them for the devices currently approved for use by the Department, and that could be applicable to devices that might be approved in the future. Twelve 4 to 6-ft long sections were submitted by the manufacturers for testing. A special fixture was developed that would submit the devices to repetitive opening and closure, and which would allow the devices to be skewed from the perpendicular at 10-degree intervals. It was found that the majority of the systems evaluated will provide their full perpendicular movement range through a 70-degree angle of crossing; as the angle becomes more severe, the total perpendicular movement the system can handle decreases. The movements that the systems can adequately provide, at various skew angles, were supplied to the Design Division. As other bridge joint systems are developed and submitted, they can be subjected to the same test program and their angle-to-movement range determined.

R-1145 - "Evaluation of Various Types of Railroad Crossings - Fourth 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 fourth 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. 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 of the magnitude experienced, and the Department has suspended the use of these crossing types. The original Steel Plank design appears to develop fastening problems; the design has been modified and an installation made. Until sufficient traffic has traversed this new design, we suggest that the Steel Plank system not be used on crossings where more than 5,000 ADT is expected or where high-speed trains cross them. The other types of crossings continue to perform in a satisfactory manner. Further progress reports will be forthcoming as time passes.

R-1146 - "Blended Aggregates Tested on the Michigan Department of Transportation Circular Wear Track," (71 C-13). R. W. Muethel.

The Laboratory's circular wear track was constructed in 1974 for the primary purpose of evaluating the polishing resistance of various available aggregates, both natural and processed. Since completion, the wear track has tested quarried carbonates, glacial gravels, slags, and individual lithologies. Recent test series have included experimental blends of gravels or carbonate aggregate with various proportions of selected anti-skid materials, primarily sandstone or crushed gravel. Due to increased interest in blending to upgrade the polishing resistance of quarried carbonates and high-carbonate gravels, results of wear track tests on these materials are presented in this report. Recommendations are given for a specific blend for an upcoming job, and some general restrictions on the use of certain materials are presented. The Laboratory will continue reporting-out the results of wear track tests as part of a long-term program.

R-1147 - "Evaluation of 22A Gradation Open Hearth Slag as a Base and Subbase Construction Material: Final Report," (68 E-43). J. H. DeFoe.

This is the final report of a lengthy investigation of the feasibility of using steel furnace slag in lieu of 22A aggregate as a base and subbase material. Laboratory and field research has shown that steel furnace slag—meeting existing Department specifications for a 22A base and subbase

gradation—has not proven to be a satisfactory construction material for these purposes. It was found to be frost susceptible and exhibits differential heaving tendencies under a pavement surface; it has poor drainability with a self-clogging tendency due to the formation of solid leachates; it exhibits unpredictable volume changes (expansion) due to internal chemical constituents which can cause heaving of the pavement surface; and its chemical composition is extremely variable and cannot be controlled by the manufacturing process at this time. Research is being conducted to see whether other gradations might prove to be more acceptable.

R-1148 - "Air Quality Report for the Ambassador Bridge Tourist Information Center," (80 AP-28A).

This report presents air quality information for a proposed Travel Information Center near the Ambassador Bridge in Detroit. Three alternate sites for the Center, along with the roadway alignment schemes that each would entail are considered. Meteorological data and estimates of pollution that might occur adjacent to receptor sites along with a total pollutant burden for the various schemes are included. The study showed that the estimated concentrations of carbon monoxide, including existing background at all the receptor sites for all alternate schemes of the proposed project are well within Federal air quality standards. There is no significant difference between the alternate schemes.

R-1149 - "Petrographic Analysis and Insoluble Residue Determination of Coarse Aggregate: Thornton Quarry, Pit No. 21-67," (Testing Laboratory Sample No. 80 A-1075). R. W. Muethel.

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

R-1150 - "Performance Evaluation of Trinidad Asphalt Cement for Bituminous Concrete Resurfacing: Final Report," (73 C-16). C. A. Zapata.

This is the last in a series of reports concerning an experimental resurfacing project; nearly five miles of US 27 in Roscommon County. The purpose of the study was to assess the service performance of the Trinidad asphalt cement blend (with respect to long-term durability in resisting surface cracking) compared with conventional 85-100 penetration grade asphalt

in bituminous concrete overlays. This final report summarizes all condition surveys (riding quality, pavement friction tests, and crack counts) taken over the 5-1/2 year period following installation. The results indicate that after this period under traffic and weathering, both Trinidad and conventional resurfacings are about equal in performance. Therefore, considering the higher cost of the Trinidad asphalt blend, it appears that there is no advantage in using this material.

R-1151 - "Performance of Several Types of Corrosion Resistant Load Transfer Bars, for as Much as 21 Years of Service in Concrete Pavements," (70 F-116 and 73 F-136). C. J. Arnold.

For years, Michigan's jointed concrete pavements have used 1-1/4-in. diameter steel load transfer dowels, 18 in. long and on 12-in. centers. The bars were coated with bituminous material; however, this was intended as a bond-breaker and not as protection against corrosion. As early as the 1950's, experimental installations of corrosion resistant dowels were placed, but only in rather recent times have coated dowels been required. This report updates the data on the very early installations, and reports on some of the recent ones. Among the coatings were stainless steel, nickle plating, Monel metal, various epoxies, and plastics. Of the treatments that are economically feasible, the older stainless steel surfaces worked very well, but the more modern stainless sleeves are of lower quality and very expensive. A polyethylene coating seems to provide the best combination of long-term protection, availability, and moderate cost. Some additional care in handling is required, but no bond-breaker need be applied. Epoxy coatings seem to perform well, but there are indications that there are some quality control problems concerning the uniformity of the coatings.

R-1153 - "Air Quality Report for M 59 in Macomb County," (80 AP-30A).

This report was prepared as part of the Environmental Impact Statement for this proposed route location. In accordance with Federal directives, the terrain and demography, meteorology, existing ambient air quality, and pollution estimates were all explored. Pollution estimates are based on a model which includes as inputs: vehicle emission factors, estimated peak and off-peak traffic volumes, meteorological conditions, road profile, and width of roadway sections. Total pollutant burden for the alternates is also given. The estimated concentrations of carbon monoxide, including existing background at all of the receptor sites for all alternates of the proposed project are within Federal air quality standards. There is no significant difference between the alternates.

R-1154 - "Screened Legend Quality of Signs from Michigan State Industries and a Review of Screening Materials," (80 TI-653). M. H. Janson.

The Maintenance Division asked that representatives of the Testing and Research Division meet with them and Michigan State Industries personnel because of problems associated with the handling and durability of signs with screened legends furnished by MSI. As a result of these discussions, and some testing of sign samples, it became evident that the problems could be alleviated by assembling and presenting a summary of information on screening and screen processing materials. Included herein are recommendations as to what thinners be used with what inks, screen mesh sizes, and requirements of each material or combination of materials (e.g., drying time, shelf life, etc.). Also included are recommendations for handling and transporting these signs.

R-1155 - "Weathering Steel Guardrail, A Materials Performance Evaluation," (78 G-241). R. L. McCrum and C. J. Arnold.

Concern over the performance of weathering steels in general, and overlapping surfaces on these structures in particular, prompted the Laboratory to evaluate some of its weathering steel guardrail. Principal areas of interest have centered on the deterioration of joint strength (performance) in relation to service age and environment. Data obtained from this investigation have been plotted and extrapolated to estimate the range of joint strength deterioration of guardrail in Michigan's range of corrosive environments. Secondary items of interest include: energy absorption of the guardrail joints in failure; several different methods of measuring thickness losses on pitted surfaces versus 'effective' thickness loss (calculated from loss in section strength); and, effects of pitting on section strength and energy absorption.

R-1157 - "Air Quality Measurements of Movable Asphalt Plants for Recycling Paving Asphalt, Progress Report," (78 G-235). J. T. Ellis.

The stacks of three movable asphalt plants processing recycled paving material (50 percent virgin - 50 percent recycled) were sampled at construction sites in 1979 and one in 1980. It was found that none of the plants tested met the Federal air quality standards for particulate emissions. However, it was shown that a baghouse filter exhaust system was capable of compliance, and suggested adjustments and refinements were offered for the wet scrubber exhaust systems. Further testing will determine whether they are capable of compliance.

LISTING OF NEW MATERIALS PROJECTS COMPLETED DURING THE YEAR

77 NM-530 - Reflexite Corp. UV Stabilized Plasticized PVC Film With 0.006-in. Cube Corners for Traffic Control Devices

78 NM-568 - Embark 2S Growth Inhibitor for Grasses Along Roadside (3M Co.)

79 NM-574 - Crafco Crack Sealer

79 NM-580 - Alucobond TM Consolidated Aluminum Corp.

79 NM-592 - Anti-Skid Studs for Steel Grid Bridges

80 NM-602 - Propellant 49 (Pace Products, Inc.) Melts Ice and Snow

80 NM-607 - "Standard Quartz" for Repair and Reconditioning Concrete

80 NM-608 - "Ceramic S Metal" for Coating Reinforcing Steel in Concrete to Protect from Rusting Due to Road Salt

80 NM-613 - "Rox" Masonry Paint

80 NM-615 - "Detectoduct" for Traffic Lighting Cables

LISTING OF TECHNICAL INVESTIGATIONS COMPLETED DURING THE YEAR

76 TI-330 - Analysis of Roadside Car-Tree Accidents for Barry County

77 TI-410 - Glare Problem on I 496 at Clare Street, Lansing Township, Ingham County

78 TI-482 - Investigation of Failure of I-Beam Joint for Continuously Reinforced Pavement I 94 West of Shook Road

78 TI-483 - Statistical Analysis of Aggregate Testing Methods - Mechanical vs. Hand Shaking

78 TI-493 - Testing of Adcolite Reflective Sheeting

78 TI-522 - Brill vs. Michigan Department of State Highways and Transportation (Ford and Lodge Interchange Median Barrier Accident)

78 TI-526 - Noise Problem, M 14 at Ridgewood Between Sheldon and Beck Roads, Plymouth

78 TI-542 - Survey of Cracking in All Concrete Patches Placed in Last Five Years

79 TI-578 - Statistical Analysis of Aggregate Testing Procedure

79 TI-603 - Noise Investigation and Request for Noise Fence on Square Lake Road (Mr. Derrick Ratcliffe), Bloomfield Hills

79 TI-607 - Noise Investigation on I 94 Between Clippert and Monroe, City of Taylor

79 TI-608 - Noise Investigation on Westbound I 94 and the Northbound Telegraph Exit, City of Taylor

79 TI-611 - Noise Investigation on I 94, North of Black River, Port Huron

79 TI-612 - Noise Investigation, Mobile Home Park, Southbound Ramp of I 75 to 12 Mile Road

79 TI-614 - Noise Investigation for Northbound Ramp, I 496 to I 96, Gettysburg Farm West

79 TI-615 - Noise Investigation, US 23 Adjacent to Fonda Lake, Livingston County

79 TI-620 - Testing of New Frangible Mulch Pin for Excelsior Blankets

79 TI-621 - Noise Investigation Adjacent to I 96, Lansing (Marscot Meadows)

79 TI-626 - Noise Investigation Adjacent to M 59 in Pontiac (Mr. Jim Davis)

79 TI-629 - Noise Investigation for Southbound M 85 (Fort Street) Between Marian and West Road

79 TI-631 - Fiber Optic Sign Installation on US 12 (Michigan Avenue), Dearborn, Michigan

79 TI-632 - Noise Investigation From M 14 Freeway - West of Sheldon Road, Plymouth Township

79 TI-633 - Investigation of Anchor Bolts From Type H Cantilever, I 75 at I 675

80 TI-636 - Test Method for Checking Salt Brine Concentration in Retention Tanks at Highway Garages

80 TI-639 - Ultrasonic Testing of Type "C" Cantilever Anchor Bolts - I 96 at Pennsylvania Avenue, Lansing

80 TI-641 - Testing of Steel on Northbound Portion of B01 of 70014, US 31 Over South Channel of the Grand River

80 TI-642 - Procedure Qualifications for A 572 and Hybrid A 572 and A 588 Butt Welds

80 TI-644 - Glare from Royal Scot Parking Lot Light, West Grand River, Lansing

80 TI-646 - Investigation of Defective Tungsten Carbide Inserts for Moldboard Assemblies

80 TI-647 - Noise Investigation on I 94 and Cutoff From I 94 to Telegraph Road, Taylor (Mr. and Mrs. L. B. French)

80 TI-648 - Silver Content of Fixer Solutions

80 TI-649 - Investigation of Expansion Joint Deterioration, Clay Balls and Pavement Deterioration on M 14, Plymouth to Ann Arbor

80 TI-652 - Noise Investigation, US 23 Brighton (Senator K. Kammer)

80 TI-653 - Unacceptable Screened Legend Film Signs

80 TI-654 - Breaking of Large Post Driving Heads

80 TI-655 - Noise Investigation, Long Leasing Truck Terminal on M 32 in East Jordan

80 TI-662 - Request for Noise Barrier (Earth Mound) on I 94 at West Willow Elementary School Between Rawsonville Road and Willow Run Airport Exits

80 TI-663 - Survey of Deterioration of Bolts in Buried Guardrail Sections

80 TI-665 - Failure of Swing Cylinder Piston Rods Used With Underbody Blades

80 TI-671 - Experimental WeldingWith the Electrogas Process

80 TI-673 - Reflective Sheeting Identification for Lenawee County

80 TI-675 - Investigating the Need for a Sound Barrier at the David Oren Hunter Elementary School, Trenton, I 75

80 TI-679 - Condition Survey of Non-Metallic Bridge Bearings

80 TI-680 - Noise Investigation in I 94, City of Ann Arbor

80 TI-687 - Noise Investigation at Chapel Hills Subdivision, US 23 and Plymouth Road

80 TI-691 - Noise Investigation, I 94 Near Saxon Street, Ann Arbor

80 TI-697 - Ford Motor Company Road Profilometer Work

80 TI-704 - Cantilever Sign Support Anchor Bolt Testing

80 TI-705 - Test of 21AA Gravel Material for Open Graded Base

80 TI-709 - Need for Lighted Freeway Signs

80 TI-710 - Testing of Detroit Motorist Aid System

80 TI-711 - Testing of Experimental Rumble Strips in Bituminous Shoulders

80 TI-714 - Investigation of Failure of Continuously Reinforced Pavement; Eastbound I 96 West of Okemos Road

80 TI-715 - Testing of Concrete Anchors by Ramset Fastening Systems

LIST OF ACTION PLANS
COMPLETED DURING THE YEAR

79 AP-24A - Air Quality Monitoring - I 96 at Wixom and Beck Rds

79 AP-25A - Air Quality Monitoring - M 24, Lake Orion, Northerly to Paint Creek

80 AP-26A - Air Quality Monitoring - M 25 at Bay City

80 AP-27A - Air Quality Monitoring - M 53, Village of Almont

80 AP-28A - Air Quality Report for Proposed Ambassador Bridge Travel Information Center

80 AP-30A - Air Quality Report for M 59, Utica to I 94

80 AP-31A - Air Quality Monitoring - M 275 West Oakland County

80 AP-32A - Air Quality Monitoring - M 25 at Port Huron

Title

77 G-231 - Pre-Icing of Bridge Decks

Purpose

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

Scope

Ten-year accident histories including time of occurrence for at least 200 bridges will be tabulated together with weather data from the nearest weather station.

Progress Past Year

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

A probability model has been developed which closely follows seasonal changes in pre-icing risk. This model uses accident statistics to estimate the relative frequency of dry and icy surface conditions as this frequency changes with season.

Planned Program for Coming Year

Data collection is now about 85 percent complete. The remaining data will be obtained in the coming year as accident reports for southwest and southcentral counties are examined. The full data set will then be used to determine parameters of the pre-icing probability model developed this year. Also, pre-icing accident severity will be compared to other types of

accident so that a final report can be written and the project terminated in 1981.

Cost 1980: $22,697

Title

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

Purpose

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

Scope

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

Progress Past Year

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

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

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

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

Planned Program for Coming Year

Completion of final report.

Cost 1980: $21,783

Title

78 G-239 - Comprehensive Analysis of Skid Resistance Data

Purpose

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

Scope

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

Progress Past Year

None.

Planned Program for Coming Year

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

Cost 1980: - 0 -

Title

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

Purpose

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

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

Scope

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

Progress Past Year

Completion of a proposal for Federal funding assistance.

Planned Program for Coming Year

Begin work on estimation procedures and computer programs.

Cost 1980: $621

Title

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

Purpose

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

Scope

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

Progress Past Year

Prepared rough draft of research proposal for Federal approval.

Planned Program for Coming Year

Completion of an experimental design comparing accident statistics for a two-year period prior to installation of roadside improvements dictated

by the manual with accident statistics for the same locations after installation of roadside improvements. The experimental design will require selection of counties for which roadside accidents appear to be a special problem.

Cost 1980: - 0 -

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. In 1979 and 1980 a third alternate latex, Thermoflex 8002, was used on three structures on I 496 in Lansing under one repair contract.

Progress Past Year

The last half of the Thermoflex 8002 project was monitored and completed. Two latex concrete overlay projects exhibiting early deep and extensive random surface cracking were evaluated by selective coring and testing for shear bond, absorption, and density of overlay. These two projects, on US 31 at Pentwater and on I 96 west of Lansing, appeared to have weather-related problems inducing the cracking, but the overlays still had adequate bond.

Planned Program for Coming Year

Complete and submit report on Dylex 1186 and Thermoflex 8002 projects in Lansing. Continue inspections of selected overlay projects as personnel and time permit.

Cost 1980: $3,464

Title

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

Purpose

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

Scope

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

Based on the results of the extensive test data from seven projects paved in 1972 to 1974, the Department approved the use of water reducers in paving concrete with a slight reduction in cement. This usage in grades 35P and 30P concrete became part of the 1976 and 1979 Standard Specifications (Table 7.01-1). The 5.6 sack/cu yd mix with water reducer, in lieu of 6.0 sacks of cement, has been widely used across the state in paving concrete.

Progress Past Year

Due to loss of personnel and higher priority assignments, the project was not closed.

Planned Program for Coming Year

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

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

The draft of the final report was completed for the I 275 paving project and the writing of the final report started for the M 14 bridge application.

Planned Program for Coming Year

The report of the bridge application will be completed and a recommendation made for inclusion of Type 1P-A cement in both substructure and superstructure bridge concrete.

Cost 1980: $812

Title

72 B-92 - Experimental Bridge Deck Surfacing Methods

Purpose

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

Scope

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

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

Progress Past Year

Due to 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 1980: - 0 -

Title

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

Purpose

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

Scope

Determine the effectiveness of low slump high density overlays in rehabilitating spalled and chloride contaminated bridge decks. For this purpose two projects on I 96 were selected to monitor and evaluate this system.

Long-term performance will be evaluated by periodic inspection and testing. In 1977 the low slump high density overlays were used both for deck repair and on new two-course construction as an alternate to latex modified concrete. Additional structures were overlayed in 1978 with low slump high density concrete overlays. These included 11 decks under two repair contracts and 8 new two-course structures on I 475 in Flint.

Progress Past Year

No additional projects were done since 1978 with LSHD concrete since all subsequent 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 six-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 1980: $184

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.

Planned Program for Coming Year

Finalize the report and distribute to close the project.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

In 1976 about 1,240 ft of Ramp A in the southwest quadrant of the Shelby Rd-US 31 interchange was constructed of a composite econocrete pavement. About 1,200 ft of Ramp A was constructed with 8 in. of grade 35P concrete. The econocrete mix contained 305 lb 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

An inspection was made of the experimental ramp indicating extensive longitudinal cracking in the econocrete section.

Planned Program for Coming Year

Profilometer tests and a final five-year condition survey is to be run early in the year to be included in a final report for typing and distribution.

Cost 1980: - 0 -

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

About three miles of the outside shoulders of M 14 were paved in 1978 in half-mile sections. The sections consisted of, alternately, grade 30P concrete, 3,000, 2,500, and 2,000 psi grade "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 draft on this project was completed, including the results of 24 selected cores from the four basic mixes involved.

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 1980: $595

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

Initial corrosion cell tests and inspections were done in 1979 on selected decks in Livingston and Macomb Counties. Due to loss of personnel and other high priority work, some of the 1980 deck overlay jobs were not followed at time of construction.

Planned Program for Coming Year

Selected portions of decks containing high chlorides and repaired in 1979 and 1980 are to be monitored during and after construction. An initial progress report is to be prepared later in the year. A few 1981 projects may be followed if the contracts are let.

Cost 1980: $580

Title

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

Purpose

This project is to re-evaluate the 1963 ban on the use of crushed limestone and high-carbonate gravels in bituminous concrete wearing courses. Of particular concern was the effect of these restrictions on the 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 re-examined on projects paved up to 1963 and also from 1963 to 1972. Primarily, bituminous concrete projects were examined under Phase 1, and bituminous aggregate jobs and initial wear track construction were done under Phase 2. Extensive wear track tests were to be run on selected coarse aggregates used in 4.12 and 4.11 mixes to define their relative wear characteristics.

Progress Past Year

Research Report No. R-1132, an interim progress report covering wear track Series 9 through 11, was distributed in January 1980.

Research Report No. R-1146, covering selected blends tested on the wear track, was completed and distributed in May 1980. The report also included the results of wear track Series No. 12 containing a high-carbonate gravel, a non-carbonate gravel, and blends of the non-carbonate gravel with the high-carbonate gravel or the control limestone.

A review draft was completed on a report describing a procedure for computing estimated wear track polishing numbers for aggregates, using established rock type polishing factors and the petrographic percentages in aggregate samples. The report also proposed the implementation of a Michigan polishing number to be included in specifications for bituminous wearing courses.

Wear track Series No. 13 containing selected high-carbonate gravels, crushed kona dolomite, and steel furnace slag was started, but not completed by the end of 1980.

Planned Program for Coming Year

A final draft of the report describing computed wear track polishing numbers for aggregates is to be completed and distributed.

Wear track Series No. 13 is to be completed.

Succeeding wear track test series are tentatively scheduled to include additional high-carbonate gravels and polish-resistant aggregates to be used as possible blending agents. Aggregates for test Series No. 14 and No. 15 have been received.

A bituminous wearing course specification incorporating the proposed Michigan polishing number may be used on one or two paving projects for evaluation.

Cost 1980: $13,037

Title

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

Purpose

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

Scope

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

Progress Past Year

An on-site inspection of the test pavements was conducted in June. The control gravel test section appeared to be somewhat smoother than the sandy limestone test section which had a pitted surface due to weathering-out of some of the sandy limestone aggregate particles.

Three-year trailer pavement friction tests were conducted on the test pavements in August, and indicated satisfactory pavement friction values. The sandy limestone test section recorded slightly higher friction values.

Planned Program for Coming Year

Four-year trailer pavement friction tests will be requested. An on-site inspection of the test pavements is scheduled for mid-summer. The results of the pavement friction tests and field inspection will be included in a progress report.

Cost 1980: $11

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. Annually inspect the bridge deck to determine if the procedure is achieving the desired results.

The first phase of this project was done as a joint voluntary venture between a contractor and the Department in 1975 to develop a procedure by which a bridge deck, in early stages of deterioration, could be restored to its original integrity without resorting to costly chipping and patching. The second phase of this project 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.

Progress Past Year

A personnel turn-over problem, which included one engineer and three technicians, precluded additional work on this project.

Planned Program for Coming Year

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

Cost 1980: $158

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

Several installations of various expansion dam systems were completed this past year. Many of these were inspected at the time of installation or shortly thereafter.

Standard details and installation procedures have been worked out with two of the manufacturers for their systems and two others are in progress. These details will provide a clear set of instructions for the Contractor and the MDOT inspector to follow, hopefully eliminating many installation problems.

Planned Program for Coming Year

Continue surveillance of installations and write a progress report.

Cost 1980: $8,667

Title

47 G-36(33) - 1980 Supplemental Traffic Paint Performance Tests

Purpose

This project is the 1980 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 1982.

Scope

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

Progress Past Year

Field tests were initiated in July 1980 including two whites and two yellows from each of five producers. Periodic ratings were made and will be continued until each paint has reached the end of its useful life as defined by ASTM D 713. A progress report was made to the Paint Committee in December of 1980.

Planned Program for Coming Year

Rating of the paints in field tests will continue until all paints have reached the limit of their useful lives. A final report will be made to the Paint Committee including recommendations as to eligibility of paints for 1982 purchases.

Cost 1980: $12,606

Title

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

Purpose

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

Scope

As noted by the number, the project was initiated in 1949 and is meant to be continuing in order to evaluate the latest developments in paint coatings. The project has two phases, (a) evaluation of paint systems by laboratory techniques, and (b) field evaluation on actual structures of the best

performing systems as determined previously in laboratory tests. Since the service life of a good paint system is more than 10 years, determining the merits of paints under phase (b) is lengthy and time-consuming.

Progress Past Year

The evaluation of the effects of field deviations from specifications is well underway. All accelerated test panels were prepared and the testing program started.

Planned Program for Coming Year

Due to delays in panel preparation, the test panels will not be removed for the accelerated test until late in 1981. Therefore, we plan to continue running the accelerated tests on a continuous basis and as panels fail, replace them with new samples. This will, in effect, again double our testing capacity and allow us to cut down lead times. We also hope to start a program of coating over old and chloride-contaminated red lead paint. A report on this project will also be started.

Cost 1980: $209

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

A great deal of time has been spent looking into the various possibilities of improving specification enforcement. Due to the fact that there are very few contracts scheduled for 1981 we have more time to develop an inspector training manual. Also this past year, the project leader started serving on an evaluation committee of a FHWA inspector training manual. This manual is scheduled for completion in June of 1981. For these reasons the inspector training program has been postponed until the winter of 1982.

Planned Program for Coming Year

Continue development of inspector and painter certification program. As in other years, there are always unique situations that require 'one time only' revisions. This work will continue under this project.

Cost 1980: $666

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 priority of work in other areas, no work was done this past year.

Planned Program for Coming Year

Continue inspections of test installations.

Cost 1980: - 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

One new design was approved and a second is under evaluation.

Planned Program for Coming Year

Evaluate new design sections as submitted.

Cost 1980: $2,461

Title

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

Purpose

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

Scope

Since accelerated laboratory tests are unsuitable, we used field service tests to determine performance of unpainted subject steel in bridge

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

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

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

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

Progress Past Year

No work was 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.

Planned Program for Coming Year

The second set of panels is scheduled to be removed and will be sent to producer's laboratories for corrosion measurements.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Epoxy mortar surfacing was applied 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 had removed approximately 1/8 in. of mortar per year. The rate of abrasion in the E815-V140 appeared to be less. In 1978 several bare areas in the Guardkote 250 mortar-surfacing had enlarged in the south span. The north span epoxy mortar, though sustaining an undetermined amount of traffic abrasion, remained essentially intact.

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.

Progress Past Year

Revised proposal was a part of a successful contract which involved the subject Creyts Rd bridge and two local area concrete bridges. The

epoxy wearing course of 1969 was completely removed and the Mobilplast Protection System applied. This included a thicker, 2-in. bituminous wearing course using Mobilplast cement binder in lieu of standard asphalt cement.

Planned Program for Coming Year

The integrity of the Mobilplast Protection System will be evaluated by electric resistance measurements, results analyzed, and the final report started. This will include the final assessment of the original 11-year old epoxy mortar surfacing.

Cost 1980: $50

Title

71 G-178 - Guardrail Wood Post Deterioration

Purpose

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

Scope

The initial phase of the project covering preservative treatments allowed by past specifications was completed with Research Report No. R-954, which showed the water-borne treatment to be inferior. A current, secondary phase of the project endeavors to determine whether the current water-borne treatment (CCA) is superior to the former, superseded one (FCAP), and equivalent to the two organic-based treatments. The oldest known (CCA) treated posts are about 11 years old.

Progress Past Year

No work was scheduled for 1980.

Planned Program for Coming Year

Make inspections of selected installations.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Sampling from 30 roadside groundwater observation wells at four statewide locations has continued. Sampling frequency has been reduced from a biweekly to monthly basis. Chloride content of the water samples has been determined and tabulated.

Additional surface water sampling sites were added at two of the four statewide locations.

Completion of a review draft of a progress report on sampling from 1976 through 1979 was delayed to include data from the new sampling locations.

Planned Program for Coming Year

A review draft of a progress report on sampling from 1976 through 1980 is to be completed.

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

Cost 1980: $6,771

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. However, initial resistance tests were run on two new deck waterproofing systems on four structures in the Lansing area.

Planned Program for Coming Year

With the help of other T&R and District personnel, it is planned to schedule final inspections on the initial 1973 projects on I 75 and selected membrane projects done since then. Results of these inspections and tests are to be assembled into a report for distribution late in the year or early 1982.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

The project is a Category 2 experiment carried out in cooperation with 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 for 1981.

Cost 1980: $41

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 53 structures in 1980. The Research Laboratory only processed special 4-in. deck cores for visual appraisal, compressive strength, and in some cases, chloride content on a few structures having bituminous overlays.

Planned Program for Coming Year

It is anticipated that there will be only a small number of special cores for bridge overlay projects to process in 1981 as the Testing Laboratory will continue to do the standard drill samples.

Cost 1980: $202

Title

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

Purpose

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

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

Scope

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

Progress Past Year

Field inspections were made in the second and fourth quarters.

Planned Program for Coming Year

Continue biannual inspections to monitor performance.

Cost 1980: $141

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 final report.

Cost 1980: $1,084

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 conducted on a monthly basis. Samples of water were also obtained from the retention lagoon and sand pile sump. The treated sand stockpile was sampled in June for chloride content determination to establish the extent of salt loss during storage.

A review draft of a progress report on the results of monitoring the effectiveness of the deicing chemical containment practices at the Reed City garage was completed.

Bimonthly reports of chloride test results were established to distribute regular monitoring up-date information.

Planned Program for Coming Year

A progress report is to be completed and distributed. Sampling of the test wells, retention lagoon, and sand pile sump are scheduled to continue on a monthly basis.

Bimonthly reports of chloride test results on water samples will be distributed.

Cost 1980: $2,409

Title

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

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

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. If no new and promising systems appear in the next two to three years this project will be dropped.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Testing of the second series of tests are well underway. These will be completed in June of 1981. Assuming the Department chooses to use zinc-rich coatings we will have a standard specification for the 1982 printing of the Standard Specification manual. Due to the inconsistency of a small portion of the test, we will be duplicating these tests this year thus delaying the final report.

Planned Program for Coming Year

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

Cost 1980: $11,622

Title

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

Purpose

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

Scope

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

Progress Past Year

The instrument is now being used for the evaluation of night visibility of traffic paints. Work on determining at which point a paint stripe has failed has been started. The results continue to be promising; therefore, work on converting the instrument for computer analysis of the data continues.

Planned Program for Coming Year

We plan to continue development of a model that uses a computer. Due to the workload in our Electronics Group, we do not have a firm schedule, therefore, work will continue with the current model with the hope that the conversion to an improved model will not change any of the failure definitions.

Cost 1980: $781

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

Testing of several systems being used by the Department was completed and reported in Research Report R-1144.

Planned Program for Coming Year

Samples of certain systems used by the Department were not available for testing with the first series. In addition, several manufacturers are submitting new or modified systems. These new submittals will be evaluated in early 1981.

Cost 1980: $5,574

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 110,000 lin ft of markings were applied in August 1980.

Planned Program for Coming Year

Periodic field inspections will be made and reported as appropriate.

Cost 1980: $4,797

PHOTOMETRY AND SPECTROCHEMISTRY UNIT

Title

73 D-28 - Evaluation of Wet Bottom Slag for Bituminous Shoulder Wearing Courses, I 94 in 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 day and night pavement-shoulder contrast was measured and evaluated.

Planned Program for Coming Year

The day and night luminances of the shoulder and pavement will be measured. Values for visual contrast will be analyzed and compared with values from the previous year. The final report will be completed.

Cost 1980: $275

Title

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

Purpose

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

Scope

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

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

Progress Past Year

Federal and State air quality regulations were reviewed as issued and a file maintained of material relevant to transportation. Information obtained from manufacturers and users was used to keep current on instrumentation available to monitor air quality. Guidelines from the U. S. Environmental Protection Agency were used to maintain quality control for air quality data added to the Department's data bank. Three mobile air monitoring laboratories operated in the field to obtain data at 10 sites. Data banks for air quality data and meteorological data were updated and expanded. Air monitoring data were supplied to the Bureau of Transportation Planning. Meteorological data were supplied to the Bureau of Aeronautics. Documentation of computer programs and monitoring laboratory construction was prepared for the project report.

Planned Program for Coming Year

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

Cost 1980: $39,112

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 visual performance. Evaluate brightness of acceptable light sources. Propose basis for legislative control.

Progress Past Year

A parking lot sodium vapor luminaire located just off I 496 in Lansing was evaluated for glare. After consultation the owner of the luminaire causing the glare agreed to divert the light beams away from drivers on I 496.

Parking lot lighting at a commercial building on business route I 96 (West Grand River) was evaluated for effect on driver vision. It showed that several of the luminaires would adversely affect driver's view of the edge of the roadway. Meetings with the manager of the building resulted in the luminaires being rotated so that the majority of light was being directed toward the parking lot.

Planned Program for Coming Year

Negotiate with owners of designated glare sources. Study drivers reactions to a standardized glare source. Formulate standards for off-road glare sources.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

The floppy disk computer system was purchased and assembled. It will be placed on board the photometric van in order to record pavement illuminance data. The previous system used, a digital recorder, did not have the necessary speed and accuracy.

Planned Program for Coming Year

1) Construct interface between computer and photocells; 2) program the computer; 3) improve zero reference method to eliminate drift in recording system; and, 4) record illuminance data.

Cost 1980: $4,496

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 1980: $13

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

Two previously rated best patterns of reflectorized and fluorescent "Blaze Orange" flagman vest material were compared with a fully reflec-

torized and fluorescent blaze orange vest. Observers riding or driving vehicles chose the patterned vests over the fully reflectorized vests.

In a second phase observers made choices among five different colors of patterned vests in an urban lighting environment and in a rural lighting environment.

Planned Program for Coming Year

Analyze data from the second phase and write report.

Cost 1980: $8,472

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. One asphalt plant was monitored for particulate emissions when recycled paving was being processed. A report on the work was prepared.

Planned Program for Coming Year

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

Cost 1980: $3,651

Title

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

Purpose

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

Scope

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

Progress Past Year

A progress report describing construction, Research Report R-1134, was published. Annual pavement friction measurements were made, which showed the sprinkle treatment to be more skid resistant than the control section.

Planned Program for Coming Year

Conduct friction level tests and observe condition of the surface.

Cost 1980: $533

Title

74 D-29 - Sulfur in Bituminous Mixtures

Purpose

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

Scope

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

Progress Past Year

Laboratory testing of pavement cores was continued to determine fatigue life and low temperature cracking potential. Testing has been delayed due to shortage of personnel and the assignment of additional projects of higher priority. The 30 percent sulfur test sections continue to perform well.

Planned Program for Coming Year

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

Cost 1980: $510

Title

75 D-30 - Recycling of Asphalt Pavement

Purpose

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

Scope

Altogether, 31 miles of I 75 freeway were rehabilitated in Otsego and Cheboygan Counties. Of this mileage, 11 miles of northbound roadway was

recycled by mixed-in-place stabilization procedures, and involved pulverizing, blending and compacting 254,000 sq yd of shoulder base and pavement materials.

Progress Past Year

The annual condition survey was performed. Laboratory tests were made to determine resilient modulus. Deflection measurements were made to permit fatigue life analysis based on elastic layer theory. Research Report R-1088 was issued which described construction of the test sections.

Planned Program for Coming Year

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

Cost 1980: $3,473

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. A five-year evaluation period is called for in the research proposal.

Progress Past Year

Rut depth and pavement friction measurements were made. Laboratory testing of road materials was continued but delayed because of a shortage of laboratory technicians.

Planned Program for Coming Year

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

Cost 1980: $913

Title

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

Purpose

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

Scope

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

Progress Past Year

Field and laboratory testing for the project was substantially completed but, due to the assignment of higher priority projects, about three weeks of testing remains to be done. Data obtained from completed test sections were analyzed for inclusion in the final report of the project.

Planned Program for Coming Year

Remaining testing will be completed and a summary report prepared, covering the following topics: conventional analysis of bituminous concrete

samples; determination of the engineering properties of the bituminous concrete test samples; analysis of the bituminous concrete aggregate; and the structural analysis of each test section.

Cost 1980: $37,196

Title

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

Purpose

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

Scope

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

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

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

analysis. A five-year evaluation period is called for in the research project proposal.

Progress Past Year

Laboratory testing was continued to assess fatigue life and low temperature characteristics. Research Report R-1129, describing construction of the project, was distributed.

Planned Program for Coming Year

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

Cost 1980: $5,690

Title

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

Purpose

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

Scope

A 1,000-ft experimental section of pavement overlay using the Sulphlex mixture will be constructed on a project to be selected. 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

Construction was delayed until 1981 because the Sulphlex binder could not be mixed and delivered as planned. A demonstration of Sulphlex paving

was observed, in Texas, by R. Moore and J. DeFoe of the Testing and Research Division.

Planned Program for Coming Year

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

Cost 1980: $4,625

Title

80 D-39 - Feasibility of Paving Over Sylvax Patches

Purpose

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

Scope

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

Progress Past Year

Three highways scheduled for resurfacing were inspected and one selected for observation. The locations of existing Sylvax patches were marked for reference.

Planned Program for Coming Year

The bituminous resurfacing at the patches will be inspected and photographed in the spring of 1981. Cores will be obtained at that time to measure bonding and stability.

Cost 1980: $893

Title

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

Purpose

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

Scope

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

Progress Past Year

A project scheduled for 1981 was selected, US 23 in Livingston County, CS 47014-17384. This job is now scheduled for a September 1981 letting but may be further delayed depending upon the availability of funds.

Planned Program for Coming Year

Preparation of necessary contract specifications and work plan for possible construction in 1981 or 1982.

Cost 1980: $190

Title

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

Purpose

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

Scope

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

Progress Past Year

Field measurements of Benkelman beam deflection and rut depth in I 75 were made at the project test sites. The black base sections continue to show more cracking than do the untreated aggregate sections. Observations to date indicate that the cracked surface condition is not due directly to the black base, which in all cases was sound, but to stripping of the leveling and binder courses which were wet. This condition could be caused by water being trapped in the binder course over the relatively impervious black base.

Planned Program for Coming Year

Performance of black base pavement on I 75 will continue to be studied. Material characterization of pavement components will be determined by laboratory test using MTS cyclic loading. A report regarding procedures for designing bituminous concrete, black base, and granular base thickness will be included in the final report which is expected to be completed in the fall of 1981.

Cost 1980: $1,350

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

Project completed. A final report, Research Report R-1147, "Evaluation of 22A Gradation Open Hearth Slag as a Base and Subbase Construction Material," was published in May 1980.

Planned Program for Coming Year

Project completed.

Cost 1980: $1,265

Title

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

Purpose

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

Scope

Originally the project was to be conducted in the laboratories of the Research Laboratory using triaxial tests developed for the equivalency studies under Research Project 68 E-42. During 1975, however, the project was expanded, through a contract with Michigan State University, to develop additional testing methods and procedures for relating soil support values to measured soil properties. The laboratory results will be

correlated with field test site data to check the method developed for calculating soil support values. Tests will include cyclic triaxial, conventional triaxial and CBR, using cohesionless soils, supplemented by tests to determine the behavior of asphalt concrete, base and subbase materials under repeated loading. An in-depth study of existing multilayer elastic solutions and finite element techniques will be made to determine the test best suited for meeting project objectives.

Progress Past Year

The MSU study of clay subgrade material is a bit behind schedule. A paper concerned with one phase of this project, "Prediction of Permanent Strain in Sand Subjected to Cyclic Loading," by R. W. Lenz and Gilbert Baladi, was published by the Transportation Research Board.

Planned Program for Coming Year

The project should be completed and a report prepared.

Cost 1980: $443

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

Use of the field permeameter and evaluation of the permeability test method on M 66 was abandoned when the Construction Division decided not to participate in the work. The project as proposed, therefore, is completed. Any future work desired with these methods will be handled under a Technical Investigation project.

Planned Program for Coming Year

Interest has been expressed in using this field test method, in the Metro District, to determine the drainability characteristics of subbase material sources in order to establish the relative quality and variability of material sources in the District. If approved, a TI project will be initiated.

Cost 1980: $1,099

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 Waiska River Elastizell test site was inspected and sampled but, due to equipment problems, testing of the St. Clair River site could not be completed. Samples collected in previous years had indicated that the Elastizell low density concrete was relatively dry and in good condition. This year's sample survey, however, indicated, for the Waiska site at least, that the fill had become highly water saturated and was in generally poor condition. Further testing is required to determine how widespread throughout the fill this condition is. Several inches of settlement had taken place at the bridge abutment. This had been repaired by an asphalt wedge. No settlement was noticeable at the St. Clair site. The condition of the Waiska River fill was discussed with the producers of the material.

Planned Program for Coming Year

Based on this year's findings, a more thorough investigation of the low density fills is planned. No new fills using Elastizell should be placed until such investigation is completed.

Cost 1980: $1,774

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 was included as part of a black base construction using normal construction procedures so that a performance evaluation could be made under typical traffic and environmental conditions.

Progress Past Year

No change has been noted in the test section during the past year. A memorandum report was prepared completing this project.

Planned Program for Coming Year

Project has been completed.

Cost 1980: $14

Title

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

Purpose

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

Scope

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

Progress Past Year

A summary report of this work was prepared and presented to the Aggregate Acceptance Criteria Committee.

Planned Program for Coming Year

Local aggregates that may be used on the I 69 construction will be tested using the particle index test. The project will be completed with the preparation of a summary report.

Cost 1980: $2,028

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

The studies planned and made under this project have been expanded and incorporated into more high priority projects (78 D-36, 74 E-53, 75 E-60, 79 TI-622). It is recommended this project be discontinued.

Planned Program for Coming Year

Project should be discontinued.

Cost 1980: $51

Title

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

Purpose

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

Scope

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

Progress Past Year

Procedures for evaluating the two type bases were developed. The report on this project is partially completed.

Planned Program for Coming Year

The load carrying capacity (life expectancy) for the pavements will be evaluated, and a final report prepared for the project.

Cost 1980: $5,988

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

Due to higher priority projects, the reporting of this project was not completed. Supplemental information relevant to the project objectives was rewritten with some revisions.

Planned Program for Coming Year

Final reporting for the project should be completed.

Cost 1980: $9,358

Title

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

Purpose

To evaluate the construction and performance of econocrete shoulders on M 14 near the Wayne County line and I 69 near Lansing. The econocrete mix on I 69 will contain a cheaper peastone aggregate. The econocrete mix on M 14 incorporated cement reductions providing compressive strengths of 3,000, 2,500, and 2,000 psi at 28 days age. Construction of the M 14 job was completed in the fall of 1978. Construction on I 69 is scheduled for 1981.

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

Semiannual measurements have been made. Early inspections showed that cracks were beginning to form on the mainline pavement near the shoulder joint locations, and now there is a crack in the pavement opposite nearly every shoulder joint.

Planned Program for Coming Year

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

Cost 1980: $495

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

Bridge deck was resurfaced to cure its increasingly rough condition.

Planned Program for Coming Year

Prepare final report.

Cost 1980: - 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

Final report published July 1980.

Planned Program for Coming Year

Project closed.

Cost 1980: $3,446

Title

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

Purpose

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

Scope

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

Progress Past Year

Surveyed condition of pavement.

Planned Program for Coming Year

Continue observation.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Nearly 1,100 lane miles of pavement were surveyed.

Planned Program for Coming Year

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

Cost 1980: $13,025

Title

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

Purpose

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

Scope

The test pavement consists of approximately a four-mile long portion of I 96. It is composed of four distinct parts: continuously reinforced sections with deformed bar mat, continuously reinforced sections with welded

wire mesh, a standard section with contraction joints spaced at 99 ft, and relief sections at the ends of the continuously reinforced sections.

Progress Past Year

Inspection of the bar mat reinforced sections indicate that no steel fractures have occurred and only small amounts of surface deterioration have developed. The repairs on the mesh reinforced section continue to perform satisfactorily. The expansion joints still provide space for slab 'growth' but the measurements indicate that for repairs spaced over 800 ft apart the provided space will probably be used in another year.

Planned Program for Coming Year

The pavement will be inspected periodically to monitor surface conditions and measurement of expansion joint widths will be taken summer and winter.

Cost 1980: $34

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

A contract for repair of distressed areas was let in September 1980. The repairs on the mesh reinforced eastbound roadway will be undowelled. Those on the westbound lanes will have dowelled joints. A special inspection of a heavily distressed area was made to determine the reasons for the concentration of failures in one area.

Planned Program for Coming Year

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 1980: Cost included in Project 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

Contract repairs were completed north of the Rouge River and about a quarter of a mile on the southbound roadway was overlaid with asphalt to evaluate the performance of an overlay on this type of pavement. A contract for repairs south of the Rouge River was let this fall with the work to be done in 1981. Periodic inspections indicate that surface deteriorations continue to develop and breakups of the slab next to repairs have occurred at a large number of repairs.

Planned Program for Coming Year

Periodic inspections of the pavement will be made to monitor the development of surface problems as well as to detect cracks with fractured steel.

Cost 1980: $1,205

Title

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

Purpose

To evaluate the effects of studded tires on pavement.

Scope

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

Progress Past Year

Answered inquiries regarding law.

Planned Program for Coming Year

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

Cost 1980: $157

Title

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

Purpose

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

Scope

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

Progress Past Year

Winter and summer readings were completed and a condition survey made. Data were tabulated and are on file. Inspection showed standard and full-depth bituminous shoulders deteriorating and sinking, no new problems with concrete shoulders. The longitudinal shoulder-pavement joint in sealcoated sections has been slurry-sealed by the Maintenance Division. Slurry sealing was not effective, deterioration is progressing. Several other bituminous locations will need repair soon. Some results from this project were included in a report to be presented at the International Conference on Concrete Pavement Design, at Indianapolis, next spring.

Planned Program for Coming Year

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

Cost 1980: $508

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 tenth winter. Routine maintenance was performed at the field exposure site. Specimens with uncoated bars still have about four times as much spalling above the rebars as do those with galvanized bars. Field inspections, 'corrosion cell' readings and delamination detector surveys were completed on the five experimental decks that are now eight years old. All data were tabulated and records updated. Quarterly reports on the project were prepared for the FHWA. The first small 'hollow areas' near uncoated bars which were reported during the evaluation two years ago were not evident during the most recent survey. However, two small hollow areas were found over galvanized bars on the Grand River Avenue Bridge. Bridge decks have not yet begun to show significant deterioration.

Planned Program for Coming Year

It is anticipated that the field exposure specimens will be taken apart next summer to observe the condition of galvanized and plain reinforcing bars, if staff can be made available to do the work. Weekly treatment of field exposure specimens will continue through this winter as will yearly inspections of bridge decks. The project has been kept up to date and on schedule.

Cost 1980: $2,459

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

None.

Planned Program for Coming Year

Complete final report if priorities allow.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

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

Cost 1980: $1,459

Title

70 F-114 - Broomed Concrete Pavement Surfaces

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

Continue monitoring experimental surfaces and make specifications and design recommendations as appropriate.

Cost 1980: - 0 -

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. First stages of surface deterioration are beginning to appear in the form of D-cracking. A report covering performance of the dowel bars was prepared.

Planned Program for Coming Year

Next year's work will be very similar to the work outlined above for last year except for the coring. 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 1980: $698

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

There was little change in joint width readings from 1979 to 1980. Joints are tightly closed and faulting has developed, but general condition is still good. The relief space that was added has provided blow-up protection in the area treated, for a total of nine years. Results of this project were included in a general report on concrete pavements.

Planned Program for Coming Year

Since virtually all the provided expansion space has been used, it is anticipated that the project may be terminated.

Cost 1980: $169

Title

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

Purpose

To determine the relative cost of improved shoulder designs.

Scope

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

Progress Past Year

A progress report was prepared for the FHWA. Costs of all scheduled projects have been evaluated. No additional effort was made on this project due to higher priority work. (These projects are still relatively new, analysis should await observable deterioration.)

Planned Program for Coming Year

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

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Periodic surveys of slipformed CRC pavements were made. I 196 is in good condition but additional longitudinal cracking was noted. US 31 continued to give good performance and no further increase in the longitudinal cracking has occurred. On I 94 no more punch-out failures were noted but high steel problems are now beginning to develop. On I 96 near the I 75 interchange surface deterioration was noted in some areas. No problems were noted on the I 696 pavement. Longitudinal cracking on the 13 mile middle portion of I 275 increased at a slower rate than in the previous year, as did punch-out failures. Underdrains were installed along the pavement-shoulder joint on the most severely cracked sections.

Planned Program for Coming Year

Condition surveys will be conducted on a periodic basis. Crack sealing of wide longitudinal cracks is planned and bituminous repair of punch-out failures will be continued as long as the punch-outs remain relatively small in size.

Cost 1980: $2,638

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 were prepared for the FHWA. Evaluation of laboratory specimens has been continued. 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 seventh 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 1980: $2,746

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

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

Planned Program for Coming Year

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

Cost 1980: - 0 -

Title

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

Purpose

To compare performance of several types of pavement systems.

Scope

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

Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made. Black base sections with no drainage show increasing signs of aggregate discoloration along the centerline and at joint intersections, and some spalling at joint intersections. Cores from the joints in the black base sections showed concrete deterioration of the joint faces and the bottoms of the slabs to be proceeding rapidly. This is providing material

which is being pumped under the leaving edges of the slabs and causing faulting which is now 3/4-in. at some locations. Sections on open-graded drainage course are performing very well as are the sections on gravel base. Commercial traffic is light. A report was prepared covering the relationship of aggregate durability and drainage, to performance of the slab. Results of the performance of the dowel bars also were included in a report.

Planned Program for Coming Year

Continue all experimental measurements and evaluations. This project will continue for many years.

Cost 1980: $8,169

Title

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

Purpose

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

Scope

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

Progress Past Year

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

It was obvious from earlier results that there were significant differences in the performance of the various construction contracts included within the limits of evaluation. During the year, all project data have been separated by construction contract, better to reflect this variation.

In general, the pressure relief joints have closed to near their capacity. Much of the expansion and contraction is occurring at open cracks, with some joints frozen. Pressure relief joints where filler was lost are inoperative as far as pressure relief is concerned. The two best and two worst construction projects within the survey limits were evaluated. It appears that deterioration is progressing at a faster rate, and that D-cracking aggregates may be involved in the deterioration.

After five years of service since preventive maintenance was done, some of the sections are badly in need of repair. However, no emergency repairs have been required.

Planned Program for Coming Year

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

Cost 1980: $10,808

Title

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

Purpose

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

Scope

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

Progress Past Year

Twenty single-track crossings were reconstructed using experimental surface materials during 1980: five Cobra, three Track-Span, one Gen-Trac, three Steel Plank, two Saf and Dri, and six Parkco. The total number of crossings included in this study is now 94. Observation of the installation procedures was made when possible. Yearly inspections were made and a fourth progress report (R-1145) was issued.

Planned Program for Coming Year

Observation of the reconstruction of crossings will be made as time permits. Surveys of completed crossings will continue to check their performance. A progress report is planned.

Cost 1980: $7,645

Title

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

Purpose

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

Scope

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

Progress Past Year

All fracture toughness testing was completed on the electroslag and submerged-arc weldments, completing the experimental work for the HP&R portion of the project. The final HP&R report is being prepared. Data reduction has been completed and work is in progress on the crack propagation phase of the study. It has been found that electroslag welds are inherently more susceptible to fatigue and brittle fracture than submerged arc welds. Fundamental problems also make the electroslag welds extremely difficult to deal with in non-destructive evaluation.

Planned Program for Coming Year

The fatigue crack propagation studies will be continued during the coming year, along with chemical analysis work and some additional fracture toughness work as well. Field investigations of existing bridges with electroslag weldments will continue as staff and funds permits. The HP&R

final report will be issued, and the remainder of the work will be carried on as a regular Michigan research project.

Cost 1980: $9,953

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 900 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 1980: $37,474

Title

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

Purpose

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

Scope

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

Progress Past Year

Scheduled faulting and joint movement measurements were completed and surveys were performed. Poured joint seals have come loose in places, unsealed joints continue to fill and 'grow.' Many neoprene seals have been lost from expansion joints. Some faulting is developing, but no trends in performance of the patches are evident that are related to project variables.

Planned Program for Coming Year

Continue to take readings, compile data, and perform condition surveys. Analyze data with respect to several variables and determine if any one kind of repair performs better than the rest.

Cost 1980: $1,290

Title

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

Purpose

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

Scope

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

Progress Past Year

Dynamic evaluations have been completed on a total of 30 galvanized, plain or "galvanized-and-then-stripped" specimens.

In all cases the fatigue life of the plain or stripped specimen has been at least twice as long as that of the corresponding galvanized specimens, with a 95 percent confidence level in the resulting data. Therefore, it appears evident that the galvanized coating increases fatigue cracking.

Planned Program for Coming Year

Perform additional evaluations to determine stress levels at which a reasonable fatigue life can be expected in the galvanized specimens. Issue a report of findings.

Cost 1980: $1,423

Title

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

Purpose

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

Scope

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

Progress Past Year

The bridges were organized in priority order, with the only nonredundant pedestrian bridge first, and the remaining redundant structures in order based on their frequency of loading by commercial traffic.

Non-destructive evaluation of the one non-redundant structure was completed during the year. This was obviously the most critical structure to be checked. No major defects were found.

Planned Program for Coming Year

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

Cost 1980: $1,117

Title

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

Purpose

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

Scope

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

Progress Past Year

Samples for three different joint types have been readied for testing. Drill equipment and test fixture have been built.

Planned Program for Coming Year

Joint samples will be tested and a field trial installation may possibly be completed, and initial evaluation begun.

Cost 1980: $3,605

Title

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

Purpose

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

Scope

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

Progress Past Year

Nearly 18,000 pavement friction tests were conducted throughout the State.

Planned Program for Coming Year

Continue established pavement friction test program.

Cost 1980: $72,114 (includes Project 54 G-74(5).

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

Final report to be drafted.

Cost 1980: $487

Title

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

Purpose

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

Scope

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

Progress Past Year

Aqua-Sans inspected and progress report published March 1980.

Planned Program for Coming Year

Continue Aqua-Sans inspections required for project evaluation.

Cost 1980: $3,573

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 of the spall repairs indicate that about 10 percent show performance problems ranging from total failure to internal cracking. Replaced neoprene expansion seals continue to perform satisfactorily but the PVC hot-poured seals have failed in adhesion.

Planned Program for Coming Year

The experimental repairs will continue to be evaluated and consideration will be given to conduct repairs of failed as well as new spalls that have developed since the previous repairs were completed.

Cost 1980: $2,824

Title

77 G-225 - Rubberized Asphalt Stress Relieving Membrane

Purpose

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

Scope

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

Progress Past Year

Construction was completed on M 55 project near Cadillac.

Planned Program for Coming Year

Conduct first annual condition survey and prepare initial report.

Cost 1980: $3,412

Title

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

Purpose

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

Scope

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

Progress Past Year

There was no progress due to higher priority work.

Planned Program for Coming Year

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

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

The monitor system used to monitor energy flow has been in operation for over one year. Data collected have been compiled using histograms. Data collected include: energy from solar cells, energy stored, energy shunted to ground (batteries fully charged), energy consumed, battery temperature, and ambient temperature.

Planned Program for Coming Year

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

Cost 1980: $1,372

Title

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

Purpose

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

Scope

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

Progress Past Year

Projects were initiated on US 2 near Manistique and M 93 near Grayling.

Planned Program for Coming Year

Complete construction and prepare initial report.

Cost 1980: $2,926

Title

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

Purpose

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

Scope

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

Progress Past Year

The Department has terminated the use of unpainted steel.

An interim report has been published outlining the findings, background, information, and photos from selected bridges, along with the reasoning behind the Department's decision.

Another report, related specifically to guardrail has been prepared as well, and work has continued on coatings for rusty steel.

Corrosion loss data have been gathered from more than 50 bridges. They indicate the following, in general:

1) There is a distinct difference in the rate of attack on urban vs. rural structures.

2) The major problem is direct attack and crevice corrosion due to leakage of saltwater through the joints onto the beams; with lesser effects due to spray from traffic below, accumulation of debris on the beams, capillarity of the rust coating, and lack of washing and drying cycles.

3) In areas directly wetted by salt solution, the rate of attack is several-fold greater than on the structure in general, and in crevices subject to drainage the rate can be several-fold greater still.

New link plates, pins and bearings were fabricated for replacement of the parts on 11 different locations on the bridge at 8 Mile Rd and I 75. Maintenance forces jacked up the bridge and removed the old pins and plates. The beams behind the plates were blasted and painted, and the new pins, plates, and bearings were installed. The old plates were brought back to the Laboratory, where they will be used in fatigue life and coating experiments. Sample preparation is in progress.

Planned Program for Coming Year

Additional observations and measurements will be made on painted structures for comparison with the unpainted ones. Experiments with cleaning and coating techniques for salt contaminated steel will continue along with evaluations of the experimental systems previously applied.

The plates removed from the bridge in Detroit will be made into specimens and experimental work on fatigue life will be done.

Cost 1980: $24,014

Title

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

Purpose

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

Scope

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

Progress Past Year

Field sites were selected, a procedure for making noise measurements was established, and a data storage and retrieval program was written. Half of the field measurements have been made.

Planned Program for Coming Year

Complete field measurements and data analysis. The parameters obtained will be used in the FHWA computer model and subsequently validated.

Cost 1980: - 0 -

Title

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

Purpose

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

Scope

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

Progress Past Year

Because of changes in contract letting schedules, the planned contract was not let in 1980. Therefore, a resurvey of the pavement conditions was made. Substantial increase in the number of joints with spalls was noted

as well as large increases in the number of cracks with fractured steel. The survey results will be transmitted to the Design Division for incorporating in the proposed contract.

Planned Program for Coming Year

A contract is planned for letting in April 1981. Research personnel will be on the project to assist in the construction process and to record any problems that might develop. An evaluation of the repair's performance will be initiated.

Cost 1980: $1,617

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

Due to financial conditions the systems have not been installed.

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 1980: - 0 -