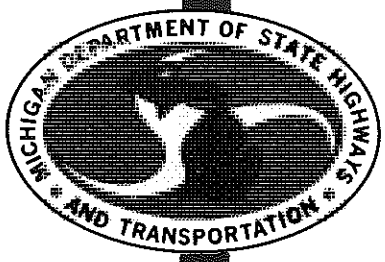
ANNUAL REPORT OF ACTIVITIES OF THE MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION RESEARCH LABORATORY



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

ANNUAL REPORT OF ACTIVITIES OF THE MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION RESEARCH LABORATORY

Research Laboratory Section
Testing and Research Division
Research Report No. R-1082

Michigan State Highway Commission
Peter B. Fletcher, Chairman; Carl V. Pellonpaa,
Vice-Chairman; Hannes Meyers, Jr., Weston E. Vivian
John P. Woodford, Director
Lansing, February 1978

CONTENTS

INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1977 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 Departmental practice.

The Research Laboratory, formerly housed in the Motor Wheel property on Saginaw St in Lansing, and the Testing Laboratory, formerly located on the University of Michigan campus in Ann Arbor, have moved into a combined facility in the State Secondary Governmental Complex southwest of Lansing. The space and flexibility offered by the new building will allow us to further explore many research areas. It should be noted, however, that the dismantling of equipment in the old Research Laboratory building began in the late summer, and that due to the moving to the new location, many projects were inevitably interrupted or their completion prolonged. Thus, the reader will find frequent reference throughout this report to circumstances brought about due to moving.

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 1977. 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 final section lists the title, purpose, scope, progress past year, and projected activities for the coming year, for all active Departmental and Highway Planning and Research projects (H. P. & R. projects are denoted by an asterisk).

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

The air quality monitoring van collected data at several locations around the State to provide information for environmental impact statements. Construction of a second air quality monitoring unit was largely completed, and analyzers and recorders have been obtained for this unit. Also in the environmental quality area, the Laboratory worked on development of a transportation control plan required by the Federal Environmental Protection Agency to control photochemical oxidants through control of hydrocarbon emissions from vehicles. Vehicle exhaust emission factors were prepared for the Michigan Energy Administration for use in energy conservation planning. The Research Laboratory supplied information to the Department of Management and Budget on air quality along the access road to a new prison in southwest Michigan, and a study was conducted for UPTRAN on leakage of carbon monoxide into new buses through openings around a wheelchair lift mechanism.

Post-construction performance of both latex modified concrete and low slump, high density concrete thin-bonded bridge deck overlays were evaluated by visual inspections, delamination surveys, corrosion cell tests, and selected coring for chloride penetration. The decks sampled included latex overlays as old as 1969 and low slump projects of 1975. Processing of the cores and data was to be completed this coming year along with some additional testing and sampling early in the year in order to further evaluate these restorative procedures.

Eight test series were completed on the laboratory wear track prior to dismantling and moving to the new laboratory quarters. Each of the test series involves exposing 16 test panels with different coarse aggregate sources to four-million wheel passes to evaluate the relative wear or polishability of stone sources used in bituminous mixes. By this controlled wear testing, it is planned to be able to preselect particular aggregate sources to produce and maintain pavement surfaces in different traffic areas with optimum frictional properties. An improved and expanded wear track has been constructed in the new Testing and Research building.

Reconstruction of 22 miles of I 75 in Cheboygan and Otsego Counties was completed in which the age-hardened asphaltic concrete surface was recycled, in place, to form a stabilized base which was overlayed with a new bituminous surface course. This was the Department's first major pavement recycling project, and its savings in dollars and in the conservation of an important natural resource hold great promise for the future. A forthcoming report will detail the Laboratory's role in the project.

Experimental sulfur/asphalt test sections were constructed on M 18 in Gladwin County to determine the feasibility and value of replacing asphalt with sulfur (up to a 1:1 ratio by weight) in an effort to reduce amounts of

asphalt required, and to obtain viscosity-temperature characteristics of the resulting leveling and wearing courses. The construction phase of the project proved to be successful, and the pavement will be monitored in the future as to its performance characteristics.

Normal Departmental procedure is to inspect construction aggregates at the producer's facilities. Since it undergoes a remixing during transport and application, a sampling, testing, and acceptance procedure for in-place aggregate inspection was developed and tried on a construction project. Data from this project will be expanded by the inclusion of another project this coming year, and then will be analyzed to see whether improved inspection results are forthcoming from in-place inspection techniques.

A unique preventive maintenance project was completed on approximately 20 miles of I 96 in Eaton and Ingham Counties. A 3-1/2 in. cross-section of pavement was removed at regular intervals and a specially designed polyurethane filler was inserted. This provides expansion space for the concrete pavement and prevents the 'blow-ups' so familiar to motorists during periods of hot summer weather. The initial observations are most encouraging, and the pavement will continue to be monitored for further confirmation of its effectiveness.

An on-board data processor for the Department's Rapid Travel Profilometer, an instrument used for measuring pavement riding quality, was completed. This electronic package allows pavement profile data obtained by the profilometer to be instantly converted to a measure of pavement roughness, termed 'Riding Quality Index.' Previously, the pavement profile data were returned to the laboratory on magnetic tape for processing; a very time consuming task.

In cooperation with the Design and Maintenance Divisions, we monitored a trial installation of a recirculating sewage system (which does not discharge effluent into the ground) at an experimental site at a rest area on southbound I 275 in Monroe County. The proprietary system is presently being used, sampled, and inspected to assess its performance. Cost of operation and the amount of maintenance involved are included in the evaluations. We also monitored a research project assigned to Michigan State University to determine the effectiveness of sewage treatment systems for freeway rest areas. Sewage treatment effectiveness of five experimental rest area sites were evaluated. Three of these did not meet discharge standards, and corrective procedures and upgrading of these systems were recommended.

A progress report was issued for nationwide distribution covering the six-year performance of concrete specimens containing experimental galvanized reinforcing bars. Although the use of galvanized reinforcing steel for concrete bridge decks has become controversial during the past few years, and has been discontinued by the Federal Highway Administration,

the Michigan data showed improved performance of galvanized bars in comparison with uncoated bars. Five experimental bridge decks in Detroit have galvanizing on one-half of the top mat of steel reinforcement, and these are being closely monitored for further information.

Scores of specimens have been prepared from tons of welded steel for a second three-year research project on problems in welded steel. This project is concerned with bridge girder butt welds and their resistance to brittle fracture, fatigue, and corrosion. Comprehensive fracture mechanics evaluations of the various welds, heat-affected zones, and base metals are now under way. Corrosion specimens have been set-up in the field for study.

Three experimental railroad crossings were installed last year and 19 are scheduled for reconstruction this coming year. Two new proprietary materials, both utilizing steel plates enclosed in rubber, have been added to the list of five experimental materials used so far in the reconstruction of crossings. A new standard plan concerning crossings was issued. Also, improvements are beginning to emerge in the area of drainage at the crossings; one crossing, for example, has been installed with drainage pipes and filter cloth. Improvements are still being sought to obtain properly dimensioned ties and to increase the quality of the joints between the crossing and the roadway.

In the area of highway generated noise, the Department-sponsored vehicle noise control bill was passed and signed into law. Noise analysis studies continued on 15 pre-1977 projects, and 19 new projects were initiated during 1977. Construction began on a 25,000-ft noise barrier project along I 275 in Canton Township, and two other noise wall projects (I 75 in Lincoln Park, and I 275 between M 153 and I 94) are in the design stage. Noise barrier guidelines for previously constructed freeways were updated and approved by the Federal Highway Administration. The presently used noise level prediction computer program underwent a validation study for low volume, low speed traffic operating on service drives along I 696. Extensive noise level analysis and subsequent noise abatement methods have been proposed for I 696.

In response to Departmental data showing excessive glare being emitted by high pressure sodium luminaires, a new reflector design was developed by the industry. The new design will lower the glare experienced by drivers while maintaining adequate roadway illumination. Design and construction were completed on a system to rapidly acquire data for evaluation of streetlight luminaires. The instrument samples the luminance intensity at selected vertical and horizontal angles. The required 4,000 data points are automatically stored on digital magnetic tape for subsequent analysis on the Department's B7700 computer.

A study was initiated to monitor the surface and groundwater at the new Maintenance garage in Reed City to evaluate storage and handling of deicing salt. Test wells in the area were drilled and a sampling regimen was begun to measure chloride content of both surface and groundwater. This was to evaluate, over a long term, the effect of certain design features for salt storage and handling at a new site on the hydrology of the area. A related study was continued through the year to sample both surface water and groundwater through test wells at four trunkline locations in the State. This study was also to monitor the effect of deicing salt usage on the groundwater adjacent to the roadway.

An instrumented van with four vehicle-mounted photocells capable of making photometric measurements in the field was constructed. The van has measured roadway illumination on two tracks in one lane simultaneously while traveling at over 45 miles per hour. Data are collected using a microprocessor and stored on digital magnetic tape for subsequent analysis on the Department's B7700 computer. Previously, technicians made time consuming stationary measurements while traffic control was maintained.

The field phases of two experimental bridge projects were essentially completed. Sampling of fresh concrete using type 1P cement, containing intergrooved fly ash, was completed on deck pours of a new structure on M 14 near Plymouth. Substructure pours were also sampled, as well as from a twin structure using normal type 1A cement. Although type 1P cement is allowed for concrete pavement, this is the first experimental use in structures. The early strength gain of type 1P cement is somewhat slower than type 1A but it has superior qualities for vibration and consolidation, which should benefit the structures.

During the second year of work on the development of preventive maintenance procedures for neoprene sealed pavements, the joints on nine miles of two-lane pavement were repaired. On the basis of the previous year's experience, only one type of mortar was used. Failed seals in 68 joints were repaired with neoprene seals or resealed with hot-poured PVC sealant. The performance of the joints in the repaired section has been very satisfactory. The few failures experienced appear, in part, to be related to the materials used and the procedures employed in the repair.

An experimental contract for epoxy injection of hollow delamination areas in the deck surface of four structures in the Lansing area was finished. Two of the decks were done in 1976; the balance plus some new areas injected in the 1976 decks, were completed in 1977. This study was to evaluate this special injection repair technique on decks which have not developed extensive open spalls to see whether the necessity for major repairs can be economically deferred.

An intersection accident model based on surface skid resistance and weather was completed. This model can be used to evaluate existing bene-

fits, and predict future ones, of intersection upgrading through surface treatment. The findings from this project were presented at the Second International Skid Prevention Conference, held in Columbus, Ohio.

A 330-ft pavement section of asphalt overlay, reinforced with a proprietary thermoplastic fabric, was completed on southbound I 75, about 10 miles north of Gaylord in Otsego County. The objective of this project is to evaluate the relative performance of the fabric as overlay reinforcement to control reflection cracking in bituminous resurfacings.

The roadside-free collision program problem was reviewed, in connection with injunctions against the Counties to prevent their removing live roadside trees. Material was developed relating to safety benefits derived from a cutting program. We participated in the selection of an environmental and safety consultant to develop Michigan's roadside cutting program.

A probability model for predicting accident frequency was developed. This model can be used to design control charts for identifying high-accident roadway segments and to estimate accident reduction for various safety improvement programs.

A new 'skidometer' trailer was constructed by Laboratory personnel. This improved unit is used for measuring the skid resistance of pavement surfaces throughout the State. It replaces a 23-year old unit that pioneered skid resistance measurements in this State and in the nation. The new unit was built for about $30,000 less than the cost of a comparable commercially constructed device.

As part of a Federally funded Highway Planning and Research project, detailed field inspections were made on four different paint systems applied in late 1976 to the steel beams of a four-span structure on I 94 near Jackson. This study is a long-term evaluation of our standard four-coat system versus some newer one and two-coat paint systems which would have a cost savings advantage in their application.

Field inspections and special 6-in. coring through selected pavement joints from 17 concrete paving projects was completed. This is a Highway Planning and Research study to evaluate the effectiveness of preformed neoprene compression seals in preventing concrete pavement joint deterioration. Field data were gathered on the seals, concrete condition at the joint, and data on the base material, such as permeability and chloride content were also collected.

A project was initiated to determine the quasi-elastic modulus for asphalt concrete mixtures currently used in Michigan to be used as a relative measurement of the stiffness of asphalt concrete surface layers. The values obtained can be used in elastic layer analysis programs.

Evaluation of nuclear gages for measuring the asphalt content of bituminous aggregate mixtures was completed. From this study it was recommended that only a gage specifically designed for measuring asphalt content was suited for such purposes and that individual calibration curves are required for each basic aggregate type used. Conventional nuclear moisture-density soil gages proved unsuitable for measurement of asphalt content.

INDEX TO RESEARCH REPORT ABSTRACTS AND ACTIVE RESEARCH PROJECTS

ABSTRACTS AND IMPLEMENTATION OF RESEARCH REPORTS
(January 1977 Through December 1977)

R-1038* - "Determination and Improvement of Relevant Pavement Skid Coefficients," (69 G-173). F. Copple and P. T. Luce.

Using Michigan's two trailer testing units, a correlation study was conducted between the two testers and the repeatability (variance) within each unit was also determined. Specific findings included: stopping distances on wet highways for a vehicle with smooth tires average 50 percent greater and may be over 150 percent greater than a vehicle with treaded tires; friction tests made with smooth tires provide a valuable tool for evaluating pavement textures; friction values for a given test speed may be reliably estimated from values measured at lower speeds; seasonal variations in friction are significant; in evaluating a wet skid area, consideration should be given to the fact that pavement friction can cause stopping distances to vary by a factor of 2.5 and changing speeds from 20 to 70 mph varied stopping distances by a factor of 25; even though our two units yield different friction values for any surface, correlation between the two units is so good that very small error is involved in transforming test values to a common standard; repeatability of the testing units is very good; and, in correcting temperature effects on tire/pavement friction, factors used for coarse textured surfaces must be different than for smooth textured surfaces.

Results of this report were used in the following ways:

1) The correlation between the two friction measuring units was used to transpose data to a common base for reporting;

2) The data on smooth tire stopping distance was provided to the legislature in support for a bill under consideration banning tires with less than 1/16 in. of tread;

3) Used results of smooth tire tests for determining effectiveness of pavement textures in preventing hydroplaning; and,

4) Used method developed in report for estimating high-speed friction values from low-speed tests for providing data on high accident areas.

R-1039 - "Concrete Arch Rib Condition Survey, M 99 (Logan St) over the GTW RR and the Grand River, City of Lansing (X01 of 33011)," (76 TI-359). H. L. Patterson

The Laboratory was requested to undertake a study to determine whether the existing arch ribs in the three south spans could be incorporated into the reconstruction plans for the bridge. Swiss Hammer readings and ex-

ploratory core drilling were performed. The Swiss Hammer readings turned out to be of negligible value; however, from the tests on the cores, and observations concerning the structure's condition, the investigation indicated that these parts of the existing structure could be utilized after some repairs are made. Repair recommendations are included as part of the report. Should repairs not be economically feasible, it is felt that the bases of the piers and abutments could be used in any case.

Implementation of this report has been made in that the Design Division has decided to retain the substructure piers and abutments and erect a new bridge on the old foundation which was one alternate suggested in the report.

R-1040 - "Statistical Analysis of Aggregate Base Course Inspection Using an End Result Aggregate Specification," (76 G-222). Wen-Hou Kuo.

Michigan's current aggregate inspection practice is to take the samples from the production site. Since stockpiled aggregate will undergo a remixing when transported to the job site, and a further one as it is spread on the grade, the Department formed the 'End Result Aggregate Committee' to investigate the feasibility of inspecting aggregate at the job site. This report outlines the design of sampling, testing, and acceptance procedures for two specific construction projects based on the in-place aggregate acceptance sampling plan recommended by the committee. Sampling lay-outs are presented for these two projects in the form of a computer printout appended to the report. This is a preliminary report; the final report will appear at the completion of the project.

The sampling, testing, and acceptance procedures outlined in this report were used for one of two construction contracts originally planned while the second construction project was cancelled. However, as a result of using these procedures which went very satisfactorily on the one project it was decided it would be used on two more construction projects in the coming construction season and if it works satisfactorily on them it will be implemented statewide.

R-1041 - "Drainage and Foundation Studies for an Experimental Short Slab Pavement," (73 F-136). T. M. Green and E. C. Novak, Jr.

This report describes one phase of an overall study to evaluate the performance of several different short slab pavement designs as constructed on three different types of base support: asphalt-treated porous material (ATPM) base; high asphalt content and high penetration bituminous stabilized base (designed for crack resistance); and standard specification aggregate base. It is these base supports that are treated in this report, concerning their construction and some initial observations about them. Special sub-

base drains of 6-in. perforated pipe, wrapped in filter cloth, were installed in areas where subbase drainage capacity was low. The ATPM base is a highly permeable material designed to keep the area under the slabs dry, which should help prevent faulting. The entire length of ATPM sections were drained with longitudinal 6-in. pipe, and transverse drains placed at the ends of each ATPM section. Observations so far indicate that all subgrades and subbases are generally well drained. No serious construction problems were encountered with any of the materials. Further reports will be issued on this project as time passes.

Implementation has not taken place since this is a progress report and observations on the performance of the various bases and drainage sections are required prior to making any decisions on using these designs in other projects.

R-1042 - "Annual Report of Activities of the MDSHT Research Laboratory Section."

R-1043 - "Edge Marking Criteria from Contrast Ratios," (68 G-165). G. M. Smith.

Initially, this study was to develop criteria, based on pavement/shoulder contrast, for edge striping priorities. Soon after the study began, funds became available to stripe the edges of all state trunkline pavements and the purpose of the study was directed towards developing maintenance restriping criteria. It was found that old paint stripes may offer no more contrast than the traffic lane and shoulder materials themselves and it was recommended that concrete pavements be restriped with the priorities ranked as: first, bituminous shoulder four or more years old; then newer bituminous shoulders; then gravel shouldered pavement, and, last, seal coat shoulders.

The original objective of this study was thwarted when money was made available to paint all state trunkline pavements with edge marking and therefore results were not implemented.

R-1044 - "Construction of a Cold-Mix Emulsion Black Base," (75 E-55). G. F. Sweeney.

This Category 2 project, conducted in cooperation with the Federal Highway Administration, involved construction of a roadway using an aggregate, cold-mix emulsion as a base course for the relocation of a portion of Canal Rd at the State Governmental Secondary Complex. The mixing and handling of the 20A aggregate/MS-2S asphalt emulsion were carried on with no problems at a nearby asphalt plant and stockpiled until construction started some two months later. The major problem encountered with the asphalt emulsion base was one of excess moisture and an inability to remove that moisture effectively during placement and compaction. Even

with careful moisture control, the addition of portland cement to the base material, and proper aeration, soft areas were still a problem. The unpredictability, with respect to moisture control, found during this job makes this material highly questionable for use in general highway construction. The cracked (soft) areas in the project were replaced with hot mix bituminous material before application of the leveling and wearing courses.

This was a progress report and observations on performance will have to be made prior to any implementation. However, as a result of this report and the difficulty of obtaining satisfactory moisture control during construction, the use of a cold-mix emulsion is deemed less desirable than asphalt cement for such black bases.

R-1045 - "Effectiveness of the Experimental Wooden Noise Wall, Interstate Highway I 75, City of Allen Park, Michigan," (71 TI-36). G. H. Grove.

In 1974, the Department constructed a 2,735-ft wooden noise barrier wall along a segment of I 75 which was causing a serious traffic noise problem to the adjacent high density, single family dwellings. After completion of the wall, the Department decided to determine the general response of the residents to the wall, and a questionnaire was designed and hand delivered to 240 homes behind the barrier. Noise measurements were also taken, and showed that the barrier reduced the L_{10} dbA noise levels at the nearest residential property lines to less than the Federal Noise Standard. Moreover, the design methods for determining barrier height and length for a given attenuation level appear satisfactory on a purely objective noise level basis. The results of the questionnaire, however, indicate a need for improved esthetic design and landscaping of noise walls, and enactment and enforcement of vehicle noise control laws.

This study and report demonstrated the reaction of individuals to a noise abatement wall where previously only speculation was available. The homeowners who benefited most by the noise abatement wall were also the ones most highly in favor of the wall. It also demonstrated that the Department should continue building noise abatement walls but that esthetic considerations were important to favorable acceptance of the wall. The report also indicated a need for vehicle noise control which it appears will pass in the legislature in the next few weeks.

R-1046 - "Comparison Study on the Performance of Bituminous Stabilized Bases (M 66 and M 20)," (75 E-59). F. T. Hsia.

This report discusses the results of a comparative pavement performance study, based on Benkelman beam readings, of a bituminous concrete pavement constructed on an 11-in. aggregate base course (M 20), and a bituminous concrete pavement built upon a 4.5-in. bituminous stabilized

base course ('black base') on M 66. In addition to Benkelman beam deflection comparisons, the two cross-sections were also compared on the basis of allowable springtime loads which were derived directly from Benkelman beam readings. The results reported, indicated that Benkelman beam measurements can be considered usable for determining the relative performance of the two test pavements. Both black base and aggregate base sections have deflection values within allowable limits, and black base sections were superior to the comparable aggregate base sections from the standpoint of reduced deflection and higher allowable springtime axle load capacities (though the differences are considered minor).

This was a progress report on the first year of observations, the study is continuing and we do not expect any implementation results until further observations and evaluations are made.

R-1047 - "Brightness Study and Specification Compliance Survey of Arrow-Bar Traffic Control Signs," (76 TI-361 and 76 TI-373). J. D. Truax and M. E. Scarlata.

This study was initiated to ascertain whether our flashing arrow-bar signs were too bright at night for truck drivers, whose cabs are more directly in line with the signs than are automobiles. Photometric measurements showed that properly aligned and properly functioning arrow-bar flashers should not cause undue discomfort. However, in the course of the investigation—and an inventory of State-owned arrow-bar flashers, also included in the report—it was noted that the units are frequently out of specification limits in various ways. Recommendations are included for upgrading our arrow-bar inspection practices and repair procedures.

This report was implemented by the Engineering Operations Committee appointing a special committee to develop procedures for testing these signs so that the non-specification items noted in these signs would not occur in the future. This committee has met and testing procedures are nearly complete for obtaining improved signs.

R-1048 - "Evaluation of Cold-Mix Emulsion Black Base (M 150 and Auburn Rd, Oakland County)," (72 D-27). J. H. DeFoe.

This Category 2 project, conducted in cooperation with the Federal Highway Administration, was conducted to determine the handling, construction, and performance characteristics of a cold-mix black base, prepared with emulsified asphalt, as compared with conventional black base construction. Construction operations involved mixture preparation and stockpiling, placement, compaction, and surfacing. The experimental cold-mix consisted of 20A aggregate, blended with 6 percent MS-2S emulsified asphalt. The most significant problem in using emulsion cold-mix was found to be its inconsistent stability due to moisture in the mixture.

Further observations based upon this project are: the emulsion mixture is not as uniform and the aggregate not as well coated as is expected with hot-mix materials; curing is required prior to surfacing under conditions conducive to drying, in order to develop adequate strength in the mixture to support paving equipment; when properly conditioned, compacted, and cured, emulsion cold-mix can result in stable highway bases; and, failures due to wet unstable cold-mix base material become apparent during or immediately after the surface paving operations. Recommendations are included concerning further use of emulsion cold-mixes.

This was a similar study to the one reported in Report R-1044 and both construction projects showed inconsistent stability due to moisture in the mix and thus reinforces the Department's decision to go slow on the use of emulsions because of moisture problems during construction.

R-1049 - "Summaries of Michigan Pavement Skid Resistance: 1975 Test Program," (54 G-74). P. M. Schafer and P. T. Luce.

This year's annual survey reports the results of 11,300 skid tests conducted throughout the State with the Department's skid test vehicle. Conventional portland cement concrete and conventional asphaltic concrete pavements were given an initial testing in order to determine their degrees of slipperiness (coefficients of wet sliding friction). Friction levels were determined for both types of pavement project after 5 and 10 years of service and reported herein. Additionally, skid tests are performed and reported upon for certain experimental resurfacing projects to monitor their effectiveness. Also included in the report are the results of skid tests at high accident locations, determined by the Traffic and Safety Division, to provide data as to whether slipperiness might be a factor. A section is included of skid data compiled at locations throughout the State by special request of other Divisions for their information. A final section of the report is devoted to special attention locations; those sites discovered during routine skid testing, that are found to be below a certain friction level. Although all skid test results are included in this report for the year 1975, the 'high accident,' 'special request,' and 'special attention' locations are immediately reported out after testing via letter to the concerned parties.

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

R-1050 - "Lincore Ni2 Low Alloy Submerged Arc Welding Wire," (76 NM-502). J. D. Culp.

This New Materials project was concerned with an evaluation of a new low alloy tubular electrode to be used in the automatic submerged arc weld-

ing of ASTM A 588 steel for unpainted exposures (a new flux was submitted simultaneously to be used with the electrode and was included in the evaluation). A series of mechanical and chemical tests were run on the electrode/flux combination's weldments. It was found that the electrode/flux combination appears to be quite well suited to the butt welding of A 588 steel plates. However, because of the higher nickle content of the weldment, galvanic action may well accelerate corrosion, thus it is recommended that we allow the use of the material in order to take advantage of its superior physical properties, but recommend that the weld areas be painted to provide the needed protection.

As a result of the recommendations in this study this wire was qualified for use in the welding of ASTM A 588 bridge steel.

R-1051 - "Mixed-In-Place Stabilization of Highway Base Aggregates and Pulverized Bituminous Surfacing Using Asphalt Stabilizers: Final Report," (72 F-125). J. H. DeFoe.

The eight projects covered in this report were intended to apply earlier laboratory findings concerning the reclamation of on-site materials to field application. They involved the pulverization of existing bituminous surfacing then blending it with existing base aggregate to a depth of 5 in. The blended mixture was then stabilized with the addition of asphalt material, aerated to proper moisture content, shaped, compacted, and subsequently paved with a bituminous wearing course. Among the findings of the project were: base aggregates containing significant portions of pulverized bituminous surfacing can be stabilized with asphalt cements using mixed-in-place methods; on the basis of strength and stability tests, mixed-in-place stabilization can best be accomplished with asphalt cements rather than with liquid asphalts; the aggregate material should be adequately dried prior to adding the asphalt, and the stabilized mixture must also be sufficiently dry when compacted in order to achieve a stable base for surfacing; and, problems with excess moisture and resultant unstable areas often developed in bases stabilized with emulsions. It was recommended that mixed-in-place stabilization should be adopted as a regular procedure and recommended specifications for the use of mixed-in-place stabilization are included as an Appendix to the report.

Based on the experience gained from these projects mixed-in-place stabilization has become a common practice in shoulder treatment, where aggregates are satisfactory, and also based on this experience it was possible to program specifications for the mixing-in-place of the pavement stabilization in the recycling of I 75 north of Indian River.

R-1052 - "Application for Federal Financial Participation in Traffic Noise Barrier Construction Along Selected Segments of I 275 in Southeastern Michigan," (76 TI-366).

The purpose of this report is to describe and justify a traffic noise abatement project for which Federal financial participation is requested; specifically, a 5,400-ft noise barrier along the west side of I 275 between M 153 and I 94. The subject area, located along the western edge of the metropolitan Detroit area, is of a high population density and is subjected to noise levels well above the Federal standard. Due to the fact that the roadway predated the Federal noise regulations, the Department is not legally required to construct such a barrier; however, it is felt that the situation existing there warrants such a structure if Federal participation can be obtained. There are procedures for applying for Federal participation in noise abatement projects involving roadways built prior to the regulations now in effect, and this report is intended to satisfy these procedures.

R-1053 - "Experimental Lightweight Fill," (75 E-54). E. C. Novak, Jr.

This Category 2 project, conducted in cooperation with the Federal Highway Administration, concerns the utilization of an experimental lightweight fill material, called 'Elastizell Concrete,' in the construction of a bridge approach. Elastizell is a low density (cellular) concrete and this report discusses its density, strength, and construction characteristics when used as a fill material. Based upon its use on this project, Elastizell was found to be easily mixed and placed; however, some of its material property characteristics (such as low compressive strength, non-homogeneity, water sorption characteristics, and equilibrium wet density) prevent its unqualified recommendation, and further studies are being undertaken to provide us with further information concerning this product.

This was the first experience with the use of 'Elastizell Concrete' as an experimental lightweight fill material behind a concrete abutment. With this good experience it was decided by the Department to construct a second with Elastizell and a third lightweight fill this coming construction season using another material 'Styropor Concrete' which it appears may be even better for this type of installation than 'Elastizell.'

R-1054 - "Petrographic Analysis of Coarse Aggregate: American Aggregates Corp., Milford Pit No. 63-97," (Testing Laboratory Sample No. 76 A-499). R. W. Muethel.

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

R-1055 - "Petrographic Analysis of Coarse Aggregate: Mickelson No. 3, Pit No. 63-88," (Testing Laboratory Sample No. 75 A-2366). R. W. Muethel.

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

R-1056 - "Petrographic Analysis of Coarse Aggregate: Wallace Stone Co. Pit No. 32-4," (Testing Laboratory Sample No. 76 A-1708). R. W. Muethel.

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

R-1057 - "Evaluation of Five Commercial Fast-Setting Patching Mortars," (73 NM-360, 73 NM-374, 73 NM-382, 74 NM-396, and 74 NM-407). K. H. Laaninen.

Five commercial fast-setting hydraulic mortars and commercial mortars containing MgO were molded into test specimens and were tested for compressive strength; tensile strength; shear bond strength; shrinkage; and, surface scaling during freeze-thaw testing. The fast-setting hydraulic mortars (Octocrete and Set-Instant Concrete Repair) and the mortars containing MgO cement (Darex 240 Concrete, Set 45 Minute Concrete, and Bostik 275) were rated on a 'combined rating scale' and Set 45 was found to be the only mortar rendering acceptable performance based upon performance testing. Based upon limited field work by ourselves and other agencies, it was recommended that Set 45 be approved for use in bridge deck repairs where closure time is a critical factor.

The Maintenance Division of the Department has informed us that they used a good deal of the Set 45 material for bridge deck patching last year and they plan to continue using it for such work in the future.

R-1058 - "Instruction Manual for Bridge Deck Delamination Detector," (68 F-106).

The MDSHT Delamination Detector is a small hand-propelled mobile cart equipped with a tapping system, acoustic sensors, and a recorder. It detects and indicates the location and extent of delaminated areas within a

concrete bridge deck as it traverses the surface. This report constitutes an operators manual which provides general information about the rig, its principles of operation, operating instructions, calibration, chart record interpretation, component descriptions, and maintenance.

R-1059 - "Petrographic Analysis of Coarse Aggregate: Emmons Pit No. 54-22," (Testing Laboratory Sample No. 76 A-2130). R. W. Muethel.

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

R-1060 - "Petrographic Analysis of Coarse Aggregate: Glancy Pit No. 62-3," (Testing Laboratory Sample No. 77 A-1). R. W. Muethel.

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

R-1061 - "Evaluation of Prewetted Salt for Ice Control," (75 G-216). J. H. DeFoe.

The Maintenance Division has been conducting a program to achieve more efficient and effective use of chlorides for highway ice and snow control through the use of sodium chloride (rock salt) that has been 'prewetted' with a calcium chloride brine. Initial results seemed to indicate that a savings on quantities of salt used might be significant by prewetting; the Research Laboratory was asked to conduct a follow-up observation along with the Maintenance Division. Evaluation of the effectiveness of the prewetted salt involved a comparison between it and untreated rock salt on comparable sections of highway. As a result of limited observations, it appeared that there is no significant difference between their ice melting capabilities and results of the Maintenance Division's earlier observations about prewetted salt being applied at a more controllable width—with less salt bouncing off the roadway—were confirmed. Somewhat more maintenance of equipment may be involved to keep the brine system working.

R-1062 - "Interim Report on Epoxy Injection Grouting Experimental Repair Procedure," (74 F-141). H. L. Patterson.

This report briefly comments upon the results of contracted epoxy injection grouting repair on two bridges in the Lansing area using procedures

developed earlier by the Research Laboratory. After one year's time, the bridge decks were surveyed and a table included in the report gives the results and certain recommendations are made for future work in this area.

At the present time the Research Laboratory is undecided as to whether a new contract for epoxy injection grouting should be proposed or not. In this interim we have decided to wait for a spring evaluation of the bridge previously injected to determine performance throughout the winter.

R-1063 - "Preventive Maintenance of Concrete Pavements - US 27: Progress Report," (72 F-123). J. E. Simonsen.

This report is concerned with an experimental project to determine the feasibility of preventive maintenance of concrete pavements utilizing precast slabs, cast-in-place slabs, and relief joints. Specifically, the project is to determine: if emergency repairs of blow-ups can be significantly reduced by repairing selected joints prior to actual failure; and, test the reliability of the method used to select joints for preventive maintenance repair. A section of US 127, constructed in 1956, was selected as an experimental pavement; the southbound roadway being used for the experimental work, the northbound roadway designated as a control pavement. Among the conclusions in the report are: by providing expansion space in the pavement at spacings ranging from 200 to 1,200 ft, blow-ups have been prevented for the four-year period since the joints were installed; there was no evidence that provision of expansion space at repairs was better than providing space by installing 4-in. relief joints; some faulting has developed at most repairs and relief joints; existing joints and transverse cracks with fractured steel in the vicinity of installed expansion joints increased permanently in width at a faster rate than those located in the interior section between expansion joints; spalling along existing joints continued on pressure-relieved pavement; and, the method for selecting joints for repair and for locating relief joints seems to be reasonable. It is recommended that the use of expansion to relieve pavement pressure be continued.

The procedures used to repair a joint with fast-set concrete were accepted as standard repair methods shortly after these experimental repairs were completed. By the end of 1977 a total of approximately 245,000 sq yd (35 lane-miles) of pavement had been replaced at a cost of 13 million dollars.

R-1064 - "Elastizell Concrete Lightweight Fill Construction (Pine River Bridge, St. Clair)," (75 E-54). E. C. Novak, Jr.

This was the second of two structures which utilized experimental installations of experimental lightweight fill consisting of a mixture of cement, water, and a foaming agent called 'Elastizell.' The other installation has been described in the abstract of Report R-1053 in this report. Again,

as cited in the previous report, Elastizell concrete appears to be a satisfactory fill material; however, it cannot be recommended for general use at this time because of concern as to the effect that non-uniform mixing (resulting in weak spots) might have on long-term performance and because an appropriate design unit weight, based on moisture sorption rate, has not been established. This particular job experienced some flooding and it is recommended that any future experimental fills using this material should include edge drains to prevent flooding and flotation of the lightweight material.

Current planning includes a lightweight fill demonstration project for the 1978 construction season using 'Styropor' concrete, which is lightweight concrete containing expanded polystyrene beads in place of coarse aggregates.

R-1065 - "Maintenance of Neoprene Sealed Concrete Pavements: First Progress Report," (75 G-217). J. E. Simonsen, F. J. Bashore, and A. W. Price.

This cooperative study, conducted with the Maintenance Division, is intended to develop procedures for maintaining concrete pavements sealed with neoprene seals. Specifically, it is aimed at: determining the suitability of various materials and methods for patching spalled joints; determining the seal size and installation methods for resealing joints with oversized grooves; determining equipment requirements and seal size for resawing and resealing expansion joints prior to damage from excessive compression; and, exploring the possibility of developing an effective and economical way of installing a doweled joint at open transverse cracks. A 34-mile section of I 69 was selected for the experimental work. Seven different types of joint distress were identified as: shattered spall, open spall, joint spall, tight seal, tight seal with spalled groove, loose seal, lost seal, open transverse crack. An Appendix to the report provides survey instructions and a distress rating scale. Repair procedures were developed for these distressed conditions and are discussed in the report. Both survey and field work are considered within this first report, and follow-up reports will be issued in the future detailing further work, and marking the progress of areas already treated.

As a result of this study further experimental repair techniques are planned at other repair sites and the Engineering Operations Committee has recommended that a contract be let for repairs to neoprene sealed joints on the basis of specifications developed from techniques used here.

R-1066 - "Raised Pavement Markers," (76 TI-377). M. H. Janson, G. M. Smith, J. D. Truax, and M. J. Tiedt.

Three different models of a proprietary raised pavement marker were used in an experimental installation, and the Research Laboratory was

asked to make some photometric assessments of them. The results are presented in this report. It was not possible to make on-site photometric measurements as initially requested, so field samples were removed for laboratory testing, and a visual field inspection was made. Although the three types tested have been discontinued, newer models containing alleged improvements are currently being tested by the Department.

R-1067* - "Epoxy Resin Coated Reinforcing Steel: Construction and Progress Report," (73 F-131). C. J. Arnold.

This report covers the construction of laboratory specimens, field exposure specimens, and experimental bridge decks, for evaluating epoxy coated steel reinforcement as a deterrent to bridge deck deterioration. This is a Highway Planning and Research project, conducted in cooperation with the Federal Highway Administration. Three different epoxies, with three different surface preparations for each epoxy, some purposely damaged epoxy coatings, and galvanized and plain bars for comparison, were cast in laboratory specimens. Field exposure specimens were prepared, and three experimental bridge decks were built, each having four spans, one span each with two different epoxy coatings, one span galvanized, and one span with plain bars. Specimens and decks involved in the corrosion comparisons are not yet old enough to develop significant deterioration and they will be covered in subsequent reports. Initial observations and tests on the epoxy coated bars have generated the following initial conclusions: commercial blast treatment is not adequate preparation for epoxy coatings on rebars; white metal blast and near-white metal blast treatments give similar results to one another; all three types of coating performed about the same when properly applied; there was only a minor effect due to 90-day outdoor exposure or one-year laboratory storage; there was a significant difference in coatings applied by two different fabricators; there was a significant difference in the amount of curing of the coatings involved in the experiment. Patching compounds furnished for repair of coatings were far from adequate.

This experimental study has been implemented in that the Department now specifies epoxy coated bars for the top steel in all bridge decks under construction.

R-1068 - "An Accident Frequency Prediction Model for Selected State Trunkline Classifications," (76 G-223). Wen-Hou Kuo.

Since highway safety funding is limited, it is neither practical nor possible for program administrators to fully examine and improve every segment of the highway system. Thus, it would seem practical to attempt to develop accident prediction models which can be used to identify segments of roadway which are considered hazardous and, therefore, may require some treatment. This report, prepared in cooperation with the Traffic and

Safety Division, provides some basic information that such models might require. It categorizes every segment of roadway in terms of 'controllable' variables, and describes the accident behavior of each roadway segment in each category in terms of accident probability distributions.

R-1069 - "Fibco 'Mod II' Portable Truck Barrier," (76 NM-507). J. F. Caudell.

This report evaluates a truck-mounted impact attenuator, intended for installation on slow-moving or stationary highway maintenance trucks. It consists of layers of expanded surlyn 'mattresses' which are affixed to the truck, providing a crash cushion. Lack of data from the manufacturer concerning angular impacts and lightweight vehicle impacts, plus theoretical data indicating necessary additional cushion length for higher speed and heavier vehicles, and laboratory results indicating that the surlyn material has different properties when re-used, as well as cost, indicate that the attenuator should not be used, and that the Texas barrel cushion, due to its service record and lower cost, be considered as an alternate.

Although this device did not prove satisfactory, the Traffic and Safety Division is purchasing a similar type unit for a safety device in connection with placing of lane paint marking stripes.

R-1070 - "Petrographic Analysis of Coarse Aggregate: Marblehead Quarry, Marblehead, Ohio," (Testing Laboratory Sample No. 77 A-426). R. W. Muethel.

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

R-1071 - "Petrographic Analysis of Coarse Aggregate: Pickitt No. 1, Pit No. 34-26," (Testing Laboratory Sample No. 76 A-1265). R. W. Muethel.

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

R-1072 - "A Study of Supplemental Drainage Methods for Preventing Frost Heave in Full-Depth Concrete Shoulders," (72 E-50). E. C. Novak, Jr.

Four separate ramps on I 69 were constructed to include four test sections each to ascertain whether supplemental drainage would prevent dif-

ferential shoulder heave. Neither section has heaved (control or drained) so no specific conclusions could be reached. It was noted, however, that installation of supplemental edge drains greatly reduced drainage time but, because of their deep placement, the drains are at times cut off from the base-subbase layers by frozen soil. The placement of subbase drains in the subbase layer would prevent this problem and be less expensive to install than the standard edge-drains. Because all of the shoulders studied have good to excellent internal drainability and have not heaved, it is circumstantial evidence that these two characteristics are related; the implication being that differential shoulder heave can be prevented by ensuring that drainability meets certain drainage criteria.

R-1073 - "Report on Commission Auditor's Recommendations Nos. 25, 27, and 28. L. F. Holbrook, et al.

This report consists of the responses of a committee made up of Research Laboratory personnel of diverse backgrounds and training to recommendations made by the Commission Auditor's specifically aimed at the Research Laboratory's operations. The three recommendations, and the committee's responses, are as follows: 25) 'Standards be issued for determining prior or current research related to proposed projects.' The committee had three responses; the first was to include within each research proposal a 'literature search tree' which graphically traces the procedure by which source materials are discovered, the second was to include a narrative summarizing salient materials discovered in the sources cited, and, third, to announce the project to the staff, prior to completion of the proposal, for possible suggestions as to further literature search and review. 27) 'Standards be issued for identifying, accumulating, and organizing project work papers,' the committee had two recommendations on this. First, each project leader will be responsible for assembly of data, upon the project's completion, for files at the Group level; second, project number, date, and investigator's name should appear on all work sheets, graphs, etc., in the files. Auditor's recommendation 28) 'Project files be combined and centralized after project completion,' was found by the committee to be somewhat impractical in many cases due to the variety of data sources. Instead, the committee recommended: 1) the Laboratory Section file in the front office contain a project summary sheet, filled-out in part at the project's inception and kept up-to-date as the project continues; 2) further, the Section file should contain project correspondence, copies of any interim and/or final reports, follow-up and/or implementation correspondence, and the original project proposal; and, 3) Group files will serve as repositories of data, in whatever form required by the project. Literature Tree and Project Summary Sheet descriptions are furnished in an Appendix to the Report.

It is planned to have an organization meeting of Research Laboratory personnel and go through these recommendations and implement them into Research Laboratory activities.

R-1074 - "Air Quality Report for M 153 in the Cities of Westland and Garden City, Wayne County," (77 AP-16A).

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

LISTING OF NEW MATERIALS PROJECTS COMPLETED DURING THE YEAR

67 NM-165 - Use of "Chem Compt" for Pavement or Bridge Concrete

67 NM-171 - "Cybond" Protective Polyester Coating for Concrete

69 NM-229 - "Epi-Top 100" Epoxy Binder for Bridge Concrete

73 NM-354 - Acton Rust Passivator (Troy Chemicals Co.)

73 NM-360 - "Octocrete" for Patching Spalled and Broken Concrete (Penn Crete Products Co.)

73 NM-374 - "Set Instant Repair" for Concrete (Set Products Inc.)

73 NM-382 - "Darex 240" and "Acmaset" Fast Set Patching Mix (Acme Highway Products and W. R. Grace)

74 NM-396 - "Set 45" for Concrete Repair

74 NM-407 - "Bostik 275" Epoxy for Quick Setting Concrete Repairs (Upco Chemical Division of USM Corp.)

75 NM-424 - 3M Metal Plating System

75 NM-455 - "Gyro-Kleen" Acoustical Panel for Noise Control

76 NM-481 - Dow Mulch Binder

76 NM-498 - Fondu Calcium Aluminate Cement for Repairing and Patching

76 NM-502 - Lincore Ni2 Low Alloy Tubular Submerged Arc Wire, 880 Flux (Lincoln Electric Co.)

76 NM-504 - Hi-Lock Nut-Torque Controlled (Hi-Shear Corp.)

76 NM-506 - Sound Fighter LSE-1000 Noise Protection Wall System

76 NM-507 - "Mod II" Portable Truck Barrier for Impact Attenuation

77 NM-511 - Falcon Foam for Insulating Bridge Decks

77 NM-512 - "Quick-Rok" Fast Setting Hydraulic Cement for Anchoring

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

77 NM-516 - "Vandex" Concrete Waterproofing and Corrosion Protection for Concrete

77 NM-520 - Polymer Portland Cement Shotcrete (Dow Chemical Co.)

77 NM-524 - "Fanwall" Modular Precast Concrete Panels for Noise Attenuation

77 NM-525 - "Katepox" Coal Tar Epoxy Anti-Corrosive Coating

77 NM-532 - "Thorocoat" for Decorating and Protecting Cement Surfaces (Standard Dry Wall Products)

LISTING OF TECHNICAL INVESTIGATIONS COMPLETED DURING THE YEAR

71 TI-29 - Construction of Plastic Concrete Roughness Measuring Device

71 TI-36 - Design Recommendations for I 75, Goddard Rd, Allen Park Noise Abatement

72 TI-104 - Hydroplaning Calculations

72 TI-137 - Alleged Structural Damage to Myers House, 8864 Ashton Ave, Detroit

73 TI-175 - Effectiveness of Alternative Skid Reduction Measures

73 TI-186 - Specifications for Diamond Saw Blades

75 TI-275 - Steel Evaluation on Vehicle Damaged Structure, I 94, Kalamazoo

75 TI-282 - Testing Welding Electrodes

75 TI-301 - Evaluation of 400 Series Coating of Stainless Steel for Dowel Bars

75 TI-308 - RTP Measurements for Ford Motor Company

75 TI-311 - Investigation of Wire Sealant and Encapsulation Performance for Wire Pavement Loops

75 TI-320 - Field Calibration Device for Portable Static Skid Tester

76 TI-328 - Survey and Recommendations on Roughness of Resurfaced Pavement, M 115 Northwest of US 10

76 TI-329 - Statistical Analysis for Harriger vs. MDSHT Litigation

76 TI-334 - Analysis of Vertical Underbody Moldboards and Edge Blades

76 TI-336 - Correlation of Pavement Performance with Freeze-Thaw Durability of Coarse Aggregates

76 TI-359 - Evaluation of Concrete in X01 of 33011 for Reconstruction

76 TI-361 - Brightness Study of Arrow-Bar Traffic Control Sign in Night Phase

76 TI-373 - Survey of Lighted Arrow Signs for Specification Compliance

76 TI-377 - Measurement of Reflectivity of Raised Pavement Markers on Temporary I 69 at Hagadorn Rd

76 TI-379 - Survey of Salt Damage to ASTM A 588 Steel

76 TI-381 - Investigation of Longitudinal Cracking of Integral Curb Section in Oakland County

77 TI-383 - Noise Complaint I 275-I 696 Interchange, Ramp F, Indianbrook Subdivision

77 TI-384 - Cost Effectiveness Study for Conversion of Mercury Lighting to High Pressure Sodium

77 TI-386 - Strength Tests of Hardwood Guard Rail Tests with Splits, Shakes, and Checks

77 TI-387 - Statistical Analysis of Bituminous Extraction Data

77 TI-388 - Analysis of Aluminum Sign Support Beams for Traffic and Safety

77 TI-391 - Demonstration of "Clarcrete" Pavement Texturing Machine

77 TI-393 - Profiles and Load-Deflection Fowlerville Scales (Eastbound)

77 TI-396 - Investigation of Concrete Floor Cracking in Michigan Technological University - Gates Tennis Courts

77 TI-400 - Truck Escape Ramps

77 TI-401 - Noise Complaint from Grand Rapids Ford Freeway Between Bridge St and Lake Michigan Dr

77 TI-405 - Investigation of Concrete Patch Performance on M 69 Near Jones

77 TI-408 - Noise Investigation, I 75 Williamsburg Village Condominiums

77 TI-409 - Vibration Problems of Mitan Residence, I 696 Centerline, Michigan

77 TI-412 - Failure of Bridge Surfacing US 2 at Cut River

77 TI-416 - Study of Cracking in Pier Caps River Rouge Bridge

77 TI-419 - Noise Measurements for SEMTA in Inkster

77 TI-421 - Eller Advertising Company Billboard Sign

77 TI-423 - Investigating Contamination in Bituminous Material Construction Project Mb 75061-10844A

77 TI-427 - Statistical Analysis of Salt Breakdown Between the Mine and Delivery at Dock

LISTING OF ACTION PLANS
COMPLETED DURING THE YEAR

77 AP-14(N) - Noise Impact, M 51 Relocation, City of Niles

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

77 AP-16(A) - Air Quality Control Section 82081, M 153 (Ford Rd) Widening from I 275 to Venoy Rd

ACTIVE RESEARCH PROJECTS

STATISTICAL ANALYSIS UNIT

Title

76 A-26 - Statistical Analysis of Concrete Pavement

Purpose

To develop statistical models for concrete pavement performance prediction.

Scope

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

Progress Past Year

The first stage of this project is to analyze relationships among variables, such as freeze-thaw durability, concrete strength, air content, unit weight of concrete, sand (percent of total aggregate), aggregate gradation, soundness, gelatinous particles, etc. This stage has been completed.

Planned Program for Coming Year

We are now in the final stage of this project, which is to find the relationship between pavement performance and the variables presented in stage 1.

Title

*72 G-191 - Aggregate Gradation Quality Control (22A Field Experiment)

Purpose

1. To develop practical and meaningful samples procedures at the production and construction site for sieve analysis of 22A aggregate.

2. To develop, based on the suggested sampling procedures, practical and meaningful aggregate inspection practices either for stockpile inspection or in-place inspection.

Scope

Development of the sampling procedures and the inspection practices for 22A aggregate, based on three available production pits.

Progress Past Year

Completed with publication of MDSHT Research Report No. R-1024.

Title

*73 G-193 - Accident Rates and Surface Properties--An Investigation of Relationships

Purpose

To construct an intersection model which will predict wet accident percentages from skid number and other relevant variables.

Scope

Development of the wet surface accident model for state trunkline intersections from knowledge of percentage wet time, skid number, seasonal drying factors and dry surface accident incidence. Data are for the entire state of Michigan for the period 1963-74.

Progress Past Year

Final report (MDSHT Research Report No. R-994) was approved by FHWA. Also a smaller report was accepted for presentation at the Second International Skid Prevention Conference.

Title

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

Purpose

The 'End Result Aggregate Committee' recommended an in-place aggregate acceptance sampling plan based on the research results of the project "Aggregate Gradation Quality Control" (MDSHT Research Report No.

R-1021). This recommended acceptance sampling plan shall be used to accept or reject base aggregate for two construction projects: M 36021 and I 50062. The purpose of this research program is to analyze the aggregate base course of these projects so that the major purpose (aggregate uniformity) of the recommended acceptance sampling plan can be evaluated.

Scope

The scope of the investigation will be limited to data obtained from projects M 36021 and I 50062.

Progress Past Year

The first stage of this project requires the design of sampling, testing, and acceptance procedures for the inspection of in-place aggregate. The first interim report was issued for Construction Projects M 36021 and I 50062. We have also explained the procedures presented in the first interim report to District Engineers, aggregate inspectors, and contractors involved in these two construction projects.

Construction Project I 50062 has been cancelled. Construction project M 36021 has been completed.

Planned Program for Coming Year

After we analyze the data from Project M 36021, the second interim report, discussing the implementation of this new procedure on Construction Projects M 36021, will be issued.

Two more construction projects have been selected for the new acceptance procedures. Construction will be started by approximately June of 1978. After the completion of these two projects we will analyze the data and issue final recommendation on in-place aggregate acceptance procedures.

Title

76 G-233 - An Accident Frequency Prediction Model for Selected Trunkline Classifications

Purpose

To construct statistical models that will predict the expected number of injury accidents.

Scope

The data needed for the development of the injury accident prediction models will be provided by the Traffic and Safety Division. These data include the number of injury accidents and the environmental and geometrical descriptions of every 2/10-mile roadway section of the Michigan trunkline system for the period 1971-75.

Progress Past Year

Completed with publication of MDSHT Research Report No. R-1068.

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 temperature, 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

Began review of relevant literature.

Planned Progress for Coming Year

Completion of data retrieval, analysis, and first draft of final report.

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 1969-71, followed by contract repair projects in 1972-76. 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) will be used in the latex modified concrete overlay of four structures on one repair project.

Progress Past Year

Latex modified concrete overlays continued to be used extensively on deck repair contracts, and on selected new structures. In 1977, latex modified concrete or low slump high density concrete overlays were considered alternate systems in two-stage construction with epoxy coated reinforcing steel in the top mat on new decks in high traffic areas.

Selected projects built with latex modified mortar or concrete overlays in 1964 through 1975 were inspected, cored, and tested with a corrosion cell and a delamination detector.

Planned Program for Coming Year

The cores obtained from the selected projects will be analyzed for chloride ion content at several depths. The data from the field inspection will be gathered and analyzed. An updated performance report will be issued in the second quarter. The repair project using latex modified concrete overlay containing latex admixture produced by Arco Polymers will be closely monitored. Samples of the fresh concrete will be obtained and subsequently tested in the laboratory. Future inspections will be made to assess the long-term performance.

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 1972-74 the Department approved the use of water reducers in paving concrete with a slight reduction in cement. This usage in grades 35P and 30P concrete became part of the 1976 Standard Specifications (Table 7.01-1). The use of 5.6 sacks/cu yd with water reducer, in lieu of 6.0 sacks of cement, were widely used across the state in paving concrete.

Progress Past Year

Tests were completed on a number of mixes of 35P and 30P concrete with type 1SA cement both with and without a water reducer. Some of these tests had to be repeated with a new supply of 1SA cement when it was found the first sample was not uniform.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

One-third of a concrete paving project was selected to directly compare type 1P cement with type 1A. Selective sampling was done in 1974 to evaluate strength and durability. Structural grades of concrete are to be evaluated in a later phase of a bridge project. A dual structure was selected so that type 1P cement was to be used in both the substructure and superstructure concrete of one structure. Normal type 1A cement would be used in all concrete of the companion structure.

The structures selected were X01 and X03 of 82102 that carry M 14 over the C&O RR northwest of Plymouth. The portland-pozzolan cement was designated to be used on the eastbound structure (X03).

Progress Past Year

The substructure units of X03 were completed and the superstructure was started and completed on both bridges. Sampling of fresh concrete continued throughout the construction season and the resulting test specimens are now in the process of being tested and evaluated. Information being obtained includes compressive and flexural strengths, shrinkage measurements, freeze-thaw durability, and specific gravity measurements.

Planned Program for Coming Year

Selected locations on both the substructure and superstructure will be cored for strength and permeability measurements on the actual bridge concrete. All test data are to be included in a report toward the latter part of the year.

Title

72 B-92 - Experimental Bridge Deck Surfacing Methods

Purpose

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

Scope

Three structures were closely followed to evaluate construction phases of a revibrated deck, two-stage deck pour using 1-in. latex modified mortar, and a two-stage pour with 2-in. of a 7.5 sack concrete mix. Post-construction performance was to be evaluated by periodic testing and inspection.

Progress Past Year

The three subject structures on US 23 in northeastern lower Michigan were monitored during construction in the summer and fall of 1972. They were inspected and corrosion cell tests run late in 1975. The structures with the latex modified mortar overlay and with the concrete overlay were inspected, cored, and tested with a corrosion cell and delamination detector during 1977.

Planned Program for Coming Year

A report incorporating the data obtained during the inspections in 1977 and the initial construction data, will be issued in the second quarter.

Title

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

Purpose

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

Scope

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

Progress Past Year

Additional structures were overlayed with low slump high density concrete overlays. The concrete density was checked by nuclear density gages using procedures developed by Testing and Research and Construction personnel. The post-construction report on the initial two structures over-

layed in 1975 was finalized for distribution. Inspection, coring, corrosion cell readings and delamination testing was performed on these decks last summer.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Tests have essentially been completed on specimens from 12 mixes of grade 35P concrete and four mixes of grade 30P concrete with both type 1SA and 1A cements with and without water reducers. Test results indicated a problem with uniformity in the cement. A new sample of type 1SA cement was received for testing. No mixes were made with this cement due to the scheduling of other critical projects and the move into the new building.

Planned Program for Coming Year

Selected concrete mixes will be made with the resubmitted type 1SA cement. Test results from these mixes will be compared with those from the mixes containing the original type 1SA cement. Results of these and earlier tests will be assembled for a report and decision on use of 1SA cement with water reducers with a cement reduction.

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 evaulated in a non-reinforced ramp carrying light commercial traffic.

Scope

In 1976 about 1,240 ft of Ramp A in the southwest quadrant of the Shelby Rd-US 31 interchange was constructed of a composite econocrete pavement. About 1,200 ft of Ramp A was constructed with 8 in. of grade 35P concrete. The econocrete mix contained 305 lb of cement/cu yd, a water reducer, and a local 60-40 sand-gravel aggregate. The composite econocrete pavement consisted of two layers each of 4-in. depth; the lower layer being econocrete and the upper layer being grade 35P concrete. The construction of the composite econocrete pavement was closely monitored. Fresh concrete specimens of both econocrete and grade 35P concrete were obtained and tested in the laboratory. Future inspections and testing were to include coring, measurements of joint openings, slab movement, profilometer, load-deflection and condition surveys of both the composite econocrete pavement and the grade 35P concrete pavement.

Progress Past Year

The initial report covering placement of the ramp concrete sections, including concrete test data, has been finalized for distribution. An inspection and coring was performed on the ramp concrete sections this past summer.

Planned Program for Coming Year

Condition surveys, coring, measurements of joint opening, slab movement, profilometer and load deflection will be made periodically.

Title

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

Purpose

To evaluate the construction and performance of econocrete shoulders on M 14 near Wayne Co. line and I 69 near Lansing. The econocrete mix on I 69 will contain a cheaper peastone aggregate. The econocrete mix on M 14 will incorporate cement reductions providing compressive strengths of 3,000, 2,500, and 2,000 psi at 28 days age.

Scope

It was proposed to pave three miles of the outside shoulders of M 14 in half-mile sections. The sections will consist of, alternately, grade 35P concrete, 3,000, 2,500, and 2,000 psi grade "econocrete."

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

Progress Past Year

Approval was granted by the Engineering Operations Committee in December for the construction of experimental econocrete shoulders on I 69 near Lansing using peastone aggregate. The contract for the M 14 paving with econocrete shoulders was let in November, Project 82102-08489C.

Planned Program for Coming Year

Closely monitor the construction of the econocrete shoulders on M 14 to include testing of sampled econocrete for strength, durability and shrinkage.

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 skid data were reexamined on projects paved up to 1963 and also from 1963-72. Primarily, bituminous concrete projects were examined under Phase 1, and bituminous

aggregate jobs and initial wear track construction were done under Phase 2. Extensive wear track tests were to be run on selected coarse aggregates used in 4.12 and 4.11 mixes to define their relative wear characteristics.

Progress Past Year

Wear track tests were completed on series 5 through 8, selected rock types from a detailed coarse aggregate study. A tabulation including wear data on series 1 through 8 has been assembled for a progress report. Scheduled field correlation tests of the laboratory skid tester and skid trailer have been completed.

Planned Program for Coming Year

The laboratory wear track is to be reconstructed in the new Testing and Research facility with modifications to permit testing of experimental bituminous mixtures. Samples of crushed gravel from 12 additional sources have been scheduled for wear track tests. Further evaluation of sandstone as non-skid aggregate is planned. Several blends of limestone and non-polishing aggregates may also be tested.

Title

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

Purpose

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

Scope

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

Progress Past Year

Paving of the experimental wearing course was completed in July. Samples of the paving aggregates were submitted to the laboratory for ana-

lysis. A preliminary field inspection and initial skid tests were conducted. Petrographic examination of the aggregates has been completed.

Planned Program for Coming Year

Completion of supplemental laboratory tests of the paving aggregates is scheduled pending installation of new laboratory facilities. A preliminary report will be issued after completion of laboratory tests. The report will also include the initial and one-year skid trailer data.

Title

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

Purpose

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

Scope

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

Progress Past Year

Field surveys of eight different types of systems on over 200 structures were made during 1977.

A progress report has been drafted.

Planned Program for Coming Year

Field surveys of several types which no longer qualify for Federal participation will be very limited. Surveys of the remainder will continue as before.

Title

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

Purpose

To adapt the bridge deck epoxy injection concept, as pioneered by the State Highway Commission of Kansas, to similarly afflicted Michigan bridges, and to evaluate the permanence of this type repair by long-term evaluation.

Scope

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

Progress Past Year

The first phase of this project was done as a joint voluntary venture between a contractor and the Department in 1975 to develop a procedure by which a bridge deck, in early stages of deterioration, could be restored to its original integrity without resorting to costly chipping and patching. The second phase of this project was carried out under an awarded development contract, and consisted of repairing the delaminations on four bridge decks that were in the initial stages of deterioration. An injection frame that produced an effective seal between the injection gun and the deck was developed by Department personnel and used throughout the second phase of this project. Approximately half of the contract was completed in the fall of 1976 and the remainder was completed during the summer and fall of 1977.

Planned Program for Coming Year

The future of this type of repair rests with its effectiveness in attenuating bridge deck delamination and the practical success of working within limiting weather requirements. Another contract to reinject new delaminations on the subject bridge decks in 1978 will be recommended to the Engineering Operations Committee. The four structures injected in 1976 and 1977 will also be inspected to assess the permanence of this type repair.

Title

47 G-36(30A) - 1977 Supplemental Traffic Paint Performance Tests

Purpose

This project is the 1977 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 1978.

Scope

This is a cooperative project with Traffic and Safety Division who assume responsibility for application of the paints in field performance tests while we assume responsibility for the field ratings, laboratory analyses, and the reporting.

Progress Past Year

The project is on schedule with application of the paints in field tests including white paints from Minnesota, Indiana, Wisconsin, and Ohio applied the third week of May 1977. Periodic ratings were made with an interim progress report made to the Traffic Control Devices Committee on December 14, 1977.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

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

Progress Past Year

No work was done on phase (a) testing. Under phase (b), all the paint systems under field tests were inspected for performance, with data to be compiled for subsequent, periodic reporting. The structure on I 94 painted in 1976 under HPR Project 76 G-219 will ultimately be added to phase (b) listing for long-range performance data.

Planned Program for Coming Year

Two new related research projects have been initiated with the specific purposes of (1) developing specifications for inorganic zinc systems, and, (2) investigating the use of water-based systems. A limited number of coating systems not included in the above categories may be evaluated in the laboratory under phase (a) of the subject project.

Field inspections will continue under phase (b).

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 revision of specifications for cleaning and painting procedures for structural steel was begun.

Planned Program for Coming Year

Above revisions will be completed and submitted through the Department channels for comments and eventual finalization and subsequent implementation.

Title

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

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

The installation will be inspected periodically.

Title

72 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

Several inspections were made on field test installations including bridge beams and hardware on structures on M 78, and US 27 north of Houghton Lake.

Planned Program for Coming Year

Continue periodic inspections of test installations.

Title

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

Purpose

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

Scope

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

Progress Past Year

None due to retirement of personnel handling project.

Planned Program for Coming Year

Check performance of field and laboratory exposures and write latex specifications, if exposures provide adequate performance data. Field installations are in three areas in District 7.

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

Evaluation of one manufacturer's newly designed line of road seals was completed.

Planned Program for Coming Year

The feasibility of upgrading the lubricant for installation of seals will be considered.

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.

Progress Past Year

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 the year. The tests appear to have been conducted in an aggressive area since the losses were higher than normal for the eight-year long tests. Because of the abnormality, the tests will be continued with Phase 2 panels. Since the producer did not submit the new test panels until mid-December, 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.

Planned Program for Coming Year

No work is planned regarding the above panels since the first panels are scheduled to be removed in June of 1979. Pending analysis of the results of condition surveys of older A 588 structures made by the Maintenance Division during 1977, recommendations concerning upgrading of deck expansion joints and protective coatings for critical areas may be requested.

Title

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

Purpose

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

Scope

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

Progress Past Year

Epoxy mortar surfacing was applied during September and October of 1969 to a minimum thickness of 5/8 in. Guardkote 250 mortar was applied to the south half of the bridge and Epon 815-Versamid 140 mortar to the north half. Subsequent inspections revealed several types of deterioration; shrinkage craze cracking was very distinct in the GK-250 and less prominant in the E815-V140; both mortars developed tensile fatigue cracks in negative moment areas of the deck; and changing features each year suggested significant traffic abrasion. The annual inspection of 1975 found spots where the GK-250 mortar had spalled off and left the steel deck exposed. At these areas it was discovered that the thickness of the mortar was 1/8 in. or less; traffic abrasion has removed approximately 1/8 in. of mortar per year. The rate of abrasion in the E815-V140 appeared to be less. In 1976 several square ft of the Guardkote 250 mortar had come off the south span exposing the steel plate. The north span epoxy mortar had not worn nearly as much and remains intact.

Planned Program for Coming Year

Difficulty is being experienced in locating a suitable material for use as a replacement sealant and wearing surface on this bridge deck. Hopefully, a suitable material will be located and a contract can be set up to effect this repair work in 1978.

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 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 nine years old.

Progress Past Year

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

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Sampling from 30 roadside groundwater observation wells at four statewide locations has continued on a year round basis. Completion of analysis of soil samples was delayed due to relocation of the laboratory.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Field evaluation of the membrane waterproofing projects was not completed due to higher priority field work commitments of available personnel and relocation of the laboratory facilities.

Planned Program for Coming Year

Inspection and field testing of the remaining unevaluated projects is to be completed for a summary report later in 1978.

Title

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

Purpose

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

Scope

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

Progress Past Year

Seventeen construction projects were cored and base materials were sampled. Chloride penetration, amount of concrete deterioration, and permeability of base materials were determined.

An extension of one year to complete the project was requested and granted. The reason for this request was loss of personnel in the Unit responsible for the work and in another Unit cooperating in a portion of the laboratory work.

Planned Program for Coming Year

Complete analysis of data and write report.

Title

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

Purpose

As per title, which is very descriptive. The test structure is P01 of 52042 over US 41 southeast of Marquette, completed in 1972.

Scope

The project is a "Category 2" experiment carried out in cooperation with FHWA as per MDSHT Work Plan No. 22, which was developed by the Department. After construction of the test structure, the project was transferred to us for follow-up surveys and reporting. The initial survey was covered by us 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

All installations were inspected by Laboratory personnel.

Planned Program for Coming Year

Future inspections will be done on a biannual basis to coincide with other biannual inspections of coating systems. Therefore no work is planned for 1978.

Title

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

Purpose

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

Scope

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

Progress Past Year

Chloride data from 58 structures were transmitted in 1977. Sampling by coring has largely been replaced by the rotohammer method which was instituted in early 1977. This field sampling was done by members of the Soils and Materials Section.

Planned Program for Coming Year

Processing of bridge deck samples is to continue, with 72 additional structures scheduled to be sampled through November.

Title

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

Purpose

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

Scope

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

Progress Past Year

Samples of the two test aggregates of high and intermediate shale content were received, screened, and preliminary petrographic tests run. Test slabs were made and wear track tests completed in 1976. Preliminary results of these tests along with other aggregate sources in the eight wear track series completed were submitted to the Bituminous Advisory Committee.

Planned Program for Coming Year

A report covering both the laboratory tests and additional field evaluations will be prepared early in the year.

Title

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

Purpose

To determine by service evaluation whether a bridge structural steel coating system based on SSPC-PS 8.01, Specification for a Thick-Film

Rust Preventive, can provide comparable protection to the Department's currently specified four-coat system when applied as either a one or two-coat system at equivalent dry-film thickness.

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

Scope

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

Progress Past Year

Initial inspections in early 1977 showed deficiencies in film thickness in the petroleum based coating described above as SSPC-PS 8.01, Rust Preventive. These deficiencies were corrected by the contractor. Film thickness measurements were made on the entire structure using a van mounted "cherry picker." A progress report covering application of the coatings was drafted.

Planned Program for Coming Year

The initial progress report will be finalized and biannual inspections will be made to monitor performance.

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

Over 12,000 lin ft of subject material was installed with only minor problems. Initial inspections were made after completion of all joint installations.

Planned Program for Coming Year

Continue biannual inspections (winter and summer). Minor difficulties in installation were attributed to variation in density in the urethane foam. We will attempt to resolve these difficulties with the producer if possible.

Title

77 G-227 - A Research Study to Monitor the Deicing Chemical Pollution Prevention System of the MDSHT 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

Placement of three groundwater observation wells was completed in November. A schedule of monthly sampling from the wells was initiated.

Planned Program for Coming Year

Sampling of groundwater from the observation wells at the Reed City facility is to continue on a monthly basis with biweekly samplings during the spring thaw period. Also scheduled are periodic samplings of brine from the retention lagoon and leachate from the sand-salt stockpile. A record of precipitation at the test location is to be maintained by facility personnel. Comparative in-laboratory tests of leaching from small covered and uncovered sand-salt stockpiles is planned. A preliminary report will be issued after completion of the sand leaching tests. The report will include initial findings from the groundwater monitoring phase of the study.

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

This project started late in the year after moving to new laboratory quarters, is currently on schedule with the literature survey almost complete.

Planned Program for Coming Year

We plan to obtain samples of selected water based paints, prepare panels, and begin the accelerated tests. Progress to be made will depend a great deal on the amount of time it takes to obtain the necessary equipment.

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

This project, started at the end of the year, is currently on schedule with the literature survey almost complete.

Planned Program for Coming Year

We plan to obtain samples, prepare panels, and begin the accelerated tests. Progress which will be made depends a great deal on the amount of time it takes to obtain the necessary equipment.

Title

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

Purpose

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

Scope

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

Progress Past Year

The pavement and shoulder luminance were measured from the driver's eye position with a telephotometer. The results were reported in Report TB-56.

Planned Program for Coming Year

Repeat photometric measurements of the pavement-shoulder contrast.

Title

51 G-54 - Revision of Standard Specifications for Reflectorized Signs and Reflective Materials

Purpose

Develop specifications for reflective materials.

Scope

Evaluate reflective materials used for traffic control devices. Develop methods of evaluation and prepare specifications or specification revisions.

Progress Past Year

In conjunction with specific new materials evaluation projects; mechanical, photometric, and weathering tests were conducted in encapsulated bead reflective sheeting manufactured by the Seibu Polymer Chemical Co.,

the Fasson Corporation, and the suppliers of Kiwalite. Assistance was given to the Traffic and Safety Division and to the Specifications Section in preparing revisions for the new edition of Standard Specifications. A final report on the evaluation of Kiwalite reflective sheeting was completed. A testing program on peel strength of reflective sheeting was completed. A roadway installation of raised pavement markers were examined for luminance and durability.

Planned Program for Coming Year

Continue evaluation of reflective materials as submitted. Complete final report of evaluation of reflective sheeting submitted by Fasson Corporation.

Title

54 G-73(3) - Revision of Specifications for Traffic Control Devices

Purpose

To develop specifications for traffic control devices, specifically, lights and lighting for hazard warning.

Scope

Evaluate the performance of warning and delineation lighting; prepare specifications and specification revisions.

Progress Past Year

Warning lights were submitted for test. A strobe light system for use in railroad crossing warning signs was visually evaluated in a field demonstration.

Planned Program for Coming Year

Evaluate lights as sampled from construction sites by project engineers.

Title

68 G-163 - Delineator Condition Survey

Purpose

To determine type and possible cause of delineator failure in the field by periodic observations of representative delineators.

Scope

Observe delineator condition periodically on approximately 5,000 delineators on both urban and rural roadways in all counties in the lower peninsula. Record installation characteristics or parameters.

Progress Past Year

None.

Planned Program for Coming Year

Complete the project with a final report.

Title

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

Purpose

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

Scope

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

Progress Past Year

Federal and State air quality regulations were reviewed as issued and a file was maintained of material relevant to transportation. Information was obtained on analyzers available to monitor air quality. The air quality van monitored carbon monoxide, oxides of nitrogen, and ozone at several locations, including Grand Rapids, Dearborn, Pontiac, Metro Airport, Allen Park, Taylor, and near the Ambassador Bridge. The van was in service for all but 10 days for moving and maintenance during the year. Carbon monoxide concentrations from our data bank were supplied to DNR. Installation of equipment in a trailer was continued and will be completed soon after receipt of long awaited components for the data logger system. The ozone analyzer was obtained for this mobile unit. Two battery operated bag samplers were constructed and used to collect air samples for analysis at the air quality van. The data banks for meteorological data and air quality data were updated and expanded.

Planned Program for Coming Year

Complete construction of the trailer air quality monitoring unit and begin monitoring air quality. Continue air monitoring with the van. Update the meteorological data bank and expand the air quality data bank. Maintain current information on State and Federal air quality regulations relating to transportation. Keep current on equipment available to monitor air quality.

Title

73 G-192 - Evaluation of Glare Sources

Purpose

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

Scope

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

Progress Past Year

The possible impact on driver vision by the glare from a proposed large advertising sign was investigated in preparation for a court hearing.

Planned Program for Coming Year

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

Title

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

Purpose

To determine maintenance factors for tower lighting. To determine pavement illumination produced by tower lighting compared with design levels of pavement illumination, and with pavement illumination produced

by conventional lighting. To determine disability ceiling glare of tower interchange lighting (roadway lighting mounted in tower clusters at heights above 50 ft) compared with conventional low-mounted interchange lighting. To determine the need for underbridge lighting at interchanges. To determine the aesthetic value of tower lighting. To determine the value of tower lighting during inclement weather--fog, haze, sleet, snow, rain.

Scope

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

Progress Past Year

A digital data acquisition system was constructed. The system was capable of recording four photocells simultaneously with the instrumentation van traveling at 40 to 50 mph. Pavement illumination was measured for six Grand Rapids interchanges and for two Detroit interchanges illuminated by tower lighting.

Planned Program for Coming Year

Measure interchange illumination a second time, analyze data and write report.

Title

73 G-198 - Specification for Roadway Luminaires

Purpose

To develop specifications for roadway luminaires, especially high-pressure sodium luminaires.

Scope

Evaluate the performance of roadway luminaires except tower lighting luminaires. Develop methods of evaluation. Correlate evaluation with the manufacturers. Prepare specifications and specification revisions and provide roadway lighting design criteria.

Progress Past Year

Evaluation of a new reflector design by General Electric Corp. was completed. Two types of low-pressure sodium vapor sources were evaluated.

Planned Program for Coming Year

Evaluate low-pressure sodium vapor sources and underbridge luminaires.

Title

73 G-200 - Experimental Settling and Oil Skimming Chamber

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Glare from oncoming vehicle headlamps was videotaped.

Planned Program for Coming Year

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

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.

The adoption of a flagman vest design by the Federal Manual of Uniform Traffic Control Devices will result in standardization, thus saving the states money and providing familiar colors and patterns for better recognition of the flagmen by motorists nationally on the Interstate System.

Progress Past Year

A research proposal was submitted to the Federal government for a Category 2 project for further research on reflectorized flagman vests.

Planned Program for Coming Year

Obtain Federal approval for project, procure and develop reflectorized materials by July 1978, and evaluate the flagman vests and write report by January 1979.

Title

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

Purpose

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

Scope

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

Progress Past Year

A final project report was prepared and is being reviewed.

Planned Program for Coming Year

Final report will be issued to complete the project.

Title

72 D-27 - Evaluation of Cold-Mix Black Base Construction

Purpose

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

Scope

A cold-mix base will be included as part of a black base construction using normal construction procedures so that a performance comparison can be made under nearly equivalent conditions.

Progress Past Year

Project was completed with publication of MDSHT Research Report No. R-1048.

Title

74 D-29 - Sulfur-Asphalt

Purpose

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

Scope

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

Progress Past Year

Construction of the test sections on M 18 was completed and laboratory test samples obtained. A construction report was prepared and is being readied for review and publication.

Planned Program for Coming Year

Laboratory testing of cores will be completed and an annual survey of the project made. The construction report will be printed and distributed.

Title

75 D-30 - Recycling of Asphalt Pavement

Purpose

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

Scope

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

Progress Past Year

Reconstruction of the 11 miles of northbound roadway was completed. Core samples have been obtained and a construction report is in the review draft stage.

Planned Program for Coming Year

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

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 resurfacing projects.

Scope

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

Progress Past Year

None. Construction planned for 1977 was delayed until 1978 because of a strike by contractor's personnel.

Planned Program for Coming Year

Experimental test sections will be constructed.

Title

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

Purpose

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

Scope

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

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

Progress Past Year

Studies were made on two of the intended five projects. Cores have been obtained for density and tensile strength analyses.

Planned Program for Coming Year

Laboratory testing of the cores will be completed. The remaining three projects will be included in the study during 1978 if additional data is thought to be necessary, and a final report will be prepared.

Title

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

Purpose

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

Scope

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

Progress Past Year

Fifth year inspection and rut depth measurements were made of the test sections. No significant differences were found that would indicate any advantage to be gained by using increased salt quantities. In fact, as also found in the Newaygo tests (Research Project 57 E-15), a slight increase in rutting was found in the higher salt content areas. Based on this five-year survey it was decided to discontinue routine testing and observation of this project and prepare a final report recommending that the higher quantity of salt (40 lb/ton of aggregate) be given no consideration for future base course treatments.

Planned Program for Coming Year

Prepare and distribute a final report which will complete this work as an active project.

Title

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

Purpose

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

Scope

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

Progress Past Year

MDSHT Research Report No. R-1025 was published and distributed. The report describes a theoretical equivalency study, using the Chevron five-layer computer program, in which resilient moduli values were obtained from the literature rather than from our own laboratory tests. In order to obtain data from laboratory tests a project was initiated (Research Project 76 TI-411) to establish a testing procedure for measuring the stiffness of asphalt concrete surface layers and to investigate various factors that influence the quasi-modulus of surface layers. This testing was begun but interrupted by the move to the new laboratory facilities and later by the resignation of the project leader.

Crack surveys of the I 75 test sections continue to show more cracking in the asphalt treated base as compared with the aggregate base section. The two sections were built by different contractors and other structural details varied so they are not entirely comparable. We will continue to observe these areas to check for any significant changes that may develop.

Planned Program for Coming Year

The laboratory work program will be re-evaluated because of the possibility of obtaining MTS equipment for performing the tests. As proposed, however, the project should provide useful information and lend itself to possible future correlation with repetitive type testing results. Crack surveys of the I 75 test sections will be continued.

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

Profilometer data have not yet been analyzed, delaying preparation of a final report on the project.

Planned Program for Coming Year

Because of extensive repairs to be made to I 75, which includes the test sections of this project, an opportunity will be afforded for making additional tests of the slag base material. These will be made during 1978 and the results incorporated into the final report.

Title

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

Purpose

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

Scope

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

Progress Past Year

All of the laboratory and field testing of sandy materials, required by the MSU project, was completed and the rough draft of a final report of the project was completed and approved by the Department. The Department was also furnished with a progress report describing background investigations of the testing methods used.

Planned Program for Coming Year

The final report of our research project with MSU will be completed and reviewed. Results of this work will determine future studies in this area.

Title

72 E-50 - Shoulder Drains in Reinforced Shoulders

Purpose

To evaluate the effectiveness of improved subbase drainage as a measure of preventing heaving of concrete base shoulders.

Scope

Concrete base shoulders with and without supplemental shoulder drains were investigated.

Progress Past Year

Project was completed with publication of a final report (MDSHT Research Report No. R-1072).

Title

*73 E-51 - Transverse Cracking of Flexible Pavements

Purpose

To determine if the model, developed by Hajek and Haas, for predicting transverse cracking frequency is reliable for use in Michigan; and if necessary, revise the model to improve its accuracy. If the model is found not reliable, to make appropriate recommendations based on project findings.

Scope

To determine the actual frequency of occurrence of transverse cracks of flexible pavements located throughout Michigan and compare these results with crack frequency predicted by the model. In addition, to perform a laboratory study of actual bituminous stiffness in a section of pavement observed to have widely varying transverse cracking frequency but whose predicted cracking frequency is a constant.

Progress Past Year

No conclusions have been reached by the Departmental Committee formed to determine how the findings of this study are to be implemented. A proposal for additional testing has not been carried out due to moving the Testing Laboratory.

Planned Program for Coming Year

Some form of action for implementing the work should be recommended by the committee.

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

No field project was found during the year for testing the method so no additional work was done.

Planned Program for Coming Year

Attempt to use the method on a construction project and from the reaction of the committee make recommendations for further action.

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

A construction report was prepared and the performance of the jobs observed. So far, moisture pick-up of the Elastizell is well within design limit expectations. Instrumentation of the jobs was completed.

Planned Program for Coming Year

Conduct annual site investigations and prepare report of performance.

Title

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

Purpose

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

Scope

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

Progress Past Year

A report describing construction procedures and presenting test data was published and observations of the job made (MDSHT Research Report No. R-1044).

Planned Program for Coming Year

Periodic observations of field performance of the test sections will be continued.

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

The final report of this project, although substantially completed, was not finished due to the higher priority of other work.

Planned Program for Coming Year

Complete and publish the final report for this project.

Title

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

Purpose

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

Scope

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

Progress Past Year

Due to the pressure of higher priority work, activity on this project continued to be deferred. Objectives of the work were reviewed and revised.

Planned Program for Coming Year

All testing of samples should be completed during 1978.

Title

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

Purpose

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

Scope

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

Progress Past Year

A progress report of this project (MDSHT Research Report No. R-1046) was prepared and distributed. The report indicates the bituminous base to be about 20 percent stronger than the aggregate base.

Planned Program for Coming Year

Continue deflection measurements of the test areas.

Title

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

Purpose

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

Scope

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

Progress Past Year

All frost indicators were modified to improve readability.

Seasonal Benkelman Beam deflection measurements were made and laboratory analysis of the foundation materials completed. A report for the overload portion of this study was partially completed.

Planned Program for Coming Year

Periodic frost depth readings will be continued, and the overload study report completed. A report summarizing deflection data will be started.

Title

72 F-125 - Mixed-In-Place Stabilization

The purpose of this study is to prepare guidelines and specifications for mixed-in-place construction of bituminous stabilized soils and aggregates with provision for reclamation of existing materials.

Scope

This study will consist of a literature study, laboratory testing, and a review of construction experience within the state. Literature will be reviewed in order to compile guidelines for the selection of materials (both soils and asphalts), appropriate test methods, specifications, construction equipment and methods. A laboratory testing program will be conducted to determine appropriate mix design and construction control tests. The relationship between mix designs based on stability and field tests of density will be determined so that existing conventional soil compaction inspection methods may be utilized as much as possible. Wherever possible, construction experience will be compared with the compiled information as a check on its appropriateness for Michigan conditions. The study will be initially limited to gravels and sands, either pit-run or processed and include pulverized bituminous mixtures.

Progress Past Year

MDSHT Research Report No. R-1051 was published, completing work on this project.

Title

75 G-215 - Pavement Feedback System

Purpose

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

Scope

For the present, the system will consist of information obtained on two sections of I 75 from the Oakland-Genesee Co. line to Bridgeport. Eventually, the system should include 80 to 90 percent of the state trunkline system.

Progress Past Year

This project was suspended early in 1977 for two reasons:

1) Problems involved in the retrieval of maintenance data for use in the secondary file. Maintenance records are currently kept on the basis of whole sections of trunklines and major facilities between county lines. This system, while adequate for the Maintenance Division, does not provide the informational detail needed in the analysis of maintenance requirements between two shorter sections (within the county-long section) which may differ from each other in pavement systems, base types, subgrade types, stabilization, admixtures, aggregates, contractors, etc.

2) The Test Report Transmittal and Retrieval System is progressing and it is anticipated that the data in that system can be used in the Pavement Feedback System.

Planned Program for Coming Year

In the event that the Test Report T&R System is completed and implemented, activity on the subject project will be resumed.

Title

75 G-216 - Evaluation of Prewetted Salt for Ice Control

Purpose

The purpose of this investigation is to evaluate the effectiveness of the method with respect to efficiency and overall economy in ice control application of rock salt.

Scope

The Research Laboratory will make observations on both normal and prewetted sodium chloride ice control applications during the 1975-76 season. These observations will include the calibration of spreading equipment, testing the pattern of spread on the road, and its melting effectiveness during actual storm applications. Such observation will be made on both conventional and prewetted operations.

Progress Past Year

This project was completed with the publication of MDSHT Research Report No. R-1061.

Title

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

Purpose

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

Scope

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

Progress Past Year

The computer output data collected from multiple runs with controlled input to determine the effects of varying the values of percent commercial vehicles, soil support, and layer coefficients were tabulated and examined. The results which were supposed to show the differences in total cost due to wide ranges in the selected parameters were not outstanding and, therefore, no satisfactory conclusion could be drawn because the basis for the structural module of SAMP 6 is empirical rather than rational. It was decided in the middle of the year to replace the structural module with one which will reflect a rational method of pavement design and analysis. Since SAMP 6 is essentially a total cost method and contains an excellent routine for summarizing the top 30 feasible trial designs, it was decided to keep that part of the SAMP 6 program. Chosen to replace the structural module is the VESYSII (Viscoelastic System II) program, obtained for us by Dr. Fred Hsia, and which is being tested in several states of the country under FHWA-sponsored projects.

So far, our Burroughs 7700 computer has accepted the VESYSII program, that is, we can enter input data and expect output. However, the limited capability of the Burroughs computer is causing significant departures in the answers from those expected from the same set of input data, especially in the creep and rut values and predictions. Presumably the

original program was developed on a machine with a much greater capability than the Burroughs. We have asked Leo DeFrain of our Instrumentation and Data Systems Group to check the cause of the discrepancies and to recommend what might be done to compensate for the limited capability of our machine.

Planned Program for Coming Year

Incorporate the structural module of VESYSII into the SAMP 6 program after the discrepancies in output values have been ironed out. Proceed with the investigation to determine how the SAMP 6-VESYSII combination can be used in Michigan flexible pavement design.

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. Then to evaluate the performance of the mastic surfaces.

Scope

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

Progress Past Year

The surfaces were inspected, skid measurements were made, and the bridge deck was tested for permeability.

Planned Program for Coming Year

Inspect surfaces, and make skid measurements. Prepare final report.

Title

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

Purpose

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

Scope

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

Progress Past Year

Interim report prepared and published, (MDSHT Research Report No. R-1030).

Planned Program for Coming Year

Continue field inspections and crack surveys.

Title

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

Purpose

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

Scope

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

Progress Past Year

Construction work completed.

Planned Program for Coming Year

Observe performance and write report.

Title

77 D-34 - Asphalt Recycling by Heat Transfer Method

Purpose

To develop expertise in recycling asphalt pavement.

Scope

An existing asphalt concrete pavement will be pulverized and processed through an asphalt batch mix plant together with aggregate and additional asphalt cement. The unheated pulverized asphalt concrete will be combined

in a pugmill with heated aggregate and asphalt cement. By preventing contact between flame and pulverized asphalt concrete, air pollution will be minimized.

Progress Past Year

Literature search done.

Planned Program for Coming Year

Select and construct project.

Title

77 D-35 - Drum Mixer Recycling of M 52 Asphalt Pavement

Purpose

To determine whether pulverized asphalt concrete could be successfully recycled through a drum mixer without causing excessive air pollution.

Scope

Using a CMI Rotomill, about 500 tons of asphalt concrete on a runway at Bishop Airport in Flint was removed and pulverized. The material was processed through a Boeing drum mixer modified with a heat shield to prevent burning of the pulverized asphalt. It was then placed as a wearing course on Route M 52 south of Perry.

Progress Past Year

Project planned and constructed. Air pollution was only slight and the recycled mix appeared excellent.

Planned Program for Coming Year

Continue observations of M 52. Plan and implement additional recycling projects.

Title

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

Purpose

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

Scope

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

Progress Past Year

Condition surveys were made of pavements scheduled for such.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Measurements and observations of the performance of the test sections were made semi-annually. Failures on the mesh reinforced pavement were repaired using full-depth, undowelled repairs. Two construction joints on the bar mat reinforced pavement were repaired by restoring the steel continuity. Steel samples at the bar mat repairs were obtained for corrosion study.

Planned Program for Coming Year

Performance evaluations of the pavement and repairs will be made. Examine and test steel samples to determine the corrosion effect on CRCP reinforcement.

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

Semi-annual measurements on movements at end anchors and at crack openings were taken on the bar mat reinforced section. The mesh reinforced section has failed in continuity at 112 locations. Visual inspections of the failures and of the general condition of the pavement were made periodically. Repairs have been made at severely deteriorated locations by Maintenance forces. Cores were taken at wide cracks on the bar mat reinforced section to study corrosion of the steel.

Planned Program for Coming Year

The measurements at end anchors and at selected cracks will continue on the bar mat reinforced section. Steel samples will be examined for determination of the amount of corrosion.

Title

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

Purpose

To establish design considerations for use on continuously reinforced pavements in metropolitan freeway locations. To 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 special constructed WF joints. A variety of construction joints were used.

Progress Past Year

The performance of the pavement was observed by conducting twice-a-year inspections. Special attention is given to detect signs of corrosion of the steel, wide cracks, spalls, and construction joint problems.

Special surveys were conducted by Maintenance and Research personnel to determine location and area where repairs are needed. This information was transmitted to the Design Division for their use in preparing contracts for median barrier and repair work. Specifications covering repair of continuously reinforced pavement were written. Repairs on CRCP on I 75 in Detroit were made and steel samples obtained for corrosion study.

Planned Program for Coming Year

The twice-a-year inspections will be continued and appropriate recommendation concerning maintenance will be made if warranted. Steel samples will be examined and tested to determine the corrosion effect on steel bars in CRCP.

Title

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

Purpose

To evaluate the effects on pavement of studded tires.

Scope

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

Progress Past Year

Annual stud use surveys and pavement rut depth measurements were made. A proposed amendment to the law regulating stud use was prepared.

Planned Program for Coming Year

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

Title

67 F-95 - Evaluation of Acme Load Transfer Devices

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Winter and summer readings were completed and the yearly condition survey was made. Since this is a long term evaluation, no other work was required. Data are kept tabulated and performance information is used in discussions pertaining to present design and construction practices. Additional problems were noted at expansion joints in the shoulders.

Planned Program for Coming Year

Make periodic evaluations as in the past. Condition is still quite good so the project will last several more years. A progress report is anticipated.

Title

68 F-103 - Galvanized Steel Reinforced Concrete Bridge Decks

Purpose

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

Scope

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

Progress Past Year

Weekly treatment of the field exposure slabs was continued through the seventh winter. Routine maintenance was done at the field exposure site. Field inspections, "corrosion-cell" readings and delamination detector surveys were completed on the five experimental decks. "Corrosion-cell" readings and condition surveys were completed on the field exposure specimens. All data were tabulated and records were brought up to date. Quarterly reports on the project were prepared for the FHWA. A formal report on the project, MDSHT Research Report No. R-1033 was prepared, printed, and distributed.

Planned Program for Coming Year

Next year's work will be essentially the same as last year's. The project has been kept up to date and on schedule.

Title

68 F-104 - Plastic Coated Dowels for Pavement Joints

Purpose

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

Scope

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

Progress Past Year

Semi-annual joint width measurements were taken and crack formation and joint deterioration surveys were conducted.

Planned Program for Coming Year

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

Title

69 F-105 - Effects of Transverse Saw Cutting PCCP on Reflection Cracking

Purpose

To evaluate the effectiveness of saw cutting concrete pavements prior to resurfacing in reducing reflection cracking in the overlay.

Scope

Two test sites are suggested, one in the north and one in the south, each with replicate sections of varying saw cut intervals and thickness of stabilized lift.

Progress Past Year

Work plan was revised to require a smaller test area.

Planned Program for Coming Year

Refer to Engineering Operations Committee for selection of test sites.

Title

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

Purpose

To 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 linear miles of shoulder on I 75 near Flint.

Progress Past Year

Shoulders were inspected.

Planned Program for Coming Year

Survey the shoulders and write final report.

Title

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

Purpose

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

Scope

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

Progress Past Year

A progress report was prepared for the FHWA, condition surveys, faulting and joint opening measurements, and profilometer surveys were completed, and all data were reduced and tabulated. Information derived from the project was used as background material in discussions pertaining to proposed changes in design and construction practice.

Planned Program for Coming Year

Next year's work will closely follow that outlined above for the past year, as this is a long-range evaluation type project.

Title

70 F-114 - Broomed Concrete Pavement Surfaces

Purpose

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

Scope

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

Progress Past Year

Experimental textured sections were tested with the Department's skid vehicle.

Planned Program for Coming Year

Continue observing and testing experimental textures. Write final report.

Title

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

Purpose

To determine the relative performance of the experimental pavement types.

Scope

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

Progress Past Year

A progress report was prepared for the FHWA. Condition and roughness surveys, winter joint readings were recorded, and all data reduced and tabulated.

Planned Program for Coming Year

Next year's work will be very similar to the work outlined above for last year. This is a long-range evaluation, and deterioration has not yet begun in any consequential amount. Therefore, we expect several more years of observation before having sufficient information available to issue a final report.

Title

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

Purpose

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

Scope

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

Progress Past Year

Data on changes in elevation between old and new slabs and on joint width variations at the repairs were obtained semi-annually.

Planned Program for Coming Year

Data collection on the above factors will continue.

Title

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

Purpose

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

Scope

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

Progress Past Year

Condition surveys were completed on the pressure relief area and the adjacent control section. Summer and winter joint readings were made, and data were reduced. Information from this project was used in the development of concepts for preventive maintenance. No repairs have been required in the relieved section, while 9 percent of the joints have been repaired in the control section of the opposite roadway.

Planned Program for Coming Year

This project will be monitored for a few more years to gain further information on the behavior of pressure relief joints over the long term. Readings and surveys will be continued.

Title

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

Purpose

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

Scope

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

Progress Past Year

Semi-annual measurements of relief joint movements were made. Annual inspections of joint spall deterioration on both roadways were conducted. Records on full-depth repairs conducted on the northbound roadway indicate 25 repairs were made while none have been done in the pressure-relieved southbound roadway during the 4 years since this study was initiated. A progress report was issued.

Planned Program for Coming Year

Measurements of relief joint movements, inspection of joint deterioration, and blowup surveys will be continued.

Title

*72 F-124 - Fracture Toughness and Fatigue Properties of Steel Plate Butt Joints Welded by Submerged Arc and Electroslag Welding Procedures

Purpose

To investigate the electroslag welding procedure in comparison to the submergec arc welding procedure for fabricating steel plate butt joints for highway bridges.

Scope

Fatigue, impact and metallographic experiments were made on electroslag and submerged arc welds in ASTM A 36 and A 588 steels, 1-3/4 and 3-in. thick.

Progress Past Year

The final report was printed and distributed (MDSHT Research Report No. R-1011).

Planned Program for Coming Year

Project completed.

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. Sixteen projects were reported in October 1974, several of the remaining projects were not scheduled for letting until 1976. The last project was let in October. A report was issued which included prices of all projects let. Concrete prices have decreased and bituminous prices have increased.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Semi-annually condition surveys were made to check the performance of slipformed CRC pavements.

Planned Program for Coming Year

Continue periodic surveys to monitor the performance of this type of pavement. Also, continue to check on construction procedures when the need arises, and assist Design and Construction Divisions in preparing plans and specifications.

Title

*73 F-131 - Epoxy Resin Coated Reinforcing Steel

Purpose

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

Scope

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

Progress Past Year

Quarterly progress reports have been prepared for the FHWA. Treatment of small size laboratory specimens was continued. Three experimental bridges have been built. Weekly "corrosion-cell" readings have been made on the laboratory specimens. Field exposure specimens were treated periodically, and evaluated. "Corrosion-cell" readings were made on the field exposure specimens. All data have been recorded and kept current. A progress report was issued (MDSHT Research Report No. R-1067).

Planned Program for Coming Year

Continue treatment and evaluation of the laboratory and field exposure specimens and experimental decks.

Title

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

Purpose

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

Scope

Approximately 1,000 ft of experimental concrete glare screen is in direct comparison with a similar length of mesh. Subjective evaluation of another construction project was added at the request of the FHWA.

Progress Past Year

A progress report was prepared for the FHWA. Recommendations were made relative to use of glare screen with the revised "New Jersey" type concrete median barrier. Additional project to be included, at Jackson, was constructed in the fall. A letter including results and recommendations was issued in December 1977.

Planned Program for Coming Year

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

Title

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

Purpose

To compare performance of several types of pavement systems.

Scope

Three experimental pavement types were installed at a rural freeway site. Plain concrete slabs with and without load transfer, on three different types of base course, were installed for comparison with the standard

Michigan pavements with load transfer and reinforcement. Three, half-mile sections of each type were built. Asphalt treated porous base, a more conventional bituminous base and aggregate base courses were placed on sand grade.

Progress Past Year

Joint and fault measurements were recorded, and profilometer runs made.

Planned Program for Coming Year

Continue all experimental measurements and data reduction.

Title

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

Purpose

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

Scope

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

Progress Past Year

Two requests were received and responded to.

Planned Program for Coming Year

Requests will be responded to as they come in.

Title

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

Purpose

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

Scope

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

Progress Past Year

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

Planned Program for Coming Year

Respond to any requests for assistance from the welding inspection group.

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-up.

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

Installation of pressure relief joints for preventive maintenance was completed on 50 miles of dual pavement on US 27 from south of Ithaca to north of Clare. Many projects were completed utilizing pressure relief in joint repair contracts. Surveys are being conducted to determine the effectiveness of completed installations. Five projects which contain pressure relief are being surveyed along with two untreated projects for control.

Planned Program For Coming Year

Complete surveys and evaluate performance of completed projects for determination of future course of preventive maintenance program. Continue promoting use of joint rating system for establishing priority for all maintenance projects.

Title

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

Purpose

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

Scope

This is an open-ended Category 2 project. Initially, 10 crossings and three new materials were included. Five new crossings and three new materials have been added since the study was initiated.

Progress Past Year

One steel plank crossing was constructed. Observation of construction procedures and evaluation surveys of completed crossings were made. A progress report is in review.

Planned Program for Coming Year

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

Title

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

Purpose

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

Scope

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

Progress Past Year

Additional background and preparatory work was done, and the experimental weldments for the project were fabricated. Corrosion specimens were made and installed. Electro-hydraulic equipment was reinstalled at the new building. Procedure qualification tests were run on all new weldments. Experimental procedures have been developed, and the first fracture-mechanics tests were completed. Many of the required specimens were prepared.

Planned Program for Coming Year

Continue sample preparation experimentation, and analysis.

Title

75 F-145 - Rehabilitation of Old Concrete Pavement

Purpose

To determine the most feasible and economical way of recycling and rehabilitating old reinforced, concrete pavement located on US 2, Mackinac County.

Scope

Literature search and review in the areas related to concrete sawing, breaking and crushing and handling mesh-reinforced concrete slabs in place; also in the areas related to the characteristics of crushed concrete as aggregate material for recycling at job sites.

Progress Past Year

Portion of available information reviewed. Recycling of concrete does not appear to be practical at this time.

Planned Program for Coming Year

Close project.

Title

75 F-146 - Steel Sampling, 76 Bridges

Purpose

To remove, test and evaluate, steel samples from girders of bridges throughout the state, to determine whether the bridges should be posted for load limits.

Scope

Samples were taken from four girders each of 76 different bridges. Tensile, impact and chemical properties were determined.

Progress Past Year

Machining of specimens for final nine bridges was completed. Metallographic examinations to explain Charpy variations were made. Some additional investigation has been done on the metallurgy involved.

Planned Program for Coming Year

Prepare a final report covering the Charpy impact evaluation, to close the project.

Title

75 F-147 - Pavement Riding Quality

Purpose

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

Scope

Conduct surveys and report results on all new construction and on past construction at 5, 10, 15, and 20 year service levels.

Progress Past Year

A total of 2,500 lane miles of concrete, bituminous, and overlays were tested and data are on tape to be processed. An on-board processor was completed and is now in use.

Planned Program for Coming Year

Continue with established survey procedures.

Title

75 F-148 - Pavement Roughness for Non-Reinforced Ramps and Service Roads

Purpose

Compare riding quality of non-reinforced pavements with pavements which are reinforced.

Scope

Ramps and service roads are now being constructed of short length non-reinforced concrete slabs. A sample of these will be selected and measured for riding quality.

Progress Past Year

A few projects were surveyed but data are insufficient for evaluation.

Planned Program for Coming Year

Continue selecting pavements for evaluation, measure their riding quality, and make a comparison of reinforced vs. non-reinforced construction.

Title

75 F-149 - Experimental Project for Variable Spacing of Expansion Joints

Purpose

To compare the performance of experimental roadways, having expansion space at various intervals.

Scope

Several experimental sections are to include variable spacing between expansion joints (from every joint to about every 1/4-mile).

Progress Past Year

None. Was previously approved by EOC but has not been included in a contract as yet.

Planned Program for Coming Year

Coordinate with Design Division to select site and incorporate special provisions in the plans and specifications.

Title

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

Purpose

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

Scope

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

Progress Past Year

Remainder of construction was completed in the spring. Joints instrumented and initial measurements made.

Planned Program for Coming Year

Take readings and compile data. Perform condition survey.

Title

76 F-151 - Field Evaluation of Guardrail to Bridgerail Connection

Purpose

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

Scope

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

Progress Past Year

The modules fixtures and load cell were built. The load cell was calibrated and testing was performed. Letter reports issued.

Planned Program for Coming Year

Issue formal report and conduct further experiments, if time permits.

Title

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

Purpose

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

Scope

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

Progress Past Year

About 11,000 skid tests were made throughout the state.

Planned Program for Coming Year

Continue skid testing program.

Title

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

Purpose

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

Scope

All areas on the state trunkline system are under observation.

Progress Past Year

About 400 skid tests were made and reported on.

Planned Program for Coming Year

Continue program.

Title

72 G-189 - Sources and Effects of Environmental Noise

Purpose

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

Scope

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

Progress Past Year

A validation study was completed (MDSHT Research Report No. R-1075) for low volume, low speed traffic operating at close distances along the I 696 service drives. The present noise level prediction model was found to be unacceptable for these conditions and thus an appropriate modification was incorporated and statistically verified for this project.

Planned Program for Coming Year

An implementation and validation of the, soon to be released, new FHWA traffic noise level prediction program is scheduled for 1978. This will require considerable field measurement work in order to determine the proper reference emission levels for the three vehicle type categories; cars and light trucks, medium trucks, and heavy trucks. Therefore, the FHWA model must be calibrated to the three average vehicle types on a state by state basis. After these reference levels have been estimated, the overall model will be statistically evaluated for numerous traffic data sets at a variety of sites in order to determine acceptability for Michigan.

Title

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

Purpose

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

Scope

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

Progress Past Year

1) Development of a program for the PDP 8/e computer to convert multi-channel analog data to digital magnetic tape.

2) Development of a computer program to program eraseable read-only-memories used in the air monitor trailer and Troxler density gages.

3) Development of data acquisition system for measuring highway light levels at highway speeds.

Planned Program for Coming Year

1) Develop hardware and electronics required to provide a non-contact sensor for the rapid travel profilometer.

2) Develop computer program and interface for data acquisition system for the Photometry Unit. This system will use a 8080 microprocessor and magnetic tape drive for data storage.

Title

73 G-203 - Experimental Evaluation of Extended Establishment Period for Freeway Landscape Projects

Purpose

To evaluate the results of extending the establishment period to two summer growing seasons following the completion of planting.

Scope

To assist the Roadside Development Section in evaluating the relative performance of two adjacent landscape projects (a conventional, one-growing season to be compared with an experimental, two-growing season); provide assistance for analyzing plant care work and interpreting maintenance cost records required for both experimental and control projects.

Progress Past Year

Project completed and final report issued by the Roadside Development Section.

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

Sewage treatment effectiveness of five experimental rest areas were evaluated and a final report issued by the University.

Planned Program for Coming Year

Project extended to include two more rest areas for sewage treatment evaluation.

Title

74 G-209 - Investigation of Truck Litter Problem

Purpose

Document problem of highway litter from uncovered trucks to initiate legislative action for a bill requiring the covering of loads.

Scope

Initial plans involved several means of quantifying the type and amounts of material deposited along the roadways by uncovered trucks.

Progress Past Year

Bill passed requiring covering of trucks. Project completed.

Title

75 G-211 - Noise Level Inventory of Michigan Freeways

Purpose

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

Scope

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

Progress Past Year

MDSHT Research Report Nos. R-1013 and R-1013A were completed.

Title

75 G-212 - No-Discharge Recirculating Sewage System for Freeway Rest Areas

Purpose

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

Scope

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

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

Project just established.

Planned Program for Coming Year

A demonstration of crack sealing and seal coat will be conducted during January by Sahuaro Petroleum and Asphalt Co. of Phoenix, Arizona. A project utilizing the interlayer concept will be programmed for the next construction season.

Title

77 G-226 - Evaluation of Snowdrift Locations

Purpose

To develop practical and economical means of identifying and controlling those factors involved in snowdrift problems at specific locations.

Scope

To develop research procedures for identifying influencing factors in snowdrift problems and for improving snowdrift control considering both economy and field performance.

Progress Past Year

A brief survey was conducted to determine the scope of the proposed study.

Planned Program for Coming Year

Waiting for further development of the proposed study.