

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

MDOT Report No. 359 (A)



**TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION**

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Research Laboratory Section
Testing and Research Division
Research Report No. R-1261

Michigan Transportation Commission
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Lansing, April 1985

INTRODUCTION

The purpose of this report is to illustrate the scope of the activities of the Research Laboratory during the 1984 calendar year. By better informing Department personnel of these activities, we hope to implement the research which is being conducted, and to integrate our research findings into Department practice.

This year, the report is divided into five sections. The first section outlines some of the highlights of the past year's research. Section two consists of abstracts of all Research Reports published during 1984. The third section contains a list of New Materials projects completed during the year, the fourth section lists the Technical Investigations completed during the year, and section five lists the Action Plans completed in 1984.

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

RESEARCH HIGHLIGHTS - 1984

The Soils and Bituminous Systems Unit, in cooperation with the Maintenance Division, completed a field evaluation of calcium magnesium acetate (CMA) which the Federal Highway Administration has identified as a possible ice control alternative to rock salt. This field evaluation was conducted as part of a pooled fund study involving 22 other state agencies, as well as the FHWA. A total of 98 tons of CMA was applied in Michigan using conventional salt spreading equipment during the 1983/84 winter season. Results of this evaluation indicate CMA to be effective in melting ice and snow, but to react more slowly than rock salt. It was concluded that CMA could be effective for ice control on critical structures or environments where chlorides should not be used.

As this was underway, the Structural Research Unit designed and constructed accelerated testing equipment to evaluate the corrosive effects of CMA on structural steel. Representative structural metals were selected for exposure to CMA and road salt environments in separate weathering chambers, where identical specimens were automatically rotated and immersed in solution then dried under ultraviolet light at an elevated temperature. Quantitative observations of the CMA and salt specimens after three months of exposure have consistently indicated considerably worse corrosion occurring in the salt environment. From a corrosion standpoint, the evidence suggests that selective use of CMA may be practical. Although initially more expensive, potential savings may be realized from decreased maintenance, increased service life, and reduced environmental damage in sensitive areas.

Because of the controversial nature of the use of chlorides for highway deicing, Research personnel, in cooperation with the Maintenance Division, are working on the development of a long-range Departmental plan for ways to reduce the amount of chloride usage in Michigan. This is aimed at reducing the adverse effects of salts on the environment, automobiles, and the highway infrastructure. Efforts are being closely coordinated with legislative initiatives to reduce the amount of salt used for highway ice control.

Development of the Department's Pavement Management System continues to progress. Preliminary surveys were completed by each District on all state highways and data were processed for use by management. The Division conducted training courses in each District on how to conduct surveys, process data, and utilize the results. Consequently, each District can now rate their pavements based upon condition, and can determine causes of pavement distress. Considerable pavement management software, for processing the voluminous data collected, were developed by our Statistics and Data Processing personnel in order to meet the specialized needs of the system.

The Structural Research Unit has completed extensive evaluations on wooden guardrail posts and, in cooperation with Michigan Technological

University, has developed a specification for implementation in 1985. The major revisions and changes in the specification centered on better quality control and more extensive inspection prior to installation. The Spectrochemistry Unit adopted analytical methods based on atomic absorption spectrophotometry to determine retained preservative levels in the posts, to support these revised specifications. The preservative solution, which is driven into the wood under heat and pressure, contains compounds of copper, chromium, and arsenic. Each of these metals must be measured in samples of wood from finished guardrail posts to determine compliance with the specifications. In the future, wooden posts of high quality and durability will be used, thus helping to ensure safer guardrail systems and increased service life.

The Materials Research Unit was involved in the installation of two concrete overlay projects, as part of the rehabilitation process of the Interstate system. A four-lane section of I 96, and a two-lane section of US 23 were overlaid with a 7-in. reinforced concrete overlay with a 41-ft joint spacing. The joints are dowelled and sealed with neoprene seals, and the shoulders consist of reinforced concrete and are tied to the pavement. The overlay is not bonded to the existing pavement, but separated by a 3/4-in. sand-asphalt layer. Test sections have been established on both projects to evaluate the bond-breaker as a means of preventing reflection cracking, and to rate the overall performance of the overlays to determine the feasibility of using concrete overlays for rehabilitating deteriorated pavements.

The Coatings Group continued its work on a performance specification for bridge paints. This past year, over 100 different paints were applied and tested in the laboratory. It was decided that the only practical method of handling the large amount of data these tests generate was to computerize the system. Work on the programs and data storage was begun. The paint schools, for training Department and contractor personnel, were continued, and were well received. This year over 112 people attended. Total shop painting continues to gain acceptance to the point that some fabricators are now promoting it for use in other states.

The Structural Research Unit continued its involvement with the Design and Construction Divisions during repair of the segmental concrete bridge at Zilwaukee. This work began in 1982, when the accident to the bridge took place, and concluded in March 1984. The Instrumentation and Data Systems Unit played a significant role in this study as well, as the instrumentation was installed and operated by Unit personnel. The repair involved lifting the superstructure off the columns and replacing the damaged bearings with new ones; i.e., lowering the superstructure onto the new bearings, and rotating the superstructure back into alignment in six increments. During the final phase of the repair procedure the primary function of the Unit was to monitor movement of the columns, the superstructure, the expansion joints, and the footing. Without this monitoring information, it would have been impossible to determine exactly what kind of forces were being introduced into the pier during each rotation. After the second

rotation, the measurements proved that the top of the column had moved to the point that no more rotations could take place without first freeing up the bearing to allow the superstructure to slide on the column rather than continue to move or bend the column. A jacking device was used to move the bearing and the repairs continued with no additional unusual movements. Had this motion not been detected by the special equipment purchased and monitored by the Unit, unplanned loads would have been applied to the columns, and the final slippage of the massive structure could have been troublesome.

Among its many activities this past year, the Instrumentation and Data Systems Unit installed an electronic scale for monitoring truck weights on the International Bridge at Sault Ste. Marie. Some of the advantages of electronic scales are that they require less maintenance and retain their accuracy much better than mechanical scales. Printouts of the weights are easily obtained and electronic displays can be provided for both the scale operator and the truck driver. An audible alarm can be set to alert the weighmaster to overweight vehicles. This allows him to visually inspect the truck for any safety violations or hazardous conditions while it is passing over the scale.

An important aspect of the Research Laboratory is the ongoing programs of testing and development that take place during each year. Regularly scheduled programs such as our pavement friction testing program—which during 1984 conducted 14,887 friction tests—and our measurements of riding quality—which surveyed 1,693 miles of pavement—continue to supply valuable information to concerned Department Divisions. On 10 construction projects, we provided the information for the Department's 'incentive/disincentive' type specification for ride quality of new paving projects. In this program, a smoother pavement gains a bonus for the contractor, but for a poorer riding quality, a penalty is assessed. Our Spectrochemistry Unit continues to provide vehicle (and ambient) exhaust emission measurements on request from other Divisions and Departments, and the Instrumentation and Data Processing Unit is continually involved in measurement of traffic-generated noise, both for the design of new route locations and to answer citizen requests for the possible construction of noise abatement provisions.

ABSTRACTS OF RESEARCH REPORTS
(January 1984 Through December 1984)

- R-1235 - "PCC Pavement Joint Restoration and Rehabilitation (FHWA NEEP Project 27): Construction Report," (79 F-159). J. E. Simonsen, F. J. Bashore, and A. W. Price.

This report describes the Department's work to date on this NEEP project, conducted in cooperation with the Federal Highway Administration. It traces the evolution of Michigan's concrete pavement joint rehabilitation method currently in use. This method begins with the full-depth sawing of the repair limits and the lifting out of the old concrete so that the existing base remains undisturbed. When these repairs were first used, it was felt that tying the new patch to the existing pavement slab would involve too much hand work on the part of the contractor; therefore, the void was filled either with a precast concrete slab or by a cast-in-place, CaCl-accelerated, 9-sack concrete mix. Although these repairs were considered to be temporary, economic conditions dictated that they remain in place well beyond their intended life, and this resulted in tilting of these repairs. Consequently, the Department developed a drilling rig that made dowelling practical. The Department now uses dowelled joints exclusively, consisting of 10 dowels, 1-5/16 in. in diameter, inserted in 1-3/8-in. machine-drilled holes.

- R-1236 - "Possible Sites for Utilizing Excess Soil from Construction of I 696, Lahser to I-75 to Provide Noise Barriers," (75 G-211). F. W. Harwood and R. J. Holcom.

This report was a preliminary study of the possibility of using excess earth from this construction project to construct noise-shielding earth berms along the route. After preliminary review by the Engineering Operations Committee, it was returned to the authors with a request to expand the scope of the original, modestly proportioned study, to encompass greater quantities of earth spoil. A report on this expanded version will be issued at a later date in lieu of this unpublished paper.

- R-1237 - "Performance Evaluation of an Experimental Slurry Seal Emulsion as Filler of Deteriorated Longitudinal Joints in Concrete Pavement Being Prepared for Asphaltic Concrete Resurfacing," (78 TI-467). C. A. Zapata, D. L. Andrews, and L. J. Pearson.

This report describes the construction and three years' field evaluations of a study to investigate the effectiveness of slurry sealing to control the problem of longitudinal reflection cracking. Test sections were selected on a concrete pavement that was scheduled for bituminous overlay: one set of sections were untreated, one set patched with MDOT's conventional bituminous mixture, and one set was treated with a slurry seal, prior to overlayment. No significant construction difficulties were experienced, and after three years, no significant difference can be noted in any of the sections. Further reports will be issued when notable developments occur.

R-1238 - "Comparison of Aggregate and Bituminous Treated Bases, I 75 South of Grayling," (68 E-42). R. C. Mainfort and E. C. Novak, Jr.

The purpose of the project was to develop a method for relating bituminous base thickness to aggregate base thickness of equal strength. Testing procedures for the determination of resilient modulus of base materials, and theoretical establishment of thickness equivalency factors, have been covered in previous reports. This report discusses the field evaluations of these two different bases as constructed on I 75. This part of the study shows that the thinner (4-in.) bituminous base sections performed as well as those constructed with a normally used thickness of graded aggregate (8 in.), and that selection of an aggregate base or the bituminous/aggregate combination would appear to depend upon economic rather than structural considerations.

R-1239 - "Evaluation of Sulphlex as a Binder in Pavement Resurfacing Mixtures: Final Report," (79 D-38). J. H. DeFoe.

In cooperation with the Federal Highway Administration, the Department placed an experimental test section, along with a conventional asphalt control section, of Sulphlex, a plasticized sulfur material developed as a substitute for asphalt cement in bituminous paving mixtures. Mix designs were prepared in the Testing Laboratory and checked by the FHWA laboratories in Maryland. The experimental sections were tested at six-month intervals during the two-year evaluation period. After two years the Sulphlex sections had deteriorated to such an extent that removal and replacement were recommended.

R-1240, (1) - (4) - "Petrographic Analysis of Dense-Graded Gravel Aggregate," (83 TI-916). R. W. Muethel.

Samples of dense-graded gravel aggregate were submitted to the Research Laboratory's Materials Research Unit for petrographic analysis from the following sources: Butkovich #2 Pit No. 49-74 (R-1240); Garfield #2 Pit No. 49-104 (R-1240 (1)); Ozanich Pit No. 49-97 (R-1240 (2)); Peters Pit No. 49-23 (R-1240 (3)); and, DNR Pit No. 49-101 (R-1240 (4)). The general petrographic composition of the material is included in the reports, as are the specific gravity and absorption data. Detailed rock type descriptions of the material in the sample are also provided.

R-1241 - "Annual Report of the Activities of the Michigan Department of Transportation Research Laboratory."

R-1242 - "Field Trial of Continuous Asphalt Concrete Density Monitoring Devices: Final Report," (83 D-45). J. H. DeFoe.

Two nuclear asphalt monitoring devices were evaluated under contract from the Federal Highway Administration; one, measuring density and temperature, was a prototype device constructed for the FHWA, the other measured density only, and is a commercially available gage. Both of these roller-mounted devices were evaluated in the laboratory (where

tests were performed on blocks of known density) and in the field (where they were compared with conventional nuclear gage values and core density results). Laboratory tests showed that the devices could both measure density with accuracy, and there was generally good agreement in the field tests with the conventional test methods; however, on layers less than 2 in. thick, measurements are influenced by underlying layers.

R-1243 - "Performance Evaluation of Plastic Fabrics as Overlay Reinforcement to Control Reflection Cracking," (71 NM-286; 74 NM-414; 72 NM-323; 78 NM-552; 80 NM-617; and, 78 NM-566). C. A. Zapata, M. A. Chiunti, and L. J. Pearson.

This report describes the field installation of fabric reinforcing strips, placed over the repaired joints and cracks of an older concrete pavement prior to bituminous resurfacing, in an attempt to reduce reflection cracking. The installation is intended to compare the performance of six different fabrics (Protecto Wrap, Y-78, Pave Prep, Roadglas, Bituthene, and Polygard) as well as to observe the general effectiveness of fabric underlayment. No undue difficulty was experienced in placing the fabrics. At this time, the results of crack surveys are inconclusive because of the newness of the installation; future reports will be issued when appropriate conclusions can be reached.

R-1244 - "Evaluation of Various Types of Railroad Crossings: Seventh Progress Report," (75 F-143). J. E. Simonsen.

Michigan has been conducting an on-going research project in cooperation with the FHWA to investigate various proprietary railroad crossing materials and designs. This report describes five such crossings: Steel Plank, Saf and Dri, Parkco, Cobra-X, and Strail. Six criteria are used to evaluate the effectiveness of the crossings: surface wear, surface damage, alignment of units, fastening of rails, pavement/crossing joint, and crossing smoothness. In general, the materials continue to perform satisfactorily, though it should be noted that the Steel Plank and Parkco are 'second generation' units, having been redesigned after the original installations developed problems. We shall continue to monitor these installations, as some of the materials have only been subject to two or three years' wear, and periodic reports will be issued.

R-1245 - "Determination of Allowable Movement Ratings for Various Proprietary Bridge Deck Expansion Joint Devices at Various Skew Angles: Second Testing Series," (78 G-242). F. J. Bashore, A. W. Price, and D. E. Branch.

Michigan specifies single element, continuous length, elastomeric strip sealing devices for virtually all new and reconstructed bridge expansion joints. Generally, these devices are not installed at a 90-degree crossing angle (0-degree skew); however, manufacturers' movement ratings are based on this angle. In order to provide some guidelines, a special fixture was developed that would submit the devices submitted by the manufacturers to repetitive opening and closure, and which would allow the devices to be skewed from the perpendicular at 10-degree intervals.

As a result of the first (1980) test series, the movements that the systems could adequately provide--at various skew angles--were supplied to the Department's Design Division. Since then, some manufacturers have re-designed portions of their expansion joint systems, and new systems have been developed and submitted to the Department. This second test series covered these later joint systems. As in the first series, it was found that the majority of the systems evaluated will provide their full perpendicular movement range through a 70-degree angle of crossing; as the angle becomes more severe, the total perpendicular movement the system can handle decreases.

R-1246 - "Air Monitoring in the Vicinity of I 475 in the City of Flint," (78 TI-451).

This is the second in a series of studies that compare preconstruction air quality with the air quality after construction to determine the effect of a new roadway on air quality in the project area. As was the case with the first study (M 99, City of Lansing) a slight decrease in measured carbon monoxide from postconstruction levels was found, indicating that new roadways which improve traffic flow appear to improve air quality in the area. This decrease in CO correlates closely with lower background levels, due to higher wind speeds during postconstruction monitoring, and the fact that new cars, with emission controls, continue to enter the traffic flow.

R-1247 - "Flexible Delineator Posts," (81 TI-766). B. W. Ness.

A set of laboratory tests were developed for the purpose of evaluating several flexible (usually fiberglass or plastic) delineator posts--some designed for roadside delineation, and some for lane delineation in construction areas. Laboratory tests for rigidity, low temperature impact and deflection, and high temperature impact and deflection were developed, and the submitted products subjected to them. In general, due to their high initial cost, flexible delineator posts do not appear to be a suitable replacement for Michigan's current unit (reflector buttons mounted on a steel channel post). Should a flexible post be required for a special purpose, specific recommendations are included as to the suitability of the posts tested.

R-1248 - "Evaluation of Calcium Magnesium Acetate as an Ice Control Agent," (82 G-259). J. H. DeFoe.

Calcium Magnesium Acetate (CMA) was evaluated by the Laboratory as an alternate to sodium chloride as an ice control agent. This field evaluation was conducted as part of a Pooled Fund Study involving 22 other state agencies and administered by the Federal Highway Administration. The study consisted of comparative applications of CMA and rock salt on two 6-1/2-mile sections of I 96 during winter storm conditions. A total of 98 tons of CMA was applied using conventional salt spreading equipment during 22 storms in the 1983/84 winter season. Results of this evaluation indicate that CMA is effective in melting ice and snow but reacts more slowly than rock salt. It was concluded that CMA

could be effective for ice control and snow removal on critical structures where chlorides should not be used.

R-1249 - "Evaluation of Glare Screen," (73 F-135). B. W. Ness, C. J. Arnold, and M. A. Chiunti.

Wire mesh glare screen, placed between lanes of opposing traffic, has proven to be expensive to install and prone to damage. As a means of alleviating these problems, a Michigan contractor devised a method of slip-forming concrete glare screen on top of concrete median barriers. After a demonstration of their technique, two installations were authorized for evaluation. This report provides an evaluation of these two original sites, as well as some steel and aluminum mesh screens. The concrete screen appears to provide longer life and less maintenance than metal mesh screen, and it is recommended that the Department use this concrete screen wherever possible. Should it be necessary to use a metal mesh type screen the expanded steel mesh seems to be preferable to aluminum.

R-1250 - "Monitoring Movement of the Zilwaukee Bridge," (82 TI-849). B. W. Ness.

In August 1982, a failure occurred in the segmental concrete bridge in Zilwaukee, causing the south end of a cantilever deck to deflect more than 5 ft downward, while the other end rose 3 ft at an expansion joint. The top of the twin columns moved longitudinally about 8 in., and excavation revealed that the column's footing had failed. The Laboratory was asked to monitor movements of the crippled structure to determine whether it had stabilized. Phase I of the report is concerned with this monitoring, as well as two further phases: Phase II reports our monitoring during retrofit construction of the new footing, and Phase III consists of the monitoring done during jacking and rotation. This monitoring during key periods in the repair process provided the Construction Division and the consultants with the information needed to make critical decisions in an extremely difficult and complex engineering task.

R-1251 - "Field Trial of Foamed Asphalt Stabilization: Final Report," (81 D-41). J. H. DeFoe.

This project, in cooperation with the Federal Highway Administration, involved the reconstruction of two shoulder projects using an in-place foamed asphalt stabilization process. Samples of the stabilized material from one project were obtained during construction and tested in the laboratory for tensile strength, stiffness modulus, and Poisson's ratio. Strength tests were performed after various time intervals to determine the curing rate of the foamed asphalt mixtures. Construction operations were monitored on both projects. Results of this evaluation show that the asphalt foaming process can be effectively used along with mix-in-place stabilization of granular base materials. The moisture added through foaming not only aids in the dispersion of the asphalt but also is beneficial to the compaction process, especially for materials high in sand content. After more than three years of service, the shoulders are in good condition showing no adverse effects due to loads or environmental conditions.

R-1252 - "Scan 16--Moisture, Frost, Ice Early Warning System: Final Report," (82 G-257). F. M. Spica.

Scan 16 is a system for detecting moisture, frost, and ice on a bridge deck surface and relaying this information to a remote monitoring point so that Maintenance forces are alerted and can take appropriate action. One such system was installed on a Lansing area bridge and this report discusses our experience with it. The reliability of the system proved to be excellent, the field equipment being particularly immune to the harsh environment in which it must function, and roadway and atmospheric sensors have performed as planned. At this point, the system is over 80 percent accurate, and improved software is anticipated to boost this to over 90 percent. It is recommended that the system be expanded.

R-1253 - "An Examination of Studies Which Investigate the Question of Accident Reduction Through Full License Plate ReflectORIZATION," (84 TI-1024). L. F. Holbrook.

This is essentially an in-house report prepared for Department and Legislative staff critiquing the research done to date on the benefits of fully reflectorized license plates. It is concluded that the presumed safety benefits of full plate reflectorization have not been unambiguously demonstrated. The early studies, which tended to support these safety benefits, have been shown to be seriously flawed in their approaches. Later studies, which obviate these flaws, have been unable to demonstrate any safety benefits derived from full reflectorization.

R-1254 - "Investigation of Low Stability Bituminous Base Course, US 131 Mecosta County: Final Report," (83 TI-942). J. H. DeFoe.

This investigation was initiated as a result of the discovery that the 4-in. bituminous base course on the subject project averaged 505 lb stability at the start of paving, rather than the required 700 lb stability. Field modification of the mix (addition of mineral filler) seemed to increase the stability; however, a significant portion of the base had already been placed. This report assesses the structural capacity of the pavement section and, based on deflection measurements and laboratory measured stiffness modulus values, indicates that the pavement should last 13 or more years without any modification or corrective action.

LISTING OF NEW MATERIALS PROJECTS
COMPLETED DURING THE YEAR

- 78 NM-549 - Darex Corrosion Inhibiter for Inhibiting Corrosion of Reinforcing Steel in Concrete Bridge Deck (W. R. Grace & Co.)
- 78 NM-553 - Semperit-Budan Railroad Grade Crossing (Meadowbrook Enterprises Inc.)
- 79 NM-582 - Oneida Steel Reinforced Structural Foam Grade Crossing
- 80 NM-604 - Sealtight Sof-Seal as a Crack Sealer
- 80 NM-619 - "Strail" Railroad Crossing Material
- 82 NM-652 - Lenton Couplers for Reinforcing Steel
- 83 NM-674 - Chemclad HDO Panel for Signs
- 83 NM-685 - Superseal 444 PVC Pavement Joint
- 83 NM-687 - "Cellu Joint" Expansion Joint Filler
- 83 NM-688 - "Ice Go" Fast Melting Ice Pellets
- 84 NM-690 - Inner Bond Water Proofing Slurry; Inner Bond Rapid Patch; Inner Bond Penetrant Hardener; Inner Bond Liquid Rapid
- 84 NM-691 - Raychem Cable Splice
- 84 NM-693 - Ceva Crete Expansion Joint
- 84 NM-697 - Molly Parabond Capsule Anchor
- 84 NM-699 - "Collt RS 600 Volt A" Battery Operated Warning Light
- 84 NM-708 - NBEC Non-Shrinking Grout
- 84 NM-710 - Ackerman-Johnson Internal Plug Drop-In Anchor

LISTING OF TECHNICAL INVESTIGATIONS
COMPLETED DURING THE YEAR

- 78 TI-467 - Joint Filling with Slurry Seal Prior to Bituminous Resurfacing
- 78 TI-548 - Preparation of Plans, Specifications and Installation of Electronic Scales at NB and SB I-75 Weigh Stations North of Allen Cove Rd., Monroe Co.
- 80 TI-656 - I-75 CRC Springwells to Gratiot Ave.; Development of Maintenance Procedures
- 80 TI-685 - Investigation of Cracking in Steel Cores from X03 of 82123
- 80 TI-688 - Vibration Complaint Pile Driving; S.E. Quadrant I-69 and Clark Rd., Clinton Co.
- 81 TI-766 - Study of Flexible Delineator Posts
- 82 TI-840 - Slide Audio Training Program for Concrete Patching Projects
- 83 TI-897 - Testing of Fence Posts X-Anchors for Chain Link Fence
- 83 TI-906 - Design and Construction of Load Transfer Drilling Machine for Maintenance Div.
- 83 TI-942 - Recommendations for Project FF 54014, Job No. 17762A, US-131, Mecosta Co., Low Stability Bituminous Base Course
- 83 TI-954 - Noise Study on I-96 East of Thornapple River, Kent Co.
- 83 TI-957 - Vibration Complaint I-196 at 20th Ave. South of South Haven
- 83 TI-959 - Investigation of Stresses in Detroit Central Automated Transit System Elevated Guideway
- 83 TI-960 - Sampling and Analysis of Structural Steel (R01 of 58051-15205D), US-24 over the Ann Arbor R.R., 0.8 Mile North of the Michigan/Ohio Line
- 83 TI-963 - Vaned Grates for I-696
- 84 TI-967 - Investigation of Distressed Ramps on I-275
- 84 TI-972 - Analysis of Failed Wire MDOT Strato Tower
- 84 TI-973 - Investigation Means of Controlling Highway Speed to 55 MPH other than Law Enforcement
- 84 TI-979 - Investigation of Welding Compatibility of Steel from B01 of 51021-21748C, M-55 over the Manistee River, 0.1 Mile East of US-31

- 84 TI-983 - Noise Investigation on I-696, Franklin Pointe Apartments
- 84 TI-984 - Ultra-Sonic Pin Inspection on Blue Water Bridge, B04 of 77111
- 84 TI-988 - Treadle Boards for International Bridge Toll Plaza
- 84 TI-989 - Hydraulic Lift for Electronic Scale Maintenance
- 84 TI-990 - Check Capacity of Hydraulic Floor Hoist, Jones Maintenance Garage
- 84 TI-991 - Vibration Monitoring During Pile Driving, M-20 over Muskegon River in Big Rapids
- 84 TI-992 - Evaluation of Plastic Reflectors for Traffic Signals
- 84 TI-993 - Quality vs. Price Analysis Program for Design Division
- 84 TI-996 - Analysis of Product ISC-108
- 84 TI-997 - Investigation of Meridian Street Bridge, City of Sault Ste. Marie
- 84 TI-1002 - Investigation of Noise Barrier for I-75 South Allen Park, West of I-75, from S. of Goddard Rd. in Southgate to a Point in Lincoln Park where the Highway becomes Depressed
- 84 TI-1003 - Statistical Review and Comments on Report TSD-550-84, "An Evaluation of Effectiveness of Deer Crossing Warning Signs"
- 84 TI-1005 - Ultraviolet and Infrared Ray Transmission Through Welding Curtains
- 84 TI-1006 - Instrumentation of Reinforcement for Prestressed Concrete Box Beam Repair
- 84 TI-1007 - Adaption of Dictaphone Transcriber Unit for Management Services Division
- 84 TI-1009 - Testing to Determine Required Anchorage in Reinforcing Steel in Footings of Zilwaukee Bridge
- 84 TI-1010 - Testing of MSI Safety Toe Shoes and Boots
- 84 TI-1013 - Testing of Guardrail Posts I-69/M-21 Freeway
- 84 TI-1014 - Investigation of Noise Problem, University Townhouses along I-94, Ann Arbor
- 84 TI-1017 - Evaluation of Pile to Rebar Weld for CATS System

- 84 TI-1023 - Testing of Soils and Water Samples Ground Water Investigation, Maintenance Sub-Garage, Kalamazoo.
- 84 TI-1025 - Galesburg Rest Area Noise Study
- 84 TI-1032 - Noise Investigation WB M-21 at Center Rd., Flint
- 84 TI-1034 - Noise Investigation US-127 near Lake Lansing Rd.
- 84 TI-1036 - Noise Study on I-96 Adjacent to Portland
- 84 TI-1042 - Vibration Problem at Residence 19676 Telegraph Rd., Detroit
- 84 TI-1043 - Noise Investigation US-127 and I-496, Lansing (Red Cedar Community Association)
- 84 TI-1047- Test of Color of Battle Creek Logo

LISTING OF ACTION PLANS
COMPLETED DURING THE YEAR

83 AP-39(A) - Air Quality Monitoring, M-44 from I-96 to Plainfield Ave.