Office of Research & National Best Practices

Michigan Department of Transportation • April 2006

Inside This Issue:

Making the Most of Every Opportunity

New office encourages research in the areas of system operation, traffic safety, incident response, congestion mitigation, and system management

Thomas Edison, responding to the question of why he employed 21 assistants in his laboratory, explained, "If I could solve all the problems myself I would." Legendary football coach Vince Lombardi described the key to teamwork by saying, "Individual commitment to a group effort – that is what makes a team work, a company work, a society work, a civilization work." Making clear the need to learn from each other, leadership and organizational development expert Ken Blanchard proclaimed, "None of us is as smart as all of us." According to these three successful and effective people, working together is the best way to get things done.

"Joining research and best practices will give Michigan's taxpayers the best bang for their buck in transportation research."

Larry Tibbits, Chief Operations Officer
Michigan DOT

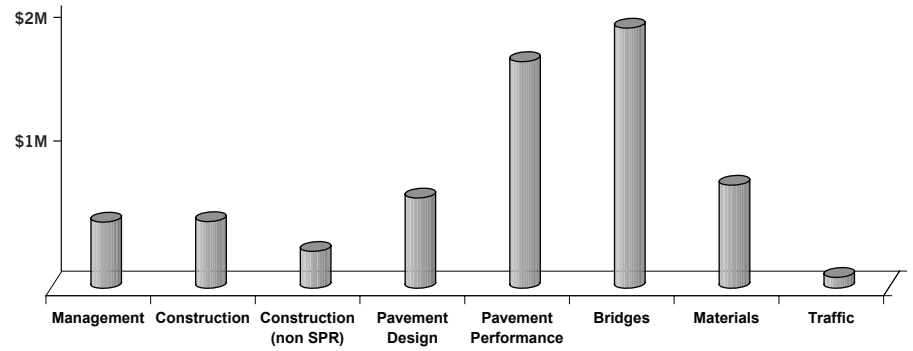
The Michigan Department of Transportation's Office of Research and National Best Practices was created, in part, to encourage the kind of culture that Edison, Lombardi, and Blanchard described. The new office is a clearinghouse for all transportation-related organizations in Michigan. The office also distributes research funding across all modes of transportation, and pulls together information from other states that can be used in Michigan. New opportunities for research through the new office include system operation, traffic safety, incident response, congestion mitigation, and system management. "Joining research and best practices will give Michigan's taxpayers the best bang for their buck in transportation research," Larry Tibbits, MDOT's Chief Operations Officer, explains, "and in addition to road and bridge projects, the area of intelligent transportation systems provides important new opportunities for research."

Calvin Roberts is the Administrator of the new office. He will oversee its operation. Roberts explains, "Our mission is to encourage a multimodal approach to transportation research and to support MDOT's strategic goals in maintaining and improving Michigan's transportation infrastructure. Through this effort we will also enhance the availability of informational resources for all transportation stakeholders in Michigan."

Dr. Sudhakar Kulkarni, University Research Administrator, will work with Michigan universities to coordinate the research activities of the office. André Clover, Administrative Engineer, will maintain relationships with transportation professionals in Michigan and across the country to encourage the exchange of information and implementation of best practices.

This newsletter, which replaces the *Research Record*, is a tool for helping to fulfill that mission. To reflect the broader scope of the new office this newsletter will communicate information about research relating to all modes of transportation. It will also cover topics about innovative applications of technology nationwide. "In the past, research efforts of the Testing and Research Section of the Construction and Technology Support Area primarily focused on issues and problems relating to roadways and bridges," Clover explains, "MDOT's new Office of Research and National Best Practice will expand research efforts to include all modes of transportation, congestion management, ITS, safety, and maintenance operations."

MDOT's intent is to make the most of available technologies, resources, and intellectual capital. "By broadening the scope of transportation research," says Clover, "and by pooling the intellectual and technological capital available in Michigan and nationwide, we hope to get more use out of every dollar spent on transportation research."



Type of Project (Number of Projects)	Cost	Percent of Total
Management (15)	$499,836	8
Construction (7)	$503,751	8
Non SPR Construction (2)	$278,807	4
Pavement Design (8)	$682,129	11
Pavement Performance (17)	$1,711,725	26
Bridges (18)	$1,965,004	30
Materials (7)	$778,353	12
Traffic (1)	$82,148	1

Figure 1. Overview of Transportation Research Spending, FY 2000 – FY 2004.

Trends in Research Spending

Historically in the U.S., spending by highway agencies for research and technology typically has amounted to about 0.6 percent of total highway spending. In Michigan, this figure has been approximately 0.4 percent of total spending.

Average spending for research by low-tech industries in the private sector ranges from 1 to 3 percent of total spending. In high-tech private sector industries, research spending approaches 10 percent of the total. MDOT's planned spending on research for FY 2006 is approximately 1.5 percent of the total spending.

Between FY 2000 and FY 2004, MDOT-funded transportation research focused on the following areas:

- Management
- Construction
- Pavement Design
- Pavement Performance
- Bridges
- Materials
- Traffic

Figure 1 provides an overview of the total spending in each area. Figure 2 shows a breakdown of the spending by year. Projects relating to pavement performance and bridges accounted for almost 60 percent of the total research spending for FY 2000 to FY 2004.

Management Projects

Funding for management-related research projects totaled almost $500,000. Approximately 80 percent of this funding was used for operating, coordinating, and managing the following research organizations at Michigan universities:

- **Transportation Materials Research Center** (TMRC) at Michigan Tech University.
- **Pavement Research Center of Excellence** (PRCE) at Michigan State University.
- **Center for Structural Durability** (CSD) at Michigan Tech University and Wayne State University.
- **Bridges and Structures Research Center of Excellence** at University of Michigan and Michigan State University.

These research organizations are referred to as Centers of Excellence; they provide important resources for transportation research in Michigan. Through these centers, MDOT encourages and supports research and graduate studies. Relationships with these centers will continue with the creation of the new office.

Management projects also included the publication of the *Research Record* by Michigan Tech University, and the review

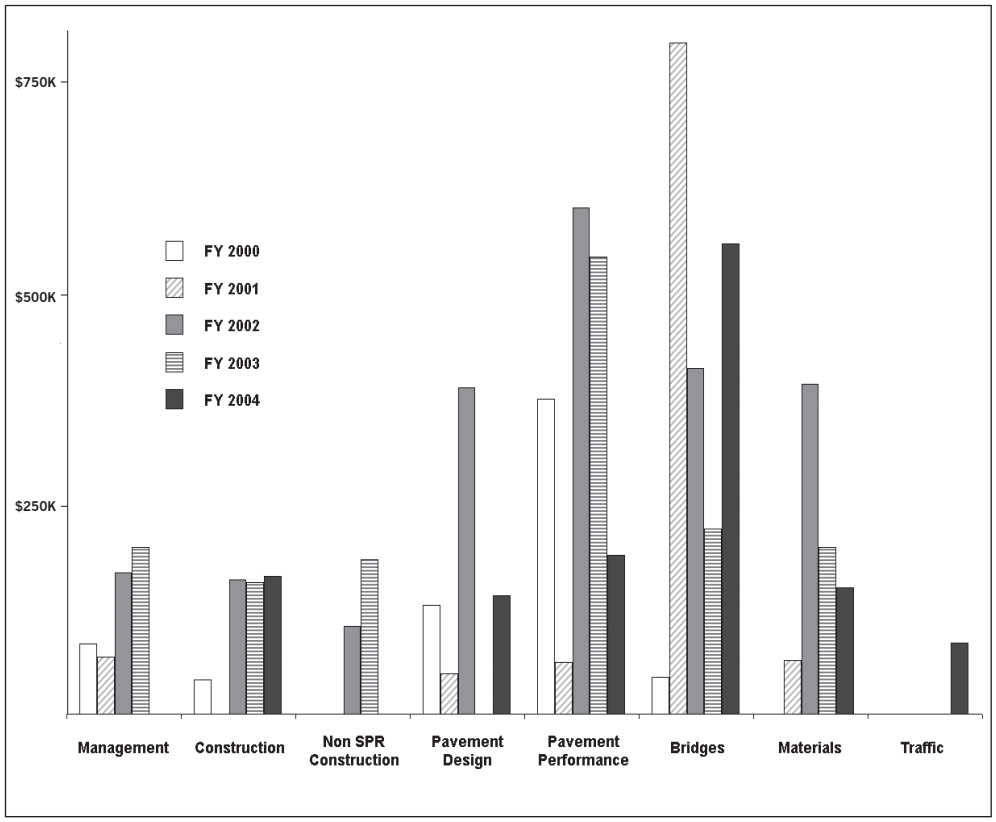


Figure 2. Transportation Research Spending by Year, FY 2000 – FY 2004.

and edit of a Policy and Procedures Manual for University Research Programs by B.T. Harder, Inc. The *Research Record* communicated the findings of research funded by the Testing and Research Section of the Construction and Technology Support Area of MDOT. The Policy and Procedures Manual provides guidelines for managing university research.

Construction Projects

Funding for construction-related research projects totaled just over $1M. Past construction research has resulted in a variety of improvements to the processes and methods that MDOT uses to manage and track contractor progress during construction projects. Work zone safety has been improved through the study of merging traffic, motorist speed, and signage in work zones.

Research projects also included evaluating construction methods to minimize early-age cracking on bridge decks. An important result of this research was the recommendation of controls to minimize thermal loading of curing concrete.

Pavement Design Projects

Pavement design projects accounted for just over $680,000 of research funding. Approximately 45 percent of the funding involved creating, modifying, or evaluating software for designing and evaluating pavement types and characteristics. One such project evaluated ISLAB 2000, which is a software product used by MDOT pavement designers and researchers to perform finite element analysis of pavements. The project involved using ISLAB 2000 to study Portland Cement Concrete (PCC) cross-sections. Researchers concluded that the accuracy of the software is sufficient for analyzing pavements using finite element analysis, and that the software may be used for forensic investigations of distressed or failed PCC pavements.

The remaining pavement design funding was used to evaluate the properties and characteristics of pavements and paving practices.

Pavement Performance Projects

Funding for pavement performance research projects totaled just over $1.7M. These projects involved examining construction practices, materials of construction, and various environmental and physical factors that lead to distress in concrete and asphalt pavements. Findings from these projects have helped to identify factors that affect pavement performance under specific conditions.

A project that studied shear capacity of transverse cracks in jointed concrete pavement (JCP) identified the following factors as having significant effects on the development and performance of transverse cracks:

- Joint spacing
- Coarse aggregate type
- Shoulder type

In addition, three analysis procedures that are based on the use of falling weight deflectometer (FWD) data were demonstrated using data from this study. The three procedures included:

- Back calculation of pavement support and stiffness parameters
- Determination of crack performance parameters
- Assessment of void potential near cracks

Threshold limits, which are necessary for using these procedures for evaluating JCPs, were developed based on the results of the FWD analyses.

These findings will be used to help assess and repair pavement that exhibits transverse cracking, and also to design pavements that resist this type of deterioration.

The results of a project that examined segregation in bituminous pavements led to adding a special provision to all MDOT surfacing projects to measure the surface uniformity of hot-mix asphalt (HMA).

A project that examined causes of premature deterioration in

rubblized concrete paving projects enabled researchers to identify characteristics of deterioration in concrete pavement that indicate a pavement should not be rubblized. The characteristics include:

- Pavements that have been cracked and seated
- Pavements supported on soil with less than 3000 psi modulus
- Pavements with extensive amount of cracking, as defined in the MDOT pavement management system (PMS) distress manual

The findings also enabled the researchers to recommend performance measures to be used during a five-year warranty period on rubblized paving projects. The measures include:

- No longitudinal and/or transverse top-down cracks
- No reflective or regular transverse or longitudinal cracks
- No faulting between two adjacent lanes
- No shear failure
- No raveling
- Less than 0.25-inch rut depth

Bridge Projects

The greatest number of research projects were related to bridges. Approximately $2M of funding was divided between 18 projects. The projects studied materials of construction, methods and materials for maintenance and repair, and various methods for evaluating existing bridges and bridge components. Research findings ultimately led to revisions in MDOT's Bridge Analysis Guide.

Projects that studied bridge repair procedures and materials yielded the following:

- Methods for using carbon fiber reinforced plastic (CFRP) laminates to repair and strengthen reinforced and pre-stressed concrete beams.
- Criteria for using fiber-reinforced polymer (FRP) wraps to rehabilitate columns damaged by corrosion.
- Methods for using electrochemical impedance spectroscopy (EIS) based sensors for monitoring bridges rehabilitated with FRP.
- Preventive maintenance and repair techniques for deteriorated ends of pre-stressed concrete beams.
- Recommendations for using penetrating sealants to protect bridge decks.
- Recommendations for heat-straightening structural steel.

The majority of research projects that examined materials of bridge construction involved some form of testing existing bridges in the field. This research determined that non-metallic reinforcement of bridge decks is feasible but cost prohibitive; and the bond strength of stainless steel reinforcing bars is not appreciably lower than that of carbon steel.

Materials Projects

MDOT funded seven materials-related research projects related to either pavement anti-icing, damage from natural and man-made environmental influences, or measuring and documenting the physical properties of natural aggregates. One project established a relationship between aggregate absorption and anti-icing performance for elastomeric concrete bridge deck overlays. This study showed that certain combinations of aggregate and anti-icing chemicals can drastically reduce the formation of frost on pavements, and minimize the potential of snow and ice bonding to pavements.

A study of materials-related distress (MRD) in Michigan's portland cement concrete (PCC) pavements proved that MDOT's method for screening aggregates is effective for preventing against freeze-thaw deterioration in new pavements, but the method for entraining air voids to protect against freeze-thaw damage was inadequate.

A study that tested the performance of polymer bridge deck overlays proved that polymer concrete overlays are effective for sealing out moisture and chlorides.

A project that examined the use of engineered cementitous composite (ECC) link slabs concluded that they can be used to seal bridge deck joints and prevent freeze-thaw damage in the joint.

Traffic Projects

A single traffic-related project was completed between FY 2000 and FY 2004. The project studied a proposed system that manages merging traffic in a construction zone. The Dynamic Early Lane Merge Traffic Control System (DELMTCS) uses traffic sensors to relay lane occupancy, speed, and traffic volume data to computers that control the operation of dynamic signs. The signs activate or deactivate to adjust the length of a "No Passing" zone based on traffic volume.

In addition to maintaining a smoother flow of traffic, motorists realized economic benefits through reduced fuel consumption and environmental benefits by reducing emissions. MDOT plans to implement the system in appropriate projects starting in 2006.

The Future is Bright

Road and bridge related research projects in Michigan have improved the efficiency and effectiveness of several aspects of road and bridge construction and maintenance. The Centers of Excellence at Michigan universities are well-suited to continue this trend, and MDOT's new Office of Research and National Best Practices is in place to ensure that similar benefits of research are realized for all modes of transportation in the state.

Produced by:

Michigan's Local Technical Assistance Program

John Ryynanen, Editor

MDOT Michigan Department of Transportation

This publication is authorized by the transportation director to disseminate technical information to MDOT personnel and is published by the Office of Research and National Best Practices. The cost of printing 5000 issues is $631.00, and it is printed in accordance with Executive Directive 1991-6.