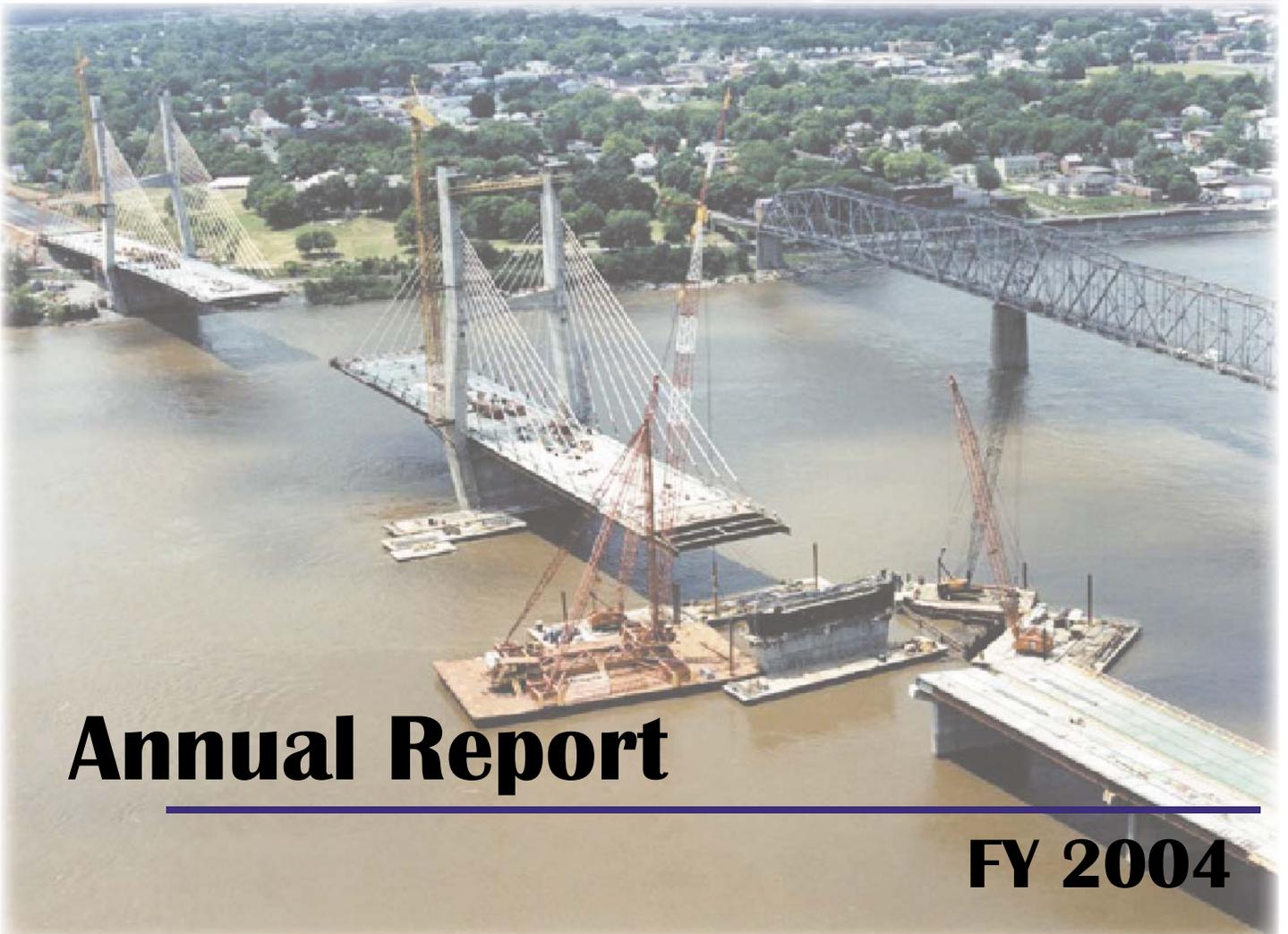




Missouri Department of Transportation

Research Development and Technology



Annual Report

FY 2004

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RESEARCH, DEVELOPMENT, AND TECHNOLOGY ANNUAL REPORT 2004

Dear Missouri Transportation Research Customer:

Change is in the wind here at MoDOT's RDT office. To begin with, Ray Purvis, retired after a distinguished career of 33 years with the department. He served the last four of those years as State Research, Development and Technology Engineer.

Fiscal year 2004 also ushered in the beginnings of the new Missouri Transportation Institute (MTI). The idea behind MTI is to build on the already strong relationships with our university partners. The goal of MTI is to build a nationally recognized transportation research institute that responds to MoDOT's research needs through a consortium of universities and non-profit research institutions. MTI will build a client base by developing relationships with other transportation research customers at the regional and national level. Other benefits of MTI include the opportunity to leverage financial resources among partnering research clients to produce research based on the common interests.

With the development of MTI, RDT will continue to ensure that research needs at MoDOT are addressed. First, RDT will be responsible for the development of a research program that meets the needs of our department and that is delivered on time and on budget. Research projects will be tied to the department's business plan. Secondly, RDT will ensure that the research work conducted has a clear implementation plan and is championed by key department personnel.

We have taken the opportunity in this annual report to showcase projects that reflect the scope and diversity of our research program. Next year will assuredly offer new challenges for research and implementation. RDT will continue to work with our customers and ensure their research needs are met.

Sincerely,



Michael W. Shea, P.E.
Assistant State Research, Development and Technology Engineer

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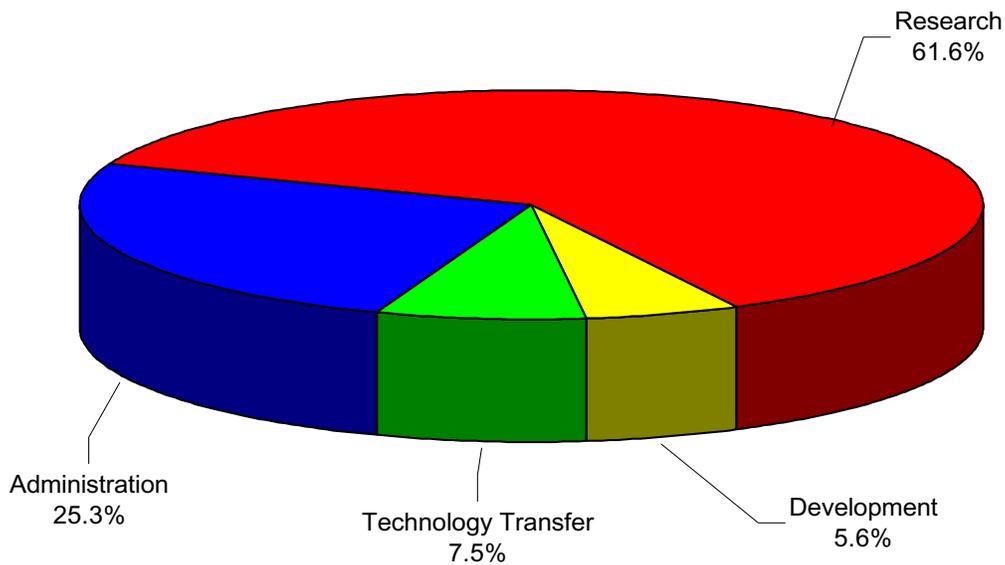
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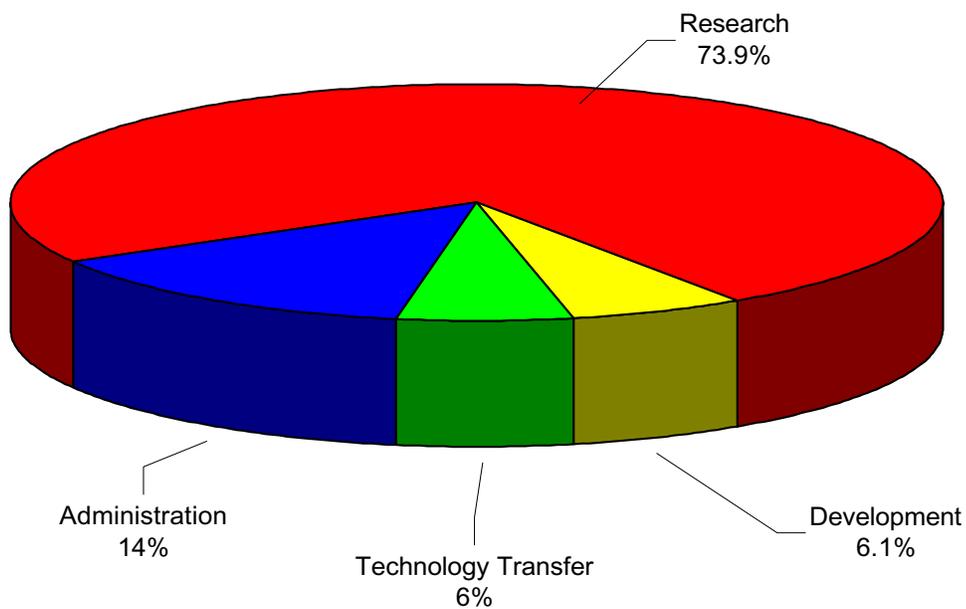
Financial Summary

	YTD FY 2004	
	<u>Budget Amount</u>	<u>Expenditures</u>
Administration	\$1,082,063	\$656,135
Research	2,640,443	3,471,221
Development	239,862	288,392
Technology Transfer	322,824	281,141
Total	\$4,285,192	\$4,696,889

Budget



Expenditures



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Social, Economic, and Environmental

- Benefits of Highway Improvements on Rural Communities in Missouri
- Integration, Status and Potential of Environmental Justice and the Social Impact Process in Transportation Development in Missouri
- Benefits and Design/Location Criteria for Passing Lanes - Phase 1 and Phase 2
- Comparison of Site Preparation and Stock Types for Tree Planting on MoDOT Clean Water Act Mitigation Sites
- Highway / Rail Crossing Project Selection

Benefits of Highway Improvements on Rural Communities in Missouri (UMC)

Purpose:

This project is designed to examine the economic development impacts of improved highway infrastructure in rural counties in Missouri. Beginning in 2000, the University of Missouri - Columbia developed a data set of economic development indicators and highway infrastructure for 105 non-metro counties. Department personnel use this data set to examine the relationships between expanded highway infrastructure and the corresponding levels of economic development at the county level. In order to track changes in transportation-related development over time, the data set will be updated as new economic, demographic, and roadway data becomes available.

Savings / Benefits:

Understanding the relationship between transportation improvements and economic development in rural counties can provide insight to aid in infrastructure investment decisions that encourage economic development in the state. While a relationship between transportation and economic development has always been evident, more precise information on how and when transportation investments spur economic development helps the state make better decisions with scarce transportation investment dollars.

Status / Results:

In 2000, MoDOT invested approximately \$350 per person in the state’s transportation system, more than \$12,000 for every one of the businesses in the state, and approximately \$2 million dollars for each one of the state’s 945 communities. This study has found that for the 105 non-metro counties in the state, greater transportation investments (measured as miles of 4-lane roadway) result in greater values for all six of the economic development variables included in the analysis. This research helps MoDOT do a better job defining where transportation can be used as an economic development tool and affirms that an efficient transportation system, teamed with local initiative, spell success for the state.

Comparison of Economic Development Indicators for Rural Missouri Counties Based on Interstate Highway Presence				
Economic Development Indicator	76 Counties with No Major Interstate Highways (2000 data)	29 Counties with Major Interstate Highways (2000 data)	Difference Between County Groups	Percent Difference Between County Groups
Population	19,680	29,229	9,549	49%
Average wage	\$ 20,480	\$ 22,189	\$1,709	8%
Household Income	\$ 29,918	\$ 34,142	\$4,224	14%
Established Businesses	470	685	215	46%
Gross Sales Tax (thousands)	\$ 3,874	\$ 5,633	\$1,759	45%
Real Estate Valuations (thousands)	\$ 119,711	\$ 193,686	\$73,975	62%

Comparison of Economic Development Indicators for Rural Missouri Counties Based on Four-lane Highway Presence				
Economic Development Indicator	50 Counties with <u>Less</u> than 15 miles of 4-lane Highways (2000 data)	55 Counties with <u>More</u> than 15 miles of 4-lane Highways (2000 data)	Difference Between County Groups	Percent Difference Between County Groups
Population	13,839	30,025	16,186	117%
Average wage	\$ 19,943	\$ 21,869	\$1,926	10%
Household Income	\$ 29,039	\$ 32,944	\$3,905	13%
Established Businesses	314	726	412	131%
Gross Sales Tax (thousands)	\$ 2,209	\$ 6,315	\$4,106	186%
Real Estate Valuations (thousands)	\$ 83,037	\$ 192,056	\$109,019	131%

105 “rural” counties are included in this analysis. Highly urbanized counties (Boone, Buchanan, Greene, Jackson, Jasper, St.. Charles, St. Louis – city and county, Clay and Jefferson) were excluded. Data compiled by the University of Missouri – Columbia, Department of Rural Sociology.

RI 02-012

Integration, Status, and Potential of Environmental Justice and the Social Impact Assessment Process in Transportation Development in Missouri

Purpose:

The Social Impact Assessment process, including community impact assessment and environmental justice, is increasing in relevancy for Departments of Transportation. This renewed relevancy is based on the Federal emphasis on transportation-related human-dimension impacts, as well as legal challenges regarding community impacts and environmental justice issues resulting from transportation improvements. The purpose of this project is to assess the current status of human-dimension considerations in transportation project development and to identify tools and practices that aid in ensuring human-dimension impacts are adequately addressed in transportation project development.



Housing Impacted by New Road



Sidewalks Used To Help Offset Neighborhood Impacts

Savings / Benefits:

Ensuring that the spirit as well as the guidance provided by the National Environmental Policy Act (NEPA), environmental justice, and community impact assessment are included in DOT planning and operations is imperative to project and organizational success. Departments of Transportation will benefit from greater consideration of human-dimension impacts through increased citizen consent for projects and decreased environmental clearance delays related to social and economic project impacts. Further, citizens and communities benefit from including these considerations in the transportation development process by ensuring that facilities enhance rather than degrade the social and economic settings of neighborhoods and communities.

Status / Results:

The project was completed in December 2003. Findings of this research indicate that the Social Impact Assessment process is under-utilized in transportation development, but holds great potential for sensitizing the environmental and transportation decision making process to greater influence by citizens and communities. Constraints to increased effectiveness of the Social Impact Assessment process include the organizational settings of Departments of Transportation, the original NEPA guidance, the lack of personnel with social science backgrounds at Departments of Transportation, the current budgetary constraints on staffing facing these organizations, and the lack of external agency influence over the Social Impact Assessment process. Departments of Transportation should aggressively pursue adoption of the principles of Social Impact Assessment to address human-dimension impacts in their work before additional oversight is provided by external agencies, through legal challenges, or through more proscriptive guidance.

RI 02-018

Benefits and Design/Location Criteria for Passing Lanes (Midwest Research Institute)

Purpose:

Passing lanes have been used in many states to improve traffic operations on two-lane highways. The objectives of this study are to demonstrate the feasibility and potential effectiveness of using passing lanes in Missouri, to evaluate the level of service and safety effects of existing passing lanes, to determine criteria where passing lanes could improve the level of service and safety on Missouri

highways, and to develop recommendations for the design, signing, and marking of passing lanes for potential applications in Missouri.



Passing Lane Application in Mountainous Terrain

Savings / Benefits:

Including passing lanes as a design option for MoDOT can decrease accident frequency and improve level of service on two-lane roads that have been treated with the appropriate passing lane configuration. Additionally, passing lanes can provide a step towards an eventual four-lane for certain facilities and provide for seasonal traffic relief on roadways that experience tourism related traffic.

Status / Results:

The project was completed in March 2004. An evaluation of current passing lanes in the state found a reduction in the time spent following on these roads by 10 to 31%. A safety evaluation found that accident frequency per mile per year within passing lane sections of two-lane highways is 12 to 24% lower than for conventional two-lane highway sections. For three of the five case studies included in the analysis, the maximum passing lane configuration would improve level of service by two levels of service. For the other two sites, level of service was improved by one level of service. Fifty-three

rural National Highway System roadway sections (767 miles) were identified in the report as meeting the screening criteria for passing lane application. Recommendations were made for further adoption of passing lanes in Missouri and MRI is currently working with MoDOT's Design and Traffic Operations staff to implement the findings of the research.

RI 03-034

Comparison of Site Preparation and Stock Types for Tree Planting on MoDOT Clean Water Act Mitigation Sites



The Beginnings...Young Trees Take Root at Forrest Keeling Nursery

Purpose:

The purpose of this project is to complete a life-cycle cost analysis of wetland mitigation involving tree planting with more expensive RPM* tree stock, and the lower cost bareroot tree stock. Based on a 5-year performance period, the question is whether the survivability of RPM trees exceed that of bareroot stock to the degree that replanting cycles are eliminated or nearly eliminated for RPM stock. Then, is the increased initial cost of RPM tree stock economic when compared to the replanting costs of bareroot stock to meet a 5-year performance period?

*RPM is a trademark for the Root Production Method, an air root pruning process developed by Forrest Keeling Nursery in Elsberry, MO.

Savings / Benefits:

If mitigation with RPM tree stock requires fewer replacement plantings, money and staff time can be saved through reduction in the replanting of traditional bareroot tree stock. If RPM stock is found to be more efficient, wetland ecosystems and function can be re-established at less cost with greater environmental benefits at a more rapid pace.

Status / Results:

One hundred sixty-eight RPM trees were planted in the Ray County, Missouri mitigation site in the fall of 2003. In the spring of 2004, bareroot seedlings were planted. Baseline data (tree size, condition) was collected in the spring of 2004, and the MoDOT wetlands team will conduct site monitoring two times a year over the next 5 years.



Wetland Scientist Planting a RPM Tree in a Wetland Mitigation Site, Ray County, MO.

Highway Rail Crossing Project Selection (UMC, UMR)

Purpose:

MoDOT currently uses an Exposure Index (EI) formula to prioritize the more than 4,000 highway/rail crossings for safety upgrades. The EI was developed in the 1970's and has not been re-evaluated or updated to represent new traffic and rail considerations in over 30 years. This study was designed to evaluate the effectiveness of the EI formula and examine the possibility of adopting an alternative formula in Missouri for prioritizing crossings for safety improvements.

Savings / Benefits:

Benefits of this project include the potential adoption of an evaluation formula that better represents current traffic and rail hazards at highway/rail crossings, and as a result ensures that scarce safety resources are invested in the most effective manner.



Typical Signalized Highway/Rail Crossing in Rural Missouri

Status / Results:

The project was completed in December 2003. Seven evaluation models used in other states were reviewed for this project. A team of officials with MoDOT, U.S. DOT, and railroad companies were assembled to evaluate the models and select formula ranking criteria. Sensitivity analysis was then conducted on the various models and compared to professional evaluations of actual crossing sites. The Kansas Design Hazard Rating model was selected by the panel of professionals for possible use in Missouri, however, subsequent evaluations of the model were inconclusive in determining an appropriate fit of the model with expected prediction outcomes. Consideration will be given to replacing the EI formula with the Kansas model, but modifications are needed to ensure model accuracy in Missouri.

Safety / Traffic

- Remote Control Flagman
- Evaluation of Waterborne Traffic Paint and Bead Combinations
- Investigation of Centerline Rumble Strips

PD02-016

Remote Control Flagman

Purpose:

The objective of the evaluation is to determine if the Remote Control (RC) Flagman unit will increase work zone safety, improve productivity, and reduce costs. As shown in the picture, the RC Flagman is a mechanical flagger that has a red and amber indication signal head attached to a portable trailer with a PVC flagger arm attached. The RC Flagman is placed at one end of the work zone as a replacement for one human flagger. On the other end of the work zone, a human flagger controls the RC Flagman with a remote controlled radio.

Savings / Benefits:

The anticipated benefits of using the RC Flagman are increased safety, reduced costs, and increased productivity. The safety aspect of the use of one human flagger and a mechanical flagger will reduce worker exposure in the work zone. The RC Flagman's red and amber lights and the larger target area of the signal head, trailer, and flagger arm should attract the traveling public's attention to the stop conditions in the work zone. When the RC Flagman can be used, the work force should be able to free a worker to perform work on a project, which may speed the completion of the project and save money.

Status / Results:

The RC Flagman units are being used on two-way, two-lane roadways with low average daily traffic (ADT), particularly bridge maintenance projects. Interim reports were written in May 2003 and February 2004, and the final report will be prepared by January 2005.



Work Zone Utilizing the Remote Control Flagman

PD01-021

Evaluation of Waterborne Traffic Paint and Bead Combinations

Purpose:

The objective of the investigation is to test different combinations of waterborne paint types, paint thickness, and bead sizes to determine the most effective waterborne pavement marking combination for MoDOT. From the information obtained, MoDOT will try to determine the service life of the material and provide a life-cycle cost analysis of the different materials tested.

Savings / Benefits:

Because of heavy volumes of traffic and snow plowing on MoDOT pavements, the investigation should provide the best combination of materials for a particular pavement. By comparing benefit/costs of the different paints/beads, we will select the most beneficial combination of paint/beads, which will allow us to stripe more efficiently.

Status / Results:

MoDOT forces installed three (3) test locations for the waterborne paint in the summer of 2003. The test locations are eight miles long with eight combinations of materials located on old and new asphalt pavement and old concrete pavement separately. The waterborne paint within the test sections will be studied with both longline (centerline and edgeline) and transverse line. Retroreflectivity readings and visual ratings will continue to be performed at approximately 6-month intervals until the pavement material average retroreflectivity readings drop below values of 150 mc/m²/lux for the white paint and 100 mc/m²/lux for the yellow paint. The readings will be collected with a LaserLux retroreflectometer.

PD01-027

Investigation of Centerline Rumble Strips

Purpose:

Centerline rumble strips (CRS) have been tested in several states in an effort to reduce the number and severity of head-on collisions and opposite direction sideswipe collisions on high-speed, two-lane highways. MoDOT is constantly looking for new ways to improve the safety of state highways. If centerline rumble strips prove to be an effective means to increase safety, it will become a desired feature for many of the narrow, winding, two-lane Missouri highways.



Centerline Rumble Strips

Savings / Benefits:

The CRS should increase safety through the reduction of the number and severity of head-on collisions and opposite direction sideswipe collisions. Any savings would come from a reduction in the number of accidents and associated property damage costs.

Status / Results:

The CRS was installed on Route 21, south of St. Louis, in the summer of 2003, and evaluations are in progress. The evaluations will continue for a total period of five years. An interim report will be prepared in the summer of 2005, 2 years after the installation, and a final report will be prepared in the summer of 2008.

Bridge / Project Development

- Comparison of Compressive Strengths Using 4x8 vs. 6x12 Cylinders for Prestress Concrete
- Stainless Steel Reinforcing Bars in Bridge Decks
- Galvashield XP Embedded Galvanic Anodes
- Implementation Issues of Metallic Dampers for Seismic Retrofit of Highway Bridges
- Steel-Free Hybrid Reinforcement System for Concrete Bridge Decks - Phase 1
- Post Earthquake Damage Evaluation of Bridge Structures
- Seismic Retrofit Techniques for Bridge Cap Beams, Columns, and Connections
- Statewide Study of Cathodic Protection Systems
- Cathodic Protection of Pier Caps Using Zinc Hydrogel Anode
- Performance Characteristics of Self Consolidating Concrete
- New Placing and Curing Specifications for Bridge Decks
- Preservation of Missouri Transportation Infrastructure: Validations of FRP composite Technology Through Field Testing

RI 03-038

Comparison of Compressive Strengths Using 4x8 vs. 6x12 Cylinders for Prestress Concrete

Purpose:

The purpose of this investigation is to determine how the compressive strengths of 4 by 8-in. cylinders compare to the compressive strengths of 6 by 12-in. cylinders for the same mix design specified in MoDOT Specifications for prestress concrete.

Savings / Benefits:

The anticipated benefits include a savings in time and materials spent on the preparation and handling of compressive strength specimens for prestress/precast companies.

Status / Results:

The final report has been written. Based on the compressive strength differences observed in this study, a multiplier of 0.94 applied to the results of the 4 by 8-in. cylinders should provide reliable compressive strength acceptance data, which can be used in lieu of 6 by 12-in. cylinder strength data. This would enable the use of 4 by 8-in. cylinders on a routine basis.



Typical 6x12 and 4x8 Cylinders and Molds

Implementation:

MoDOT's Construction and Materials Division has recently revised Field Section 705, Prestressed Concrete Members for Bridges, in the Materials Manual to incorporate the results of this study. When finalized, this section will be found in the Materials Manual, Field Section 1029.3.8.1, Concrete Testing.

RI 00-027

Stainless Steel Reinforcing Bars in Bridge Decks

Purpose:

The main objective of this project is to extend the service life of bridge decks. This study will determine if using stainless steel reinforcement in place of epoxy-coated reinforcement in bridge decks will reduce corrosion and extend the service life of the bridge deck long enough to make them cost effective. This will be tracked by doing yearly checks on fiber optic chloride sensors, permeability tests, and half-cell potentials along with visual inspections on the bridge deck to determine the extent of corrosion of the rebar.

Savings / Benefits:

Although the stainless steel reinforcing bars are more expensive than epoxy-coated reinforcing bars, they are designed to more than double the service life of the epoxy-coated reinforced bridge decks. By reducing the corrosion, the need for patches and overlays would also be reduced, which would result in decreased life cycle costs. This would therefore reduce the overall costs of maintaining the bridge.

Status / Results:

The Rte. 6 Grundy County Bridge that is using stainless steel reinforcement was opened in 2001, and a construction phase report was published in February 2003. An interim report will be completed in 2005. Future monitoring will be done, and reports will follow as appropriate. In the future, a final report will be prepared that will discuss project findings on the overall performance of the stainless steel reinforcement versus the epoxy-coated reinforcement.

RI 01-028

Implementation Issues of Metallic Dampers for Seismic Retrofit of Highway Bridges (UMR)

Purpose:

This is contract research with the University of Missouri - Rolla. The purpose of this project is to address several issues related to the implementation of metallic dampers in steel girder bridges with rocker bearings for improved seismic performance. Specifically, the project should establish design equations for the load-carrying capacity of rocker bearings and damping property of metallic dampers consisting of tapered rods, address the effect of cross frames on the damping property of dampers, and validate the previously proposed design procedure for bridge systems including metallic dampers.

Savings / Benefits:

Metallic dampers provide an economic solution to upgrade deficient bridges to current design guidelines in the New Madrid Seismic Zone (NMSZ). Additionally, retrofitted bridges will perform better in the case of the next big earthquake in the NMSZ. As a result, these bridges will provide critical links for emergency vehicles to transport disaster relief to the areas in a timely manner.

Status / Results:

Full scale testing of the tapered rod system is completed, and the report will be released in fall 2004. Upon completion, an in-service bridge in the New Madrid fault area will be retrofitted with this damper system.

RI 00-061

Galvashield XP Embedded Galvanic Anodes

Purpose:

The objective of this study is to prevent new concrete repairs from being affected by early corrosion of rebar. Approximately 2,750 Galvashield XP anodes were installed on 26 bridges to minimize or reduce the onset of future corrosion in these bridges and to reduce the effect of "ring anode" corrosion associated with concrete patch repairs.

Savings / Benefits:

Stopping the "ring anode" corrosion effect will prolong the life of the concrete patch repairs. The cost of having to repair these areas in the future will be eliminated, and the health of the rest of the concrete decks will be enhanced by not allowing the deterioration to spread from repaired areas.

Status / Results:

The installation was completed during construction in 2002. Three locations of deck edge repairs with the Galvashield XP anodes were instrumented to allow the reading of current outputs of the anodes. After the first year, readings will be taken annually until 2006 to verify adequate current flow for cathodic protection. Three deck edge locations, on the twin bridges directly across from those instrumented areas, were patched without the Galvashield XP anodes. The condition of the concrete patches will be annually compared between those with anodes installed and those without. Additionally, one deck patch was instrumented so that current readings can be taken and annually compared to nearby patches without anodes. A short summary report was made on the installation of the anodes, and a final report will be published in 2006.



*Anode Installed Before
Concrete Repair*

RI 02-002

Steel-Free Hybrid Reinforcement System for Concrete Bridge Decks - Phase 1 (UMC & UMR)

Purpose:

The main objective of this collaborative research is to develop a nonferrous hybrid reinforcement system for concrete bridge decks using continuous fiber reinforced polymer (FRP) rebar and discrete randomly distributed polypropylene fibers with a view to eliminate corrosion in bridge decks. Fiberglass FRP rebar (glass FRP or GFRP) rebar will be used in the top mat of reinforcing and carbon FRP (CFRP) bars will be used in the bottom mat. The fiberglass is less expensive than the carbon fiber but is still corrosion resistant while the CFRP has higher strength. The polypropylene fibers in the mix should help keep the concrete from cracking.

Savings / Benefits:

Limited service life and high maintenance costs are associated with corrosion, fatigue, and other degradations of highway bridges and reinforced concrete structures. The combination of FRP reinforcement with the use of polypropylene fibers offers an innovative hybrid bridge deck system that can eliminate problems related to corrosion of steel reinforcement while providing requisite strength, stiffness, and desired ductility.

Status / Results:

A Research Advisory Committee consisting of representatives from MoDOT, UMC, UMR, the FRP rebar manufacturer, and the fiber manufacturer was formed to oversee the progress of the project, and have met for the second time. Concrete cylinder and beam tests and pull out tests on the GFRP and CFRP bars are being done at UMC. UMR is doing load tests before and after strengthening. Successful completion of this project will lead to fabricating and testing of full-scale steel free slabs. The project will be completed by December 2004, and a report will be issued.

RI 02-010

Post Earthquake Damage Evaluation of Bridge Structures (UMR)

Purpose:

Many bridges in Southeast Missouri are vulnerable to earthquake effects originating from the New Madrid Seismic Zone. For example, along U.S. 60, the designated emergency vehicle access route, 42 of 55 bridges were designed without seismic considerations. Non-destructive evaluation (NDE) methods will be found that are suitable for the examination and evaluation of the bridge damage levels resulting from a major earthquake. The feasibility of using microwave technology to detect plastic deformation of re-steel within concrete will be studied. Also, inspection techniques and retrofits for bridge parts will be tested.

Savings / Benefits:

The developed and/or validated techniques in this study will provide viable tools for the rapid evaluation of bridge conditions immediately after an earthquake so that emergency vehicles can be assured of passing the bridges safely. These techniques are also applicable in the assessment of structural conditions of truck- or ship-impacted bridges.

Status / Results:

The study has been underway for two years. It is scheduled to be completed in September 2004, and a final report will follow.

RI 02-011

Seismic Retrofit Techniques for Bridge Cap Beams, Columns, and Connections (UMR)

Purpose:

Multiple column bridges are widely used in the construction of highway bridges. In earthquake prone areas like Missouri and Alaska, these reinforced concrete components have to be strengthened in order to dissipate the energy and to prevent failure. MoDOT and Alaska DOT (ADOT) pooled funds together for this research. Based on a recent assessment of highway bridges in Missouri's New Madrid Seismic Zone it was found that two of the four bridges studied, the New St. Francis River Bridge and Old Wahite Ditch Bridge, may potentially collapse due to insufficient flexural/shear strength in the cap beams. In Alaska, because of ice flows, most of the columns are built stronger than the cap beams. A full scale model will be built and tested to come up with good seismic retrofit strategies for both Missouri and Alaska's multiple column bridges.

Savings / Benefits:

The proposed retrofit schemes will address the following requirements: (1) It should be simple to implement in the field, (2) traffic disruptions should be maintained at minimum levels, and (3) it should be durable. The research results of this study can be used to effectively retrofit inadequate bridges along U.S. 60 and other emergency routes. These efforts will ultimately reduce the potential loss of lives and property damage in Southeast Missouri in the event of a catastrophic earthquake event.

Status / Results:

The study is scheduled to be completed in December 2004.

RI 92-004

Statewide Study of Cathodic Protection Systems

Purpose:

The objective of this study is to provide guidance for MoDOT's program for cathodic protection (CP) of bridge decks as well as looking at new CP technology.

Savings / Benefits:

Cathodic protection is the only known means to stop corrosion of uncoated steel reinforcement. It will remain an option for rehabilitating existing bridges as long as uncoated bars remain in our bridges or alternate reinforcing materials are not practical enough to replace steel. Besides the eighty bridge decks using impressed current systems, a project using galvanic or passive anodes (no AC power is needed to run the system) is also under way (RI 00-061).

Status / Results:

MoDOT's newest impressed current CP systems are being installed on a deck rehabilitation project involving two bridges on Rt. 71 in Cass County.

RI 03-052

Performance Characteristics of Self-Consolidating Concrete

Purpose:

The objective of this investigation is to determine the performance characteristics, benefits, and cost savings of self-consolidating concrete (SCC) used in prestressed concrete members.



Savings / Benefits:

Some of the issues that arise in prestressed concrete members are surface defects that form at the form/concrete interface. These defects are commonly called "bug holes". Although the defects do not hinder the structural integrity of the member, the bug holes create an unsightly appearance of the members.

SCC is a standard concrete that incorporates a high dosage of polycarboxylate superplasticizer that causes the concrete to flow under the influence of its own weight without the need for vibration. The advantages of using SCC are as follows:

- Eliminates surface defects or bug holes
- Lower water/cement ratios and higher early strengths
- Less energy inputs that decrease labor
- Low noise level at the plants
- Higher production rates

If SCC performance characteristics meet or exceed MoDOT's standard mix, then MoDOT and industry could realize a savings from using SCC.

Status / Results:

The self-consolidating concrete mix and MoDOT's standard mix have been sampled from two precast plants to conduct performance testing. A final report detailing the results and recommendations should be finalized by October 2004.

RI 02-019

New Placing and Curing Specifications for Bridge Decks

Purpose:

In 2002, a new placing and curing specification was established for concrete bridge deck construction. The new specification was developed in an effort to minimize early cracking observed in several of Missouri's new bridge decks, a problem recognized to lead to poor deck performance, high maintenance costs, and decreased service life. Requirements for lower placing temperatures, application

of an interim curing compound, and an extended 7-day wet cure are included in the new specification and are expected to result in less cracking in bridge decks. This particular study involves monitoring the performance of bridge decks constructed with the new specification to validate improved deck performance.

Savings / Benefits:

Reduced cracking in bridge decks should result in improved performance, less corrosion of steel reinforcement, lower maintenance costs, and extended service life producing overall lower bridge deck life-cycle costs.

Status / Results:

The bridge deck cracking evaluation program was initiated in 2002, and should continue through 2004. Results to date indicate that the new specification has resulted in approximately 50% less cracking in bridge decks as compared to decks constructed using the old placing and curing specifications.

Implementation:

The new specification was implemented in 2002. The results of this study will be used to recommend any needed changes to the specification.

RI 02-022

Preservation of Missouri Transportation Infrastructure: Validation of FRP Composite Technology Through Field Testing (UMR)

Purpose:

Fiber reinforced polymer (FRP) composite technology continues to advance as an alternative to conventional structural materials because of its strength, light-weight structure, corrosion resistant capability, and versatility as a structural material. Through strengthening five structures currently rated structurally deficient in Missouri with externally bonded carbon FRP laminates, this project with the University of Missouri - Rolla (UMR) should validate FRP composite strengthening technology and result in the development of design, materials, and installation specifications written and formatted for potential AASHTO adoption.

Savings / Benefits:

Applications of FRP composite strengthening technology offers a potentially cost-effective means of strengthening structures rated structurally deficient. The speed and ease of FRP materials installation should result in significant time-savings during construction while also reducing or eliminating traffic disruption.

Status / Results:

The contract for this 5-year project with UMR was signed in early 2003. FRP strengthening improvements to the five structures took place as scheduled during the summer of 2003. Monitoring and validation efforts are currently underway and will continue throughout the duration of the study until its conclusion in 2008.

Implementation:

It is anticipated that the results of this study will provide FRP composite strengthening design, materials, construction, and maintenance guidelines for future AASHTO adoption and MoDOT implementation.

- Slope Stabilization Using Recycled Plastic Pins - Phase III
- Decision Support for Management of Slope Construction and Repair Activities
- Evaluation of Bridge Approach Slabs, Performance, and Design
- Development of a Highway Rock Cut Rating System for Missouri Highways
- A Two-Dimensional MASW Shear-Wave Velocity Profile Along a Segment of I-70, St. Louis, Missouri
- Engineering Evaluation and Optimization of Polymer-Based Drilling Fluids for Missouri Shale
- Comprehensive Shear Wave Velocity Study in the Poplar Bluff Area, Southeast Missouri

RI 98-007D

Slope Stabilization Using Recycled Plastic Pins - Phase III (UMC)

Purpose:

The objective of the project is to develop and document a technique for stabilization of surficial slope failures using recycled plastic pins (RPP). The constructability of the RPP technique was demonstrated in Phase I of the project, which was completed in June 2000. In Phase II, five additional field test sites were established using a variety of reinforcement configurations to assess the effectiveness of the technique in varied site conditions, to provide additional field performance data for optimization of the technique, and for calibration of a design method developed as part of the project. Phase II was completed in December 2003. Phase III, the current and final phase of the project, was initiated in November 2003. The overall objective of Phase III is to complete the evaluation of the technique and establish tools, documentation, and other items necessary for widespread implementation of the technique.



Close-Up of Recycled Plastic Pin Stabilizing Slope

Savings / Benefits:

Many small slides occur around the state that require repeated attention from MoDOT maintenance forces. A permanent solution would save time and money and, in some cases, provide support to the embankment to prevent eventual pavement distress related to slope failure.

Status / Results:

This project is being conducted by the University of Missouri - Columbia. Significant progress has been made on several tasks during this year. Specific activities include:

- Regular monitoring of field instrumentation at all field test sites;
- Preliminary analysis of field instrumentation data from the field test sites; and
- Preliminary calibration of the design method based on the field performance at the I-435-Wornall Road test site.

Implementation:

This phase of the project will result in final design documents and construction procedures. Following this work, a decision will be made to undertake this repair method with MoDOT forces or contract this type of work.

RI 00-014

Decision Support for Management of Slope Construction and Repair Activities: An Asset Management Building Block (UMC)

Purpose:

In the state of Missouri, it is not uncommon to have on the order of 100 nuisance slides annually. Repair methods are often chosen based on tradition rather than technical or economic reasons, and many slides tend to be repetitive occurrences. Decisions about whether, when, and how to repair slides are often made with little or no consideration given to economics from a broader, organizational perspective.

The objective of this project has been to develop a decision support framework to facilitate effective programming of slope maintenance and repair decisions. The essential questions to be answered (decisions to be made) using the framework include: "Should a slope failure be repaired?", and if so, "What repair measure(s) should be taken?". Two basic models were developed, each with different advantages and disadvantages, as described in this report. Both models incorporate reliability-based concepts to facilitate effective decision making from an overall organizational perspective.

Savings / Benefits:

Effective decision making concerning slope maintenance and repair could result in a cost and time savings. Identifying the appropriate locations and type of maintenance or repair is essential in maximizing available funding.

Status / Results:

The draft final report was received from the University of Missouri - Columbia in early 2004, and is currently under review by MoDOT.

Implementation:

While good progress has been made on evaluating and developing models to be used for slope management decision making, additional work is needed before implementing. Training will also be necessary for potential users.

RI02-033

Evaluation of Bridge Approach Slabs, Performance and Design (UMR)

Purpose:

Current construction practices often result in settlement of approach slabs near bridges. As a consequence there is often times a bump at the ends of the bridge. In some cases the settlement leads to cracking in the approach slab. Slight settlement in the approach slab is responsible for reduced ride quality of the facility and severe settlement may create an unsafe condition. MoDOT districts have spent considerable time and money in an effort to repair these settled slabs, with varying degrees of success. A MoDOT task force recommended the problem be researched. The purpose of this project is to identify and quantify the failure mechanisms observed at the approach slabs and to make recommendations to avoid this type of failure in the future.

Savings:

An improved design will result in pavements that will last longer will not require the types of repair that some current approach slabs need. The ride of the facility, and possibly the safety, will be improved. The reduced incidence of settlement repairs will save time and money.

Status / Results:

This project is being conducted by the University of Missouri-Rolla. The final report was received in February of 2004. The results of the project are currently being implemented.

Implementation:

A meeting was held in March of 2004 between the principal investigator and a MoDOT task force to review the recommendations of the report. The team will determine the course of action to implement some changes in current procedures to help correct this problem.

RI02-046

Development of a Highway Rock Cut Rating System for Missouri Highways (UMR)

Purpose:

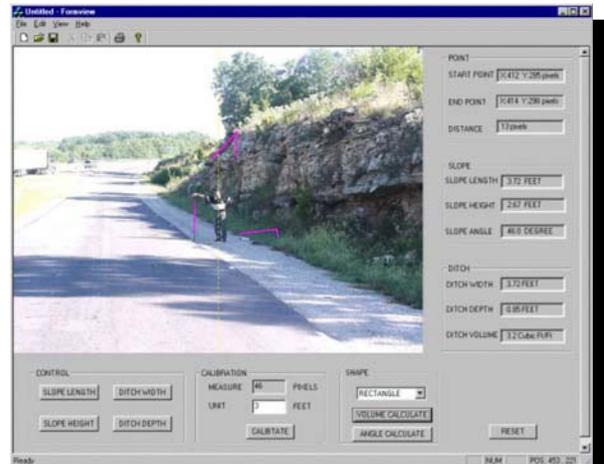
The purpose of this study is to develop a rating system, designed specifically for Missouri, which will identify criteria that are important, yet quick and easy to measure, to assess the stability of rock cuts along Missouri's highways. Rock cuts will be analyzed through imaging software. The criteria will be sorted by risk, consequence, and repair costs, so that a priority for maintenance or remediation may be determined. A system that allows quick assessment and prioritization of potential rock cut failures will help provide safe transportation for all who use the highways.

Savings:

The system will allow engineers to identify areas that need attention to prevent failures. Preventing failures will reduce traffic delays, property damage, and even possible fatalities.

Status / Results:

The system is being developed by the University of Missouri-Rolla. The various criteria have been established and individual factor values to be used in the rating system have been revised. The final report was submitted in early 2004.



Example of Software Used to Calculate Rock Cut Features

Implementation:

As the system becomes finalized, MoDOT engineers will be able to review the system and make comments for improvements. When the system meets MoDOT's approval, training will be held to educate district personnel on its use.

RI03-005

A 2-D MASW Shear-Wave Velocity Profile Along a Test Segment of I-70, St. Louis, Missouri (UMR)

Purpose:

The objective of this study was to acquire MASW (Rayleigh) wave seismic data along a 7,000 ft. segment of I-70 in downtown St. Louis. The intent was to process (through spectral inversion) these Rayleigh wave data and generate a 2-D MASW shear-wave velocity profile consisting of multiple traces (shear-wave velocity curves) spaced at 40 ft. intervals. This 2-D MASW profile was to be interpreted and compared with proximal borehole control (provided by MoDOT).

There were two primary goals. The first was to determine if the shear-wave velocity functions generated by the non-invasive MASW technique were reliable. The second was to determine if the MASW tool could be used to create a reliable and interpretable 2-D shear-wave velocity profile. If the MASW technique proved to be reliable and cost-effective, it could represent an alternative to conventional methodologies, including the seismic cone penetrometer (SCPT) and the CH techniques.

Savings:

The interpreted 2-D MASW shear-wave velocity profile was compared to available bedrock (borehole) and SCPT control provided by MoDOT. The geotechnical data provided by MoDOT indicate the interpreted 2-D MASW shear-wave velocity profile correlates well with available bedrock and SCPT control, supporting the conclusion that the non-invasive MASW technique can be used to generate reliable 2-D shear-wave velocity profiles.

Status / Results:

The project was completed by the University of Missouri - Rolla, and the final report was submitted in February 2004.

Implementation:

MoDOT will continue to pursue the use of this technique to evaluate subsurface conditions on future projects.

RI03-008

Engineering Evaluation and Optimization of Polymer-Based Drilling Fluids for Applications in Missouri Shale (UMR)

Purpose:

Polymer-based slurries have emerged in recent years as attractive alternatives to conventional water-based or oil-based mineral slurries (e.g., bentonite, attapulgite) for drilling in problematic swelling shale and rock formations. Polymer-based fluids, which are considered to be non-particulate, non-hazardous, and readily disposable, retain the environmental advantages over traditional drilling fluids while in many cases providing effective inhibition of swelling pressure and deformation at the bore hole wall.

Despite the apparent advantages of polymer-based fluids, recent experiences associated with drilled shaft installation in Missouri shale has demonstrated that site specific evaluation of the fluid-shale interaction behavior is desirable. Specific questions that remain unanswered include the following:

- 1) What is the optimum type of polymer-based drilling fluid to use for specific Missouri shale sites?;
- 2) What is the optimum concentration of polymer slurry required to adequately inhibit swelling for shale materials located at that specific site?;
- 3) What type of experimental program or laboratory/field testing procedures may be conducted to quickly and effectively answer these questions?

Very little research has been conducted to date regarding polymer slurry - shale interactions and the consequent effects on the durability and strength of the shale.

Research Investigation RI03-008 has six primary objectives, summarized as follows:

- 1) Quantify the engineering index (liquid limit, plastic limit), mineralogical (X-ray diffraction, XRD), and strength (unconfined compression) properties of soil/rock materials obtained from select Missouri shale formations.
- 2) Quantify the slake durability and jar slake (erosion and sloughing characteristics) of selected shale specimens upon interaction with control fluids (distilled water or tap water) and an experimental matrix comprising various types and concentrations of commercially available polymer-based drilling fluids.
- 3) Quantify the volume change characteristics of select shale specimens upon inundation with control fluid (tap water) and various types and concentrations of commercially available polymer-based slurries.
- 4) Develop a new testing apparatus and procedure to evaluate the hardness of shale specimens after exposure to control fluids and various types and concentrations of polymer-based drilling slurries.
- 5) Establish empirical correlations among measured limits, mineralogical, and strength properties (Objectives 1 and 2) and slake durability, jar slake, linear swell, and hardness properties (Objectives 3 and 4).
- 6) Establish and document specific laboratory testing procedures such that acceptable polymer-based fluids for drilling applications in Missouri shale may be more rationally specified.

Savings:

The practical product of this project is a demonstrated and documented series of laboratory procedures that may be followed to more effectively specify polymer-based fluids on a site-specific basis.

Status / Results:

The project was completed by the University of Missouri - Rolla. The final report was submitted in June of 2004 and is still under review.

Implementation:

The conclusions and recommendations are currently being reviewed by MoDOT to determine what changes can be made to improve the effectiveness of polymer-based fluids specifications.

RI03-029

Comprehensive Shear-Wave Velocity Study in the Poplar Bluff Area, Southeast Missouri (UMR, MoDNR)

Purpose:

The University of Missouri - Rolla (UMR) and the Missouri Department of Natural Resources Geological Survey (MoDNR) in collaboration with the Missouri Department of Transportation have initiated a study of the predictability of ground motion within surficial soils in response to earthquake shaking. The project will examine several conventional and newly-developed methods for characterizing the shear-wave velocity of surficial soils with a view to estimating frequency-dependent soil motion amplification and/or deamplification. These alternate methods will be compared and contrasted in terms of functionality, accuracy, and efficiency.

The study area is in the Poplar Bluff area in Butler County Missouri. Two differing physiographic areas are included in the study area, the Mississippi Embayment (ME) alluvial lowlands in the southeast half of the area and the Ozarks uplands in the northwest half of the area. The ME contains thick water saturated sandy alluvium with some silty, clayey or gravelly alluvium surficial materials. The Ozarks contain thin to very thick non-water saturated gravelly clay residuum with some clayey or sandy residuum. Therefore, the study area includes shallow subsurface materials and conditions representing a large portion of Missouri. The Poplar Bluff area has been selected for study because significant basic geologic and earthquake data already exists for the area, and the area is currently being investigated for earthquake soil amplification by the MoDNR, Geological Survey as part of an Association of Central United States Earthquake Consortium State Geologists project. Exchange of data between that project and the research proposed here should provide a synergy that will benefit both projects.

Savings:

This project will result in more available information for geologic evaluation and provide additional methods for the evaluation.

Status / Results:

The design phase of the field program (the field program involves the acquisition of MASW, CPT, SCPT, borehole and borehole test data including sampling) is essentially complete, however a couple of test sites have not yet been selected. This initial phase of the project took longer than anticipated, but has not delayed the onset of the drilling program. The acquisition of the MASW transect data has been delayed by about two months. The field program has begun, and the first quarterly report was submitted in April of 2004.

Implementation:

The comprehensive report will include a suite of maps depicting spatial variations in the shear-wave velocity, thickness, and stratigraphy of the soils, and a discussion of the same. A revised 3-D surficial materials map and an earthquake soil amplification map will be incorporated. The results of these intensive studies will be compared and contrasted to more traditional geologic mapping products.

Operations

- Snowplow Blades Wear Surface Designs, Configurations, and Operational Methodologies
- Ultrasonic Testing of Snowplow Blades
- URETEK Pavement Leveling and Undersealing
- AC15-5TR Chip Seal

RI03-054

Snowplow Blades Wear Surface Designs, Configurations and Operational Methodologies



Usual Set-Up for MoDOT 14 ft. Plow.

Purpose:

The purpose of this investigation is to determine which blade designs, truck and blade configurations, and plowing parameters will provide the most durable snowplow blade.

Savings / Benefits:

The Missouri Department of Transportation has over 1,700 snowplows in service and spends over \$400,000 a year on blades to outfit those plows. In past years, blades lasted from several snowstorms to an entire winter before they

were replaced. Current experience indicates premature failures occur during the first to the fourth snowstorm of the season. Replacing blades represents an increase in blade replacement cost, and also an increase in down time and personnel maintenance cost. Replacements are frequently performed during a snowfall event, which removes personnel from the snow removal effort and subjects Missouri drivers to decreased safety while the plow is out of service.

Status / Results:

An interim report has been written for the 2003-2004 winter season. It was concluded that raised pavement markers have a significant effect on some snowplow blades and a relatively insignificant effect on others. However, there were only three blades that were evaluated during the 2003-2004 winter season. Further study into the blade configurations and evaluation of different blade designs will be conducted for the 2004-2005 winter season.



Damaged Carbon Inserts and Blade.

RI01-023

Ultrasonic Testing of Snowplow Blades

Purpose:

The purpose of this project is to use ultrasonic testing to determine the source of defect propagation in carbide/steel snowplow blade inserts and to qualify a non-destructive testing technique that will; (a) locate defects originating in the manufacturing process and determine if they have an impact on blade service life, (b) be able to monitor in-service blades to determine the rate of carbide insert and bond breakdown in the field, and (c) evaluate various carbide insert configurations in the field.

Savings / Benefits:

Savings will be realized through the extended life of snowplow blades, and through the implementation of the recommendations outlined in the final report.

Status / Results:

The final report was completed in December 2003 and distributed. It has been shown that ultrasound examination can divulge pre-service and in-service defects in single layered carbide chip insert blades. Conclusions were drawn based on observed procedures from blades received directly from the manufacturer before being placed in service and from in-service performance of blades and their configurations. From these conclusions, recommendations were formed and another study has been

generated to evaluate blade configurations and methodologies to continue monitoring the failure rate of snowplow blades. RDT is currently evaluating different configurations and blade types of several snowplow blades, and will continue to monitor and observe these blades in upcoming winters.

PD98-072

URETEK - Pavement Leveling and Undersealing

Purpose:

Data for this product has been collected to provide an alternative to the existing mudjacking method where lime, cement, and water slurry have been used to level and underseal pavements. Many times, after mudjacking, repair crews have had to come back to perform additional mudjacking. So far, data collection of the URETEK method has shown return visits have not been needed to redo the application to the same locations.

Savings / Benefits:

Bids submitted for in-place material have been ranging from \$5.50 - \$6.50 per pound. Under normal lifting and undersealing conditions, the amount of material needed to accomplish this has been found to be between 0.5 - 0.75 pounds per square foot. Assuming averaged values and that the void under the pavement isn't very large, the cost calculates to be \$3.75 per square foot to raise and underseal the pavement. This method is more expensive than the conventional mudjacking method. However, lifting pavements using the mudjacking method have proven to be mostly unsuccessful with most attempts causing more damage to the pavement. In addition, once the URETEK method has been used, additional applications are not needed, which eliminates future costs associated with return visits.

Status / Results:

A generic specification has been developed enabling MoDOT districts to use this product for pavements in need of lifting to grade and undersealing. The product seems to be performing well at the original trial site on Rte. 63 near Ashland. RDT is now completing the evaluation of the Ashland site, and we are expecting an RDT final report on the performance of the URETEK method in late 2004.

PD02-014

AC15-5TR Chip Seal

Purpose:

This product is being evaluated to provide an alternative economical option for a preventive maintenance treatment for high volume roads. Currently, the only options available for preventive maintenance treatments for high volume roads are hot-mix overlays and micro-surfacings.

Savings / Benefits:

Savings will be realized when placing this treatment for preventive maintenance applications. Currently, for high volume routes, options are limited to more expensive treatments such as hot-mix overlays and micro-surfacings. This chip seal process is estimated to be approximately half the cost of hot-mix or micro-surfacings.

Status / Results:

This product was placed at the end of May 2002. To date, it is performing well with some minor raveling occurring at the centerline. "Before" photos of the pavement show that higher deterioration levels were present along the centerline of the roadway. A possible reason for centerline raveling may be due to the oil being absorbed by the porous pavement resulting in less oil on the surface to bond the chips to the pavement. RDT will continue to monitor the performance of the treatment for any other problems until late 2007.

Pavements

- Evaluation of Potential Alkali Silica Reactivity (ASR) of Various Aggregates
- Void Detection at Bridge Approach Slabs
- Precast Post-Tensioned PCC Pavement Investigation
- Mechanistic-Empirical Pavement Design Calibration

Evaluation of Potential Alkali Silica Reactivity (ASR) of Various Aggregates



ASR Deteriorated Concrete Pavement.

Purpose:

Alkali Silica Reactivity (ASR) is a type of concrete deterioration that occurs when certain silica minerals of some types of aggregates react with the alkali hydroxides in the concrete. MoDOT has not had significant problems with ASR in the past; however, new aggregate sources are being utilized in the construction of pavements and structures which may be prone to ASR.

The objective of this investigation is to find potentially reactive aggregate sources and determine effective methods to mitigate the alkali-silica reactivity occurring within these aggregates.

Savings / Benefits:

If potentially reactive aggregate sources can be identified before MoDOT approves new aggregate sources, then the savings realized from preventing early deterioration of concrete structures would be invaluable.

Status / Results:

Five aggregate sources are currently being tested to determine their ASR potential. These aggregates, such as granite sources, are composed of higher silica content compared to Missouri's typical limestone sources. The five aggregate sources will be tested and compared to a Missouri limestone that has non-reactive mineralogy and no history of ASR. The tests to determine ASR potential of the aggregates are described as follows:

ASTM C 1260, *Standard Test Method for Potential Alkali Reactivity of Aggregate (Mortar-Bar Method)* will be conducted using the different aggregate sources proposed for evaluation.

ASTM C 1293, *Standard Test Method for Determination of Length Change of Concrete Due to Alkali Silica Reaction* will be conducted using different aggregate sources proposed for evaluation.

Different supplementary cementitious materials are also being evaluated in this investigation to determine the effective method of mitigating alkali-silica reactivity in concrete using various aggregate-cementitious material combinations. This will provide data indicating the effectiveness of certain pozzolanic materials to mitigate alkali-silica reactivity in concrete mixes using potentially reactive aggregates/aggregate combinations.



Beam Measuring Device

An interim report identifying any ASR reactive sources will be complete by May 2005. A final report documenting the findings of this study and the effectiveness of the supplementary cementitious materials in mitigating ASR is estimated to be complete by January 2006.

RI 99-044

Void Detection at Bridge Approach Slabs

Purpose:

The objective of this investigation was to evaluate the effectiveness of the Falling Weight Deflectometer (FWD) at detecting voids under PCC pavement bridge approach slabs.



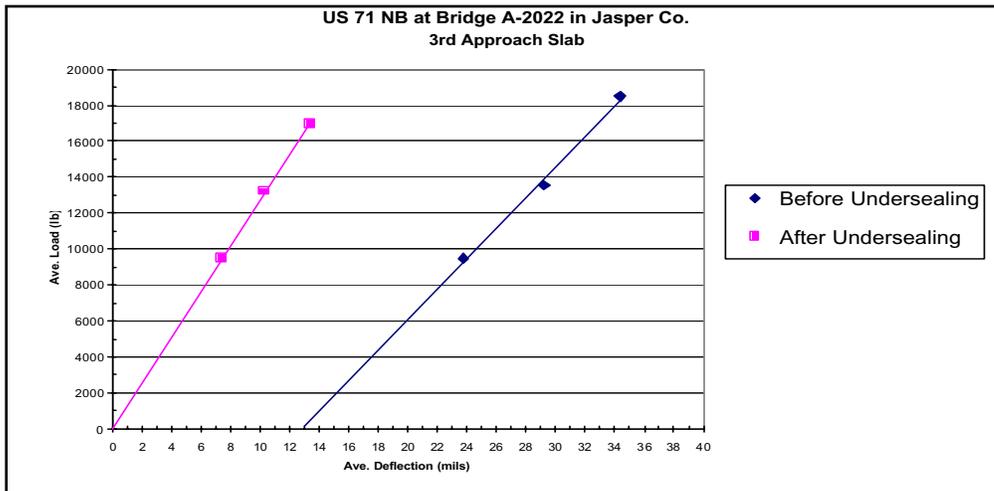
Falling Weight Deflectometer (FWD)

Savings / Benefits:

By detecting the development of voids underneath pavement slabs at bridge approaches, MoDOT can, either with its maintenance forces or by contract, apply remedial treatments at an early stage and avoid costly full-scale rehabilitation or replacement at a later date. The FWD can be used for determining voids under PCC slabs when conventional proof roll testing is not desirable because of lane closure time restrictions, unstable pavement shoulders to set the proof roll measurement apparatus on, and/or the need for more clear and quantifiable indications of undersealing improvements.

Status / Results:

Based on recommendations from the RDT Division from earlier FWD testing in 1999 on over 200 joints at 27 bridges on I-44 and US 71 in Lawrence, Jasper, and MacDonald counties, MoDOT District Seven had a contractor underseal the joints with polyurethane during the Spring of 2001. FWD testing was performed on 22 undersealed joints in the Spring of 2002. Tests were conducted on the leave side of the joint near the outside corner of the driving lane. Load levels were approximately 9,000, 12,000 and 16,000 pounds. Plots of load versus deflection were generated and compared with pre-undersealing data. Sixteen of the 22 slabs showed positive reduction in deflections after undersealing. The average reduction for the 16 improved slabs was 12.7 mils.



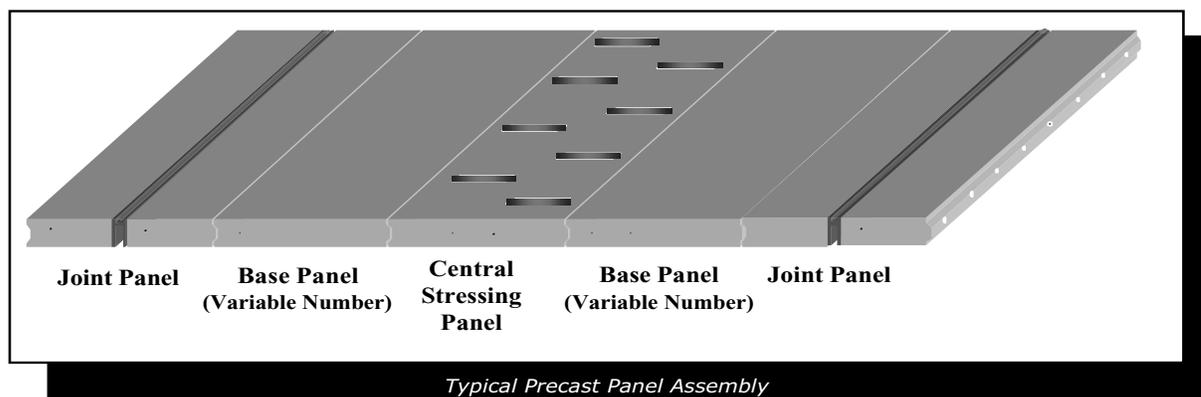
RI 03-007

Precast Post-Tensioned PCC Pavement Investigation (UMC)

Purpose:

The purpose of this investigation is to evaluate the level of installation difficulty and subsequent performance of a PCC pavement composed of prestressed precast panels that are post-tensioned after

placement. This design is extremely innovative, and short sections have been constructed at only two other locations in the country thus far. The design minimizes tensile stresses in PCC pavement that lead to fatigue failure. Structurally, an eight-inch precast post-tensioned pavement is equivalent to approximately 14 inches of jointed plain concrete pavement.



Savings / Benefits:

This design type, which is still very much in its infancy, may result in significant cost savings at project locations where excessive profile grade changes are not possible (i.e. insufficient bridge clearance) or impact roadside appurtenances (i.e. having to raise guardrail), or where high traffic makes long term lane closures prohibitive.

Status / Results:

Structural design has begun for the construction of approximately a quarter-mile section of north-bound I-57 in Mississippi County near Bertrand, Missouri. Initial discussions have been held with probable precast panel suppliers about the manufacturing feasibility of different designs. Faculty at the University of Missouri - Columbia are running preliminary tests on various pavement response gauges that will be installed in the panels.

RI 04-002

Mechanistic-Empirical Pavement Design Calibration (ERES Consultants)

Purpose:

The purpose of this work is to calibrate the mechanistic-empirical (M-E) pavement design guide program, developed under NCHRP Project 1-37A, to Missouri conditions. Converting the empirical pavement design method, currently used by MoDOT, to an M-E method was one of the major implementation recommendations made by the Pavement Team. This Pavement Team, consisting of MoDOT, FHWA, and paving industry representatives, was honored for its efforts by receiving the AASHTO Exemplary Partner award in 2004.

Savings / Benefits:

The M-E design program will more accurately predict future pavement performance, thus allowing MoDOT pavement engineers to avoid the under or over designing that disrupts service life expectations and to better optimize pavement management functions. It will also allow the easy incorporation of new materials, traffic, and climatic conditions into the pavement design process as they occur in the future.

Status / Results:

ERES Consultants was hired to facilitate the M-E design guide calibration process. Material testing plans have been developed, pavement sections for design factorials that will be calibrated in the model are currently being selected, and existing traffic data is being analyzed for acceptable default values.

Pooled Fund Studies

- Wind Induced Vibration in Cable Stay Bridges
- Design of Bridges for Security
- Long Term Maintenance of Load Resistance Factor Design (LRFD) Specifications
- Transportation Asset Management Research Program
- Advanced Research of an Image Analysis System for Hardened Concrete
- Accelerated Pavement Testing - Midwest States Pooled Fund Study
- Midwest States Regional Pooled Fund Crash Test Program
- Evaluating Traffic Safety for Nighttime and Daytime Work Zones

SPR-3(078)

Wind Induced Vibration in Cable Stay Bridges (RI 98-034)

Purpose:

The purpose of the investigation was to develop guidelines for enhanced design for future bridge structures and to provide mitigation of vibration on existing structures created in cable stay bridges by the combined action of wind and rain. In late 1999, MoDOT agreed to be the lead state and participate in the \$800,000 national pooled fund project. Eleven other states and the FHWA agreed to participate, as well. The study also included brief studies on live load induced vibrations and criteria to respond to the comfort levels of drivers and pedestrians. Missouri has three cable-stayed bridges which cross the Mississippi River and link with Illinois.

Savings / Benefits:

Testing cable vibration will help show the effects of cable movement due to wind, live loads, etc. and also the effect that the dampening system has in reducing these reactions to prevent cable damage or failure. This will help prolong the life of the cables and lessen expenses associated with maintenance or replacement of cables.



Bill Emerson Memorial Bridge, Cape Girardeau, Missouri

Status / Results:

The construction on one of Missouri's cable-stayed bridges, the Emerson Memorial Bridge in Cape Girardeau, is complete. A cross tie dampening system was used on this bridge. Through this pooled fund study, testing was done in Fall 2003 on the vibration in the stay cables and the effect of the cross ties before the bridge was opened. The dampening system worked very well. The final report on this project will be finished in the fall of 2004.

TPF-5(056)

Design of Bridges for Security (RI 02-037)

Purpose:

This is a pooled fund study initiated by Texas Department of Transportation (TxDOT). Because bridge engineers have not needed to consider structural integrity in response to terrorist attack, current

guidelines do not consider the issue of bridge security. Information will be gathered and used to develop guidelines for the economic design of new bridges for security.

Savings / Benefits:

The benefit will be a design for structures that will withstand terrorist attack with minimal damage to the bridge, avoid long term loss of use of the structures, and avoid any loss of lives.

Status / Results:

The project is underway and is comprised of two phases. Phase I entails an international literature review and planning activities for carrying out Phase II. Phase II will result in comprehensive recommendations for transportation agencies. The final report should come out by the end of 2004.

TPF-5(068)

Long Term Maintenance of Load Resistance Factor Design (LRFD) Specifications (RI 02-031)

Purpose:

A critical element in the future adoption and use of AASHTO LRFD methodologies by state departments of transportation is an awareness that the methodology and specification will be maintained. The AASHTO Subcommittee on Bridges and Structures proposed a technical service program for the long term maintenance of LRFD specifications which will fund the maintenance and development for four years starting in 2002. Iowa DOT agreed to act as the lead state for this effort and handle administrative duties for the project. The project objectives: Task 1 - Resolve areas in LRFD documents requiring modification, clarification, or interpretation. Task 2 - Assist the technical committees of the bridge committee with special interpretations of LRFD documents. Task 3 - Prepare and submit recommended revisions for LRFD provided by the work of Tasks 1 and 2. Task 4 - Maintain a "Load and Resistance Factor Home Page" to ask questions and to present the ongoing tasks of the project to the AASHTO committee and State DOT's.

Savings / Benefits:

MoDOT will contribute to funding this 4-year project. MoDOT is planning on implementing LRFD design in 2005, so this project will be of great value in transitioning our bridge design methodologies.

Status / Results:

A Quarterly Progress Report was completed for the quarter ending June 31st, 2004. The progress report lists project accomplishments to date, and can be found on the transportation pooled fund website (www.pooledfund.org).

TPF-5(036)

Transportation Asset Management Research Program (RI 01-059)

Purpose:

The purpose of this pooled fund study is to maximize benefits of a transportation program to its customers and users based on well-defined goals within available resources. The pooled fund study is being lead by the Midwest Regional University Transportation Center.

Savings / Benefits:

The anticipated benefits include obtaining valuable information from the research, making quality decisions within MoDOT based on those findings, and avoiding duplication of research projects.

Status / Results:

MoDOT is serving on the project advisory committee along with members from Georgia, Michigan, Ohio, Wisconsin, and Wyoming. Many research projects have been approved and/or are underway such as "Transportation Asset Management Threshold Levels" and "The Use of Functional Silos to Optimize Agency Decision Making". "The Maintenance Quality Assurance Peer Exchange" will be held in Madison, WI on October 11-13, 2004. The research project "Incorporating Road Safety Into Pavement Management" is scheduled to be complete by 2005.

TPF-5(014)

Advanced Research of an Image Analysis System for Hardened Concrete (RI 98-006)

Purpose:

Serving as the lead agency in this pooled fund study with twelve other participating states, MoDOT initiated this effort to develop an automated system for analyzing the air-void system in hardened concrete. Analysis of hardened concrete in accordance with ASTM C-457 is routinely conducted to determine concrete air content and its air-void structure for research and evaluation purposes. The air content and characteristics of the air-void system are commonly known as reliable indicators of a concrete's resistance to freezing and thawing. The current standard and most reliable means of analyzing hardened concrete is a human-based operation using ASTM C-457, which is tedious, time-consuming, and requires a skilled and experienced operator.

Savings / Benefits:

Automating the system would save both time and labor for increased efficiency, and would improve consistency and repeatability of the operation for improved accuracy. Development of a reliable and accurate system producing results comparable or better to the current human-based ASTM C-457 test method would offer an efficient means of hardened concrete analysis for many in the field of concrete materials, construction, and research.

Status / Results:

The National Nuclear Security Administration-Kansas City Plant, a government contractor for the U.S. Department of Energy and the primary contractor for the pooled fund study, will soon complete the construction of a 2nd generation prototype image analysis system reflecting recent hardware advancements. Software improvements continue to be integrated into the system. The system is expected to be finalized and the study completed in late 2004.

Implementation:

At the completion of the study, hardware specifications and software required for the image analysis system should be ready for deployment so that they may be used by those in the concrete materials, construction, and research field.

TPF-5(048)

Accelerated Pavement Testing - Midwest States Pooled Fund Study

Purpose:

The purpose of this study is to evaluate the structural integrity of various pavement features through accelerated loading in a controlled environment. The accelerated testing lab (ATL) is located on the campus of K-State University in Manhattan, Kansas. MoDOT has participated in this pooled fund with Kansas, Nebraska, and Iowa for several years.

Savings / Benefits:

The results of the ATL experiments allow the participating state DOT's to better understand the long term performance characteristics of various materials and pavement designs, and also help decide whether or not to implement them.

Status / Results:

The latest experiment to be completed was a foamed asphalt base study. The results indicated that a base, composed of cold in-place recycled asphalt and smaller quantities of underlying deleterious material stabilized with foamed asphalt emulsion, had stiffness characteristics equal to or moderately better than good crushed stone in a flexible pavement.



Kansas State University Accelerated Testing Lab

SPR-3(017)

Midwest States Pooled Fund Crash Test Program

Purpose:

Since 1990, MoDOT has been a member of this regional crash testing pooled fund program, which is led by the University of Nebraska - Lincoln at the Midwest Roadside Safety Facility. The purpose of the project is to provide safer roads through the testing and evaluation of roadside safety appurtenances to assure that they meet FHWA and industry requirements and standards. Also, the pooled fund program eliminates duplication in testing and evaluation efforts by member states.

Savings / Benefits:

The savings attributed to the program may not be monetary to MoDOT except in eliminating testing duplication, but may be seen more in the reduction of accidents and injuries associated with impacting MoDOT roadside safety hardware. This should result in a decrease in MoDOT's liability costs.

Status / Results:

The Midwest States Pooled Fund Crash Test Program is an ongoing project with yearly testing programs established and approved by the technical committee at its yearly meetings.



*Crash Test at the Midwest Roadside Safety Facility,
University of Nebraska - Lincoln*

Evaluating Traffic Safety for Nighttime and Daytime Work Zones (RI 02-043)

Purpose:

Nighttime construction and maintenance operations have become more common at MoDOT as a result of efforts to reduce work zone related congestion. The change to increased nighttime operations stems from work policy changes enacted in 2000. With the changes, field crews and managers alike wonder about the relative safety of nighttime operations versus those in the daytime due to contributing factors such as reduced visibility, increased drunken and drugged drivers, and the expectations of drivers. After a review of work zone safety research, it was determined that no real conclusions could be drawn regarding the relative safety of nighttime versus daytime operations. The data regarding the safety climate of these operations is plagued by uncertainties in 1) the level of detail about crashes, 2) the relationship of crashes to location of the work zone, and 3) variations in reporting practices.

In response, MoDOT submitted a research proposal to the NCHRP process that was accepted and awarded to the Texas A&M Research Foundation as NCHRP 17-30. The project is a 30-month research project to determine the crash rates and nature of traffic related crashes in nighttime and daytime work zones. The project is also designed to develop work zone crash reporting recommendations to improve the collection of work zone crash data.

Savings / Benefits:

While there is a perception that night work zones are less safe than daytime work zones, evidence to substantiate these perceptions is not available. However, recent research suggests that crash rates for nighttime work zones are up to three times higher than those for daytime operations. If nighttime operations are as dangerous as the data and perceptions suggest, more significant resources must be directed towards ensuring worker and driver safety in nighttime work zones. As we are aware, working on the road is already dangerous enough, thus changes in work zone operations must be accompanied by appropriate hazard mitigation to ensure that employees and drivers alike, get home safely.

Status / Results:

NCHRP 17-30 is currently underway with an expected report completion date of October 2006. A literature review has been conducted and a survey of State DOT's is underway. An interim progress report can be expected in December of 2004.



Nighttime Work Zone

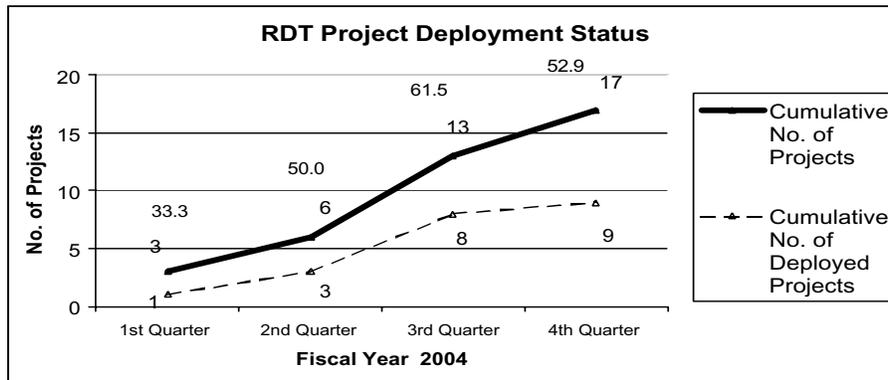
Photo by: Gerard Kennedy, Nova Scotia Dept. of Transportation

Technology Transfer

- Deployment
- Publications
- Missouri Local Transportation Resource Center:
Home to Missouri's LTAP
- Library Automation Project
- Summer Transportation Institute
- RDT Training

Deployment

We are in our second year of using a Dashboard/Score Card System to track the department's progress in reaching the mission and goals of MoDOT's business plan. RDT has been charged to measure the deployment of research projects completed. For fiscal year 2004, seventeen projects were completed with nine projects implemented. This represents a 52.9% deployment rate.



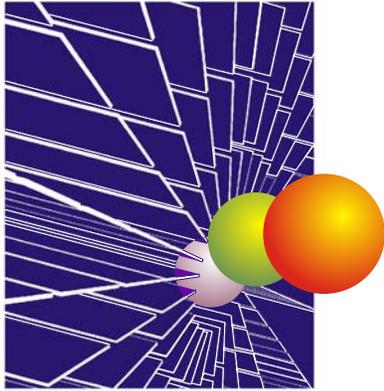
Publications

RDT publishes findings of its research through letters of findings, technical briefs, and final reports. Final Reports are prepared for all investigations. Reports normally document the work carried out, conclusions reached, and recommendations derived from the investigation. Technical briefs are prepared for most investigations. Technical briefs summarize reports and briefly explain how to implement various technologies or product features. Technical briefs provide a brief but complete overview of the project, allowing those interested to then read the entire report.

MoDOT
Research, Development and Technology
University of Missouri-Rolla RDT 04-017

**Design, Fabrication
and Testing of Low Profile
Composite Bypass Road Panel:
Phase 1**

RI 02-016



June, 2004

Brief

Research Investigation RI 02-016
Research Report RDT 04-017 August, 2004

**Design, Fabrication, and Testing of
Low-Profile Composite Bypass
Road Panel: Phase I**

Description:
The use of glass fiber reinforced polymer (GFRP) sandwich panels in civil engineering applications, especially for bridge deck rehabilitation and military airfield matting, has become more accepted in recent years as a result of demonstration projects that have shown the concept feasibility in rather demanding transportation infrastructure applications. Typically, these sandwich panels feature a fiber reinforced (bidirectional) high-density foam core and GFRP facings that provide full integrity and strength to the system (Figure 1). The application of GFRP sandwich panels for application in temporary reusable bypass roadways has been identified as a high-interest alternative to traditional construction by the Missouri Department of Transportation (MoDOT).

In order to investigate the performance of the sandwich construction, an experimental program including static and dynamic fatigue tests was performed, and both tests included two different characterizations: compression and flexure. In both cases, the specimens were conditioned to 500,000; 1,000,000; 1,500,000 and 2,000,000 cycles. The specimens utilized in the experimental program were collected from different sandwich panels with the purpose of verifying homogeneity in the mechanical properties of the material. Cubic specimens of 4 in (102 mm) by 4 in (102 mm) and 3.5 in (89 mm) thick, and two types of beams (longitudinally-cut and transversally-cut) 8 in (203 mm) wide and 58 in (1.47 m) long were utilized in the compressive and flexural tests, respectively. The investigation focused on the ultimate capacity and stiffness (compressive and flexural) of the sandwich structure, as well as its residual strength and rigidity after fatigue conditioning. Figure 2 illustrates the test setup of the Fatigue Flexural Test.

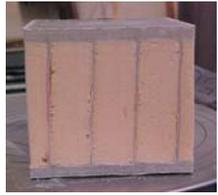


Figure 1: Sandwich Panel Cubic Specimen

**Research
Development
and Technology**

Missouri
Department
of Transportation

1617 Missouri Blvd.
P.O. Box 270
Jefferson City,
Missouri 65101

All publications are posted on RDT's website at <http://www.modot.org/services/rdt/index.htm>. Each calendar quarter, RDT distributes its publications through electronic transmittal to all partners including MoDOT management, transportation advisory groups, TRB, and national transportation libraries.

Missouri Local Transportation Resource Center: Home to Missouri's LTAP

Funded by the Missouri Department of Transportation (MoDOT), the Department of Civil, Architectural, and Environmental Engineering, and the University Transportation Center, the Missouri Local Transportation Resource Center (MLTRC) serves as the Missouri branch of the Local Transportation Assistance Program (LTAP). Through training programs, information resources, and purchasing programs, the center works to get the latest transportation resources out to city and county agencies across the state.



MLTRC takes a two-pronged approach to training. The first prong is the Customized Transportation Education Program (CTEP). Through CTEP the center helps agencies organize learning opportunities tailored to meet their specific needs. In 2003-2004, THE MLTRC assisted 5 agencies with over a 175 attendees. The second prong, the Proactive Training Program (PTP), offers popular workshops at pre-determined times and locations. The first program, titled the Local Roads Workshop Series, offered up to 3 workshops in each of the 10 MoDOT Districts during the spring of 2004. In total, MLTRC conducted 20 workshops with over 300 participants attending. For 2004-2005, both programs will continue under the direction of a dedicated part-time training coordinator.

Task Progress Statistics

TASK PROGRESS STATS	QUARTER				TOTAL
	2003: 3rd	2003: 4th	2004: 1st	2004: 2nd	
New contacts added to the mailing list	9	113	253	4	379
Number of contacts on the mailing list	N/A	N/A	N/A	N/A	4300
Newsletter issues published and mailed	1	1	1	0 (2 issues will be published 3rd qtr.)	3
Items added to the library	29	87	41	53	210
Library items, publications, and materials distributed	71	138	167	1461	1837
Requests for Coop. Purchasing Program assistance	22	21	21	8	72
Requests for technical/other assistance (non-Coop)	37	32	261	40	370
Seminars/training sessions presented	0	6	8	21	35

Training Details

Year: Quarter	Title	Location	Number of sessions presented	Number in attendance
2003: 3 rd	(no offerings)	N/A	0	0
2003: 4 th	District 9 Local Asphalt Training (co-sponsored)	Salem, MO	1	42
	District Ambassador Workshop	Rolla, MO	1	27
	Snow and Ice Workshop	St. Peters, MO	1	64
	Gravel Road Maintenance, Ashgrove Aggregates	Buffalo, MO	1	24
	Gravel Road Maintenance, Ashgrove Aggregates	Butler, MO	1	20
	MINK3 Conference	St. Joseph, MO	1	67
2004: 1 st	Work Zone Safety Training	Ballwin, MO	4	69
	Flagger Training	District 5,6,10	2	13
	Gravel Road Maintenance		2	16
	Designing Healthy Communities, Mid-America Regional Council	Kansas City, MO	1	58
	Sustainable Highways, Mid-America Regional Council	Kansas City, MO	1	57
2004: 2 nd	Flagger Training	District 2,3,7,8	4	73
	Work Zone Traffic Control & Safety	District 2,3,7,8	4	67
	Gravel Road Maintenance	District 1,2,3,7,8	5	75
	Fiber Reinforced Polymer Strengthening Technique Training	Phelps County	1	25
TOTALS			30	697

The center's information resources include a quarterly newsletter, lending library, distribution library, and website.



The quarterly newsletter *MOInfo* is a joint project between the MLTRC and MoDOT's Research, Development, & Technology (RDT) division. The style and format of the newsletter were designed to appeal to a broad audience that ranges from county officials to transportation field engineers. Regular features include the following:

- "New in the Library" — highlights newly acquired library items and materials for distribution;
- "On the Horizon" — details upcoming learning opportunities and conferences across the country; and
- "Tech Brief" — summarizes the latest technical results from RDT transportation research activities in accessible language.

MLTRC continues to enhance its education and technology transfer capabilities via use of the Internet. In 2003-2004, the lending and distribution libraries were published online with search and request capabilities. In June 2004, work began on converting the MLTRC's library of training videos to a "streamable" and downloadable format.

Center operations are guided by Director Mohammad Qureshi, assistant professor of civil engineering; Program Manager Lonnajeon Yoest; and the expertise of an advisory committee which consists of a diverse group of professionals, including MoDOT & Federal Highway Administration personnel, county engineers, and local elected officials. Center activities include substantial involvement of students both at the graduate and undergraduate level, in the hope of spreading interest not only in the transportation field but also in the concept of technology transfer.

Library Automation Project (UMC)

Purpose:

The purpose of the project is to automate the department's technical library. RDT is completing the 2nd year of the project to automate the inventory of its holdings. To date, over 3,400 publications have been cataloged.

Savings / Benefits:

Savings and benefits are achieved through improved reference search capabilities for MoDOT staff and online customer base. An automated library will serve as an essential tool for customers to conduct literature searches, research analyses, and technology transfer activities.



RDT Library



MoDOT Employee Entering Library Materials to the Online Catalog

Status / Results:

The key features on the 2nd year include the following: (1) Continued cataloging of documents, (2) Training of staff to utilize online searching capabilities, (3) Physical reorganization of RDT publications that are updated by providing shelving tags, (4) Continued development of a "prototype library portal" is also underway to allow online usage of RDT's library, (5) Exporting department Machine Readable Cataloging (MARC) records to the

Online Computer Library Catalog (OCLC), (6) Continued partnering with the Midwest Transportation Knowledge Network (MTKN), (7) and Participation in the creation and development of the Transportation Libraries Catalog (TLCat), which enables greater resource sharing among all national transportation agencies.

STI

Summer Transportation Institute (FHWA, UMR)

RDT conducted several presentations for a group of 15 high school students enrolled in the University of Missouri-Rolla's sixth annual Summer Transportation Institute (UMR STI). Traditionally UMR STI hosts students from across the nation, and this year, added a new dimension by including a student from Japan. The program is designed to introduce students to careers in transportation engineering and to expose them to the "college experience." Participants study areas such as the modes of transportation, surveying, bridge design, construction, and materials engineering.



Snowplow Blade Presentation to STI Students

Additionally they develop their interpersonal and communications skills through a series of workshops. As a part of the institute, all participants enroll in a three-hour college-level liberal arts course. This year the course covered American history since 1877 and highlighted transportation developments during that period.

UMR STI is funded through the combined resources of the university, FHWA, and UMR's University Transportation Center (UTC). The National STI program began at South Carolina State University in 1992 and has since expanded to 42 sites around the nation. UMR's program was awarded to Dr. Gary Spring in 1999 and is now being directed by MLTRC Program Manager Lonnajean Yoest. Since 1999, the program has graduated over 100 students.



Lab Demonstration to STI Students

RDT Training

Technical training courses are available to provide direction and support to personnel. These courses are scheduled to maintain an understanding of new needs and enhance abilities to support the core mission of the department. Typical audiences include personnel from FHWA, MoDOT, consultants, and local government. Training is further accomplished by field assistance demonstrations, which depict a hands-on, best practices method of sharing.

TRAINING COURSES SPONSORED BY RDT

FISCAL YEAR 2004

	Consultant	Technical Contact	Date	Location
Advanced Relocation	NHI	Selene Fults	September 16-18, 2003	Jefferson City
Engineering Concepts for Bridge Inspectors	NHI	Ken Foster	December 8-12, 2003	Jefferson City
Safety Inspection of In-Service Bridges	NHI	Ken Foster	January 5-16, 2004	Jefferson City
Pedestrian Facility Design	NHI	Caryn Giarratano	October 21-23, 2003	Jefferson City
Bicycle Facility Design	NHI	Caryn Ciarratano	October 21-23, 2003	Jefferson City

**Research, Development, and Technology
"Final Publications"
July 2003-June 2004**

Report Number	Title	RDT Report Date Published	RDT Brief Date Published
RDT 03-007	Rumble Strips in Missouri	July 2003	-
RDT 03-010	Signal Mast Arm Failure Investigation	July 2003	-
RDT 03-011	Development and Use of Social and Economic Data at MoDOT	August 2003	August 2003
RDT 03-012	RDT Library System Development	September 2003	-
RDT 03-013	Benefits of Highway Improvements on Rural Communities in Missouri: Economic Development Consideration	September 2003	-
BRIEF	MoDOT Application of Maturity Technology	-	July 2003
RDT 03-015	Evaluation of Cracking in Pre-Service and In-Service Snow Plow Carbide Wear Surfaces	December 2003	-
RDT 03-016	Slope Stabilization Using Recycled Plastic Pins: Phase II - Assessment in Varied Site Conditions	December 2003	-
RDT 03-017	Highway Rail Crossing Project Selection	December 2003	-
RDT 03-019	Evaluation of Recycled Plastic Products in Terms of Suitability for Stabilization of Earth Slopes	December 2003	-
RDT 04-001	Strengthening of Martin Springs Outer Road Bridge, Phelps County	January 2004	-
RDT 04-003	Assessment of Multiple Left-Turn Phasing Strategies	January 2004	June 2004
RDT 04-004	Void Detection with the Falling Weight Deflectometer	January 2004	June 2004
RDT 04-005	Comparison of Compressive Strength Using 4x8 vs. 6x12 Cylinders for Prestress Concrete	February 2004	March 2004

**Research, Development, and Technology
 "Final Publications"
 July 2003-June 2004**

Report Number	Title	RDT Report Date Published	RDT Brief Date Published
RDT 04-006	Decision Support for Slope Construction and Repair Activities: An Asset Management Building Block	February 2004	-
RDT 04-008	Benefits and Design/Location Criteria for Passing Lanes	March 2004	-
RDT 04-009	Development of a Highway Rock Cutting Rating System for Missouri Highways	March 2004	May 2004
RDT 04-010	The Evaluation of Bridge Approach Slabs, Performance, and Design	April 2004	May 2004
RDT 04-018	Evaluation of Cutco Sawing and Sealing Method	June 2004	-
BRIEF	Pavement Rehabilitation Through Ultra-Thin Whitetopping (UTW) Overlays	-	May 2004

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**MISSOURI DEPARTMENT OF TRANSPORTATION
RESEARCH, DEVELOPMENT AND TECHNOLOGY
RESEARCH IDEA STATEMENT**

Research Idea Title:

Research Idea Statement:

Objectives:

For further review, please specify the appropriate Technical Advisory Group (TAG) according to research idea emphasis area.

- Project Development/Bridges
- Operations
- Pavements
- Geotechnical
- Traffic/Safety
- Social/Economic/Environmental
- Other

Implementation of Research Results:

Functional Units Affected:

Name: _____ Date: _____
Title: _____
Organization: _____ Functional Unit/Dist. _____
Address: _____ Phone: _____

Complete and return to: Missouri Department of Transportation
Research, Development & Technology
P. O. Box 270
Jefferson City, MO 65102
Phone: (573) 751-3002

For RDT Use Only:

RI # _____
TAG Assn _____
ADMIN Approval _____

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MISSOURI DEPARTMENT OF TRANSPORTATION

PRODUCT LISTING/NEW PRODUCT EVALUATION REQUEST FORM

When request is submitted, enclose a completed copy of this form and the required information as indicated below.

Circle One: **Manufacturer** **Fabricator** **Distributor** **Other** _____

Business Name: _____ Contact Name: _____

Address: _____ City: _____

State: _____ Zip: _____ Telephone No: _____

Fax No: _____ Email: _____ Website: _____

Product: _____ Name of Manufacturer: _____

Name of Product: _____ Model No. _____

Description and intended application of product: _____

Key words (requested for literature search): _____

List other states using the product: _____

What is the approximate unit cost of the product? _____

Is material available at no cost for lab and field installation evaluation? _____

Applicable Specifications: (MoDOT specifications and MSP's are available at www.modot.state.mo.us/business/business.htm or by request.)

	Indicate	(If yes, provide specification name/number. If no, attach separate explanation
Does product comply with	Yes/No	as to why not and why MoDOT should consider the product)
MoDOT specifications?	_____	_____

Does product comply with other specifications (such as ASTM, ITE, AASHTO, NEMA, NTPEP, etc.)?	_____	(If yes, provide specification name and number. Attach additional sheets if necessary.)
---	-------	---

Required Information (to be submitted in addition to this form):

- 1) Product data (mixing info, installation requirements, product brochures, specification sheets, etc.)
- 2) Documentation required by the MoDOT specification (if applicable)
- 3) Applicable test data
- 4) Unit cost data and whether the unit cost includes installation
- 5) Material Safety Data Sheet

Submitted by:

(Sign) _____ Date: _____

(Print) _____

Please send the new product evaluation request form and all other required information to the appropriate address below. Submittals related to the Traffic Signal and Highway Lighting Approved Products List should be submitted to Traffic Operations. Submittals that meet a current MoDOT specification and have a Qualified or Pre-Acceptance List should be submitted to Project Operations. All other submittals should be submitted to Research, Development and Technology. If a sample is required by the specification, submit the sample with a copy of the required documentation to the Central Laboratory. If the specification does not specify a sample or there is no specification, sample submittals will be required upon request.

Traffic Operations P.O. Box 270 2211 St. Mary's Blvd Jefferson City, MO 65102	Project Operations P. O. Box 270 2211 St. Mary's Blvd Jefferson City, MO 65102	Research, Development and Technology P.O. Box 270 1617 Missouri Boulevard Jefferson City, MO 65102	Central Laboratory 1617 Missouri Boulevard Jefferson City, MO 65109
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Office Use:

Initial date received: _____ All required documentation submitted? (Y/N) _____

Date of additional documentation receipt: _____ Product Development/NP number assigned: _____

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Missouri Department of Transportation
P.O. Box 270
1617 Missouri Blvd.
Jefferson City, MO 65109
www.modot.org

Michael Shea, Assistant State Research,
 Development and Technology Engineer
 Tim Chojnacki, Director, Research
 Don Davidson, Director, Development
 Patty Lemongelli, Director, MTI
 Transition

MoDOT Research,
 Development and Technology
 Implementation Form

Research Investigation and Implementation

Project Information

Project Title:	Project ID:	Date:
Technical Advisory Group:	Technical Advisory Chair and Phone Number:	
Project Start Date:	Approved Contract Amount:	
Project End Date:	Final Project Expenditures:	
Final Report Draft Date:		
Principal Investigator:	Principal Investigator Phone:	
	E-Mail:	

Technical Advisory Group Recommendation

- Check one of the two below:
 Yes. We recommend changes to current practice based on some or all of the results of this report. The research was sound, and the report’s conclusions appear to offer an advance over current practices.
 No. We do not recommend changes to current practice at this time. This approach does not appear fruitful OR future study is needed OR our objectives have changed, etc.
- If implementation is recommended, we suggest the following specific changes to current practice detailed in the final report and timeline. (check applicable items)
 Standard Specifications
 MoDOT Functional Unit Manual (i.e. Maintenance, Design, Construction, Materials, etc.)
 Standard Drawings
 Job Special Provisions
 Training, Outreach
 Other (describe):

3. Approval of this implementation plan by the Technical Advisory Group (chair on behalf of TAG):

Signature:

Date:

4. Approval of final report and timeline by the MoDOT personnel responsible for the policies described in item # 2 above:

Signature(s):

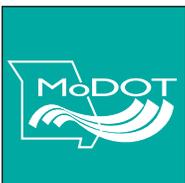
Date:

5. Approval at Implementation

Name:

Functional Unit:

Research Investigation Number RI 04-041
Report Number RDT 04-022



Missouri Department of Transportation
Research, Development and Technology
1617 Missouri Blvd.
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Web Address: www.modot.org/services/rdt