ODOT Research News

Fall 2005

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Northwest Transportation Conference

The 2006 Northwest Transportation Conference will be held February 7-9, at the Oregon State University CH2M-Hill Alumni Center in Corvallis. The conference theme is ***Road Ecology: Surface Transportation and the Environment***. In line with that theme, there will be sessions on: transportation and land use, historic highway preservation, pavements, structures, alternative and bio fuels, geotechnical hot spots, local road maintenance, wild life crossings and habitat connectivity, road pricing, update of the Oregon Transportation plan, and a session on the new Oregon Temporary Traffic Control Handbook. There will also be several sessions organized by ITS Oregon featuring aspects of Intelligent Transportation Systems technology.

Several guest speakers are planned for the conference, including: Grace Crunican, Director of the Seattle Department of Transportation, and Gordon Price, adjunct professor of urban planning at the University of British Columbia.

A student poster competition will also be held, recognizing outstanding transportation research by students of northwest universities.

Vendor displays will be open throughout the conference with hosted breaks. Free Professional Development Hours are also available: one hour of instruction equals 1-PDH.

Sponsors for the conference include: the Oregon Department of Transportation, The Kiewit Center for Infrastructure and Transportation, Oregon Technology Transfer Center, ITS Oregon, Association of Oregon Counties, Federal Highway Administration and many others.

For more information, the conference schedule, and online registration, visit the NWTC web site at: http://kiewit.oregonstate.edu/nwtc/index.html

FY 2007 Project Selection

The annual project solicitation for ODOT's research program is underway. The deadline for submitting research problem statements is December 16, 2005.

Funds and other resources are available for the following areas: research (study of a transportation problem), development (design and/or testing of a new transportation tool or procedure), and technology transfer (demonstration of, or education about new transportation technologies).

The project selection process involves several steps. First, one or more of the eight Expert Task Groups (ETG), each consisting of 6 to 9 technical experts, will review the problem statements. The ETGs are organized into the following areas:

- Construction and Maintenance
- Pavements and Materials
- Hydraulics, Geotechnical and Environmental
- Planning and Economic Analysis
- Structures
- Traffic, Safety and ITS
- Roadway Design and Human Factors
- Integrated Multimodal

Problem statements identified as top candidates by one of these groups will be developed into a more detailed "second stage" problem statement. Near the end of February, the ODOT Research Advisory Committee (RAC) will decide which of the second stage problem statements will receive funding in FY 2007, starting July, 2006. Project screening and selection will focus on projects related to priority research needs. A summary of priorities identified for this year is available on the Research Unit web site.

All of the information and materials needed to submit a problem statement on-line can be accessed from the Research Unit web site at: www.oregon.gov/ODOT/TD/TP_Res/

Remember, the deadline for submitting a problem statement is **December 16, 2005.**

For more information please contact Barnie Jones at 503-986-2845 or by e-mail at Barnie.P.Jones@odot.state.or.us.

LIVING WITH CRACKED BRIDGES

Oregon has several hundred reinforced concrete deck girder (RCDG) bridges, built in the late 40s to the early 60s, that now exhibit diagonal cracks in the girders. Diagonal cracking in beams has been associated with inadequate shear capacity, a situation engineers design to avoid because it may lead to a sudden failure. Research funded by ODOT and conducted by Oregon State University (OSU) showed that repeated traffic loading was not causing the steel reinforcement to gradually deteriorate; a critical consideration in deciding whether to replace or repair a bridge. The research also defined an accurate method to estimate the load capacity of the cracked girders, which was incorporated into a reliability-based procedure to load rate the cracked bridges. Subsequent efforts have focused on implementing the load rating method for cracked girders, repairing cracked girders, developing an analysis method for cracked bent caps, and deploying bridge monitoring technology.

Load Rating

To be practicable, the load rating method developed for the cracked bridges requires automation. Computer software is being developed at OSU to perform the reliability-based assessment on RCDG bridges. An initial load rating software package has been completed and a second generation package is being developed that will provide more flexible analysis capabilities and enhanced visualization modules.

The reliability-based assessment methodology for RCDG bridges uses a system-wide threshold to delineate acceptable and unacceptable reliability values for bridges. An investigation is nearly finished to determine an appropriate threshold based on a comparison of reliability values with conventional load rating factors for a suite of twenty bridges.

Repair Methods

Epoxy injection, supplemental steel stirrups, post-tensioning, and fiber reinforced polymer composites are being investigated by OSU for repair options. Large-scale laboratory specimens cracked and repaired are loaded with increasing amplitude until failure to determine the increase in shear capacity. The effect of repeated loading to simulate traffic on the behavior and performance of the different repair methods is evaluated. The research includes investigation of in-service repaired RCDG bridges. This effort will provide accurate methods of predicting the increase in capacity for specific repair types, determine the longevity of repairs, and recommend effective repair approaches optimized for the diagonal cracking prevalent in Oregon's vintage RCDG bridges.

Cracked Bent Caps

Bent caps are transverse beams that support the main girders. Though generally more heavily reinforced than girders, bent caps are non-redundant and could potentially cause a bridge to collapse if one were to fail. Many of Oregon's 1950's vintage RCDG bridges have cracked bent caps along with cracked girders. Because of the relative dimensions of bent caps, the analytical method for estimating load capacity of cracked girders may not be accurate for bent caps. Consequently, OSU is conducting research on large-scale bent caps in the laboratory to evaluate the capacity and estimate the remaining life of cracked bent caps.

Bridge Monitoring

Acoustic emission testing at Banzer Bridge

Monitoring a damaged bridge in conjunction with load rating can provide additional comfort that a bridge will perform as expected. Consequently, ODOT has contracted with Engineered Monitoring Solutions to install a demonstration structural health monitoring system on four RCDG bridges with cracked girders. The system will send strain and crack size data to ODOT personnel along with alerting engineers to any sudden changes in the condition of the bridge due to an overload.

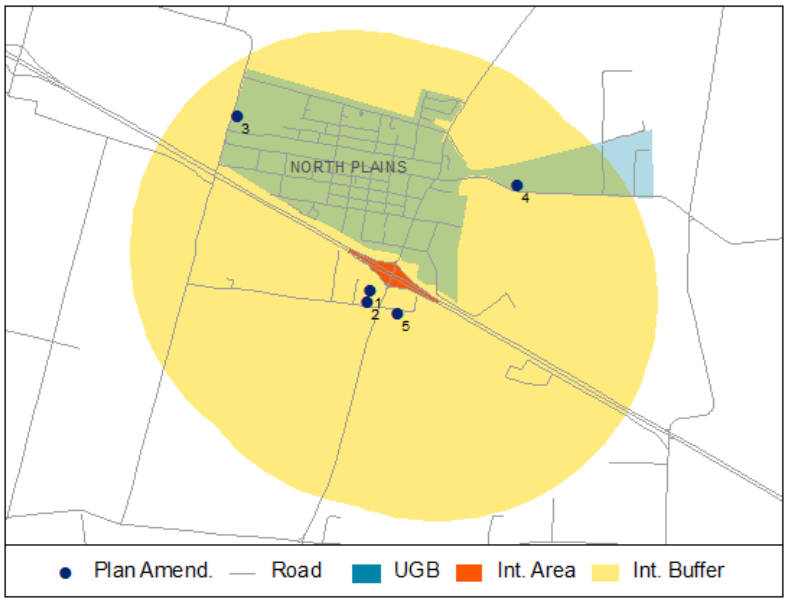
In addition to bridge monitoring using conventional technology, a joint research project between ODOT, OSU, and Portland State University is investigating acoustic emission (AE) testing as another tool for determining the health of our bridges. In AE monitoring, the sound given off by damage is detected and characterized by the AE system. This research will develop a protocol for applying AE testing to RCDG bridges in order to assist in bridge element rating, setting load restrictions, and predicting the rate of damage progression.

For more information contact Steve Soltesz at 503-986-2851 or by e-mail at Steven.M.Soltesz@odot.state.or.us

LINKING LAND USE TO TRAFFIC IMPACTS AT INTERCHANGES

Land development near highway interchanges can increase the traffic loads on these facilities. When the potential for such land development is known ahead of time, an interchange can be designed to accommodate the development when it eventually occurs. The city and county comprehensive plans are the guiding documents which indicate what the intended land uses are in an area. But plans are subject to change. When a comprehensive plan is amended to designate a more intensive land use near an interchange, earlier traffic projections can be undermined, and the design life of the interchange can be affected.

But how much do land use changes occur at interchanges? How much effect do they have on the interchange traffic counts? Do we have the necessary tools to address the need to manage existing interchange capacity? ODOT Planning staff wanted to know. ODOT Research worked with Dick Reynolds and other planning staff to further define the problem and identify possible research approaches. They also enlisted the help of the Center for Urban Studies at Portland State University. The research team included Dr. James Strathman, Dr. Tom Kimpel, Dr. Kenneth Deuker, and Paul Leistner.



Case study map showing the locations of comprehensive plan amendments within the one-mile radius of the North Plains interchange on U.S. 26

In July 2004, PSU undertook an ambitious data collection effort to manually assemble 15 years of interchange traffic count data and comprehensive plan data and construct a GIS database that would allow an analysis of the data to estimate the effects of comprehensive plan amendments on interchange traffic counts. The research also included a thorough review of interchange management in Oregon and elsewhere, plus a series of case studies of comprehensive plan amendments at interchanges.

The findings indicated that comprehensive plan amendments in urban areas are about 25 percent more likely to occur within a mile of interchange areas than elsewhere. Plan changes in rural areas and in the urban fringe were significantly associated with increases in traffic, although to differing degrees. Those occurring in urban areas were not. While any one comprehensive plan amendment may not have a large effect on interchange traffic, the cumulative effects were likely to shorten the useful life of the interchange.

The case studies revealed that in the past, ODOT's role in many comprehensive plan amendment cases near interchanges was minimal, probably because many did not involve large acreage. With the evidence that even small changes can add up to have significant impacts, plus a new focus on Interchange Area Management Plans (IAMPs), ODOT has been working with local governments to clarifying their respective and collective roles in the preservation of interchange capacity.

The study provides a level of clarity about the concern with protecting the large investments in interchanges and assuring their vital function to serve communities and the traveling public. It verifies the importance of developing long-range plans to manage and balance the activities around these important facilities. It also heightens the awareness and indicates the importance of the role local governments play in helping to manage interchange areas.

The study confirms what planners have suspected but could not quantify – that interchanges are a significant attractor to development with a high degree of potential for land use change and intensification. With this information, both state and local planners can focus their efforts to bring long-term stability to interchanges and thereby protect their function in the transportation system.

The study also helps to set priorities for the types of interchange conditions that need heightened attention. IAMPs provide the best process to achieve the desired long-term stability for interchange areas and are currently being developed primarily by the ODOT Region planners. They are working on high priority interchange areas in concert with cities and counties to establish agreements on how best to manage these areas with the tools available. To date, interchange management plans have been developed or are in the process of being developed at 30 interchanges throughout the state.

For more information on the PSU study, contact Alan Kirk in ODOT Research at 503-986-2843 or by e-mail at Alan.R.Kirk@odot.state.or.us For more information on Interchange Area Management Plans, contact Dick Reynolds in ODOT Planning at 503-986-4222 or by e-mail at Richard.D.Reynolds@odot.state.or.us

ODOT AND ODFW COLLABORATE TO COLLAR COLLISIONS ON A HIGHWAY CORRIDOR

The Oregon Department of Transportation and the Oregon Department of Fish and Wildlife are partnering on research regarding what is literally an everyday occurrence. Thousands of times a year, deer attempt to cross an Oregon Highway at the same time a vehicle is traveling down the highway. The results are almost always frightening for both the deer and the driver. Frequently these encounters also result in the death of the deer and damage to the vehicle. Less commonly, injury or death of an occupant of the vehicle can also result.

Deer killed on U.S. Highway 97 south of La Pine, Oregon

This research project seeks to better understand deer migration, habitat use, and interaction with highways. The research will be focusing on the Mule Deer in the region around the Highway 97 corridor between Bend and the California-Oregon Border. Portions of intersecting highways in this region are also included.

One component of this research involves placing tracking collars on deer to determine how their daily and seasonal movements relate to the highway system. The collars use a variety of different technologies for tracking the deer. Some collars use the tried and true VHF radio telemetry technology of the 20th century. Newer collars have been acquired that also track and record the deer's movement more precisely using the global positioning system (GPS) and digital data storage. The collars can be programmed to automatically release from the deer after a specified period of time or release in response to a radio signal so that the data can be retrieved from the collar. The latest technology is especially important for studying the movements of deer around highways. Some of the collars purchased for this study allow the data to be retrieved remotely, while the collar remains on a free roaming deer. The data collection parameters can also be adjusted remotely. In this way, it will be possible to observe the movement of deer near the highway in great detail.

Another facet of this research project will be to collect data on the location and date of deer being killed by vehicles. Information about the gender, size, age, and condition of the animals will also be gathered. Some information about deer fatalities has been collected for a number of years, but not to this level of detail.

It is hoped that, by better understanding deer behavior, management approaches for both the highways and the deer can reduce collisions. A variety of possible strategies have already been developed. These include habitat modification or improvement, modified roadway geometry, advanced warning systems, and above or below grade crossings for wildlife. Research results are intended to help determine which strategies will be the most effective and where they should be used.

Trim pieces and transmission fluid from a truck that struck a deer on U.S. Highway 97 south of La Pine, Oregon

In addition to ODOT and ODFW, the Bureau of Land Management, U.S. Forest Service, Deschutes County, the Confederated Tribes of Warm Springs, and the Klamath Tribes are cooperating with the project.

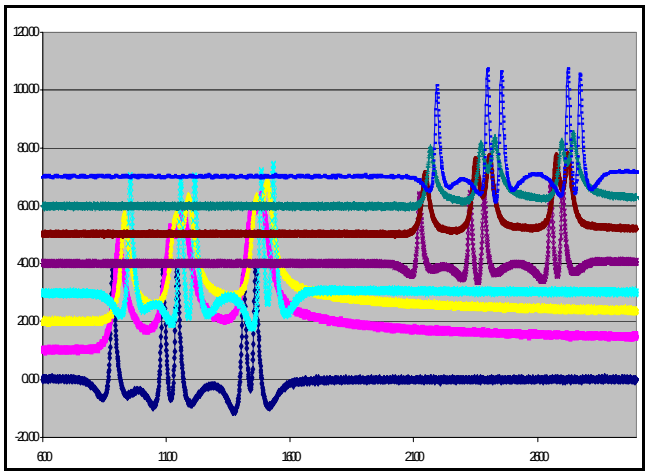
For more information contact Matthew Mabey, 503-986-2847, or e-mail at Mathew.Mabey@odot.state.or.us

Deer tracking collar like those used for this research project

LOAD SPECTRUM PROJECTS

As the design community moves toward the use of mechanistic empirical (M-E) design techniques, the need for quality load data has been recognized. Currently there are several research projects in progress, or recently completed, related to the development of load models for pavement and bridge design.

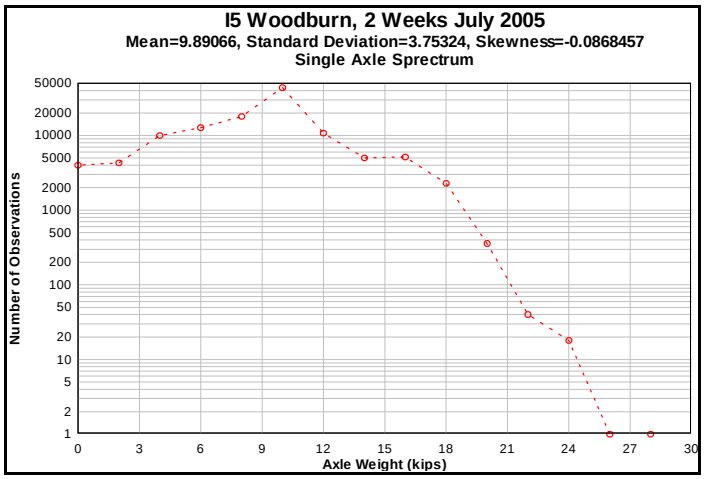
The Oregon Department of Transportation designed a pavement structure for new construction on Interstate 5. In an initial research project, a set of 24 strain gages and 4 temperature gages were installed in a southbound lane of Interstate 5. Twelve strain gages were installed over rubblized portland cement concrete, while the remaining gages were installed over an aggregate base.



Plot of strain imposed by a 5 axle Log truck measured by the middle row of strain gages. Four gages over aggregate base and four gages over rubblized concrete base. (10 micron offset each gage for clarity)

Oregon State University (OSU) will perform a follow-on study that will monitor the pavement structure to investigate if the assumptions used in the mechanistic-empirical design were correct, or if adjustments are needed. The study will also be able to assess the reaction of the pavement structure to traffic loading to evaluate if the pavement structure is experiencing the stresses and strains assumed in the design process. The pavement structure will be monitored to validate the assumptions used in the mechanistic-empirical analysis and the pavement performance. Ultimately, design inputs that have not been required for the design procedure currently used by ODOT and an evaluation of pavement performance models (transfer functions) and failure criteria for Oregon conditions, will be developed.

Bridge design and load rating rely on national truck models that are based on data collected in other states, which may not accurately reflect Oregon load conditions. OSU is conducting another research project to define a small number of truck configurations that accurately represents truck loading on Oregon bridges. The effort is based on data from all of Oregon's weigh-in-motion scales. These data are being synthesized into load spectra. The load spectra will also be applied to the new generation of pavement design models being implemented at ODOT.



For more information contact Norris Shippen at 503-986-3538 or by e-mail at Norris.Shippen@odot.state.or.us

Overlooking the instrumentation site of the strain gages on Interstate-5. The strain gages will help evaluate if the pavement structure is experiencing the stresses and strains assumed in the mechanistic-empirical design process.

RECENTLY PUBLISHED REPORTS (click on underlined items for electronic reports)

Intermittent Application of Cathodic Protection-Interim Report FHWA-OR-RD-05-08

Field and laboratory studies were conducted to evaluate commercial corrosion rate monitoring devices suitable for use in intermittent cathodic protection field operation on Oregon's coastal reinforced concrete bridges. A two-year field study is recommended for an Oregon coastal reinforced concrete bridge with multiple thermal spray zinc anode cathodic protection zones, to assess the effectiveness of intermittent cathodic protection compared to present Oregon DOT practices.

Automated Data Collection Equipment for Monitoring Highway Conditions FHWA-OR-DF-05-10

This study was conducted to evaluate automated vehicle-mounted equipment to collect data on the needs of Oregon's highway inventory. Four vendors accepted an invitation to evaluate their equipment. The evaluation included an assessment of the equipment's performance in a survey of pavement condition, road roughness and the Oregon DOT video log program.

The Effect of Crack Motion During Epoxy Crack Injection FHWA-OR-RD-05-11

One strategy to regain structural integrity of cracked reinforced concrete bridge deck girders is to inject the cracks with epoxy. Many bridge owners allow all traffic to use the bridge during injection and curing, while others restrict traffic to produce a hold time, in which cracks do not open and close. The research study used a laboratory set-up to determine the effect of temperature and hold time on epoxy undergoing curing.

Pedestrian Safety Evaluation of Curb Extensions: A City of Albany Case Study FHWA-OR-DF-06-01

This report documents a case study evaluating motorist yielding behavior at a crosswalk in Albany, Oregon. The focus of the study was an intersection that had a curb extension on only one side of the street, thus allowing for an analysis of motorist behavior toward pedestrians crossing from either the side, with or without the curb extension.

Evaluation of Wearing Surface Materials for FRP Bridge Decks OR-DF-06-02

The wearing surface on many fiber reinforced polymer (FRP) composite bridge decks have cracked or delaminated after only a short time in service. Consequently, a set of tests were conducted on four wearing surface products in order to select the material with the best performance with respect to service conditions on an FRP deck. The products were evaluated for tensile strength, failure strain, bond strength, and abrasion resistance.

Dynamic Revetments for Coastal Erosion in Oregon FHWA-OR-RD-06-03

Gravel beaches have long been recognized as one of the most efficient forms of "natural" coastal protection, and have been suggested as a form of shore protection. "Cobble berms," "dynamic revetments" or "rubble beaches" involve the construction of a gravel beach at the shore, in front of the property to be protected. Dynamic revetments are much easier and cheaper to construct than a conventional riprap revetment or seawall. There remain unanswered questions about their design, particularly along the high-energy Oregon Coast. This study involved an examination of the morphological and sedimentary characteristics at 13 naturally occurring gravel beach study sites along the Oregon Coast.

Washing Bridges to Reduce Chloride FHWA-OR-DF-06-04

Chloride ions are known to promote the corrosion of steel in reinforced concrete. This project was undertaken to investigate the efficacy of washing, to reduce existing chloride content and chloride ion uptake. The project consisted of a laboratory component over four years, and a field component over two years.

Optimum Illumination for Nighttime Flagger Operations FHWA-OR-RD-06-05

Highway maintenance and construction undertaken by ODOT can involve the use of flaggers to control the work zone. When the work is undertaken at night, illumination of flaggers is needed to ensure the safety of the motorists, flaggers, and workers. A number of recent developments have taken place that improve the ability of motorists to see flaggers. This study developed guidelines for the optimal illumination of flaggers during nighttime maintenance and construction operations on highway projects. The guidelines address minimum and optimum lighting levels, optimal methods of delivering the light, and maneuverability of the lighting equipment.

Assessing the Effectiveness and Environmental Impacts of Using Natural Flocculants to Manage Turbidity FHWA-OR-RD-06-06

The objective of the research was to determine the feasibility of using chitosan as a natural flocculant to control turbidity during in-stream construction work. A series of field tests were conducted in order to test the effectiveness for turbidity control and the environmental impacts of applying chitosan directly into a stream environment.

(Continued on page 7)

Comprehensive Plan Amendment Impacts on Interchanges in Oregon OR-RD-06-07

This report examines the effects of amendments to local comprehensive plans on interchange performance on the Oregon highway system. Plan amendments over a 15-year period in Oregon, resulting in changes to industrial or commercial land use, were reviewed to identify those that occurred within one mile of an interchange.

Transportation Planning Performance Measures
FHWA-OR-RD-06-08

Oregon transportation plans contain some policy areas that are not adequately addressed by performance measures. To address some of the deficiencies and to better address other plan policies, this research project developed and tested six performance measures.

NEW RESEARCH NOTES (click on underlined items for electronic reports)

Non-Destructive Evaluation of FRP-Strengthened Reinforced Concrete RSN 05-08 (April 2005)

Many reinforced concrete structures across the country are being strengthened with fiber reinforced polymer (FRP) composites to increase the load capacity. This summarizes a research project that evaluated non-destructive detection methods for composites and developed guidelines on the criticality of various defects.

Traffic Restriction for Epoxy Crack Injection
RSN 05-09 (June 2005)

Reinforced concrete bridges with detrimental cracks are typically repaired by injecting the cracks with epoxy to regain concrete capacity. During the injection process, traffic may or may not be restricted on the bridge. This summarizes the research project that determined whether crack movement during epoxy curing degrades the ability to restore concrete strength in cases where cracks are injected with epoxy, and if traffic needs to be restricted, how long should the restriction be in place.

Wearing Surfaces for Plastic Bridge Decks
RSN 06-01 (July 2005)

Fiber reinforced polymer (FRP) composite bridge decks based on fiberglass materials are being installed on bridges across the country. Many states, including Oregon, have experienced cracking and delamination of the wearing surfaces, which are applied after the FRP decks are installed on the bridge. To improve the selection of wearing surfaces for FRP bridge decks, ODOT undertook a research project to characterize the service capabilities of four wearing surface systems.

Measuring the Strain of the Road
RSN 06-02 (September 2005)

This summarizes the installation of several strain gages placed in a recently reconstructed section of Interstate 5. The gages will be used to monitor the pavement structure and to investigate the assumptions used in the mechanistic-empirical design analysis.

Bridge Washing to Reduce Salt
RSN 06-03 (October 2005)

Reinforced concrete bridges on Oregon's coast are exposed to chloride ions from marine salt that penetrate into the concrete and cause the reinforcing steel to corrode. ODOT investigated periodic bridge washings as a way to possibly remove chloride from the concrete and stop further uptake of chloride ions.

T2 CENTER

Oregon Technology Transfer Center

The Research Unit also manages the Technology Transfer Center, which provides resources for local governments on transportation, particularly: roads, streets and bridges. The T2 Center offers training through its *Roads Scholar* and Circuit Rider programs. The center also provides a lending service for publications and videos on safety, maintenance and other transportation topics.

Additional information about the center is available on the T2 web site at www.oregon.gov/ODOT/TD/TP_T2/. The current issue of the *Oregon Roads* newsletter, as well as past issues, are also available on the web site, providing the latest in T2 news.

For more information contact T2 Center Director Bob Raths at 503-986-2854 or by e-mail at Bob.Raths@odot.state.or.us, or T2 Assistant Beth Hunter at 503-986-2855 or by e-mail at Beth.Hunter@odot.state.or.us.

ARE YOU LOOKING FOR TRANSPORTATION INFO?

If you are looking for transportation-related information, there are several on-line resources available to you. Here are four resources that have proved very useful for collecting transportation-related information.

TRIS - Transportation Research Information Services
TRIS Online is the largest and most comprehensive source of information on published transportation research on the Web. Access TRIS at http://trisonline.bts.gov

RiP - Research in Progress
RiP is a Transportation Research Board database that contains current or recently completed transportation research projects. Most of the RiP records are projects funded by Federal and State Departments of Transportation. Access RiP at http://rip.trb.org

Wisconsin Department of Transportation
Another great resource for keeping updated on transportation research is the Wisconsin Department of Transportation's monthly e-newsletter, *Putting Research to Work* - Success stories from the field that showcase applications of highway research and technology from throughout the country and abroad. Access current and past editions at http://www.dot.wisconsin.gov/library/research/reports/research2work.htm

Wisconsin DOT also produces another monthly e-newsletter that summarizes recent transportation research categorized by topic, with links to full reports. View their *Recent Research Review* at http://www.dot.wisconsin.gov/library/research/reports/researchreview.htm

RESEARCH

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What can we do for you?

Let us help you! Do you have a transportation-related problem that you think could be addressed through research? Need help in locating current research on an issue? The Research Unit may be able to help. We are available year-round to help answer transportation-related questions.

We often answer information requests from ODOT staff by locating technical references, conducting literature searches, or conducting a research project.

Check Us Out!
www.oregon.gov/ODOT/TD/TP_RES/