Summer 2012

Research Newsletter

Responsive - Accessible - Relevant

A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

The Research Division hosted a successful workshop in May to identify problems and potential solutions to our transportation challenges. Similar to last year, we were able to fund about a third of the submitted problem statements. Details and results of the workshop are described on page 2.

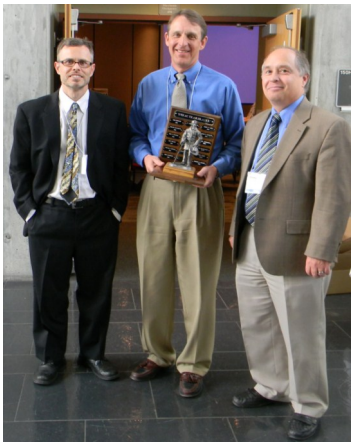
Looking ahead at other opportunities, NCHRP traditionally requests problem statements for highway transportation related research in July with a deadline of mid-September. They provide about $35 million which is distributed among approximately 60 projects, two-thirds of which are new projects.

This year UDOT ranked 15 NCHRP problem statements, worth over $7 million, as highly valuable. Once approved by the AASHTO Board of Directors, results of these projects will further our research goals while preserving our limited funding. Each of these projects is expected to cost ten times more than the average UDOT-funded research project.

NCHRP problem statements may only be submitted by state or federal transportation agencies. However, past funded problem statements share a couple important characteristics. First, they focus on topics of interest to committee members. And second, they propose solutions of regional or national significance.

I encourage our research community to meet UDOT engineers who are active on technical committees. Understanding the challenges facing other DOTs will help submit problem statements that offer solutions for both local and national issues.

Information about the Workshop and other funding sources can be found on the Research Division website: **www.udot.utah.gov/go/research**



2012 Research Workshop (UTRAC)

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Completed and Active Research Available at: www.udot.utah.gov/go/research

Editorial Staff: Steve Bagley sbagley@utah.gov and David Stevens davidstevens@utah.gov

By: Kevin Nichol, P.E.
UDOT Research Division
Catherine Higgins
UDOT Communication Department

The 2012 Research Workshop (UTRAC)

Projects have been selected for funding from the 2012 UDOT Research Workshop held on May 10. (For more information on the Workshop itself, visit the UDOT blog.)

Fifty-two projects were submitted this year to the UDOT Research Workshop. Of these, nine projects will be funded through the Research Division, one of which was combined from two submitted problem statements. Several other projects of those submitted will be funded directly by other divisions. Several other projects of those submitted may also be funded directly by other divisions.

The workshop serves as one step in the research project selection process which involves UDOT, FHWA, universities, private sector firms and other transportation agencies. UDOT Research Division solicited problem statements for six focus areas: Structures and Geotechnical, Environmental and Hydraulics, Construction and Materials, Maintenance, Traffic Management and Safety and Pre-construction.

At the workshop, transportation professionals met to prioritize problem statements in order to select the ones most suitable to become research projects. Three voting criteria were used: importance of research, relevance to UDOT, and likelihood of implementation. All UDOT staff voted during the prioritization process.

After the workshop, UDOT Research Division staff reviewed prioritization and funding for each recommended problem statement with division and group leaders. The outcome is that

The selected projects include:

- Development of a Utah Winter Severity Index
- Additional research into sampling and testing proto cols for cold in-place recycling of asphalt pavements
- Development of mobile applications for use by UDOT Maintenance
- Additional funding toward a multi-state pooled fund project to investigate lateral pile resistance near MSE walls
- Additional funding toward a multi-state pooled fund to research passive force-displacement for skewed bridge abutments
- Research into environmentally friendly and sustainable stream stability treatments in the vicinity of bridges
- Evaluation of effective construction risk management through CMGC contracting

Projects presented at the Research Workshop to be funded by other divisions include:

- The Aurora Project working to advance road weather information systems technology
- Improving wet night visibility of pavement markings
- Development of a culvert management plan
- Implementing safety analysis tools in planning, programming, design and operations
- Other projects are being considered an may yet be added.

1 of 6 Research Workshop (UTRAC) groups

A significant factor for success was the broad project support from various UDOT Divisions and university representatives. We were excited that a number of projects may receive funding from other sources. Many UDOT divisions including Maintenance, Planning, Traffic and Safety and the TOC are considering contributing funding along with University Transportation Centers.

To see details on the list of final projects, visit the UDOT Research Division website . For more information contact Kevin Nichol, at knichol@utah.gov or Catherine Higgins, at chiggins@utah.gov. Related information can be found on the UDOT blog (High Value Research).

By: Eric Rasband
UDOT I-15 CORE
David Stevens, P.E.
UDOT Research Division

UDOT Diverging Diamond Interchange Experience

In recent years the Diverging Diamond Interchange (DDI) emerged as a viable option for some busy interchanges in Utah, with proven effectiveness. The DDI channels the two directions of traffic on an arterial over each other before a limited-access highway and then returns each direction to the regular side after crossing the highway. This promotes traffic flow and safety with free flowing left and right turn movements onto the on-ramps, better accommodation of left turn movements, and elimination of a phase for the signals.

Earlier this year the I-15 CORE traffic team evaluated the functionality of Utah's first DDI at American Fork Main Street (Pioneer Crossing) over I-15, which was new construction and opened to traffic in August 2010 by the Access Utah County team. This evaluation incorporated review of population trends, traffic patterns, detoured traffic, and design features to see how this new interchange operates for the traveling public. Fig. 1 shows the DDI's 2011 peak hour volumes compared to 2030 projections, included in the study.

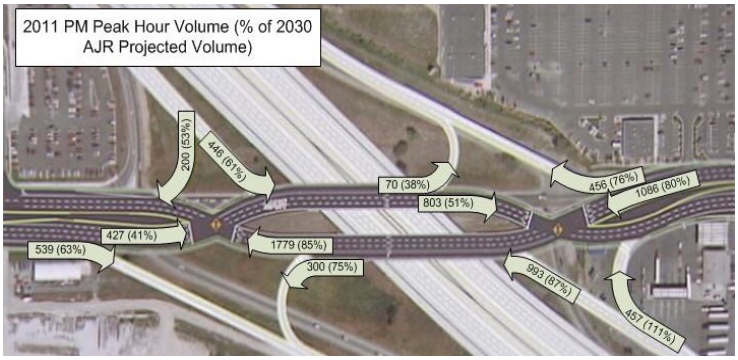


Figure 1. 2011 Peak Hour Volumes for the American Fork Main Street DDI

Since 2010 three more DDIs have opened to traffic in Utah: Bangerter Highway over SR-201 in West Valley City (retrofit), Timpanogos Highway under I-15 in Lehi (retrofit), and 500 East over I-15 in American Fork (new construction, Fig. 2). The I-15 CORE team completed an observational study of all four DDIs in Utah.

Figure 2. 500 East American Fork DDI, Nov. 2011

Characteristics recognized for working well with the DDI design include:

- Directional traffic flow maintained with either high demand from the interstate to the cross-street or across the interchange with lower exiting volumes;
- Left turn lanes on the cross-street help to separate turning traffic from through traffic.

Characteristics recognized for not working well with the DDI design include:

- Heavy traffic demands at the freeway exit and the cross-street simultaneously result in congestion from vehicle storage between the two cross-over signals;
- Coordination of the DDI with closely spaced adjacent signals is not easily done. The DDI uses a short signal cycle that doesn't always match the needs of conventional intersections.

Additional observations and conclusions from the DDI evaluation are included in the study report by the I-15 CORE traffic team and Horrocks Engineers. The report has been posted on the Research Division website and shared within UDOT and with other state DOTs.

For more information contact Eric Rasband at erasband@utah.gov. Related information can be found on the UDOT blog from the May 2012 DDI tour and presentations hosted by UDOT: French Connection and The DDI Advantage.

By: Paul Barr, Ph.D.
Utah State University
Joshua Sletten, P.E.
UDOT Structures Division
Abdul Wakil, P.E.
UDOT Research Division

Developing Design Guidelines for Integral Abutment Bridges

Temperature effects for bridges have traditionally been incorporated in design by allowing for expansion and contraction through the utilization of bearings and joints. However, bearing and joints have been locations of serviceability issues throughout the state due to the winters in Utah. Bridges built with integral abutments offer advantages for both seismic and maintenance issues. Despite the benefits, proper accounting of bridge behavior due to changes in temperature has been found to be essential for integral abutment bridges.

In order to investigate whether temperature effects for integral abutment bridges are being properly taken into account in the design process in the state of Utah, a study was initiated. The primary goal of the study was to determine whether changes to the UDOT design manual were needed to accurately account for changes in bridge temperature. The design parameters we are looking to investigate involve span length, skew and bridge geometry.

To meet the overall goal of the project, a Technical Advisory Committee was formed involving UDOT engineers, consulting engineers and university expertise. It was determined that bridge data, analytical modeling and temperature readings would be needed. As such, a three-part study was implemented.

Figure 1: 400 South I-15 bridge

With the cracking observed at the north abutment of the 400 South Bridge on I-15 in Salt Lake City (Figures 1 and 2), it was selected to provide the data to meet the intended goals of the study. Contact targets were placed

Figure 2: Cracking on 400 South I-15 Bridge

on each span of the bridge and were used to monitor changes in bridge movement. The measured bridge movements, in addition to temperature readings, were used to compare with predicted behavior according to a finite-element model developed for the bridge. This modeling scheme was then used to investigate critical bridge parameters when considering temperature effects for general integral abutment bridges.

The impact of this study will be focused on the design implications for integral abutment bridges. The findings will be used to develop design guidelines for the UDOT Bridge Design Manual. These guidelines will aid engineers to accurately account for the temperature effects during the design process.

Currently the investigators have nearly completed monitoring changes in temperature and movements for the 400 South Bridge on I-15. The finite-element modeling has already been started with an initial parametric study completed. With the guidance of the Technical Advisory Committee, model refinements and additional parametric studies are planned. These results will be used to provide design recommendations.

For questions regarding this project, please contact Paul Barr (Principal Investigator) – Paul.barr@usu.edu, Utah State University or Abdul Wakil (Project Manager)– awakil@utah.gov, UDOT Research Division.

By: Kyle Rollins, Ph.D.
Brigham Young University
David Stevens, P.E.
UDOT Research Division

Wick Drain Effectiveness With Spacing For Utah Silts & Clays

Wick drains are routinely used to accelerate the consolidation of clay layers under bridge approach fills. Closer drain spacing can increase the rate of consolidation leading to reduced construction time and lower highway costs. However, a minimum spacing of 5.75 ft has typically been used in Utah based on tests done during I-15 reconstruction in Salt Lake Valley, which showed no improvement for closer spacing due to installation disturbance.

Recent research suggests that this minimum spacing could be decreased for smaller anchor/mandrel combinations or less sensitive soils. Improved understanding of these factors for Utah soil conditions would lead to accelerated construction times and reduced construction costs. The goal of this study was to validate design methods for predicting the drain performance based on full-scale field testing.

Fig. 1. Wick drain field tests at Mountain View

To validate these design methods, full-scale field tests were conducted at Mountain View Corridor in Lehi, Utah (Fig. 1). Tests were performed for triangular drain spacings of 5.8, 5.0, 4.0 and 3.0 ft with both rebar and plate anchors. Test results showed that installation disturbance is less important for thickly bedded than for thinly bedded clays; therefore, drain spacings of 3 ft can be used in thickly bedded clays. Disturbance was a function of drain spacing divided by mandrel-anchor diameter. Results also showed that rebar anchors caused about twice the disturbance of the plate anchors.

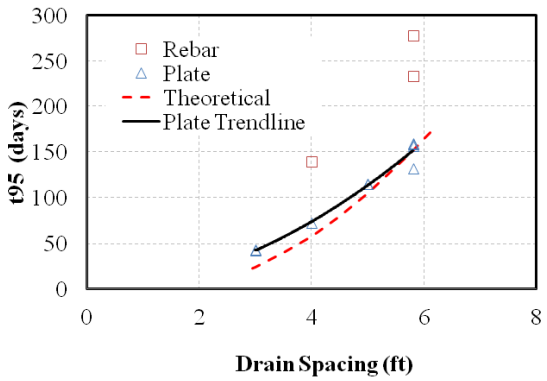


Fig. 2. Wick drain effectiveness vs. spacing in thickly bedded clays with rebar and plate anchors, where t95 is time required to obtain 95% consolidation

Using the design chart in Fig. 3 engineers can now optimize wick drain design for minimum costs and construction time.

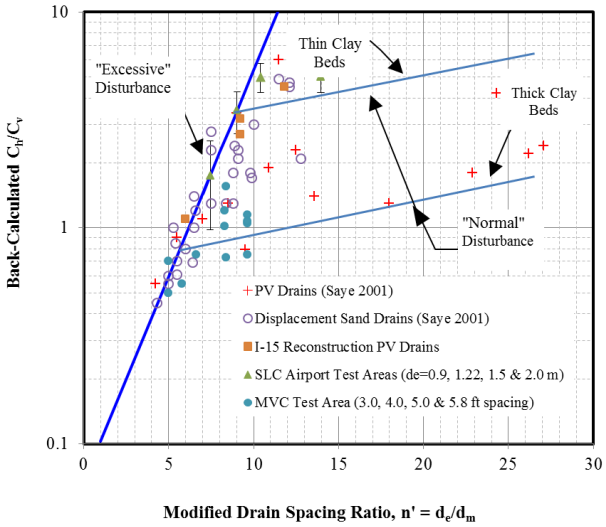


Fig. 3. Design chart for wick drain performance

For more information see the final report on the Research Division website, or contact Dr. Kyle Rollins of BYU at rollinsk@byu.edu, or the following UDOT partners: Jon Bischoff (jonbischoff@utah.gov) and David Stevens (davidstevens@utah.gov).

By: David Stevens, P.E.
UDOT Research Division

Update on Utah's Wildlife Crossings

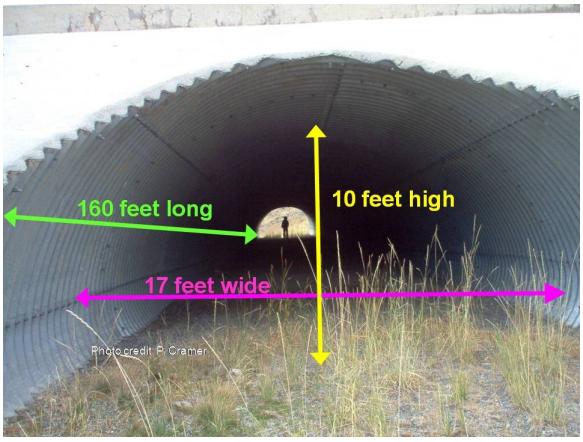
In a recent newsletter we featured a research project that UDOT initiated in 2007 with Dr. Patricia Cramer of Utah State University to evaluate how well different wildlife crossing structures in Utah work for passing mule deer, elk, and moose. Additional camera images collected at the crossings through June 2011 have since been analyzed, and the study results are now available in the final research report to UDOT on the Research Division website.

This study is unique in that it examined wildlife crossings and other structures across the entire state, a feat not undertaken by any other state in the U.S. or province in Canada. In this study, remote motion-sensed cameras were used at 14 designated wildlife crossing culverts and bridges, and 21 existing culverts and bridges built for other purposes. Between 2008 and June 2011 the 35 cameras recorded 23,957 mule deer passages through designated wildlife crossings, and 1,093 passages under existing culverts and bridges. During that time there were 45 elk passages, 127 moose passages, and several passages by other species of wildlife recorded. Many of these sites had wildlife fencing (up to 8 feet high).

Deer used new arch wildlife crossings, I-70

Bridge designs monitored had 89 to 98% success rates, meaning 2 to 11% of the mule deer approaching the structure repelled away, while the rest went through. Culverts had between 75 and 95% success rates. Culverts that were over 120 feet long had the lowest success rates.

Based on the photographic evidence, UDOT wildlife crossings are working for mule deer. The most successful crossing designs for passing mule deer are those that minimize lengths under the road and maximize the width or span of the structure. Future research will help determine if any designs work in passing skittish elk in Utah, and if placing wildlife fencing at existing box culverts and bridges can motivate mule deer and elk to use these structures.



Wildlife culvert near Wellsville, US 89/91

The potential impact of implementing the research results is that wildlife crossing structures would be more consistently designed and constructed to pass mule deer, and potentially elk, under or over highways. This would contribute to fewer wildlife-vehicle collisions, thus increasing safety for motorists and maintaining wildlife populations. The research results have helped to coordinate efforts between multiple agencies in locating and building new wildlife crossing structures in Utah.

This study continues with funding from the Utah Division of Wildlife Resources and conservation organizations. For more information, see the research report or contact Dr. Cramer at patricia.cramer@usu.edu, or the following UDOT partners: Brandon Weston (brandonweston@utah.gov), Paul West (paulwest@utah.gov), and David Stevens (davidstevens@utah.gov).

By: Steve Bagley, M.P.C.
UDOT Research Division

Research Calendar of Events/Updates

NEW RESEARCH REPORT GUIDELINES & FLOW CHART

The UDOT Research Report Guidelines document has been updated and revised (April 2012) to add clarity and structure to formatting the research final report. In addition, the publication process and issuance of a report number has been standardized so the experience is the same for each report. A flow chart has been created as a useful tool to help P.M.'s and P.I.'s through the final report review and publication process. Lastly, a report template has been created to help simplify the research report formatting. The template reflects the revised guidelines and may be used by the P.I.'s to prepare research reports. All three documents can be found on our website under the "Tool Box" section or by following these links:

1. Report Guidelines
2. Publication Flow Chart
3. Report Template

RESEARCH FUNDING OPPORTUNITIES (click to see the full document)

SEPTEMBER 1, 2012 - NCHRP Highway IDEA Proposals **DUE**

SEPTEMBER 15, 2012 - NCHRP FY 2014 Problem Statements **DUE**

SEPTEMBER 16, 2012 - 2013 AASHTO Technology Implementation Group (TIG) Nominations **DUE**

SEPTEMBER 28, 2012 - ACRP Synthesis of Practice Topics **DUE**

WEBINARS (click to see the full document)

JULY 11, 2012 - Guidelines on the Use of Auxiliary Through Lanes at Signalized Intersections

JULY 18, 2012 - Transportation Asset Management: Highlights from Beyond Pavement and Bridges Track

AUGUST 01, 2012 - Bridge & Buried Structures

AUGUST 21, 2012 - Alternative Uses of the Highway ROW

AUGUST 22, 2012 - Project Management Plans