

# Research Newsletter

**Responsive - Accessible - Relevant**

## A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

2015 looks like a busy year for research at UDOT. The week of January 12<sup>th</sup> is the TRB Annual Meeting in DC where about a dozen UDOT engineers will join 12,000 others to learn about advances in transportation. Each engineer is expected to return with specific advancements to deploy, which are tracked for merit. The current benefit ratio (to the cost of attending) is over 300 to 1.

NCHRP has recently requested state DOTs to vote on 106 new problem statements for FY2016 funding. There is approximately \$35 million for new and continuation projects. UDOT submitted or co-submitted eight of those problem statements, which represents a combined budget many times that of the Research Division. This March I will attend an NCHRP meeting that assists in distilling the first round of balloting.

The Research Division will host our annual research workshop (UTRAC) on March 24<sup>th</sup>. All interested transportation and research professionals are encouraged to submit problem statements that address challenges and potential improvements to our roadway infrastructure and operations through research. Problem statements must be submitted by March 10<sup>th</sup> and should focus on one of the subject areas listed on our website. Last year 59 problem statements were submitted from UDOT, university and consultant professionals. Seventeen problem statements were subsequently funded for research by the Research Division and other divisions and agencies.

The day after UTRAC we will coordinate the third Leadership Book Discussion by Shane Marshall, UDOT's Deputy Director. This is a UDOT-only event and participation is voluntary. Shane will discuss *The Speed of Trust* by Stephen M.R. Covey, which is available from the UDOT Library.

This past October we met Mr. Richard Cunard of TRB, who coordinates national research projects on traffic operations. He met with Rob Clayton and his staff at the Traffic Operations Center (TOC), along with UDOT traffic and safety engineers. This group shared information with Mr. Cunard regarding UDOT's innovative efforts in traffic management and traffic safety. Mr. Cunard gave an overview of traffic operations-related activities at TRB, including the latest on connected and automated vehicles. His visit wrapped up with a local driving tour and discussion of innovative interchanges and intersections. We appreciate Mr. Cunard sharing his insights during the visit, and everyone who helped at the TOC.



TRB's Richard Cunard with UDOT's Glenn Blackwelder, Lisa Miller, and Blaine Leonard

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**Completed and Active Research Available at: [www.udot.utah.gov/go/research](http://www.udot.utah.gov/go/research)**

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2015 UTRAC

# RESEARCH

## WORKSHOP

**March 24<sup>th</sup>**

**Salt Lake Community College – Miller Campus  
9750 South 300 West  
Sandy, Utah**

**Subject Areas:** *Materials & Pavements, Maintenance, Traffic Management & Safety, Structures & Geotechnical, Pre-Construction, and Planning.*

The Problem Statement form is online and will be due by **March 10, 2015**. Please contact Jason Richins (jtrichins@utah.gov) for more information.

UTRAC website: <http://www.udot.utah.gov/main/f?p=100:pg:::::1:T,V:234>

***WE HOPE TO SEE YOU THERE!***

## Highlights from the 2014 Annual Efficiencies Report

Efficiencies within UDOT often generate cost savings for the public and the Department through better utilization of resources and innovative technologies. At the end of each year, UDOT prepares an efficiencies report which summarizes key efficiency initiatives from the year. The annual report fulfills a requirement for UDOT to describe the efficiencies and significant accomplishments achieved during the past year to the State Legislature. UDOT Senior Leaders use the report in presentations during legislative committee meetings.

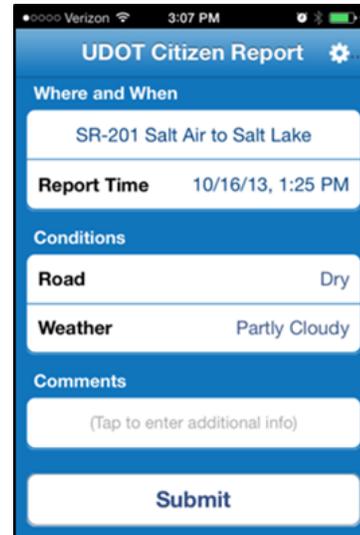
Following are the key efficiency initiatives summarized in the FY 2014 report:

- ◆ SUCCESS Framework Initiative
  - ⇒ Statewide Access Management Program
  - ⇒ Preconstruction Project Scoping
  - ⇒ Ports of Entry Truck Processing
  - ⇒ Snow and Ice Control
  - ⇒ Procurement System
  - ⇒ Heavy Duty Truck Maintenance
- ◆ Report Auto Generator for Roadway “As-Builts”
- ◆ Uinta Basin Rail
- ◆ Outdoor Advertising Control Map
- ◆ Automated Queue Warning Detection System
- ◆ Cement-Treated Asphalt Base
- ◆ Citizen Reporter Program
- ◆ Real-Time Winter Road Weather Index Performance Measurement
- ◆ Variable Speed Limit in Parley’s Canyon
- ◆ Snow Fencing Efficiencies

One example from the 2014 report is the SUCCESS Framework Initiative, a set of management principles from the Governor’s Office of Management and Budget, designed to boost the quality and efficiency of government services, with the goal of improving government operations and services by 25% by the end of 2016. One of the six major systems that UDOT is focusing on for the SUCCESS Framework is the Statewide Access Management Program. With a lot of hard work and collaboration, the Access Management Team reduced the time and labor cost required for processing access permit applications. As a result, the per-permit processing cost was lowered from \$1,709 to \$1,532 (\$177 per permit), providing approximately \$42,000 in annual cost savings to UDOT.

Another example from 2014 is the Citizen Reporter Program, which enlists trained volunteers to report on road weather conditions along specific roadway segments across

Utah. This citizen crowd-sourcing contributes to the quantity, quality and timeliness of traveler information, especially in rural areas. As a result, UDOT saves approximately \$250,000 annually from the reduced need for road weather instrumentation, and from efficiencies in storm forecasting.



Screenshot from the Citizen Reporter mobile app

The UDOT Research Division coordinates each year with UDOT Senior Leaders and the Communications Office to collect and compile write-ups on the past year’s key efficiency initiatives. We appreciate all of the UDOT Regions and Groups that submitted FY 2014 efficiencies topics and write-ups on the key items. This process will start again in August for FY 2015.

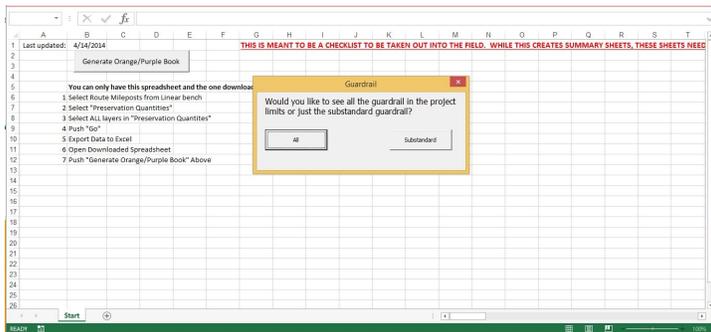
The 2014 and earlier annual reports are available online at [www.udot.utah.gov/go/efficiencies](http://www.udot.utah.gov/go/efficiencies). For more information, contact David Stevens ([davidstevens@utah.gov](mailto:davidstevens@utah.gov)) or Joni DeMille ([jdemille@utah.gov](mailto:jdemille@utah.gov)) of the Research Division.

## Auto-generated Design Summary Sheets

A new Auto Report Generator produces design summary sheets by integrating asset data and information from previous projects into a multi-tabbed spreadsheet. UDOT designers need to produce summary sheets that contain measurements and material quantities needed for each roadway preservation or rehabilitation project. The traditional method of gathering information is to use surveyor's wheel and measuring tape to quantify all roadway assets in the project area. Collecting data on-site, compiling data and then figuring quantities can take weeks.

Former UDOT Rotational Engineer John Guymon developed a tool, called the Auto Report Generator, that helps UDOT designers and materials technicians work more efficiently. The new tool is an example of how UDOT is making good use of an extensive and innovative data collection effort that gathers vital information on every state roadway asset visible from a car window.

To create the tool, Guymon used coding to integrate asset management data from UDOT's online data repository with standard formulas for figuring material quantities. Activating the tool populates a Microsoft Excel spreadsheet. The Auto Report Generator works along with the Linear Bench, a straight line diagram tool – both are accessible on the [UDOT Data Portal](#), an online one stop shop for geo-located business data.



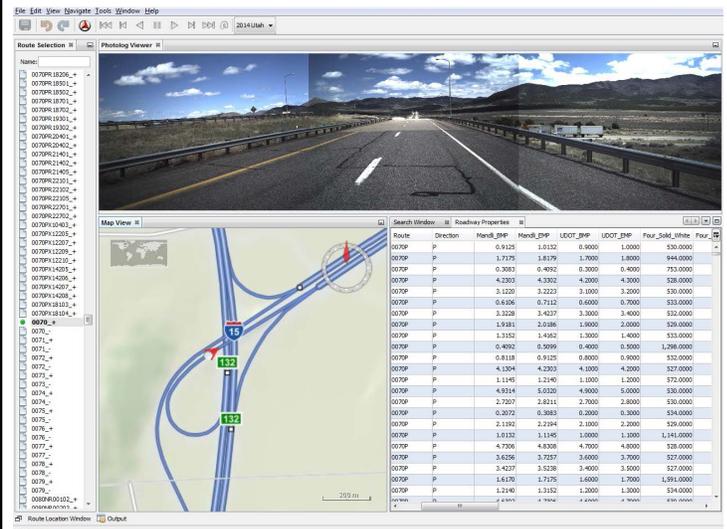
Screenshot from the Auto Report Generator

Once populated, the summary sheets show:

- Climate-specific pavement type, surface area and material amounts for granular borrow and base course.
- Barrier and post type, all sorted into standard and non-standard types.
- Signs, including location, sign type, size and any damage

present.

- Pavement markings, paint amounts, messages, rumble strips and grooved-in paint.
- Hyperlinks that access previous design that include past summary sheets and as-built files.
- Hyperlinks from each asset category to Roadview Explorer, an online, searchable video inventory of all state routes.



Using Roadview Explorer to verify information on summary sheet tables

The summary sheet tables can be used to verify measurements, barrier type, roadway geometry, etc. by visiting the field, or by using Roadview Explorer.

The form has been downloaded over 1,100 times since April 2014. Employee reaction indicates that quantities pulled by the Auto Report Generator are within 2% of field quantities, and that generated notes for features point out deficiencies that may have otherwise been overlooked. Users also appreciate the side benefit of being out of harm's way when collecting data or verifying amounts or assets via Roadview Explorer. Employee feedback and new data will be used to continually improve the tool. UDOT is in the process of a new and improved roadway data collection effort. As new and better data becomes available, the Auto Report Generator will also be improved to provide greater utility.

For more information, contact UDOT's Catherine Higgins at [chiggins@utah.gov](mailto:chiggins@utah.gov).

## To Corrode or Not to Corrode, a GFRP Question: GFRP Reinforcing Bars in Concrete Columns

Concrete bridge structures are typically designed to last 50 to 75 years but seldom last half that time before needing major rehabilitation due to degradation caused by corrosion of steel reinforcement similar to that shown in **Fig. 1**. Corrosion in commonly used epoxy-coated steel bars has raised concern with its use and has raised interest in the use of alternative reinforcement like fiber-reinforced polymer (FRP) bars. Glass FRP (GFRP) bars are a cost-competitive alternative to epoxy-coated steel bars and have been found to not corrode (see UDOT Report No. UT-11.16).



*Fig. 1. Typical corrosion found on bridge structures*

Many transportation costs and user impacts associated with typical corrosion problems could be potentially eliminated with a proactive approach of using non-corrosive reinforcement (e.g. GFRP) in the original construction of concrete elements. Experimental tests were conducted recently at the University of Utah on circular concrete columns reinforced with GFRP and/or steel longitudinal bars and GFRP confining spirals to evaluate their behavior and viability as a potential construction alternative.

One set of columns was reinforced with GFRP spirals and GFRP longitudinal bars, another set of columns was reinforced with GFRP spirals and steel longitudinal bars, and a final set of columns was reinforced with double GFRP spirals and a combination of GFRP and steel longitudinal bars (see **Fig. 2**). Tests were performed on 12 in. diameter short (3 ft tall) and slender (12 ft tall) columns. These are the only tests known to the authors which have investigated the stability of slender FRP reinforced concrete columns.



*Fig. 2. GFRP reinforcement used in column tests*

An analytical confinement and buckling model was developed and validated against the tests to provide a means to predict the behavior and capacity of FRP reinforced concrete columns. This enabled the analysis of additional reinforcement scenarios utilizing FRP (glass or carbon) longitudinal bars and spirals.

In general it was found that FRP spirals and FRP longitudinal bars can be a viable method of reinforcement for concrete columns, particularly in corrosive environments. FRP spirals, however, need to be placed at a closer pitch spacing to provide confinement levels similar to steel spirals due to the lower modulus of elasticity of FRP composites. On the other hand, FRP longitudinal bars can provide increased deflection capacity as compared with steel bars due to the higher tensile capacity of FRP composites.

Additional research is needed to better quantify the confining capacity of FRP spirals and the required pitch spacing needed. Also research investigating the behavior of FRP-reinforced columns under seismic loading will be an important consideration.

Tom Hales will be presenting on this research on Wednesday, January 28 from 11:00 AM—12:00 PM in the Project Development Conference Room on the fourth floor of UDOT's main Complex.

For more details contact Tom Hales with UDOT's Research Division ([tahales@utah.gov](mailto:tahales@utah.gov)) or Dr. Chris Pantelides of University of Utah ([c.pantelides@utah.edu](mailto:c.pantelides@utah.edu)).

## Vertical Earthquake Drains for Soil Liquefaction Mitigation

Limited blast liquefaction testing, vibration testing, and centrifuge testing suggest that vertical drains can be effective in preventing earthquake-induced soil liquefaction and associated settlements or lateral spreading. However, no full-scale drain installation has been subjected to earthquake-induced ground motions. This lack of performance data under full-scale conditions has been a major impediment to expanding the use of this technique for mitigating liquefaction hazards.

To determine the viability of large diameter (4 in.) prefabricated vertical drains for preventing soil liquefaction and associated settlements under full-scale conditions, the pooled fund study no. [TPF-5\(244\)](#) was initiated in 2013 by UDOT, Brigham Young University (BYU), and other state DOTs from California, New York, and Alaska, in conjunction with the National Science Foundation's George E. Brown Jr. Network for Earthquake Engineering Simulation (NEES) Facility at the University at Buffalo (UB) of The State University of New York.



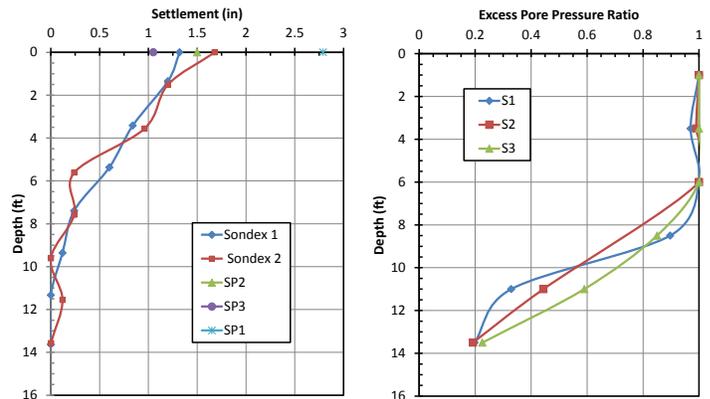
Vertical earthquake drains developed by Nilex, Inc.



NEES-UB 20-ft high laminar box with hydraulic actuators

In August and September 2014, two test series with vertical drains in liquefiable (loose and saturated) sand were com-

pleted using the laminar shear box and high speed actuator system at NEES-UB. Tests involved level ground conditions with two drain spacings: 4 ft for the first series and 3 ft for the second series. For each drain spacing, the soil profile was subjected to a total of nine sinusoidal motions at increasing peak base accelerations of 0.05g, 0.10g, and 0.20g. The settlement of the soil profile was measured using surface settlement plates, string potentiometers, and Sondex profilometers. Pore pressure transducers were used within the sand at various depths to measure pore water pressures. Accelerometers and LVDTs were located along the height of the shear box to define the acceleration and deflection profiles induced by the shaking at the base. Example data plots are shown below.



Settlement and excess pore pressure ratio versus depth plots during the first shaking test at 4-ft drain spacing, with 15 cycles of shaking and 0.05g peak acceleration

A few video recordings from the first series of tests at NEES-UB are available for viewing at this [link](#). Progress reports and the overall scope of work for the study are provided on the web page for study no. [TPF-5\(244\)](#).

Remaining tasks on the project include data analysis, comparison with previous tests on untreated sand, evaluating predictive methods, and preparing the final report regarding drain effectiveness. If full-scale tests prove the effectiveness of the drainage technique, significant time and costs savings can be achieved for both new construction and for retrofit situations, as compared to other mitigation techniques.

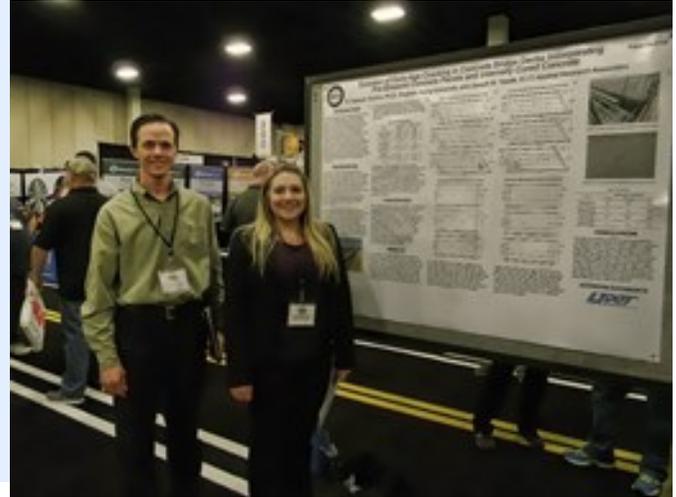
For more information, contact Prof. Kyle Rollins of BYU at [rollinsk@byu.edu](mailto:rollinsk@byu.edu); Jim Higbee in the UDOT Geotechnical Division at [jhigbee@utah.gov](mailto:jhigbee@utah.gov); or David Stevens in the UDOT Research Division at [davidstevens@utah.gov](mailto:davidstevens@utah.gov).

## 2014 UDOT Poster Session Summary

The Research Division held its annual Research and Innovation Poster Session in conjunction with the 2014 UDOT Annual Conference this past October. The poster session was an opportunity for university students to present the transportation-related research they had performed, under the direction of their university professors. Ten students and five professors, representing all three research universities in Utah, participated in this year's poster session. Valuable research was presented on the following topics:

- Flexural, Shear, & Punching Shear Capacity of Light-weight Double-Tee Girders
- Modeling Spatial Relationships between Access to Multi-modal Transportation and Traffic Safety Outcomes
- Multimodal Corridors Assessment with Transit Priority Enhancements: Case Study of the Future Airport Light Rail Line in Salt Lake City
- Analyzing the First Mile Last Mile Problem for Transit Systems
- Cracking Evolution on Internally Cured Concrete Bridge Deck on Mountain View Corridor
- Simplified Web-Based Decision Support Method for Traffic Management and Work Zone Analysis
- Shear Failure Analysis of Galvanized Steel Light Pole Subjected to Impact
- Crack Opening Prediction of Thin Fiber-Reinforced Concrete Overlay Subjected to Drying Shrinkage and Temperature Changes
- Dynamic Testing and Modal Analysis of a Concrete Bridge
- Use of Waste Glass as a Supplementary Cementitious Material
- Preventing Low Temperature Cracking in Asphalt Pavements
- Carousel Method: A Reliable Method for Collecting Vehicle Occupancy Data
- Live Load Testing of the Icy Springs Bridge in Coalville, UT
- Empirical Analysis for Quantifying the Freeway Incident-Induced Delay

After the conference, the participants were surveyed to determine what worked well and areas that could be improved. A number of good suggestions were made for future poster sessions intended to improve participation for both the presenters and conference attendees. We'll be looking for ways to incorporate the best ideas in future sessions.



UDOT's David Stevens and BYU's Amanda Bitnoff at the 2014 Poster Session

For more information, contact Kevin Nichol in the UDOT Research Division at [knichol@utah.gov](mailto:knichol@utah.gov).



Most people fail in life not because they aim too high and miss, but because they aim too low and hit.

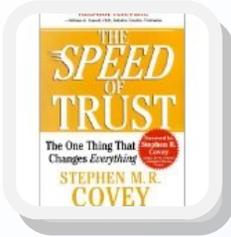
--Les Brown

Difficulty, my brethren, is the nurse of greatness. A harsh nurse, who roughly rocks her foster children into strength and athletic proportion.

--William Cullen Bryant

## Calendar of Events

### LEADERSHIP BOOK DISCUSSION



The third leadership book discussion with Shane Marshall will be held on Wednesday, March 25 from 11:00 AM to 12:00 PM in the Njord Conference Room of the UDOT Complex for all interested UDOT employees. The intent of these discussions is to share valuable and insightful lessons that support UDOT's culture of innovation and improvement. The book being discussed is ***The Speed of Trust: The One Thing That Changes Everything*** by Stephen M.R. Covey. This discussion will focus on the first two "waves" from the book and the next discussion will focus on the remaining 3 "waves". Contact Joni DeMille in the UDOT Library ([jdemille@utah.gov](mailto:jdemille@utah.gov)) to borrow a copy of the book. The presentation will be broadcast to the regions.

### RESEARCH FUNDING OPPORTUNITIES (click to see the full document)

Round 5 of SHRP2 Solutions Implementation Assistance Applications, DUE on February 13, 2015

NCHRP Synthesis of Practice Topics, DUE on February 13, 2015

NCHRP Highway IDEA Proposals, DUE on March 1, 2015

UDOT Research Problem Statements, DUE on March 10, 2015

### WEBINARS (click to see webinar details)

Title	Day/Date	Time
Guide to Regional Transportation Planning for Disasters, Emergencies and Significant Events (TRB)	Wednesday, Jan. 21	12:00 PM – 1:30 PM
(SR500A) Transportation Planning Information Exchange on Regional Models of Cooperation [NHI]	Tuesday, Jan. 27	11:00 AM – 12:30 PM
Tools for Pedestrian and Bicycle Volume Data Collection (TRB)	Thursday, Jan. 29	11:00 AM – 1:00 PM
Maintenance Training and Certification Programs (TRB)	Monday, Feb. 9	12:00 PM – 1:30 PM
Planning for Safety Considerations on Airfields (TRB)	Wednesday, Feb. 11	12:00 PM – 1:30 PM
(SR200) Sequential Flashing Warning Light System [AASHTO Innovative Initiative] (NHI)	Thursday, Feb. 19	12:30 AM – 2:00 PM
Performance of WMA Technologies: Stage 1 – Moisture Susceptibility (TRB)	Thursday, Feb. 26	11:00 AM – 12:30 PM
The Real Leadership Lessons of Steve Jobs	On Demand	On Demand
Rethinking Five Beliefs that Erode Workplace Motivation	On Demand	On Demand
Fully Charged: How Great Leaders Boost Their Organization's Energy and Ignite High Performance	On Demand	On Demand