FALL 2016

Research Newsletter

Responsive - Accessible - Relevant

A MESSAGE FROM THE RESEARCH DIRECTOR

By: Cameron Kergaye, PhD, PMP, PE

Fall is a good season for research in the academic world since students and professors return to a predictable working routine. In our spring workshop we awarded 12 of our new projects to our universities. Three reasons we like to use university resources are: depth of knowledge, educational support and costs. The latter is sometimes assisted at the federal level with grants for matching research funds. Two of our public universities have been part of the US DOT's University Transportation Center program for several years. By the end of this calendar year the US DOT will announce those universities that will be grantees for the next five year period.

The US DOT also recently published a highly anticipated policy for automated vehicles. A Federal Automated Vehicles Policy was released in September and addresses safety, testing and deployment of automotive technologies. The policy outlines a progressive yet cautious path for manufacturers and addresses performance and testing, inter-state consistency and regulatory guidance. The policy also anticipates the need to accommodate new technologies that may outpace the agencies traditional level of responsiveness.

New innovations at UDOT will now be included in our annual Innovation and Efficiencies Report, which is compiled every fall with all of UDOT's Regions and Groups. Traditionally this document presented efficiencies realized throughout the Department at the completion of each fiscal year. Examples of past efficiencies are included in previous annual reports at www.udot.utah.gov/go/innovation. This year we will include innovations that offer obvious improvements for transportation maintenance and operations though may not yet have quantifiable savings. This change is intended to share valuable innovations more rapidly.

Research is taking on a more active role on the State Transportation Innovation Council, which represents a federal initiative to seek and support innovation among transportation agencies, universities and practitioners. STIC also offers an incentive program that provides up to $100,000 to implement promising innovations. In the last two years UDOT was awarded these funds for Utility Conflicts and 3D Construction. This year we are applying for funding to develop a Progressive Design Build Template.

UDOT will host its Annual Conference in early November and the Research Division will present our most recently completed projects in a break out session on November 2nd. This session will highlight valuable research with implementable results. Please attend this rapid fire format as researchers quickly present new advances and technological discoveries.

Finally, the date of our next Research Workshop (UTRAC) will be March 20, 2017. Please mark your calendars and plan to help set the direction of next year's transportation research agenda for UDOT.

In This Issue: (click on desired article, click on logo at top to return to this page)

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

Editorial Staff: Joni DeMille jdemille@utah.gov **and David Stevens** davidstevens@utah.gov

By: Winston Inoway
UDOT Learning and Development

Access to UDOT University Learning Portal Now Available

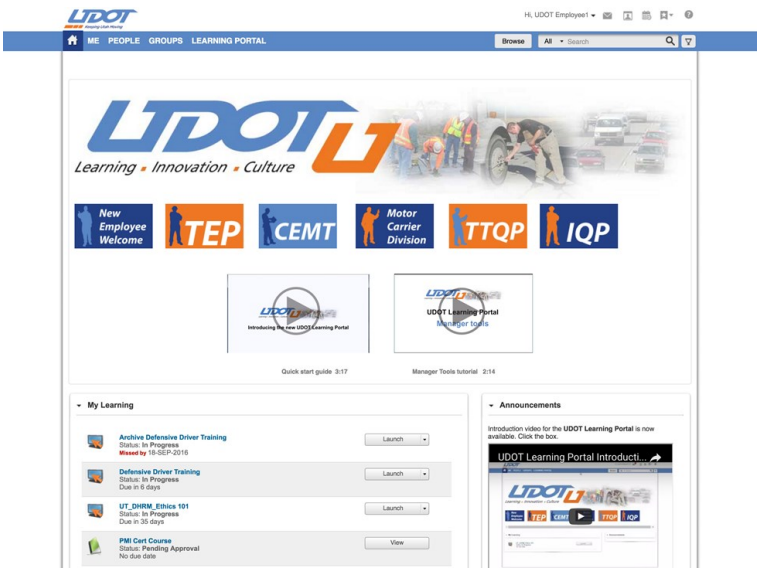
UDOT has launched a new online portal for training, certifications and on-demand learning, which is all housed as part of UDOT University.

The UDOT-U Learning Portal provides access to a wide range of on-demand instructional learning topics. From learning how to use applications such as MS Excel or manage your Google Calendar to leadership and management topics, the Learning Portal provides a comprehensive catalog of learning opportunities.

The Learning Portal interface is easy to use and finding topics of interest as well as completing required training is straight forward. Online courses completed using the Learning Portal are automatically recorded on the employee's learning plan. Users can also record in-person training and conference attendance as part of their personal learning transcript.

Connecting to the Learning Portal is easy because the log-in is the same as the user's email and computer network log-in. Future UDOT required training, certifications and other career development information will be accessed through the Learning Portal. Click-through and bookmark the portal at https://utah-udotu.sabacloud.com

For questions or comments about the UDOT-U Learning Portal, please contact the Learning and Development team at udotu@utah.gov.



Main page of UDOT U Learning Portal with links to training programs & videos

If opportunity doesn't knock, build a door.
–Milton Berle

Success consists of going from failure to failure without loss of enthusiasm.
–Winston Churchill

I opened two gifts this morning. They were my eyes.
—Zig Ziglar

By: Amanda Bordelon, PhD, PE
University of Utah

Building a Restrained Shrinkage Test Apparatus at UDOT

Concrete restrained shrinkage cracking is a significant issue for the durability of bridge decks. ASTM C157, a standard procedure for the determination of the free shrinkage of a concrete or mortar prism, cannot be correlated to the restrained shrinkage exhibited on bridge decks. There are few developed or standardized procedures that test the restrained shrinkage cracking of a specific concrete mix design. These procedures all involve different geometries, limit material components, or can be inconclusive making it difficult to universally predict restrained shrinkage cracking. Although it is expected that cracking can be reduced with the incorporation of polymer-modified or fibrous materials in the mixture, there is a need for a commonly accepted standard method that can predict the cracking tendency of a variety of the different mixtures.

The primary objective of this research project is to assist UDOT in building a restrained shrinkage test apparatus that can be used to predict the restrained shrinkage performance of bridge decks based on the concrete mixture properties. The goal of such an apparatus is to develop a specification that testing labs can use to determine the restrained cracking properties of a mixture prior to implementing that mixture in a bridge deck.

The AASHTO T334 procedure is a standard method for testing the cracking tendency of restrained concrete. The procedure involves casting a 3" thick concrete ring with the geometry seen in Figure 1. The test assures that the concrete shrinks circumferentially, mimicking the one-sided drying condition similar to the conditions found on a bridge deck. The main advantage of this method is that it can be used for testing both pavement and bridge deck mixtures because it allows for nominal maximum aggregate sizes up to 1".

The AASHTO ring test procedure had some known disadvantages. The main challenge is that it is commonly known to be a method which never shows cracking, resulting in many test batches that are inconclusive. Along with many samples never cracking, there is no specified end period for which the test is said to be complete. In this study, mixtures were removed from the apparatus after 90 days even if no cracking was observed, this way additional mixtures could be tested in a timely manner.

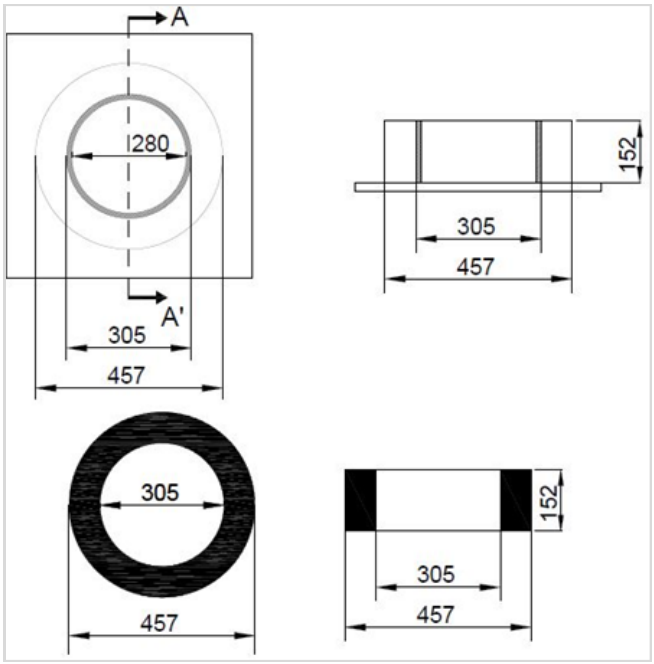


Figure 1 AASHTO T334 a) Steel Ring Geometry
b) Concrete Specimen Geometry (units: mm)

An alternative restrained shrinkage test ASTM C1581 involves a thinner concrete ring. This alternative ring has shown good correlation to bridge deck cracking and has a limit of a 28-day period. The reason for not implementing this method at this time is because only mixtures with a ½" maximum aggregate size or less can be evaluated.

Several observations were made during the setup of the AASHTO ring apparatus that must be taken into account for anyone planning to similarly use this method.

1—Testing Considerations

a) The steel ring must be custom made and chosen to have a low coefficient of thermal expansion to minimize temperature strains. Invar type steel is the ideal option.

b) High quality strain gauges are preferred. The gauges should be installed by a person with experience as to avoid any measurement errors caused by improperly installed gauges.

By: Amanda Bordelon, PhD, PE
University of Utah

Building a Restrained Shrinkage Test Apparatus at UDOT (cont.)

c) Continuous data logging is preferred as to be able to monitor the changes over time. The data acquisition hardware and software should be chosen carefully based on accuracy and ease of use.

d) The rings take up to three square feet of area and thus sufficient area should be provided for all test specimens. The standard allows for the movement of the specimen after assembly. However, care should be taken while moving the specimen as to avoid disturbing the sample or wiring attached.

e) The rings should be placed in an environment with a tightly controlled temperature 73 +/- 3 F and relative humidity 50% +/- 4%. An example plot of the climate fluctuation when the humidity is out of range from this study is seen in Figure 2.

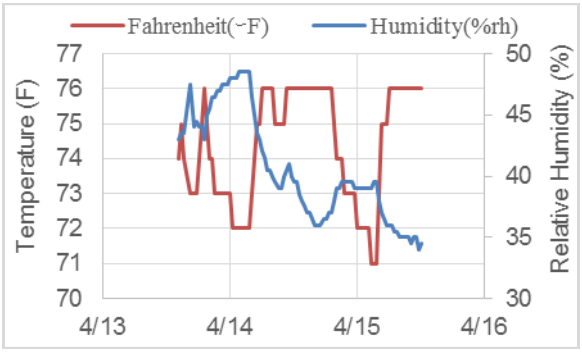


Figure 2 Temperature fluctuation in testing room

2—Monitoring considerations

a) Temperature and humidity of the environment should be monitored and controlled because extreme fluctuations can cause the sample to crack due to environmental effects rather than mixture effects.

b) In addition to electronic strain monitoring, the ring samples must be visually inspected for verifying the age of cracking.

The high dependability on the surrounding environment and the over-sensitivity of the strain gauges make this procedure unfavorable in comparison to the ASTM C157 free shrinkage method. The free shrinkage has its own challenges, including similar climate constraints, and the size and curing must be specified for consistency between measurements. Figure 3 shows the free shrinkage value over time for prisms of different sizes.

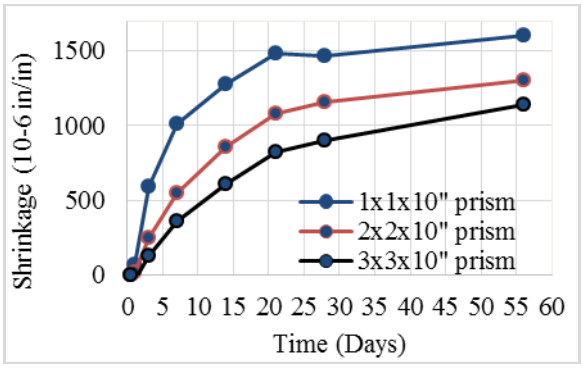


Figure 3 Shrinkage of three prism sizes over time

This study has focused mainly on building the apparatus and attempting to ensure it can be appropriately used to evaluate performance of bridge deck mixtures. High variability was found in the procedure. Thus, is recommended that UDOT should remain using the ASTM C157 method until an appropriate and consistent restrained shrinkage test procedure is developed.

For more information, contact Amanda Bordelon of the University of Utah's Civil and Environmental Engineering Department (bordelon@civil.utah.edu), Bryan Lee of UDOT's Central Materials Division (bryanlee@utah.gov), or Tom Hales of UDOT's Research Division (tahales@utah.gov).

By: Ziqi Song, PhD
Utah State University

Implementation of Aerial LiDAR Technology to Update Highway Feature Inventory

Highway inventory is a compilation of components and conditions of a highway system. State departments of transportation (DOTs) and local transportation agencies always need up-to-date inventory data to establish the condition of the road networks within their jurisdictions, to prioritize reconstruction and repair work, and to value their highway assets. Federal, State, and local governments also use road inventory data for traffic engineering studies, planning, and meeting federal data reporting requirements. Because of the importance of collecting highway inventory data, transportation agencies are always looking for better inventory methods. The main objective of this study is to analyze and demonstrate the feasibility of airborne LiDAR technique in collecting and recording highway inventory data. A field experiment to collect the airborne LiDAR data was conducted, and an algorithm based on ArcGIS to extract certain types of highway features from the raw LiDAR data was developed by the research team at Utah State University (USU).

Four highway sections in Utah were covered in the data collection, including one on I-84, two on I-15, and one on US-191.

Figure 1: Aerial LiDAR Data Collection Team

After the raw airborne LiDAR data is preliminarily calibrated and evaluated, the LiDAR data can be viewed and processed in the form of point clouds in ArcGIS. Most highway features, for example, large traffic signs, traffic signals, billboards, light poles, guardrails, bridges, and culverts, are fairly conspicuous in aerial LiDAR data. The study also found that several small road features (e.g., speed limit signs) cannot be effectively identified in the point clouds because of the relatively low point density and vertical scanning.

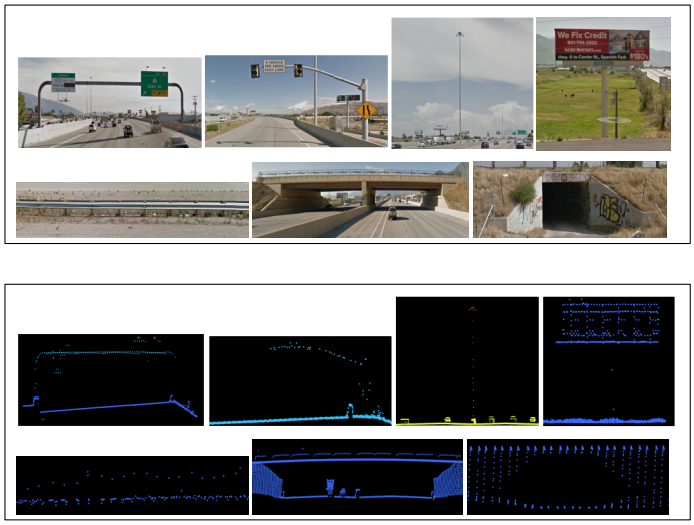


Figure 2: Highway Features in Image and mobile LiDAR Point Cloud

For all the road features that can be identified in airborne LiDAR data, their specific location information and structure characteristics can be manually measured and recorded in LiDAR data. However, manually identifying all the road features requires a great deal of time and effort. Meanwhile, it may lead to mistakes due to human error. Therefore, an ArcGIS-based algorithm was developed to extract certain types of road features from airborne LiDAR data. Based on the algorithm, target features were automatically detected and recorded in the four highway sections.

This study demonstrated that airborne LiDAR technique is capable of efficiently detecting and recording most types of road features. Furthermore, airborne LiDAR has the advantage over ground-based inventory technologies of being able to provide a different perspective. As a result, it can detect objects such as culverts and ditches that may have been hidden from the mobile platform. In addition, the data processing algorithm proposed in this study improves the efficiency of airborne LiDAR data post-processing. In conclusion, airborne LiDAR is a promising technique that can serve as a complement to other techniques for road inventory data collection for UDOT.

For more information, contact USU's Ziqi Song (ziqi.song@usu.edu) or Tom Hales (tahales@utah.gov) of the UDOT Research Division.

By: Vincent Liu, PE
UDOT Research Division

Implementing Research Project Findings

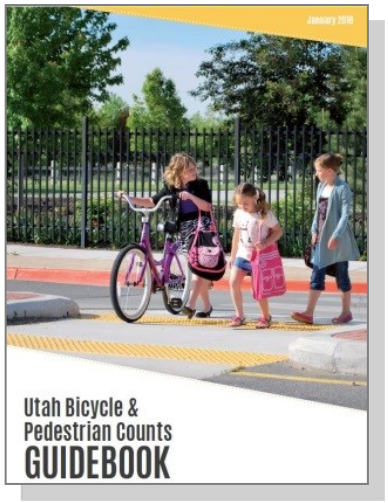
Innovation is one of the emphasis areas to support UDOT's strategic goals. To assist in these efforts, the Research Division has dedicated resources to promote and encourage the implementation of research project findings. One of our main goals is to fund quality research projects with a high potential for implementation that will allow UDOT to apply research findings and put them into practice.

At present, Research has developed an Excel program to help facilitate the tracking of project implementation for all active research projects. We plan to convert this into an Access database in the near future.

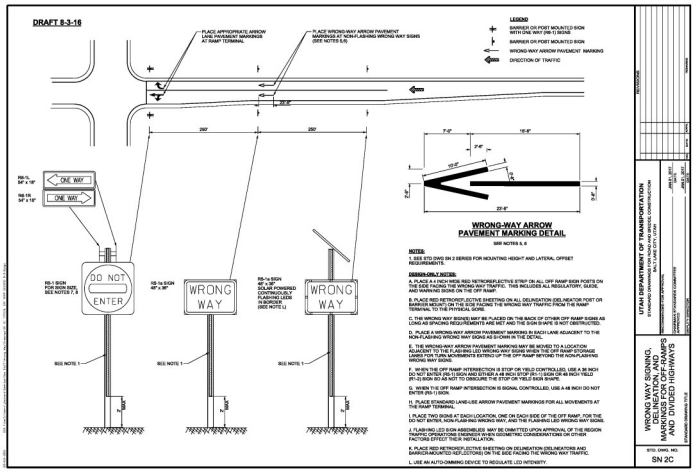
Many projects are in various stages of being implemented into UDOT practice. The following are a few examples of implementation efforts from research projects that are currently under way:

- Correlation of Laboratory and Field Friction Measurements to Optimize Utilization of Bituminous Surface Aggregates: Skid resistance findings were incorporated into the Special Provision Section 03373S (Polyester Concrete Overlay) for I-215 Knudsen Corner Bridge Preservation project (F-R299 (217); PIN 13158).

- Developing a Rubric and Best Practices for Conducting Bicycle Counts: A guidebook has been developed and is being used by UDOT's Active Transportation Coordinator to assist and educate local governments.



- Evaluation of Wrong-Way Driving Detection: Cutting-edge warning techniques via strategically placed flashing signs are being proposed for installation at select ramp locations. A research committee is reviewing the following drawing and selecting ramp locations for implementation. Cost estimate and scope of work has been prepared by Travis Jensen with WCEC Engineers, Inc.



- Developing a Low-Shrinkage, High-Creep Concrete for Infrastructure Repair: Laboratory experiments of various concrete mixes have been completed and four selected mix designs are being planned for field testing in one of two proposed rest areas (Grassy Mountain or Echo Canyon Westbound).

For more information on research implementation efforts contact Vincent Liu of UDOT's Research Division at (vliu@utah.gov).

By: **Kevin Franke, PhD, PE**
Brigham Young University
Darin Sjoblom, PE
UDOT Geotechnical Division
David Stevens, PE
UDOT Research Division

Simplified Performance-Based Liquefaction Assessment Using the Standard Penetration Test

Since 2014, Dr. Kevin Franke, a civil engineering professor from Brigham Young University, has been working with engineers from seven state departments of transportation (DOTs) to develop an improved methodology for evaluating earthquake-induced liquefaction triggering and several of its possible effects including post-liquefaction settlement, lateral spread displacement, and seismic slope displacement. UDOT is the lead agency in the FHWA Transportation Pooled Fund study, which also includes support from Alaska, Idaho, Montana, Oregon, Connecticut, and South Carolina DOTs.

Example of the effects of liquefaction caused by an earthquake on apartment buildings (Niigata, Japan 1964)

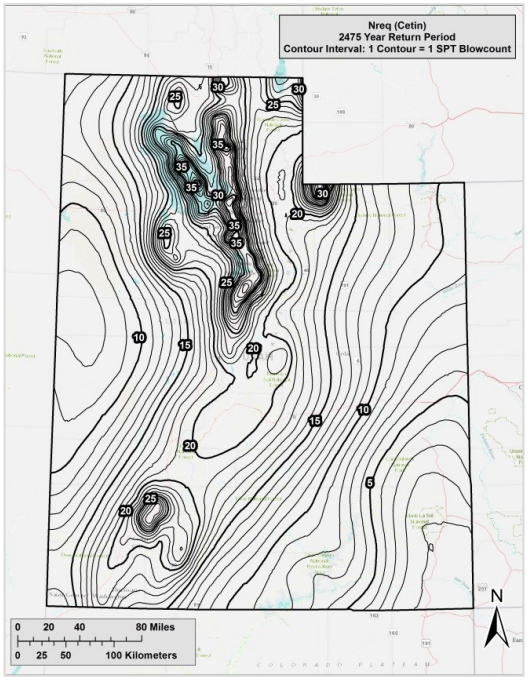
The TPF study focuses on the idea that uncertainty in predicting soil liquefaction and its effects is generally not adequately accounted for in conventional analysis approaches employed routinely by engineers. This uncertainty includes the earthquake occurrence and its resulting ground motions, geotechnical characterization of the soil (i.e., the "true" Standard Penetration Test, or SPT resistance of a given soil layer), and predictive model scatter. Engineers have traditionally applied conservatism to indirectly account for these uncertainties, but doing so has introduced two significant problems in the process:

1. Excessive conservatism can result in costly designs and mitigation of a potentially unlikely hazard, and

2. Engineers' perceived conservatism may be based on incorrect assumptions, and may in fact not be conservative at all.

Rather than rely upon conservatism to account for uncertainties, a performance-based design approach attempts to quantify and account for all sources of uncertainty, and then relate various liquefaction consequences to hazard levels or return periods. These hazard levels or return periods can then be used to define the standard to which various performance levels of the structure must be designed to achieve.

The greatest challenge for engineers in implementing a performance-based approach in liquefaction hazard assessment has been quantifying the various uncertainties associated with the problem, and then mathematically accounting for them using probabilistic integration. This TPF study has introduced an alternative, simplified approach. Dr. Franke and his students have developed reference parameter maps across the seven participating states at three different return periods of interest. The reference parameter maps incorporate all of the necessary uncertainties and probabilistic integrations, and thereby remove the need for the engineer to perform these difficult tasks. With a reference parameter map, the engineer simply needs to read and interpolate the reference liquefaction hazard value associated with his/her site. Then this reference liquefaction hazard value is corrected for site-specific geotechnical and topographical information to develop a performance-based liquefaction hazard estimate that closely approximates (i.e., within 5%) the hazard value that would be obtained if the engineer had performed the full performance-based analysis for the specific site.



Sample liquefaction parameter map, N_{req} for Utah (T_r = 2475 years), where N_{req} is the SPT resistance required to resist or prevent liquefaction based on a reference soil profile

By: Kevin Franke, PhD, PE
Brigham Young University
Darin Sjoblom, PE
UDOT Geotechnical Division
David Stevens, PE
UDOT Research Division

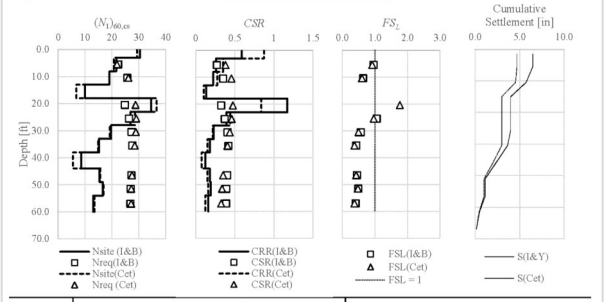
Simplified Performance-Based Liquefaction Assessment Using the Standard Penetration Test (cont.)

To assist engineers in implementing the new simplified performance-based procedure, a simple analysis spreadsheet called "Simplified Performance-based Liquefaction Analysis Tool" or "SPLiq" has been developed by Dr. Franke and his students. The spreadsheet already incorporates all of the reference parameter map information internally, so the user simply needs to enter a latitude/longitude and a desired return period for the analysis, along with the site-specific geotechnical (SPT data, etc.) and topographical information.

The implications of this new simplified performance-based approach for liquefaction hazard analysis are significant. Computed liquefaction hazards will now be much more consistent across different seismic environments. The simplified performance-based approach does not require any more site-specific information or input than current conventional approaches require. Finally, engineers will have a means to quantify the likelihoods associated with different liquefaction triggering events and their corresponding effects. Usefulness of the simplified approach could extend to other infrastructure and industries in addition to highway transportation.

Company:	GEO Company	**Project:**	Example Problem
Designer:	BME	**Location:**	Salt Lake City, UT
Date:	6/1/2016	**Project #:**	AB-123-4567

Liquefaction Initiation and Settlement Simplified Performance-based Results:



	Idriss and Boulanger (2008, 2012); Ishihara & Yoshimine (1992)					Cetin et al. (2004, 2009)				
Depth (ft)	$(N_1)_{60,cs}$	N_{req} site	CSR^{site}	FS_L	$\sum S$ [in]	$(N_1)_{60,cs}$	N_{req} site	CSR^{site}	FS_L	$\sum S$ [in]
1.50	30.47	#N/A	#N/A	#N/A	4.69	29.30	#N/A	#N/A	#N/A	6.48
5.50	21.68	22.31	0.2710	0.959	4.69	20.69	21.84	0.3809	0.920	6.48
10.50	19.10	25.69	0.3499	0.636	4.53	19.07	26.08	0.4558	0.602	5.72
15.00	9.97	#N/A	#N/A	#N/A	2.99	6.80	#N/A	#N/A	#N/A	3.99
20.50	34.64	24.84	0.3260	3.598	2.99	36.63	28.78	0.4757	1.767	3.99
25.50	26.96	26.37	0.3718	1.058	2.99	28.53	29.05	0.4597	0.964	3.99
30.50	19.72	27.29	0.4059	0.568	2.99	19.25	28.88	0.4343	0.498	3.63
35.50	15.24	27.58	0.4183	0.431	2.08	14.85	28.45	0.4051	0.373	2.45
41.00	8.50	#N/A	#N/A	#N/A	1.01	5.50	#N/A	#N/A	#N/A	1.13
46.50	15.39	27.23	0.4038	0.450	1.01	15.69	27.43	0.3510	0.427	1.13
51.50	16.62	26.95	0.3926	0.494	0.44	16.90	27.18	0.3357	0.474	0.49
57.00	12.97	26.86	0.3894	0.409	0.14	13.55	27.10	0.3248	0.375	0.14

Sample output from the new SPLiq tool

Dr. Franke trained 30 consultants and UDOT engineers on the simplified approach and SPLiq tool in a one-day workshop in August 2016. UDOT intends to incorporate the new simplified performance-based liquefaction hazard analysis approach in its next Geotechnical Manual of Instruction update. It is anticipated that the approach will improve the seismic design process for highway structures with regard to liquefaction hazards. A similar research project was also just initiated this year by Dr. Franke and his students in which simplified performance-based liquefaction hazard analysis procedures will be developed for the cone penetration test (CPT). That project is projected to finish by summer of 2018 and is also a pooled fund study involving a few states.

A final report on the SPT liquefaction research and tool will be published soon. Various progress reports from the study are available at the TPF-5(296) study webpage. For more information, contact Dr. Kevin Franke (kevin_franke@byu.edu) of BYU, Darin Sjoblom (dsjoblom@utah.gov) of the UDOT Geotechnical Division, or David Stevens (davidstevens@utah.gov) of UDOT's Research Division.

"Now hiring," read the classified ad. "Cemetery superintendent. The ideal candidate must be able to supervise in a fast-paced environment." (from *Reader's Digest)*

Two factory workers are talking. One says, "I can make the boss give me the day off." The other replies, "And how would you do that?" The first says, "Just wait and see," then proceeds to hang upside down from the ceiling. The boss comes in and says, "What are you doing?" The worker replies, "I'm a light bulb." The boss then says, "You've been working so much that you've gone crazy. I think you need to take the day off." The second worker starts to follow and the boss says, "Where are you going?" The worker says, "I'm going home, too. I can't work in the dark."

By: Amanda Bordelon, PhD, PE
University of Utah

Does the Cementometer™ Probe Actually Indicate Water-Cement Ratio of Concrete?

The main indicator of the overall strength and durability of concrete is the mass ratio of water to cementitious material (w/cm). This ratio is usually specified by the designer in order for the concrete to meet certain strength and durability limits. However, extra water is added often times without adjusting the batch ticket to reflect the real w/cm. The most accurate standard method available to measure this ratio at the job site is the AASHTO T318 using a microwave oven. Although accurate, this method can take up to 30 minutes before a moisture level is known, which still needs to be converted to w/cm, and the method requires the presence of a microwave oven for testing. Thus, a faster method to determine the ratio would be more useful. UDOT purchased a microwave based moisture meter called a Cementometer™ that is claimed to be accurate and instantaneous for displaying the w/cm value. If true, this makes the meter an excellent on-site Quality Control (QC) and Quality Assurance (QA) method. The purpose of this research study was to investigate the actual level of accuracy and precision of the meter by calibrating and testing it on mixtures with known w/cm, and develop a correlation between the meter's output and the known w/cm.

A total of 157 concrete mixes were tested, of which some mixtures were from The Point project and Harper Precast plant. The meter has four measurement settings: the Direct Reading (a unitless number believed to correlate to the measured dielectric permittivity), the User-program (stated to be the most accurate because it requires the calibration of the device to a specific mixture's source material before being used for testing), along with Type I and Type III modes that are pre-calibrated by the manufacturer to concrete mixtures that use ASTM C150 Type I and Type III cements, respectively. Once a mixture was calibrated, various mixtures with known w/cm were batched and the four settings were used to measure the w/cm of each mixture.

To determine if a correlation exists between the actual (known) w/cm and the meter's output, a linear regression analysis was performed. The analysis was performed on the User-program, Type I and Type III settings. Figure 1 show the results of the analysis on the User-program and Type I only.

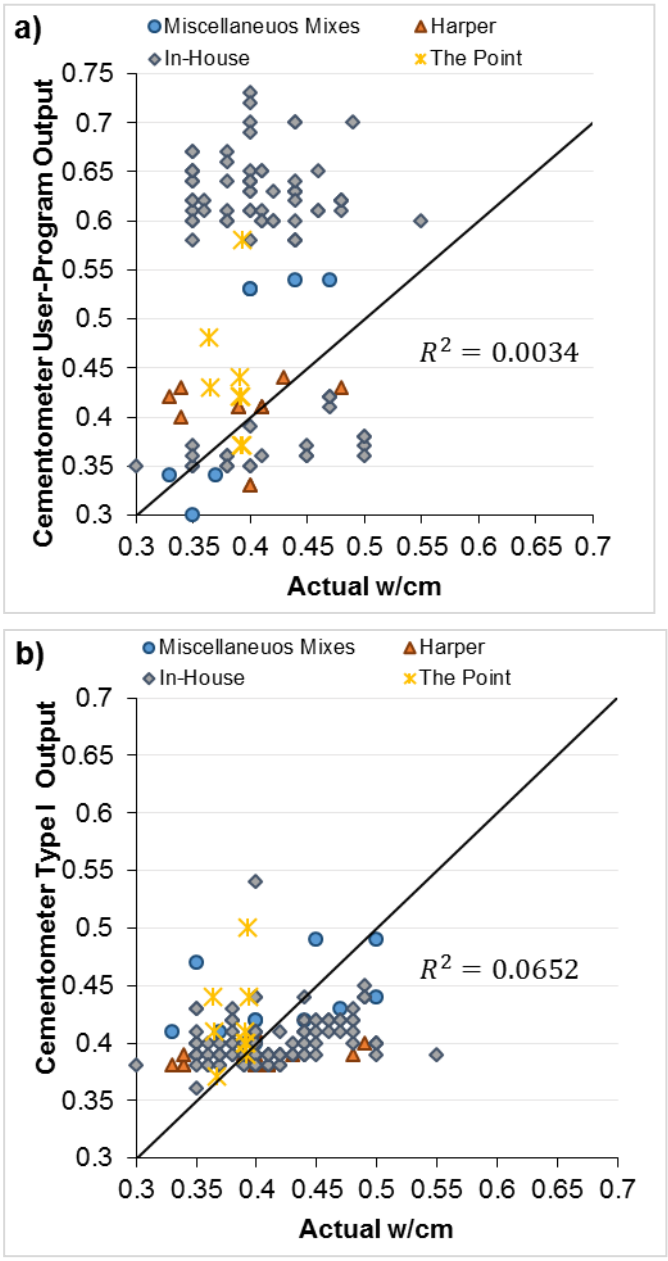


Figure 1. Linear Regression Analysis on a) User-Program Setting b) Type I Setting

By: Amanda Bordelon, PhD, PE
University of Utah

Does the Cementometer™ Probe Actually Indicate Water-Cement Ratio of Concrete? (cont.)

To further determine the accuracy and precision of the device, a statistical T-test and confidence interval were calculated from the data. The null hypothesis tested was that the mean of the actual (known) w/cm is equal to the mean of the output values obtained from the different measurement settings. Table 1 summarizes the T-test values obtained. P-values less than 0.05, which was found for all meter settings, indicated there was no statistical equivalence between the actual and output values. With 95% confidence and the Type I mode setting, a batched mixture at a given w/cm would produce the expected output values shown in Figure 2.

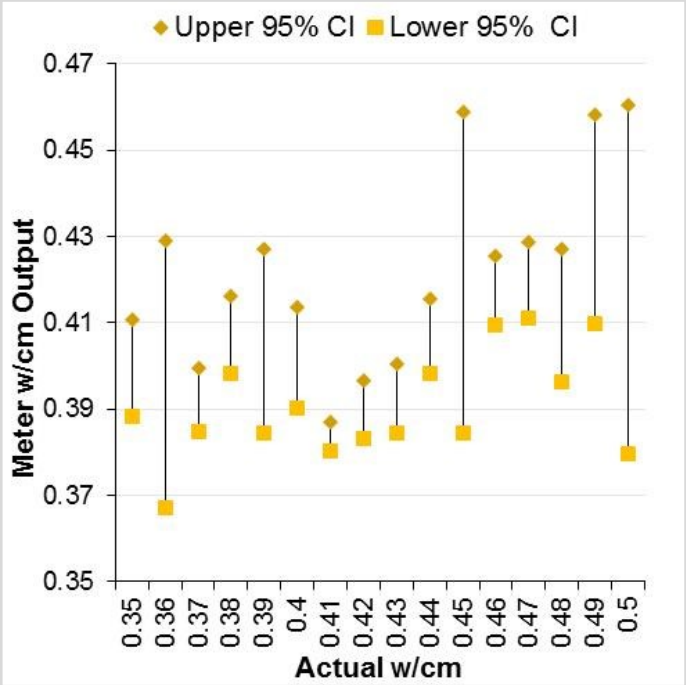


Figure 2. 95% Confidence Interval for Type I Mode

The meter did not correlate well to known w/cm, and no accuracy or precision in measurements were found. The low R^2 correlation value from Figure 1 along with the low p-value from the t-test in Table 1 again indicated there was no precision or accuracy of the Cementometer™'s output. The output w/cm values also had a wide confidence interval which is not satisfactory as a QC/QA tool. An example is that if the device was used in the Type I setting to test a 0.45 w/cm mixture, then the meter's output value 95% of the time will show a value anywhere between 0.38 and 0.46 (Figure 2). The high variability of the device causes difficulty in developing a mathematical relationship between the output and actual w/cm.

Overall, the Cementometer™ was statistically proven to not be accurate or precise for determining w/cm content. It should not be used as a QC or QA method. Simultaneous testing using the AASHTO T318 method did verify this existing alternative to be accurate and precise. Therefore, it is recommended that DOTs use the AASHTO T318 standard to measure the in-situ moisture content of fresh concrete until a faster and reliable method is invented.

For more information, contact Amanda Bordelon (bordelon@civil.utah.edu) of the University of Utah, Scott Strader (sstrader@utah.gov) of UDOT Materials, or David Stevens (davidstevens@utah.gov) of UDOT Research.

Mode	Sample Size	Mean Difference	Standard Error	T-value	p-value	Hypothesis x = 0
User-Mode	108	0.12347	0.0861	11.47	0.000	Reject
Type I	156	-0.00813	0.0356	2.02	0.044	Reject
Type III	157	0.05943	0.0356	14.80	0.000	Reject

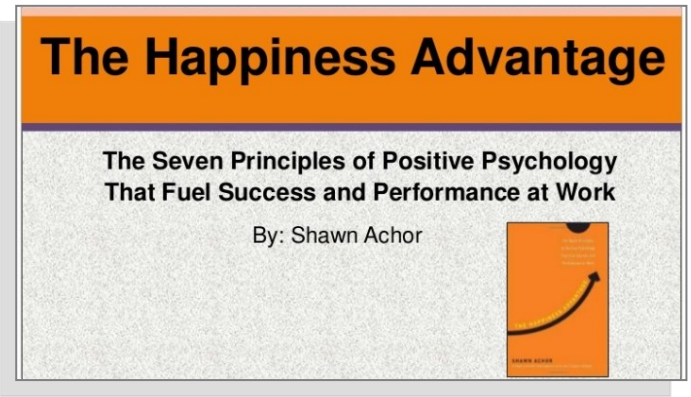
Table 1. T-Test Parameters for Entire Mode Data Set of Concrete Mixtures

By: Vincent Liu, PE
UDOT Research Division

Book Discussion: Review of *The Happiness Advantage*

UDOT employees continue accepting the challenge to read the book, ***THE HAPPINESS ADVANTAGE***, by Shawn Achor. In the book, the author begins with a demonstration of the traditional view of the relationship between success and happiness. "Conventional wisdom holds that if we work hard, we will be more successful," Achor says, "and if we are more successful, then we'll be happy."

With the author's decade-long groundbreaking research in the fields of positive psychology and neuroscience, his studies have found that positive psychology or emotion can bring a competitive edge, success and greater performance in academic and business settings.



Shawn concludes that the following seven principles, quoted directly from the book, can help all of us to become more successful:

The Happiness Advantage - Because positive brains have a biological advantage over brains that are neutral or negative, this principle teaches us how to retrain our brains to capitalize on positivity and improve our productivity and performance.

The Fulcrum and the Lever - How we experience the world, and our ability to succeed within it, constantly changes based on our mindset. This principle teaches us how we can adjust our mindset (our fulcrum) in a way that gives us the power (the lever) to be more fulfilled and successful.

The Tetris Effect - When our brains get stuck in a pattern that focuses on stress, negativity, and failure, we set ourselves up to fail. This principle teaches us how to retrain our brains to spot patterns of possibility, so we can see-and seize opportunity wherever we look.

Falling Up - In the midst of defeat, stress, and crisis, our brains map different paths to help us cope. This principle is about finding the mental path that not only leads us up out of failure or suffering, but teaches us to be happier and more successful because of it.

The Zorro Circle - When challenges loom and we get overwhelmed, our rational brains can get hijacked by emotions. This principle teaches us how to regain control by focusing first on small, manageable goals, and then gradually expanding our circle to achieve bigger and bigger ones.

The 20-Second Rule - Sustaining lasting change often feels impossible because our willpower is limited. And when willpower fails, we fall back on our old habits and succumb to the path of least resistance. This principle shows how, by making small energy adjustments, we can reroute the path of least resistance and replace bad habits with good ones.

Social Investment - In the midst of challenges and stress, some people choose to hunker down and retreat within themselves. But the most successful people invest in their friends, peers, and family members to propel themselves forward. This principle teaches us how to invest more in one of the greatest predictors of success and excellence—our social support network.

The final discussion of this book with UDOT Deputy Director Shane Marshall is scheduled for October 11 at 10:00 am in the Njord Conference Room. This discussion will focus on how UDOT employees have been applying the principles learned from the book. All interested UDOT employees are welcome to attend.

Copies of *The Happiness Advantage* or any other books from the discussion series can be checked out from Joni DeMille (jdemille@utah.gov) in the UDOT Library. Contact David Stevens (davidstevens@utah.gov) or Joni DeMille in UDOT's Research Division for more information.

By: David Stevens, PE
UDOT Research Division

Joni DeMille
UDOT Research Division

Research Calendar of Events

2017 UTRAC—SAVE THE DATE (click to see webpage)

The 2017 UDOT Research (UTRAC) Workshop is scheduled for Monday, March 20, 2017 from 7:30 a.m. to 3:00 p.m. at the Salt Lake Community College Miller Campus, 9750 S 300 W, Sandy, UT. It is anticipated that the following subject areas will be covered: Materials & Pavements, Maintenance, Traffic Management & Safety, Preconstruction, Planning, Asset Management, Structures and/or Geotech, and Public Transportation. For those interested, please mark the date on your calendar. We look forward to seeing many of you there to make this a worthwhile and successful event as UDOT prioritizes research needs for the coming year. We will send out more information on the problem statement submittal process in a few months. You may contact Tom Hales for more information (tahales@utah.gov).

COME MEET SOME TRB ROCK STARS!

On November 16 UDOT will host a visit by Bernardo Kleiner, Senior Program Officer and Transportation Safety Specialist with TRB. One of the meetings that we have arranged for Mr. Kleiner is an informal TRB 101/Committee Discussion in which he and a few UDOT personnel currently serving on TRB committees will share their knowledge and experience on the *how* and *why* of getting involved with TRB committees. This one-hour session will be held Nov. 16 at 8:30 A.M. in the 1st Floor John Njord Conference Room at the UDOT Complex. All are welcome to attend and ask questions. For more information or to arrange video conferencing for UDOT regional offices, contact Joni DeMille at jdemille@utah.gov.

RESEARCH FUNDING OPPORTUNITIES (click to see full document)

NCHRP FY 2018 Problem Statements, DUE on October 14, 2016
2017 US Domestic Scan Program Topic Proposals, DUE on October 15, 2016

WEBINARS (click to see details)

Title	Day/Date	Time
Selection of Alternative Quality Management Systems for Highway Construction (TRB)	Wednesday, Oct 12	12:00 PM -1:30 PM
ActiveTrans Priority Tool: A Model Methodology for Prioritizing Pedestrian and Bicycle Improvements on Existing Roads (TRB)	Monday, Oct 17	12:00 PM – 1:30 PM
Performance of Geosynthetic Reinforced Soil Integrated Bridge Systems (TRB)	Monday, Oct 24	12:00 PM – 1:30 PM
Improving Rear Seat Passenger Safety: Challenges and Strategies (TRB)	Thursday, Oct 27	12:00 PM – 2:00 PM
Using Electrical Resistivity for Geotechnical Applications (TRB)	Monday, Oct 31	12:00 PM – 1:30 PM
Using Interferometric Synthetic Aperture Radar for Network-Wide Transportation Infrastructure Monitoring (TRB)	Monday, Nov 7	12:00 PM – 1:30 PM
How to Survive and Thrive at the TRB Annual Meeting (TRB)	Wednesday, Nov 16	11:00 AM – 12:00 PM
Safety on Low Volume Roads (TRB)	Tuesday, Nov 29	11:00 AM – 12:30 PM
Roller-Compacted Concrete: Recent Research and Development (TRB)	Wednesday, Nov 30	12:00 PM – 1:30 PM
NON-ENGINEERING WEBINARS		
Developing Good Leadership Habits Early (Instead of Trying to Fix Them Later)	On Demand	On Demand
Mastering the Five Skills of Disruptive Innovators	On Demand	On Demand
Stress in the Workplace: Using Mind over Matter to Become a Star Performer	On Demand	On Demand