

A Newsletter by the Arkansas Department of Transportation



## Pile Driving Monitor (PDM)

BY JOSEPH JABO, PH.D.

The ARDOT Research Section purchased a Pile Driving Monitor (PDM) to be utilized in LRFD study and support the development of cost effective QA/QC for pile foundations. This PDM device is also intended to be utilized in the development of Special Provisions to allow the use of the Modified Gates formula as an End of Drive (EOD) dynamic formula determination of pile capacity in conformance with LRFD design of foundations.

The PDM is wirelessly controlled by software on a tablet PC. To monitor piling jobs in real time and predict pile capacity, the PDM is placed on the ground generally 5 m to 15 m from the pile

being driven. The aim is to monitor only the final section of driving (relevant for pile sign-off). A disposable 3M reflector is placed on the pile and the PDM measures the position of the reflector (and hence pile) 4000 times per second and to an accuracy of better than  $\pm 0.1$  mm. This allows the measurement of pile set, temporary compression, and maximum pile movement during pile installation. PDM recording of the piling measurements is achieved using optically safe infrared lasers while protecting the health and safety of site personnel who otherwise would be using traditional set card measurement

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## Investigating the Use of GPS Data Collection for Maintenance Operations

BY CHRIS DAILEY, P.E.

Asset collection is one of the essential requirements of a maintenance management system. TRC1307 – Investigating the Use of GPS Data Collection for Maintenance Operations was created in 2012 to study ways to obtain locations of roadway assets as well as locations of maintenance activities to be included in a Geographic Information System (GIS) platform. Locations for these assets and activities have long been determined using the County, Route, Section, and Log Mile identification system. Initially this project involved testing Dell Latitude tablets with in-house developed asset collection software.

In late 2015, with the development of new commercially available data collection software, availability of new GPS-enabled tablets, and the Maintenance Division's renewed emphasis on a Maintenance Management System; the scope of the project was modified. In 2016, the Panasonic FZ-G1, Getac F110, and Samsung Tab S2 were selected for purchase and further investigation, following a field evaluation of six different tablets. Both the Panasonic and Getac tablets utilize a Windows 10 operating system and provide field personnel the functionality of Kronos as well as internet access. The Samsung Tab S2s operate on an Android based system. All three of the tablet types make use of ESRI's ArcGIS Collector software for data collection.

Currently, the Getac and Panasonic tablets are being evaluated by a few of the state-wide maintenance crews. The tablets allow the field crews to collect a geo-referenced accounting

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## Spotlight On T<sup>2</sup>

Does a sign or a painted line "control" a driver? Of course not, but signs and markings should certainly provide consistent guidance for drivers. The T<sup>2</sup> program is now offering a new course entitled "Guide for Traffic Signs, Markings, and Signals." This class provides training on the latest requirements of the *Manual on Uniform Traffic Control Devices*

### NEW T<sup>2</sup> COURSE – GUIDE FOR TRAFFIC SIGNS, MARKINGS, AND SIGNALS

BY STACY WILLIAMS PH.D., P.E.

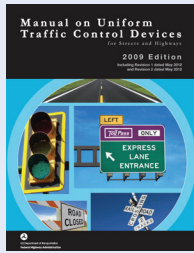
(MUTCD), which is the national standard governing traffic control devices. It also plays a critical role in improving the safety and mobility of road users. This information is important for making sure that local agencies are informed regarding proper usage of traffic control devices, and are aware of current issues relating to signs, markings, and signals. *Continued on page 2*

## SPOTLIGHT ON T<sup>2</sup>

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The MUTCD addresses standards relating to traffic control devices, including low-volume roads, school areas, and work zones. By following these standards, drivers are much more likely to successfully navigate unfamiliar areas, and to properly interpret instructions. Specific characteristics of signs, such as color and shape, have special meaning, and improper usage can create confusion. Correct installation of signs (height, location, advance distance, clear distance) is also important for safety reasons. The color, placement and dimensions of pavement markings are also necessary for clearly communicating driver expectations. Work zones are another focal point of the course, noting common errors and associated risks of incorrectly designed work zones.

The pilot offering of this course was held in November 2016, with several local agencies participating not only as students, but also as advisors in determining whether the course content was appropriate. Since that time, three courses have been offered in central Arkansas, and additional courses are slated for the Fayetteville and Jonesboro areas. During the course, participants work in groups to design a temporary work zone with proper signage and delineation. Responses have been extremely favorable, due to the emphasis on local agency needs. ❄️

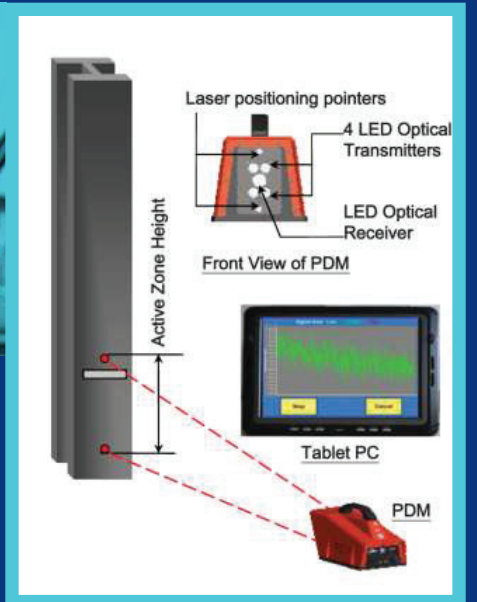


### PILE DRIVING MONITOR (PDM)

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and working in close proximity to piling hammers that present significant safety risks, such as high noise, falling debris from hammers, lead or spalling concrete from the pile head.

Testing each and every pile on job site is accompanied by the use of high resistance factor, which leads to more reliable and cost effective bridge foundation. However, current practice for pile acceptance is generally characterized by a 'tick-the-box' approach whereas what is needed is an integrated whole system approach to ensure that every pile on a site – whether tested or not – meets the design requirements. Pile Driving Analyzer® (PDA) is a tremendous technology, but its greatest limitation is that it is not practical to apply this test to every pile on the site due to its installation requirements. The common practice is to rely on simple methods (e.g. measurement of blow count) to assess the untested piles which may be 90% or more of the foundation piles. When PDM is used in tandem with PDA to test representative test piles or a small percentage of production piles, the PDM can then provide an estimation of imparted energy for piles monitored



with only the PDM by comparing real time velocity measurements against a reference PDA Wave Up. Subsequently, the PDM can be utilized to provide real-time pile capacity evaluation during driving or on restrrike for each and every pile installed.

The Research Section will expand its PDM research by investigating the PDM use for continuous blow count recording for entire pile drive, for pile integrity screening, for monitoring pile driving situations where excessive lateral movement of the pile or excessive ground vibrations are encountered. Apart from monitoring pile installation, the PDM system will be utilized as a structural monitoring tool to assess the effect of dynamic loads on foundations, such as general traffic or test vehicles on bridge structures. ❄️



### INVESTIGATING THE USE OF GPS DATA COLLECTION FOR MAINTENANCE OPERATIONS

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of the maintenance activity performed (similar to Motorola Passport devices) as well as additional attributes of work performed such as type of material used, amount of material used, and equipment used. The Samsung Tab S2s are being used by District 3 as well as Maintenance Division staff to collect culvert assets data. As of January 2018, over 7,000 culvert locations have been collected by four crews of two people each in Districts 3 and 6.

Following the evaluation period, a determination will be made if these tablets will be purchased for the remaining nine Districts for implementation of the new Maintenance Management System. ❄️





# Recent Research on the Seismic Design of Bridges in Northeast Arkansas

BY CLINT WOOD, PH.D., P.E. AND JOSEPH JABO, PH.D.

**N**ortheast (NE) Arkansas is located in the heart of the New Madrid Seismic Zone, an area of the US that has some of the highest design ground motions in the nation. NE Arkansas is also located inside the Mississippi Embayment (ME), a geologic unit characterized by very deep sedimentary deposits. These two characteristics significantly increase the seismic design costs of bridges, approach embankments, and deep foundations in NE Arkansas. To more accurately estimate the seismic design forces that bridges in NE Arkansas will have to resist, ArDOT commissioned the research project TRC 1603: Deep Shear Wave Velocity Profiling in North-Eastern Arkansas.

As part of the project, active and passive surface wave testing was conducted at 15 bridge projects throughout NE Arkansas. At each site, shear velocity profiles (soil stiffness with depth) were developed to bedrock, which is over 3,500 feet below the surface in some locations. These shear wave velocity profiles represent a significant advancement in the understanding of the dynamic structure of the Mississippi Embayment.

To demonstrate the benefit of this project, a case study was conducted at a newly designed and built bridge in Monette, AR. This bridge is a seven span, four lane bridge that stretches 330 feet across Cockle Burr Slough along Arkansas Highway 18. The site specific ground motion response analyses (SSGMRA) conducted at the site indicated that the 2,200 feet of soil below the site would attenuate the short period seismic waves that affect the bridge. This resulted in a reduction in the seismic demand for the piles, restraining blocks, and approach embankments for the bridge compared to the simplified procedure. These bridge components were then redesigned based on the reduced seismic demand. Potential cost-savings associated with conducting the SSGMRA were estimated based on a reduction in bid item quantities and the savings calculated based on the as bid unit prices. The results indicate that a



gross cost savings of \$205,000 or 7% of the total bridge project cost would be possible for this bridge because of the reduced seismic demand.

Overall, the project has developed the tools and assembled information necessary for conducting SSGMRA at bridge sites in NE Arkansas and demonstrated the dramatic cost savings potential associated with conducting SSGMRA for future bridge projects. The implementation of this research could lead to millions of dollars in savings for ArDOT and Arkansas taxpayers, while maintaining the necessary level of safety for bridges in NE Arkansas. For more information on the project, please visit the Principal Investigator's website at <https://sites.google.com/site/clintonmwood/home>.

This research would not have been possible without the hard work from graduate students Michael Deschenes, Ethan Baker, and Ashraf Himel. Special thanks also goes out to Steve Peyton, Courtney Rome, Paul Tinsley, Matt Green, and many others at ArDOT. Their advice and assistance was instrumental in the success of the project. ❄️

## CURRENT RESEARCH HIGHLIGHTS

### TRC1901

Previous ArDOT research projects indicated that seismic demands can be reduced in portions of Arkansas by conducting a site-specific ground motion response analysis (SSGMRA). This is expected to have economic benefits regarding the construction of bridges. Variables that influence the seismic design (i.e. distance from the fault, seismic design category, soil conditions, liquefaction analysis, embankment requirements, etc.) vary across the state so the locations and conditions where cost savings from SSGMRA can be realized is unknown and needs to be determined to provide the most economic benefit for bridge design and prevent conducting SSGMRA when economic benefits would not be likely. This project will conduct a spatial sensitivity analysis to fully understand where and under what site specific conditions a SSGMRA would be economically beneficial for bridge design. ❄️

### TRC1902

The overall performance of concrete in bridge decks can be affected by current curing regimens. TRC1902 will explore the technology external sensors that will be incorporated into concrete bridge deck pours. The objective of this project is aiming to investigate the use of an external Capillary Pressure Sensor System (CPSS) to monitor capillary pressure development in the surface of fresh concrete bridge decks. The potential outcomes utilizing the CPSS would provide contractors information to determine which curing products and/or methods works best. ArDOT currently allows the use of lithium cure under special provision when requested by the contractor. Knowing when additional curing compounds and/or moisture can be added to reduce or mitigate the effects of evaporation could be a cost/benefit to the Department. ❄️

# Product Evaluation — Rumble Strips vs. Mumble Strips

BY BENTLEY REYNOLDS

Anyone who has driven along highways in Arkansas has at one time drifted slightly across the pavement markings. Did you feel the vibration and hear that loud rumble? It probably made you a little more alert and aware of your surroundings and that's the idea behind rumble strips.

Shoulder rumble strips have been proven to have significant benefits in preventing roadway departure crashes and centerline rumble strips can prevent head on crashes. Both of these safety measures do have their critics as residents living near them say the noise produced is a nuisance. Several states have begun looking at ways to reduce the noise

level produced by changing the width, depth, and scallop distance of rumble strips without sacrificing the safety aspects. The outcome of this research has produced what researchers now call mumble strips.

Minnesota recently completed two studies looking at the difference in noise levels produced by rumble strips and mumble strips. MnDOT concluded that sinusoidal strips produce effective interior noise to alert drivers while lowering external noise to the environment compared to traditional rumble strip design. MnDOT analyzed multiple mumble strip design modifications to find which strip maximized driver safety while producing the least amount of external sound.



The Research Section of ArDOT is expounding on MnDOT's research by analyzing sound profiles at 0, 75, and 150 feet from the roadway surface. These distances are a better reflection of the average distance of homes along our highways. ArDOT is also analyzing pre and post mumble strip installation sound profiles on a site specific basis, to determine how effective the new strips compare to current roadway safety measures. ArDOT has begun installing these new mumble strips at several locations across the State. We expect our findings to confirm what MnDOT has concluded and to assist in determining which design is best for the state of Arkansas. We anticipate that this product evaluation will help improve safety on our highways while lowering noise pollution to the public. ❌



## 2018 Transportation Engineering Conference

ArDOT'S 106TH TRC TRANSPORTATION ENGINEERING CONFERENCE was held May 15-17, 2018 at the Hot Springs Convention Center. The conference included workshops, break-out sessions, roundtable discussions, and an exhibit hall; as well as the usual highly informative presentations on everything from the research, design, operation, planning, and safety of Arkansas highways.

ArDOT's 108th TRC Transportation Engineering Conference will be held June 4-7, 2019. Additional information will be available online at <http://ardot.gov/TRC/trc.aspx>. ❌



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