Delaware T²/LTAP

INFO-CHANGE

Volume XXV, Issue 11 Fall/Winter 2014

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Message from the Director - Earl "Rusty" Lee, Ph.D.

As we enter this busy holiday season, I ask everyone to try to slow down the holiday hustle and bustle. Be a little more tolerant in traffic. Give yourself that few extra minutes to get somewhere. Exercise caution on the roads and sidewalks when winter weather arrives. And please make sure that holiday party isn't a night you regret, ending with an alcohol-related accident or fatality.

This has been another great year for the Delaware T²/LTAP Center. I would like to take this opportunity to thank our partners – the Delaware Department of Transportation and the DelMar Division Office of the Federal Highway Administration. They not only provide the Center with the financial resources we need to operate, but with their time, experience and energy.

I would like to thank all those who attend our training sessions/workshops. No matter if the topic was winter maintenance, MUTCD, ADA, etc., we hope those hours were valuable to you. As you think of training needs, please contact the Center and we will see what we can do to support you.

I would like to thank our student interns who have provided great services to the local agencies. Students have been working with public works agencies in Newark, New Castle, and nearby Cecil County on asset management programs for signs and pedestrian access. I have been fortunate to attend meetings when they are reporting project status to the agency managers and I am always impressed by their professionalism and outstanding work.

I am most thankful for the great people I get to work with each day. Our technical expert, Matt Carter, who puts together so much of the training we do. Our event coordinator Sandi Wolfe, who schedules all the venues and takes care of the advertising of events and registrations for them. Ellen Pletz, who manages all the Center's finances and makes sure everything and everyone gets paid. And the director of DCT, Dr. Arde Faghri, who oversees the program and takes care of all the details and issues that come with directing a Center.

Self-Evaluation Under the ADA

Have you completed your self-evaluation for ADA? The Americans with Disabilities Act (ADA), through its Title II enabling regulations, requires that public entities complete a self-evaluation of its services, policies, and practices to identify elements that do not comply with ADA and initiate a program to correct deficiencies. This, of course, includes any buildings, pedestrian pathways, sidewalks, crosswalks, etc.. For entities with 50 or more employees, a transition plan is required to set forth the steps necessary to complete such remedies. Transition plans must (pursuant to 28 CFR Part 35 Sec. 35.150):

- Identify physical obstacles in the public entity's facilities that limit the accessibility of its programs or activities to individuals with disabilities;
- Describe in detail the methods that will be used to make the facilities accessible;
- Specify the schedule for taking the steps necessary to achieve compliance with this section and, if the time period of the transition plan is longer than one year, identify steps that will be taken during each year of the transition period; and
- Indicate the official responsible for implementation of the plan.

With the 25-year anniversary of ADA approaching, it is essential for agencies that have not completed or updated a self-evaluation (and where required, a Transition Plan) begin doing so immediately.

If you need help getting started, contact Matt Carter, our Municipal Engineering Circuit Rider, at (302) 831-7236 or matheu@udel.edu.

Ethics Training for DAPE Requirements

"Ethics training always seems to be a challenge but it is needed using the nature of the complaints received by DAPE as a gauge."

- Hans M. Medlarz, P.E., President, Delaware Association of Professional Engineers

As most know by now, the Delaware Association of Professional Engineers (DAPE) has instituted Continued Professional Competency (CPC) requirements for the 2016 renewal cycle. Twenty four professional development hours (PDH) must be earned during each two year renewal period and at least 3 PDHs must be related to engineering ethics.

At the request of DelDOT, the Delaware T^2/LTAP Center contracted with Jim Johnson (EA Engineering, Science, and Technology) to develop and teach a 3-hour ethics course to satisfy the requirement, using relevant Delaware ethics cases as a basis.

The course has been taught several times at DelDOT and has been well received. It will now be offered to private sector professional engineers on a fee basis that will cover the cost of the instructor.

Currently, four sessions are being planned for January and February 2015, with one each in Sussex and Kent County and two in New Castle County.

Locations and dates will be announced soon on our website and we will also attempt outreach through engineering professional organizations.

Distributed Power Safety

"The electrical distribution system was originally designed for one-way flow of energy - from the utility sources, down the distribution line and to the customer. The design of its protection was implemented with this paradigm in mind."

- Mitch Bradt, P.E., Program Director with the Department of Engineering Professional Development at the University of Wisconsin-Madison

Several Delaware municipalities have standalone electric utility operations and must deal with the same safety issues faced by large regional utilities. Recently, needs were raised regarding the identification and safeguards available when employees must work on these lines. Specifically, the concern centers on the sharp increase of interconnected distributed power sources, such as solar panels, wind turbines, and home or commercial backup generators. These distributed sources can push electricity out onto the grid in the opposite direction that the lines were originally intended for and all such interconnects should have a transfer switch (automatic or manual), the electric utility does not always know where all these sources are, nor can they be sure that all power sources are locked out before they operate on the lines.

We posed the question to our national forum and received the following from a fellow LTAP/T^2 Center. Mitch Bradt, P.E., Program Director with the Department of Engineering Professional Development at the University of Wisconsin-Madison provided some advice and insight.

Mitch said that, "while the interconnection of distributed resources can be a good thing for limiting peak loads on the grid, providing backup for critical systems (think hospital or data center), and allowing for the local generation of renewable resources, done incorrectly, a distributed resource can be dangerous to the property owners, their neighbors and utility crews. The electrical distribution system was originally designed for one-way flow of energy - from the utility sources, down the distribution line and to the customer. The design of its protection was implemented with this paradigm in mind."

He continued, saying, "with the wide implementation of distributed resources begs a new look at the operation and protection of the utility system and the property owners' lines and generation asset. With that in mind, utilities have created policies or rules for interconnection in order to prevent undue loading of distribution lines (i.e. sending too much current on small wires) and especially to prevent back feeding of power to the grid when the utility crews have locked out the system from the sources they know about. This is usually implemented with the requirement for a transfer switch that can manually or automatically disconnect the distributed generator. It could be set up, as with a backup generator, that when the grid power goes down, the line from the grid is cut to the property's main panel, the generator fires up, and the power from the generator is switched into the panel - notably, the generator and panel have no connection to the grid. When the grid comes back, the transfer switch can reverse its operation, break power from the generator, and reconnect the grid to the panel.

"In the case of a renewable resource that is in-

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When Do Curb Ramps Require Upgrade?

DOJ/DOT have clarified ADA alterations triggers.

Enforcement of the Americans with Disabilities Act within the public right of way rests with the U.S. Department of Justice (DOJ). DOJ delegated responsibility for implementation to the U.S. Department of Transportation (DOT) for those programs and services involving transportation. As such DOJ and DOT have joint enforcement authority within the public right of way.

Case law (particularly Kinney v. Yerusalim, 9 F 3d 1067 (3rd Cir. 1993)) and DOJ regulations (28 CFR 35.151(b)) define alteration as a change that affects or could affect the usability of all or part of a facility (which in our case is a roadway and the associated sidewalks, crosswalks, and so on). The regulations go on to tell us that altered streets must contain curb ramps where there are curbs or other barriers to a pedestrian walkway. However, the regulations do not identify specific road treatments that qualify as alterations versus treatments that that are simply maintenance.

Until the summer of 2013, the only guidance we had from DOJ was that paving, repaving, or resurfacing were generally considered alterations and filling potholes was not considered to be an alteration; that left a lot of room for interpolation between. DOT attempted some guidance in 2006, but it still left many questions and led to some confusion and inconsistency with DOJ's enforcement.

Assistance came by way of a Joint DOJ/DOT Technical Assistance document. The summary below captures the more common surfacing, resurfacing, pavement preservation, and maintenance techniques in use and categorizes them as either alteration or maintenance. Simply put, if the alteration techniques are employed, curb ramps must be upgraded.

While the document created a flurry of debate in the transportation community as to where the line was drawn (the People's Choice Award went to, "but microsurfacing and chip seal are almost the same thing!"), the DOJ had originally considered, effectively, that pothole patching was maintenance and just about everything else was an alteration. Hence, DOJ considers this a significant compromise from its vantage point.

The bottom line is this - it's time to "ramp up" our ADA compliance. Road agencies are strongly encouraged to read the two documents referenced above and modify pavement management strategies (and project budgets) accordingly. For further questions, contact Matt Carter at the Delaware T^2/LTAP Center at matheu@udel.edu.

Find the Joint DOJ/DOT Technical Assistance document at:

http://www.fhwa.dot.gov/civilrights/programs/doj_fhwa_ta.cfm

and a glossary of terms can be found at

http://www.ada.gov/doj-fhwa-ta-glossary.pdf.

See a short video on ADA resurfacing requirements using the QR Code below or at: http://www.fhwa.dot.gov/federal-aidessentials/catmod.cfm?id=107

Sign Retroreflectivity - Did You Meet the Deadline?

"Compliance with the Standard... is achieved by having a method in place and using the method to maintain the minimum levels established in Table 2A-3. Provided that an assessment or management method is being used, an agency or official having jurisdiction would be in compliance with the Standard... even if there are some individual signs that do not meet the minimum retroreflectivity levels at a particular point in time."

- MUTCD Part 2.08 ¶03

The Delaware Manual on Uniform Traffic Control Devices (MUTCD) required that by July 10, 2013 all agencies that own and/or maintain roadways open to the public must implement and continue, "use of an assessment or management method that is designed to maintain regulatory and warning sign retroreflectivity at or above the established minimum levels" (in Table 2A-3).

By observation, it would appear that many Delaware municipalities and other agencies have significantly upgraded their sign retroreflectivity, but the protections of the support statement shown in the sidebar will be more readily available if you have some form of, albeit simple, contemporaneous documentation in your files that detail how you have chosen to comply with the standard and your methods of inspection.

There is no prescribed format for such a document and it needn't be lengthy. It might be a simple memorandum to file, but it could mean all the difference in unfortunate situations where attorneys get involved.

Even if you believe you are well-positioned for compliance, this is a good time to verify that you've documented your program and your activities towards compliance.

If you have questions about retroreflectivity or other sign requirements, contact Matt Carter, our Municipal Engineering Circuit Rider, at matheu@udel.edu or (302) 831-7236.

The Delaware MUTCD can be found at www.mutcd.deldot.gov.

New Crack Sealing Best Practices Document

"Crack filling and sealing is our first line of defense in roadway maintenance. Crack sealing should be done within 2 years after an asphalt overlay. At a time when highway crew manpower is shrinking, along with the funds to support road maintenance, crack sealing stands out as an economical maintenance technique."

— Nebraska Department of Roads Pavement Maintenance Manual

The Transportation Research Board released a new report on crack sealing that is free, easy to read, and relevant to every agency that owns and maintains improved roadways: NCHRP Report 784, "Best Practices for Crack Treatments and Asphalt Pavements."

The report discusses in three successive chapters the State of the Art, the State of the Practice, and then Best Practices, using the same structure in each chapter (general issues, contracting procedures, contracting, materials, construction, quality control, and performance).

We all know that water is the enemy of pavements, since it weakens underlying support soils and can foster structural failures, and that sealing and filling cracks is the most cost-effective pavement preservation technique, when applied to the right pavement at the right time. This report, in relatively plain, simple language, goes on to illustrate that how crack sealing/filling is done is just as essential as picking the right time in the pavement's life.

Once a decision is made to address cracks in a pavement, a fundamental choice is whether crack sealing or crack filling is appropriate, which drives the selection of materials used. To begin, determine if your cracks are "working cracks." Unless you have the luxury to study your pavement cracks regularly throughout the year, this is a judgment call based on whether you believe the cracks are moving as a result of expansion and contraction at least ⅛" throughout the year, a generally accepted definition of a working crack. Oftentimes, transverse cracks are working cracks (since environmental expansion and contraction is the dominant distress mechanism) whereas longitudinal cracks are not. However, there is no clear cut rule and one rarely has all working cracks or no working cracks; hence, you make an overall judgment as to whether working cracks dominate. Indeed, the report acknowledges that many road agencies do not differentiate.

Why differentiate, then? Simply put, because the materials and preparation ideally used for crack filling (i.e., non-working cracks) are less expensive. Crack sealing (working cracks) requires more thorough crack preparation and the use of specialized, high-quality materials to prevent the intrusion of water and incompressi-

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The Proper Installation of Steel Road Plates

By Richard M. Balgowan, P.E., P.P., CPWM, CPM, PWLF, Highway & Municipal Engineer, Robson Forensic Inc., Hamilton, New Jersey. Member, APWA Engineering and Technology Committee .

[This article was originally printed in in the APWA Reporter, June 2014 issue; reprinted with permission.]

Steel plates can create differences in surface elevation and can be slippery. They can be especially hazardous to motorcycles, bicycles and pedestrians. The transportation and construction industries are well aware of the hazards associated with the use of steel plates in roadway projects. Their use allows roadways to remain open during construction periods effectively increasing the utilization of roadways.

To improve safety, there are a number of standards and industry documents guiding the usage of steel plates in construction work zones that should be followed. The following describes the proper installation of steel road plates:

Attaching steel plates to the road surface

Steel plates must be fixed in place to avoid movement. If they are not firmly in contact with the pavement, they can rock and displace, exposing the hazard for which they were protecting motorists and pedestrians, and become a hazard themselves. In addition to being firmly in contact with the pavement, they should be either pinned or recessed into the pavement. Pinning into the pavement involves driving pins into the pavements along the edges of the steel plates to prevent movement. Recessing involves cutting out the area where the steel plate will be placed. If a one-inch steel plate is used, the cutout will be one inch deep. This results in the steel plate being flush with the pavement. In addition, when multiple steel plates are used and butt up to each other, they should be welded together at the longitudinal seams.

Skid resistance

Steel plates can be very slippery, especially when wet, unless they have an anti-skid coating applied. Some plates can be purchased with the anti-skid coating already applied while others will require that the user apply the anti-skid coating. The anti-skid coating can be painted on or applied using an adhesive and abrasive sheeting. Covering steel plates with a material that increases friction particularly helps motorcyclists and bicyclists retain control, especially in wet weather.

Tapered Ramps

A common hazard in steel plate installations occurs when the user fails to construct properly tapered ramps from the roadway to the raised edges of the steel plate(s). If one-inch steel plates are placed on top of a roadway surface, it creates a sharp edged elevation change of at least one inch from the pavement to the top of the steel plate. Many of the steel plate installations I have observed over the years have ramps that are short and abrupt. Ramps/tapers of ten to fifteen inches are common for steel plates laid on top of the pavement. If a taper is abrupt and steep, it will be a hazard to motorists and pedestrians. It poses a significant hazard to motorcyclists and bicyclists who can lose control when they contact the abrupt/steep tapered ramp and the steel plate.

Properly tapered ramps allow users to safely cross over the steel plates. Tapers for steel plates are normally constructed of asphalt. The taper lengths vary from state to state and generally range from 20 to 1 to 120 to 1. The U.S. Department of Transportation's Federal Highway Administration (FHWA) requires that transverse pavement joints, which result in a bump, must be tapered at 60 to 1 (five feet horizontal for every one inch of vertical elevation difference). 120:1 seems way too long and

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The Proper Installation of Steel Road Plates (cont'd)

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impractical to construct.

The following are guidelines for proper plate installation:

- Select the correct size.
- Ensure an adequate overlap. Normally, steel plates must extend at least one foot beyond the pavement opening onto firm ground.
- Edges must be properly secured and feathered with asphalt.
- Welding is done when more than one steel plate is used and they butt up to each other.
- Plates must be countersunk when necessary due to uneven roadways. What makes it necessary?
- Plates should be coated with an anti-skid coating.
- The edges of steel plates should be marked/painted to improve visibility.
- Proper advance warning signs should be used. For example, "Steel Plate Ahead," "Bump."
- Roadway and trench wall conditions must be constantly reevaluated throughout the day to ensure safety.
- The proper authorities should be notified of plate locations in the winter.
- End-of-the-day inspections must be made before leaving the job.

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New Crack Sealing Best Practices Document (cont'd)

"Cracks happen. Cracks move. Cracks grow. Cracks get worse. Cracks accelerate pavement deterioration."

— Jim Chehovits, 2012 National Pavement Preservation Conference

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ble materials, whereas crack filling typically involves less crack preparation and the material performance requirements can be lower. However, the NCHRP report summarizes input from Departments of Transportation (DOTs) across the country and concluded that while crack sealing can perform for 5-10 years, crack filling has an expected performance of 1-4 years. All of this helps shape the work that is specified and the discussion above should illustrate that some thought should go into what exactly is being contracted.

The report goes on to discuss the various aspects of material choices, crack preparation, material placement, inspection, and other factors in an easy to understand format. The Best Practices section finds a middle ground between the ideal State of the Art and the practical realities of many agencies in practice.

NCHRP Report 784 is available as a free download from the National Cooperative Highway Research Program at http://www.trb.org/Main/Blurbs/171266.aspx. Winter is upon us and this is a great document to curl up next to the fire with. Seriously, it's an easy read and has some very practical insight for implementing one of the cheapest forms of pavement preservations there is. If you own and maintain asphalt pavements, the new NCHRP Report 784 is worth a read.

Finally, while crack sealing and filling is an economical pavement preservation method, it also presents safety risks for anyone performing or inspecting it. Please ensure that everyone involved has proper personal protective gear and are properly trained for the parts they play in the operation.

Road Science: Down to Earth

Geosynthetics of all types speed construction allowing bridges, highways to be built faster and enhance pavement performance.

By Tom Kuennen, Contributing Editor, Better Roads Magazine [reprinted with permission from Better Roads Magazine, May 2014 issue]

Geosynthetics comprise a family of value-added products that allows bridges, highways and roads to be built faster, cheaper and to last longer.

Some geosynthetics enhance pavement longevity by separating good materials from bad, while others promote water flow from pavement structures as they facilitate drainage.

While most geosynthetics are planar or sheet-like in format, 3D geogrids add structural strength to a road section, permitting reduced depths of aggregate bases and bituminous lifts.

Family of geosynthetics

ASTM (2006) D 4439 defines a geosynthetic as a "planar product manufactured from a polymeric material used with soil, rock, earth or other geotechnical-related material as an integral part of a civil engineering project, structure or system."

"Geosynthetics are man-made polymeric materials used for geotechnical application," says the California Department of Transportation (Caltrans) in its *Caltrans Geotechnical Manual*. "They are used in lieu of conventional materials and often are more cost effective with equal or improved engineering performance."

"Geosynthetics are materials that are incorporated into layers of rock or soil that can provide stabilization as well as separation of good material from lesser material," says Aaron Schlessinger, E.I.T., southwest region manager for Tensar International Corp. "Still, others enhance drainage."

There are four different types of geosynthetics:

- **Geotextiles** are either woven or nonwoven and used in civil engineering projects. Their mission is to prevent soils from migrating into drainage aggregate bases or pipes, while maintaining water flow through the system. They are used for filtration, drainage, separation, reinforcement and as a fluid barrier. A subset of geotextiles is paving fabrics used between pavement lifts.
- **Geogrids** are formed by a network of tensile elements with openings of sufficient size to allow interlock with the surrounding fill materials. They provide reinforcement or stabilization, with geogrids oriented such that their principal strength is in one direction (uniaxial), both directions (biaxial geogrids) or in three directions (triaxial).
- **Geocomposites** are a combination of two or more geo- synthetic materials, such as geotextiles with a core, and are used to enhance drainage, for example as prefabricated longitudinal edge drains or a layer feeding those drains.
- **Geomembranes** are a single, solid sheet of polymeric material, used in construction as an impermeable barrier.

Use of a geosynthetic for separation prevents intermixing between two adjacent dissimilar materials, so the integrity of materials on both sides of the geosynthetic remains intact, according to Caltrans. This keeps weak subgrade soils from pumping through overlying fill or prevents contamination of select fill by intrusion into the subgrade. "This may allow stable construction over soils that may otherwise require expensive ground improvement technologies," Caltrans says.

Geosynthetics can add value to the construction sequence by saving material costs associated with working surfaces, ex- pediting construction schedules and providing a permanent working surface that yields a smooth riding surface, Tensar says. Their added cost, though, must be balanced by savings in material and labor, along with long-term benefits in increased pavement durability. Finding the right combination is the challenge of the civil engineer.

Geotextiles separate layers

Whether woven or nonwoven, the "planar" geotextile (vs. 2D or 3D geogrid) must allow migration of water while keeping dissimilar materials apart. They perform according to their apparent opening size (AOS), which must be smaller than the smallest size particle to be retained, and still allow for the flow of water through the geotextile material.

Geotextiles (woven and nonwoven) are used as separators and filters to prevent soils from migrating into drainage aggregate, granular bases or pipes, while maintaining water flow through the system, ac-

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For additional information on geosynthetics, visit betterroads.com/down-to-earth for a web extra on "Geocomposites for Drainage."

Road Science: Down to Earth (cont'd)

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cording to the Iowa DOT.

"Geotextiles are also used below riprap and other armor materials to prevent erosion of the soils from the stream bank," Iowa DOT says. "The geotextile should be selected to prevent the migration of fines based on the AOS criteria. In addition, geogrids may also be used as a separator to prevent the migration of granular materials (aggregate) into fine- grained, soft subgrade soils. However, this application will not prevent the migration of fines from the subgrade soil into the aggregate."

Even as separators, nonwoven needle-punched geotextiles and geocomposites provide drainage by allowing water to drain from or through low-permeability soils.

Paving fabrics, warm-mix asphalt

Geosynthetics are used within asphalt pavement structures as well as below them. "Geosynthetic pavement interlayers [also called paving fabrics] provide numerous benefits to a pavement system," say Bradley J. Putman and William P. Bolger, Clemson University, in their 2014 Transportation Research Board paper, *Laboratory Investigation of the Effect of Compaction Temperature on Geosynthetic Pavement Interlayers Made with Warm Mix Asphalt Overlays.* When used properly, these interlayers can prevent water from infiltrating a roadway base and also assist in absorbing pavement stresses, which then extends the life of a pavement. "Geosynthetic pavement interlayers lead to an increase in the performance of a pavement overlay by retarding fatigue and reflective cracking," Putman and Bolger say.

Fabric applied in conjunction with chip seal to minimize reflective cracking, Chesapeake City, Maryland.

Typically, the most common geosynthetic interlayer system consists of the existing base pavement, tack coat, nonwoven geotextile paving fabric and an asphalt overlay.

One of the most important factors affecting the performance of geosynthetic interlayers is the bond that is established between the old pavement and the new overlay, they say.

"This interfacial bond is directly affected by the type and amount of tack coat," Putnam and Bolger write. "Paving fabric interlayer systems are typically constructed beneath hot-mix-asphalt overlays having a minimum thickness of 1-1/2 inch to ensure enough heat to draw the asphalt tack coat up into the paving fabric."

It's generally recommended the overlay temperature does not exceed 325 degrees Fahrenheit to prevent thermal damage to the paving fabric, the authors say, adding it's also recommended the overlay temperature is not below 250 degrees Fahrenheit because lower temperatures may not generate sufficient heat to warm up the tack coat enough to saturate the overlying paving fabric to create a well-bonded interlayer that will be a moisture barrier and provide stress-absorbing benefits.

In view of the increasing use of warm-mix asphalt, which may not reach those temperatures, Putnam and Bolger evaluated the feasibility of using paving fabric interlayers with the lower compaction temperatures encountered with WMA overlays. Using Petromat 4598, they studied paving fabric interlayers made with four different tack coat binder grades and asphalt overlays ranging from 200 to 300 degrees Fahrenheit using a melt-through test and an interlayer shear strength test to determine the minimum WMA overlay compaction temperature to ensure the interlayer system will perform properly.

"The results indicated that the saturation of the paving fabric in an interlayer system is dependent on multiple factors: temperature of the overlay, compaction effort used to compact the overlay and the grade of binder used for the tack coat," they conclude. "It's recommended that the compaction temperature of an asphalt overlay be limited to a minimum of 250 degrees Fahrenheit when using conventional interlayer construction practices."

Geogrids reinforce structures

While planar or sheet-like geotextiles provide separation be- tween pavement layers, 2D and 3D geogrids provide stabilization in addition to separation.

Their benefits are such that they not only physically rein- force a weak subgrade, but also can allow reduction in asphalt and aggregate layers above, saving time and money.

"Geogrids stabilize subgrades, providing a construction platform over a soft subgrade," Tensar's Schlessinger says. "But they also facilitate design optimization of pavement sections, where the thicknesses of the structural layers of a pavement section may be minimized, particularly over

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Recent Student Field Trips

Scott Keefer from AECOM leads ASHE@UD students on a tour of the work on the 896 bridge over I-95

UD Students on a tour of DelDOT

Distributed Power Safety (cont'd)

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tended to feed some power to the grid, as with a solar array that is producing power when no one is home and selling the energy back to the grid, the transfer switch is connected in parallel. The property panel, generator (PV array, in this example), and grid are all connected. The fact that this distributed generator is installed and the nature of this construction/operation should be something the utility has data on and should be labeled. When the utility needs to de-energize a line for maintenance or service restoration following a storm, there should be a means for the utility to have control to disconnect the grid connection from the property's generator. This could be a manual switch that is accessible and can be locked-out/tagged-out, or it could be an electronic signal to control the local transfer switch."

Mitch relates one such utility that has had a great deal of experience with interconnection of distributed recourses - San Diego Gas and Electric (Sempra). He points out that the SDG&E website has good information for its customers who want to interconnect, under what it terms "Rule 21." As guidelines, he suggests "Electric Rule 21" (http://www.sdge.com/generation-intercon ... ic-rule-21) and "Electric Rule 21 Resources" http://www.sdge.com/business/electric-rule-21-resources). In this second link, (in the Downloads section, fifth item) they present a sample single line electrical diagram. On the same web page (in the Additional Resources sections, second item), there is a link to the "Distribution Interconnection Handbook."

We thank Mitch for providing some directions to those concerned about distributed energy safety with electrical line work.

Road Science: Down to Earth (cont'd)

Geotextile used between layers of aggregate to form a Geosynthetic Reinforced Soil, Integrated Bridge System (GRS-IBS).

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competent subgrades... Both asphalt and aggregate base layers may be reduced in depth by stabilizing them with a geogrid. Because the geogrid stabilizes the sections, less material is required to achieve a certain performance criteria."

The resulting mechanically stabilized layer is a composite layer of a defined thickness made up of unbound granular materials combined with one or more layers of geogrid. "The combination of the two materials creates an enhanced composite layer that has improved pavement properties and performance," Caltrans says.

Geogrids may be biaxial or triaxial in design. A biaxial geogrid can be a punched-and-drawn polypropylene geogrid with rectangular or square apertures, resembling wire cloth with square openings. A triaxial geogrid has triangular apertures, which allow for greater stability, multi-directional stabilization and ultimately maximum performance efficiency.

"Biaxial geogrids are geosynthetic materials formed into a grid of integrally connected tensile elements," says Caltrans in its October 2012 publication, *Aggregate Base Enhancement with Biaxial Geogrids for Flexible Pavements*. "[They have] apertures of sufficient size to allow 'strike-through' and interlocking with surrounding aggregate base materials. Biaxial geogrid increases the stiffness of unbound aggregate base layers and confines the aggregate particles under repetitive loading."

This begs the question of which geogrid geometry works better in creating a mechanically stabilized layer below: biaxial (square) or triaxial (triangular) "holes."

"The effectiveness of geogrid-aggregate interaction depends on the relative geometry of the geogrid and aggregate," Giroud says. "Square or rectangular apertures can be expected to promote a cubic arrangement of aggregate, which is a loose arrangement that would limit the benefit of interlock- ing. In contrast, triangular apertures can be expected to pro- mote a hexagonal arrangement of aggregate, which is a dense arrangement. Therefore, geogrid-reinforced aggregate bases can be expected to deform less than geotextile-reinforced aggregate bases."

Geogrids cut base costs

That use of a geogrid can save money was affirmed in a critical project in a remote area last summer.

In a fast-paced project last year in the north Arizona mountains east of the Grand Canyon, a geogrid helped cut a nine-month construction period to three months, while saving more than $2 mil- lion in aggregate base (AB) and trucking costs in the remote area.

In the early morning hours of Feb. 20, 2013, a landslide ripped through a section of U.S. 89 along a mountain slope about 25 miles south of Page, buckling more than 150 feet of the roadway and tearing the pavement up in 6-foot-high sections.

The damage forced the Arizona Department of Transportation (AZDOT) to immediately close a 23-mile-long stretch of U.S. 89 and begin work on a temporary detour (U.S. 89T), which follows the route of the existing Navajo N 20, a Navajo Nation road. By paving US 89T, the 115-mile detour route travel time was cut in nearly half and is similar in length to the closed U.S. 89 route.

The $35 million paving project to adopt N20 temporarily into the state highway system was finished only three months by FNF Construction, Tempe, an impressive feat considering the 44-mile-long tribal route was primarily a dirt road before work began in late May. "It was a high-intensity, short-duration project," says Audra Merrick, Flagstaff district engineer at AZDOT.

Placed between the graded sub-base and the aggregate base, approximately 583,000 square yards of Tensar TriAx 130s geogrid saved time and money for the road project. An added structural benefit of the grid was a threefold increase the design life of the road.

"Six days a week, operations would start about 6 a.m. and go all day," says Steve Monroe, senior resident engineer for AZDOT's Flagstaff District. "At 6 p.m., a crew would come in and go to work; this went on 18 to 20 hours each day."

The result was major savings, AZDOT's Monroe says. "The geogrid is much less expensive and easier to put down than hauling all of that additional asphalt base," Monroe says.

Upcoming Events

The T²/LTAP Center is currently planning the following upcoming events. Others will follow. We will announce exact dates, locations, and other information as we finalize details. Monitor our web-site for up to the minute details and registration.

- Training Workshop - Ethics in Engineering (January/February)
  - New Castle County - 2 sessions TBA
  - Kent County - January 30, 2015, UD Paradee Center, Dover, Delaware
  - Sussex County - February 10, 2015, UD Carvel Center, Georgetown, Delaware
- Training Workshop - Designing Pedestrian Facilities for Accessibility - April 2-3, 2015, UD Newark Campus
- OSHA 10-hour training, combined with Preventing Runovers and Backovers - spring 2015.

See our website for further details: http://sites.udel.edu/dct/t2-center.

"Training" Get it?

T²/LTAP Center Request Form

Your feedback and interests help us increase the T²/LTAP Center's effectiveness, so please complete and return this form or email us—all compliments, criticisms, and ideas are welcome!

_____ Please add my name to the T²/LTAP INFO-CHANGE subscription list—subscriptions are free

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_____ Please consider these topics for future training sessions
Topic:
_____
Topic:
_____

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Name:
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Delaware T²/LTAP Center, Delaware Center for Transportation
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Delaware T²/LTAP

Care to contribute an article? Just let us know by filling out this form or emailing us.

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Helping to Bridge your Transportation Gaps

The Local Technical Assistance Program (LTAP) is a nationwide effort financed jointly by the Federal Highway Administration and individual state departments of transportation. Its purpose is to conduct training and technology transfer in the form of workshops, seminars, and conferences. The Delaware T²/LTAP Center Info-change is published semi-annually. T²/LTAP Center articles also appear semi-annually in the TransSearch - the newsletter of the Delaware Center for Transportation. Any opinions, findings conclusions or recommendations presented in this newsletter are those of the authors and do not necessarily reflect views of the University of Delaware, Delaware Department of Transportation, or the Federal Highway Administration. Any product mentioned in the newsletter is for information purposes only and should not be considered a product endorsement.

The Delaware T²/LTAP Center is a member of the National Local Technical Assistance Program (LTAP)

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