Vol. 26, No. 2 – September 2012

The Bridge

A quarterly newsletter from Michigan's Local Technical Assistance Program

Consistent results

Fly ash (like lime, cement kiln dust, and other fine-grained materials for stabilizing soil) requires a **pulverizer** to work the material evenly into the subgrade. The results are more uniform than with "remove-and-replace" methods for dealing with unsuitable soils. "With fly ash, you end up with a uniform subgrade because you mix together the entire layer—not just the bad spots," said James Rosenmerkel, P.E., president of Rosenmerkel Engineering.

Fly ash — one of several options for stabilizing soil before building a road

By John Ryynanen, Editor; and Melanie Kueber Watkins, P.E., Research Engineer
Center for Technology & Training

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Michigan's Local Technical Assistance Program

Road agencies have been using fly ash in concrete for years, but it also has potential for adding strength to unstable sub-grade soil in roadways. Industry professionals, like James Rosenmerkel, P.E., president of Rosenmerkel Engineering, and Jeff Dusseault, site coordinator at Presque Isle Facility for LaFarge North America, want to change this. Both arrange shipments through Lafarge North America to make use of Class C fly ash on roadway construction projects. Rosenmerkel works on projects in Wisconsin; Dusseault works at We Energies' Presque Isle Power Plant in Michigan.

Classification

Fly ash is a fine-grained coal combustion product (CCP) produced by coal-burning power plants. It is most commonly classified as Class C or F, depending on the oxide content (the sum of silicon dioxide, aluminum trioxide, and iron oxide) in the material. Class C ash has higher amounts of calcium oxide (lime), which gives it cementitious properties, in addition to being pozzolanic. Class F ash has no cementitious properties, but can be used for soil stabilization if combined with lime or some other activator. For more on using ashes other than Class C for stabilizing soil, see *Stabilizing soil with "non-spec" ash* on page 6.

Fly ash classification is determined through criteria specified in AASHTO M 295-11 and ASTM C618-08a, and test procedures laid out in ASTM C311-11a.

Good results quickly for less money

Class C fly ash is a cementitious material, which makes it particularly useful for stabilizing wet and soft clay soils that would otherwise be unsuitable for road construction. According to Rosenmerkel, traditional soil stabilization methods on a road construction project often create a non-uniform and potentially unstable subgrade. "When prepping a road bed you typically undercut any soft spots and replace them with granular backfill, but that can create an inconsistent load-bearing layer," Rosenmerkel said. "With fly ash as a stabilizing agent, you end up with a much more uniform subgrade because you mix together the entire layer, not just the bad spots, and then the fly ash cures to create a layer that is stable, consistent, and durable."

In full-depth reclamation projects, fly ash is so effective as a soil stabilizer that it can increase the California bearing ratio (a measure of subgrade strength) by as much as ten times. This increased strength creates a durable base that minimizes pavement deterioration and maximizes pavement life.

Using fly ash as a stabilizing agent can also significantly reduce the cost of a construction or reclamation project. On a typical soil stabilization project that uses fly ash instead of aggregate, Rosenmerkel said agencies can expect to save up to 50% on materials and about 15% on the total project

A condensed project schedule is a final incentive for using fly ash in road subgrade stabilization. Since it takes less than a day for fly ash to set, construction on top

▶ Fly Ash, page 6

Benjamin Franklin was a fascinating fellow. I'm sure you know him as a printer, author, inventor, statesman, patriot, political theorist, scientist, and overall fine man. If not, certainly you recognize his face from the front of a $100 bill.

Did you know that Franklin was also a volunteer firefighter? In fact, he organized the very first volunteer fire department (Union Fire Company) in Philadelphia, 40 years before 13 precocious British Colonies fought hard for independence and became the United States of America. Before long, several similar groups sprang up throughout Philadelphia.

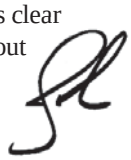
Franklin was delighted with the expansion of his effort. The only thing he enjoyed more than knowing and doing many different things was getting other people together to learn and do a lot too.

Today it is estimated that one million men and women in the U.S. serve as volunteer firefighters. According to the U.S. Census Bureau there are approximately 250 million adults in the U.S. today, which means one out of every 250 people in this amazing country is willing to drop what they're doing at any hour of the day or (very often) night to respond to all manner of emergency. That's pretty impressive. But what does that have to do with roads, bridges, and technology transfer? Let me explain (you will be even more impressed).

A few issues ago, I wrote an editorial about leadership among local road agencies in Michigan. In that editorial, I mentioned that I often see people wearing volunteer firefighter and first responder jackets, sweatshirts, hats, and other articles of clothing at workshops that I coordinate for mechanics. Since writing the editorial, I have been waiting to get a precise estimate of volunteers among attendees of workshops. This summer I got my chance.

Standing at the back of the room (garage bay, actually) at a recent air brakes workshop, I counted three people wearing volunteer fire department T-shirts. The next day (in a different garage), one person wore a T-shirt from a volunteer fire department. Over the next three days at three different facilities, I counted five more. In five days 84 mechanics attended five different sessions of the workshop. Among them, nine wore volunteer firefighter apparel. If the wearing of fire department T-shirts is an accurate indication of volunteerism, about one out of ten people who attended this series of workshops serves as a volunteer firefighter.

According to my (admittedly brief and unscientific) survey, the men and women who maintain the vehicles that keep our roads clear and safe for travel are about 27 times more likely to help out in this way than an adult in the general population. Mr. Franklin would be delighted with this crowd.



Center for Technology & Training

Michigan's Local Technical Assistance Program

The Center for Technology & Training is part of the Michigan Tech Transportation Institute at Michigan Technological University in Houghton, Michigan. The mission of the CTT is to develop technology and software, coordinate training, and conduct research to support the agencies that manage public infrastructure. In support of this mission, the CTT houses Michigan's Local Technical Assistance Program, which is part of a national effort sponsored by the Federal Highway Administration to help local road agencies manage their roads and bridges. For more information, visit ***www.MichiganLTAP.org.***

The Bridge

The Bridge is published quarterly by the Center for Technology & Training (CTT) through Michigan's Local Technical Assistance Program at Michigan Technological University. Subscriptions are free of charge. To request a subscription, contact the CTT.

Michigan's Local Technical Assistance Program
Center for Technology & Training
Michigan Technological University
309 Dillman Hall
1400 Townsend Dr.
Houghton, MI 49931-1295

Telephone 906-487-2102
Fax 906-487-3409
E-mail .....CTT@mtu.edu
On the web ..... www.MichiganLTAP.org

The Bridge is printed with soy-based ink on recycled, acid-free paper (50% recycled, 10% post-consumer waste). 4000 copies mailed this edition.

See Joe run (and run and run...)

John Ryynanen, Editor
Center for Technology & Training

"Running clears my head and cleanses my soul," Joe Pulver, managing director of Clinton County Road Commission, said. "It's a great way to get rid of all my worries and concerns." Pulver has completed 20 marathons and 11 ultra marathons (including three 100 mile races) since 2002.

***Editor's Note**: The transportation community in Michigan is full of interesting people with fascinating stories that go far beyond building and maintaining roads and bridges. This column is the first in a series that we plan to publish to tell these stories. Look for the next installment in issue 26.4. If you would like to suggest someone to cover in a future column, send me an email: johnryy@mtu.edu.*

Joe Pulver, P.E., managing director of the Clinton County Road Commission, loves to run. Since 2002 he's completed 20 regular marathons and 11 ultra marathons, three of which were 100 miles long. Races have taken him to Disney World in Florida, across the National Mall in Washington DC, through the desert of Arizona, up heartbreak hill in Boston, and even through the foothills of the Prussian Mountains in Reichweiler Germany. He fondly remembers the pain, sweat, and sometimes tears of each competition. "I have always enjoyed running to keep in shape," he said. "Then in 2001 I was in Washington DC with my wife during the Marine Corps Marathon. It looked pretty cool, so I decided to try one." The following year, Joe ran the Detroit Free Press Marathon. He has been running since.

> When you're out there facing the cold, dark, pain of the race, it becomes more about helping each other run well and finish than it is about one person beating another.

More than a marathon

A regular marathon is 26.2 miles long and takes a decent runner about four hours to complete. A 50-mile race requires 10 to 12 hours, and a 100-miler takes 24 to 26 hours. According to www.athlinks.com, which is "… the largest and most complete results database for endurance races on the planet," (as stated on their web site), Joe has been very competitive in every race he's run. His fastest time in a standard marathon was 3:26:26 in the 2004 Bayshore in Traverse City. His best time in a hundred miler was just over 22 hours in the desert foothills of McDowell Mountain Regional Park in central Arizona. What drives him to run for a full day and night without stopping? "I love running," he explained. "It clears my head and cleanses my soul; it's a great way to get rid of all my worries and concerns." Joe also likes the level playing field that is unique to the sport of running. "I'll never play tennis against Roger Federer or golf with Tiger Woods, but I've run with the best in the world," he said. "That's pretty neat."

Rewarding, not fun

Even the best runners in the world admit that running the equivalent of almost four marathons without stopping is not easy and it's never fun. But they all agree that it's extremely rewarding. To run that distance for that length of time, a person has to break through physical and emotional barriers that most of us will never come close to encountering. Pain, blisters, nausea, and dehydration are nothing compared to the loneliness, doubt, fear, and utter emotional distress that ultra marathoners must overcome. "It's impossible to explain what happens out there," Joe said. "It's much more than a physical challenge—you can train for that part. There's no way you can prepare for the deep mental anguish. You just have to keep going until you reach that point and then work through it."

Don't try this alone

The worst part of a 100 mile race is after the halfway point. Between 60 and 80 miles, even elite racers begin to break down mentally. It is during this period (which usually happens in the dark of night) that racers are most vulnerable to injury or worse. For this reason, race organizers encourage all competitors to employ a "pacer" to help them through. Officially, pacers ensure the safety of tired runners; but according to Joe, they do much more. "As human beings, we're not designed to push that hard for that long, alone," he explained. "The pacer steps in when you're at your most vulnerable and basically does whatever he or she can to help you keep going."

Joe and his wife Linda (who also runs ultras) take turns pacing for each other. "Sometimes a pacer will give a firm kick in the butt, sometimes it's a gentle word of encouragement; it's different for different people," he explained. "For Linda and me, having each other there is often all we need. Many times, just seeing her appear in my head lamp beam after being out on the trail alone in the dark is enough to give me a boost."

Lessons from the trail

Joe said that ultramarathons have taught him a great deal about himself and about life. As managing director of a road commission, his job can be complicated, unpredictable, and stressful. Running for 24 hours straight has helped him appreciate the importance of preparation; it has given him confidence to adapt on the fly when complications arise; and it has taught him how to deal with stress and to persevere when all else fails. "The best way to prepare for a race is to train for the hardest part," he said. "But no matter how hard you train or how thoroughly you prepare, you will reach a point where you're totally used up and all you can do is place one foot ahead of the other." Joe has never reached that point at work, but if he does he'll be better prepared to handle it because he's been there before.

The most profound life lesson involves people helping people. "There's something magical about being in a race where everyone is pushing themselves until they can't go any further, and then they push a little further," he said. "When you're out there facing the cold, dark, pain of the race, it becomes more about helping each other run well and finish than it is about one person beating another. It's an amazing experience." ■

Testing a vehicle's charging system

By Steve Sutton
AIS Construction Equipment Training Center

Charging systems are one of the most misdiagnosed systems on and off the road, especially in today's electronic-immersed culture where lights, radios, navigation systems, controllers and other consumers of power fill the passenger cabin of most vehicles. The load on a charging system, which should be the first of three considerations when troubleshooting, is often overlooked when a system begins to show weakness.

Steve Sutton, service trainer at AIS Construction Equipment Training Center in Lansing, demonstrates the use of an inductive amp meter to test an alternator. "It's a fairly expensive piece of equipment, but it's worth it for the convenience, especially if you're working with a large fleet of vehicles," he said.

Center for Technology & Training

Flows like water

A charging system is made up of an alternator, a battery, and all components that draw power from the system. An easy way to describe a complete system is to compare it to a municipal water delivery network. The battery is like the water tower, the alternator is like the pump that keeps the tower filled, and all of the electrical components are like spigots that drain water from the system. In terms of system operation, voltage is like water pressure and amperage is like flow. As long as the alternator (pump) maintains a good level of voltage (pressure) in the battery (tower), there will be plenty of amperage (flow) to meet demand.

Continuing the water system analogy, resistance in an electrical system is similar to the role of pipe size in a water system. For the purpose of this brief article, appropriate resistance is assumed.

Before you begin

Proper safety equipment and procedures are extremely important when working with vehicle electrical systems. Battery acid is extremely corrosive, the voltages are high enough to give you a dandy shock, and there are hot moving parts all over under the hood. For this reason you should wear rubber gloves and safety glasses at all times, and you should remove any jewelry (see *OUCH!* at right) or clothing that could cause an electrical short or that could get tangled in a moving part.

Before you test individual components on your system, you should first check all battery and alternator connections to ensure that they are clean and tight, and you should check the tension on all your belts. Improper connections and loose belts can cause a vehicle electrical system to perform poorly.

Battery basics

A good charging system must have a good battery. If your battery easily starts your engine, you can assume it is in good condition; skip this section and check the alternator instead. To test your battery:

1. With your vehicle ignition off, connect the negative and positive volt meter leads to the negative and positive terminals on your battery.
2. Check your volt meter.
   The reading normally hovers between 12.5 and 13.5 volts; if it is less than 12.5, your battery likely either needs to be charged or it is unable to hold a charge.
3. With the volt meter still attached, have an assistant start the engine.
4. While the engine is cranking, watch the reading on the volt meter.
   Depending on temperature, length of cranking time, age of battery, and other variables, the voltage may fall to about 10 volts before the engine starts. After the engine starts, the voltage should climb quickly to 13.5 to 14 volts, and then stabilize at up to 14.5 volts with the engine idling.

Testing the alternator

When testing your alternator, the first thing you should consider is the load: are your electrical components drawing too much for your alternator to handle? If so, you will have to upgrade your alternator. To test your alternator:

1. Connect an inductive amp meter to the alternator output cable. This cable is usually red and it runs from the alternator to the cable that connects to the positive battery terminal.
2. Start your vehicle and then turn on all electrical components (lights, heater blower, wipers, radio, etc.)
3. Check your amp meter.
   The reading should not be more than half of the alternator rating. For example, an alternator that is rated at 120 amps will produce that much flow but it is not designed to sustain it for more than a few seconds at a time. Under peak load (with all electrical components on), the alternator should produce about 60 amps.

For more information

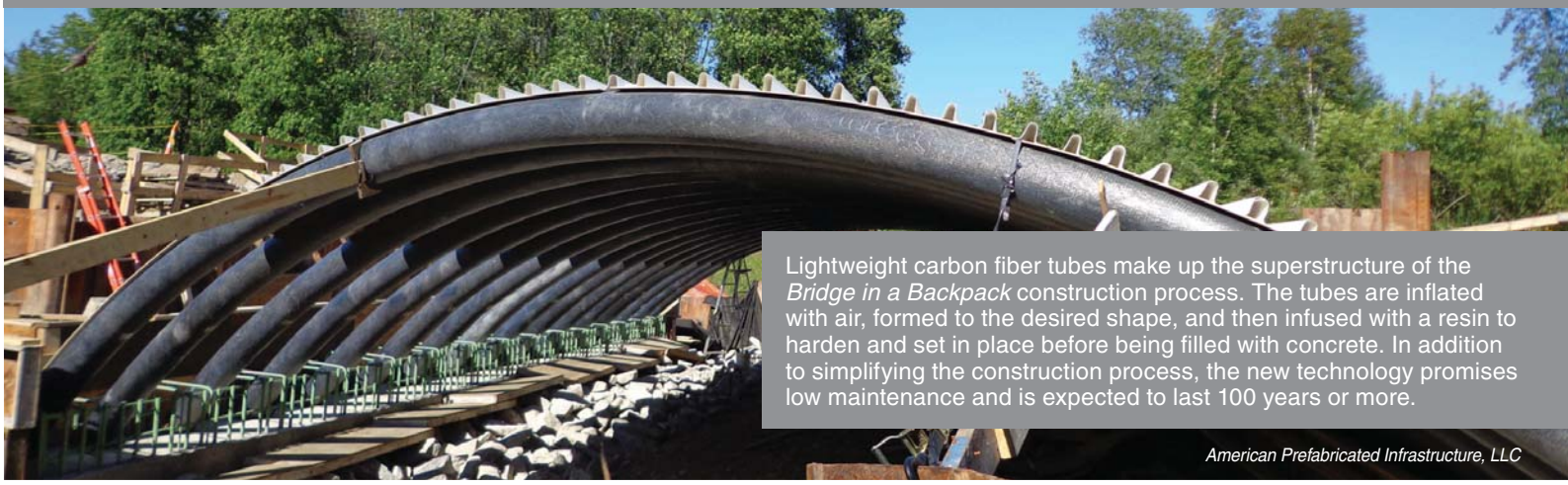
This brief article only covers the most basic tests for the battery and the alternator. To download a detailed procedure for testing a vehicle electrical system, please visit: **www.MichiganLTAP.org/ElectricalTest.** ■

OUCH!

John Kiefer, P.E., research engineer at the Center for Technology & Training, was recently reminded how much pain an automobile battery can inflict on a weekend auto mechanic. John was tightening the positive connection on his truck battery recently when the wrench he was using touched a spot of bare metal under the hood. He saw a spark and felt a significant jolt of electricity burn the little finger on his right hand. "It felt like a hornet sting," he said. "I dropped the wrench and grabbed my right hand in my left." Looking down, he saw that his *Order of the Engineer* ring was sizzling hot. The ring, held tightly against the wrench in his hand, conducted enough electricity to burn a ring around his finger when the wrench contacted bare metal. "My finger hurt for many days," he said. "It's easy to forget how much energy is stored in a basic automobile battery."

21st century bridge

John Kiefer, P.E., Research Engineer
Center for Technology & Training



Lightweight carbon fiber tubes make up the superstructure of the *Bridge in a Backpack* construction process. The tubes are inflated with air, formed to the desired shape, and then infused with a resin to harden and set in place before being filled with concrete. In addition to simplifying the construction process, the new technology promises low maintenance and is expected to last 100 years or more.

American Prefabricated Infrastructure, LLC

The Michigan Department of Transportation (MDOT) is currently engaged in a bridge replacement project that uses lightweight carbon fiber tubes as key elements of support. The Composite Arch Bridge System, commonly referred to as Bridge in a Backpack®, was developed at the University of Maine's Advanced Structures and Composites Center. The "backpack" part of the concept originated from the fact that the main components of the bridge superstructure are small and light enough to be hauled to the job site in a backpack.

Lightweight superstructure

Components consist of concrete-filled fiber-reinforced polymer tubes (CFFTs). Each tube is inflated with air, formed to the desired shape, and then infused with a resin to harden and set in place. The tubes, which become the main members of the bridge superstructure, serve three purposes: they are stay-in-place forms, they provide reinforcement for the concrete (no steel reinforcement is required), and they protect the concrete from environmental deterioration.

The tubes are light in weight for their size; they can be set in place using light equipment or in some cases by hand, and they are filled with concrete after they are positioned. Typical tube spacing is two to five feet on center; they can span up to 75 feet with single or multiple spans and standard or customized geometries. The AASHTO sub-committee on bridges recently approved a guide specification for design with this new technology.

Foundation and decking

The foundation is designed as a typical reinforced concrete foundation with spread footings on bedrock, spread footings on soil, or pile-supported abutments. Headwalls can be constructed with fiber reinforced polymer (FRP) panels using mechanically stabilized earth (MSE) or tied anchorage, precast concrete using MSE, tied or gravity anchorage, or cast in place (CIP) concrete using tied or gravity anchorage.

FRP or polymer coated galvanized decking is installed over the tubes before they are filled with concrete. After the concrete has cured, the structure is backfilled with soil. Depth of cover is typically between four and fifteen feet. The *Bridge in a Backpack* process creates a buried arch structure where the arch is in compression and the soil provides load distribution and passive restraint of the structure. The system will deflect to provide a warning prior to failure.

Simplified construction, long life

Benefits of this technology include simplified shipping and handling logistics, increased speed of construction, low maintenance as provided by a joint-free buried structure, no disruption to the natural streambed, and expected service life of 100 years or more.

First in Michigan

The MDOT *Bridge in a Backpack* project is located on highway M-25 crossing over Harbor Beach Creek in Rubicon Township, Huron County, Michigan. The original structure was built in 1953 with cast-in-place concrete T-beams. It spanned thirty feet. The foundation consisted of spread footings that were exposed due to erosion of the adjacent soils, which resulted in the structure being listed as scour critical. Also, the bridge deck and beams were considered structurally deficient.

The new foundation is pile supported and the carbon fiber superstructure spans just over 43 feet. It uses 16 twelve-inch diameter CFFTs. Corrugated fiberglass decking was attached to the top of the tubes before each was filled with self-consolidating concrete. A seven-inch thick layer of concrete was placed over the decking. Headwalls were placed and the structure was then backfilled with granular material that was compacted in lifts. The new bridge was scheduled to be open to traffic on September 21.

This first of its kind project in Michigan using the *Bridge in a Backpack* system was funded in part through the Federal Highway Administration (FHWA) Innovative Bridge Research and Deployment (IBRD) Program.

For more information about *Bridge in a Backpack*, see the additional resources for this issue on the Michigan LTAP web site: **www.MichiganLTAP.org/Bridge/26-2.** ■

More about *Bridge in a Backpack* at the 2013 Michigan Bridge Conference

The Michigan Department of Transportation (MDOT) will provide a detailed case study of the M-25 *Bridge in a Backpack* project at the 2013 Michigan Bridge Conference. The conference will be held at Cleary University in Howell on March 19 and 20, 2013. For more information, please visit the conference website: **www.MichiganLTAP.org/workshops/2013BridgeConference**.

Fly ash (from page 1)

of stabilized soil can begin quickly. This is especially useful in cold regions where long construction times due to poor weather conditions often hinder project continuation.

Planning a Stabilization Project

Harnessing the benefits of fly ash begins at the source: the power plant. Fly ash is collected in exhaust stack precipitators as a dry material after coal is burned. Anyone who is looking to use fly ash for soil stabilization will need to work with either a recycling contractor who has access to ash that has been classified by AASHTO M 295-11 and ASTM C618-08a, or a power plant willing to sell fly ash directly.

Once a recycling contractor is found, they generally take charge of the stabilization project because special testing and equipment is required. Rosenmerkel cautions that local road agencies need to be sure that the contractor they hire is using an approved soil-ash mix design. "Any geotechnical engineer should be able to test fly ash for use as a stabilizer," he said. "They can bring samples to a lab and assess different application rates and moisture content levels to determine optimum density for a project. Agencies need to make sure their contractor conducts proper testing during the planning stages of a project." Although there are no formal specifications for fly ash in Michigan, like there are for similar stabilizing agents such as lime and cement kiln dust, Natural Resources and Environmental Protection Act 451 of 1994 allows fly ash for use as a road base or construction fill when it is placed at least four feet above the seasonal water table and covered by an impervious surface. For details about fly ash in Act 451, and for more information about other stabilizing agents, see *Many Options for Improving Poor Soil*, on page 7.

Currently, very few contractors deal with fly ash for soil stabilization in Michigan, but recent increases in fly ash supply at plants like Presque Isle in Marquette are presenting more opportunities. According to Presque Isle's Dusseault, the plant did not have the capacity to support fly ash soil stabilization projects until recently. "Our Class C fly ash has always sold out for use in concrete," he explained. "But in 2011, we upgraded two combustion units at the plant for emission reasons. These units used to produce a Class F ash, which must be combined with lime to stabilize soil. Now they are producing Class C ash."

A large number of power plants in Michigan are experiencing similar increases in fly ash production after upgrad-

▶ next page

Stabilizing soil with "non-spec" ash

Larry Sutter, Ph.D., professor and director of the Michigan Tech Transportation Institute, encourages road builders to consider using all classes of fly ash to stabilize soil, not just Class C ash. "ASTM C618 is a specification for fly ash used in concrete, and the requirements for concrete are far more stringent than for soil stabilization," Dr. Sutter explained. "It is important to note that ashes that do not meet ASTM C618 criteria for Class C or Class F can be used for soil stabilization; some may require the addition of lime. Using non-spec ash in this way is a great alternative to disposing of the material in a landfill." ASTM C593 provides guidance on selecting fly ash for use with lime for soil stabilization.

One of Dr. Sutter's areas of research interest involves using fly ash in concrete, and he is Chair of the ASTM Technical Committee on Concrete and Concrete Aggregates that is responsible for ASTM C618.

Class C fly ash to stabilize soil

Five-step process ensures optimum results

1. Excavate or pulverize existing soil or road surface to specifications determined by engineers. If necessary, use a staging area near the site for reclaimed material that needs to be pulverized.
2. Spread fly ash on the road bed at a specified rate. If any reclaimed material is being used, spread it onto the road bed at this time.
3. Use a reclaimer/pulverizer to pulverize and mix the materials in an enclosed chamber with directly injected water.
4. Compact the pulverized road bed using a vibratory pad-foot roller.
5. Smooth the road bed with a grader and smooth-drum roller. The surface is generally ready for paving within a day.

ing coal burners. "The easiest way for an agency to find a local supplier is to contact power plants or contractors directly," Dusseault said.

Specifications and Equipment

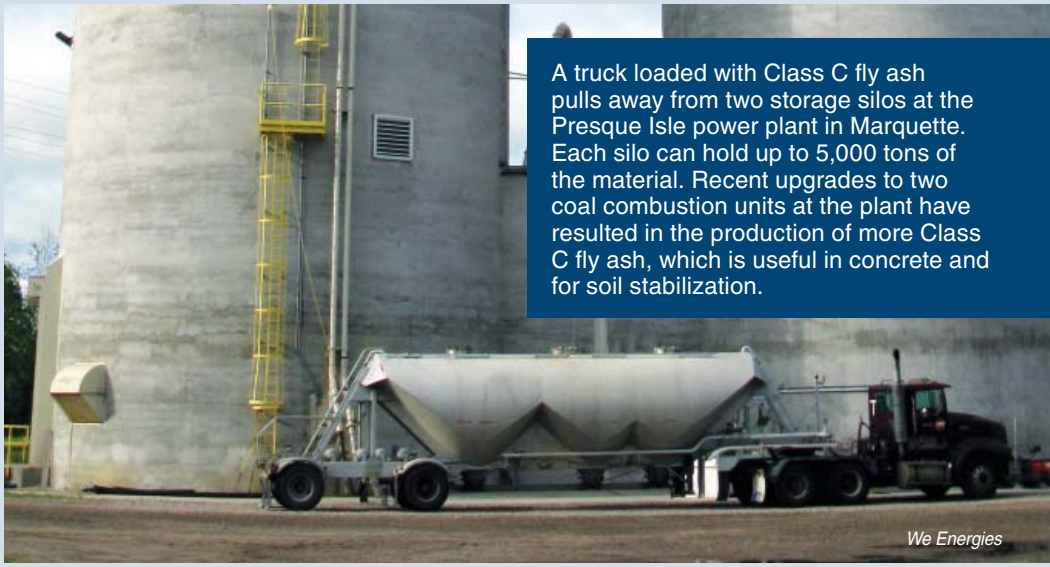
Since there are currently no specifications for use of fly ash in Michigan, Rosenmerkel recommends obtaining a soil-ash mix design from an agency or contractor that has experience using the material. These specifications can be incorporated into the project with approval from stakeholders. If they don't meet approval, they can be optimized through additional laboratory evaluation and testing.

Once a soil-ash mix design is approved, the contractor will need access to a specific set of equipment to complete the project. This equipment includes:

- Distributor that minimizes dusting, such as a vane spreader
- Reclaimer with a shrouded mandrel and an injection manifold
- Water truck that can be attached to the reclaimer
- Grader
- Vibratory pad-foot roller
- Smooth-drum roller

The equipment must be used in a specific order to ensure the soil is properly stabilized and compacted. See *Class C fly ash to stabilize soil*, on page 6 for details.

With an experienced contractor, a proven soil-ash mix design, and appropriate equipment, a fly ash soil stabilization project can be completed at a higher daily production rate when compared to other stabilization methods. "If someone is skeptical of that claim, I suggest visiting an agency that is in the process of performing fly ash stabilization on a project," Rosenmerkel said. "It's one thing to read about fly ash stabilization, but there's nothing like seeing it work in the field. It dries and firms up soil rapidly so you can start construction work quickly. We've saved a lot of time and money on projects using fly ash." ■



A truck loaded with Class C fly ash pulls away from two storage silos at the Presque Isle power plant in Marquette. Each silo can hold up to 5,000 tons of the material. Recent upgrades to two coal combustion units at the plant have resulted in the production of more Class C fly ash, which is useful in concrete and for soil stabilization.

We Energies

Options for improving poor soil

Portland cement, lime, fly ash, slag, bitumen, cement kiln dust, and lime kiln dust have all been proven effective for soil stabilization in different situations. Whatever means you use to stabilize soil for a road project, make sure to consider project specifications, effective depth of treatment, and environmental regulations. You should also use an approved soil-stabilizer mix design.

For links to helpful information about soil stabilization, please visit **www.MichiganLTAP.org/publications**, and then click on *Soil Stabilization Resources* under *Other Available Publications*. Linked documents include:

Michigan Department of Transportation

In 2008, The Michigan Department of Transportation used Cement Kiln Dust (CKD) to stabilize two test sections of a road reconstruction project near the Ambassador Bridge in Detroit. Dynamic Cone Penetrometer (DCP) testing on the sections showed an average strength gain of nearly 900%, compared to the existing soil. MDOT published details of the project in a construction report, which is available through a link (see list at left) on the Michigan LTAP web site.

- MDOT Construction Report: Cement Kiln Dust Stabilized Test Section on I-96/I-75;
- MDOT Article: Improving Subgrade Strength and Pavement Performance by Chemical Treating Subgrade Soils;
- Michigan Natural Resources and Environmental Protection Act 451 of 1994, Part 115 – Solid Waste Management (Excerpt);
- U.S. EPA Proposed Rule for Coal Combustion Residuals. ■

Quotes and thoughts on
Thinking, Judgement, and Innovation

"Some problems are so complex that you have to be highly intelligent and well-informed just to be undecided about them."
– Laurence J. Peter

"It's easy to come up with new ideas; the hard part is letting go of what worked for you two years ago, but will soon be out of date."
– Roger von Oech

"To think creatively, we must be able to look afresh at what we normally take for granted."
– George Kneller

"The most serious mistakes are not being made as a result of wrong answers. The truly dangerous thing is asking the wrong questions."
– Peter Drucker

What got you here won't get you there.
– Title of book by Marshall Goldsmith

The **Bridge**

Bridging the gap between research and practice since 1986

Vol. 26, No. 2 – September 2012

Michigan's Local Technical Assistance Program
Michigan Technological University
309 Dillman Hall
1400 Townsend Drive
Houghton, MI 49931-1295
906-487-2102

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Upcoming Events

(details at www.MichiganLTAP.org)

Workshops and Conferences

Local Concrete Seminar: Design and Construction of Concrete Streets and Parking Lots

October 10 – Livonia
October 17 – Grand Rapids
October 24 – Okemos
October 31 – Kalamazoo

Michigan Winter Operations Conference

October 16-17 – Lansing

Introduction to Roadsoft®

October 23 – Kalamazoo
October 24 – Ann Arbor
October 25 – Saginaw

Fall Asset Management Conference

October 24 – Marquette

Asset Management Workshop

Oct. 30-31, Nov. 1, and Dec. 5-6
(locations and facilities to be determined)

Don't miss the largest gathering of snow-fighters in Michigan!

MICHIGAN **Winter** Operations Conference

October 16-17, 2012 • Lansing, Michigan

- ☑ **Choose your content:** 22 technical presentations, including separate tracks for operators/mechanics and managers/supervisors
- ☑ **Meet with vendors:** Over 27,000 square feet of exhibit space to browse the latest equipment, materials, and technologies
- ☑ **BONUS:** Optional guided walking tour of downtown Lansing to learn about effects of winter maintenance on the natural and built environment

For more info:
www.MichiganLTAP.org/2012WinterOps

To register:
906-487-2102