Local Technical Assistance Program

The Bridge

Linking Transportation Research and Practice

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New bridge technology saves 25 percent or more

Compared to conventional construction methods, Geosynthetic reinforced soil integrated bridge system (GRS IBS) is less expensive and easier to build

By Federal Highway Administration

Instead of conventional bridge support technology, Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) technology uses alternating layers of compacted granular fill material and fabric sheets of geotextile reinforcement to provide support for the bridge. GRS also provides a smooth transition from the bridge onto the roadway, and alleviates the "bump at the bridge" problem caused by uneven settlement between the bridge and approaching roadway. The technology offers unique advantages in the construction of small bridges, including:

- Reduced construction time and cost, with costs reduced 25 to 60 percent from conventional construction methods.
- Easy to build with common equipment and materials; easy to maintain because of fewer parts.
- Flexible design that's easily modified in the field for unforeseen site conditions, including unfavorable weather conditions.

Modern Twist on an Old Idea

Some ancient buildings remain stand-ing because their builders understood an important concept: reinforcing mud building blocks with woven reeds greatly increases a structure's strength and durability. When the Federal Highway Administration (FHWA) launched its "Bridge of the Future" initiative, its forward-thinking engineers applied modern technologies to this old concept for a radical result: the Geosynthetic Reinforced Soil Integrated Bridge System (GRS IBS).

By using geosynthetic reinforced soil to create an integrated bridge system, FHWA managed to solve a durability problem that plagued those ancient architects. By using geosynthetic materials, FHWA researchers were able to create durable structures that can withstand the elements more effectively.

Geosynthetic materials offer a major advantage over the woven reeds used by the ancients. When the reeds were exposed to water and weather, which happened when the blocks were broken, they decayed. This weakened the structures. By contrast, synthetics remain strong, and the structures remain strong.

Bridges built with this GRS IBS are not only stronger and more durable than bridges built by traditional methods; they are also less expensive to build.

See *GRS IBS* on Page 7

Ancient Secrets, Modern Science

The Federal Highway Administration's "Bridge of the Future" initiative took a wise look at the past before soaring ahead to the future. The result was the Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS), which combined cutting-edge geosynthetics with ancient building secrets. This radically simple construction method can lower costs, slash construction time, improve durability, and increase worker safety.

FHWA

More inside

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Earlier this winter, I taught my 14-year-old son how to operate a snowblower. As I was showing Johnny the finer points of this popular northern Michigan activity, I could tell he was anxious to stop listening to me and start moving snow. Like most kids his age, he doesn't have a great deal of patience when taking advice or instruction from his Dad. Nonetheless, I briefed him on the most important points, and then stood back and watched for a few minutes to make sure he would be OK. He was fine.

Over the winter Johnny had to ask for my advice or help a couple of times. Each time I advised him I noticed the same impatience and eagerness to get going.

One day after a particularly heavy snowfall, I noticed (from the comfort of my warm living room) Johnny deep in conversation with my neighbor, Art. (Remember Art? I wrote about him about six years ago after he helped me sharpen my chain saw – see Issue 20.3). Art is 84 years old now, and he shows no sign of slowing down. A retired heavy equipment mechanic and farmer, Art is constantly moving. He trims trees, cuts wood, clears his own driveway, works in his yard, and builds stuff. His lawn and garden are both perfect. He also loans out tools and gives free advice about all kinds of things. Art is a great neighbor and friend.

Through my living room window, it was clear that Art was giving Johnny a bit of free advice about clearing snow. I was pleased to see Johnny patiently and contentedly watching and listening as Art talked and gestured around the idling 10 HP Briggs & Stratton® engine. Johnny clearly respected Art and appreciated whatever information he was communicating. I'm certain Art didn't share something about snowblower operation that I had overlooked; Johnny was just more willing to listen to him than to me. In addition to having over 40 years more life experience than I have, Art also has a way about him that commands respect—he's passionate about nearly everything, and he's a super nice guy.

In my work with Michigan's LTAP, I often see a similar phenomenon among supervisors, employees, and trainers at hands-on workshops that we organize. Countless times, on my way out of a shop after conducting a training session, I've had a supervisor pull me and the trainer aside to say, "I've been telling my guys exactly the same thing for years." Thanks to my son and my neighbor Art, I know exactly how they feel.

Art reminds me of the trainers we work with to conduct our workshops. In addition to being a little bit older and more experienced than other people, they are so excited about their areas of expertise (and life in general) that they can't **not** share their wisdom. And they're easy to listen to.

If you haven't been to an LTAP training event for awhile, keep on eye on www.MichiganLTAP.org/workshops for a list of upcoming sessions. Or if you're especially experienced in (and excited about) some aspect of local road agency operations that might benefit others in this unique industry, let us know. We're always looking for great trainers for our workshops and great presenters for our conferences.

The Bridge

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

Director	Tim Colling, PhD., P.E.
Sr. Research Engineer	Christopher Gilbertson, PhD., P.E.
Research Engineer II/Civil Engineer	John Kiefer, P.E.
Research Engineer II/Civil Engineer	Melanie Kueber, P.E.
Editor/Technical Writer	John Ryynanen
Technical Writer	Enneesa Ewing
Technical Writer	Shaughn Kern
Assistant Technical Writer	Trevor Kuehl
Sr. Software Engineer	Nick Koszykowski
Sr. Proj. Manager, Training & Operations	Christine Codere
Office Assistant	Devin Seppala
Telephone	906-487-2102
Fax	906-487-3409
E-mail	CTT@mtu.edu
Michigan's LTAP	http://www.MichiganLTAP.org

LTAP Steering Committee

The Local Technical Assistance Program (LTAP) is a nationwide effort financed by the Federal Highway Administration and individual state departments of transportation. It intends to bridge the gap between research and practice by translating the latest state-of-the-art technology in roads, bridges, and public transportation into terms understood by local and county highway or transportation personnel.

The LTAP Steering Committee makes recommendations on, and evaluations of, the activities of the Local Technical Assistance Program.

Kurt E. Zachary, P.E. 517-702-1832 FHWA
Local Program Engineer, FHWA

Bruce Kadzban, P.E. 517-335-2229 MDOT
Local Agency Programs, MDOT

Wayne Schoonover, P.E. 616-527-1700 CRAM
County Highway Engineer, Ionia County Road Commission

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Long-time Michigan LTAP supporter retires

By Center for Technology & Training Staff

As a young man growing up along the shores of Lake Huron in Alpena, Michigan, Ronald A. Young enjoyed technical classes in school, and he was always fascinated by construction activities. A family friend was a civil engineer. The job seemed interesting to young Ron, so after graduating from high school, he travelled 365 miles northwest to study Civil Engineering at Michigan Technological University (MTU) in Houghton. "I knew Michigan Tech was a good school, and I liked the small town setting of Houghton," he said.

39 years later, after a few years of work as a consultant and nearly three decades as engineer-manager at the Alcona County Road Commission (CRC), Ron is looking forward to slowing down. "Working as a county engineer has been fascinating," he said. "You have to be sound on the technical side and you also have to know how to handle public relations and politics. It's challenging, but it's very interesting and it's been a lot of fun."

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Tim Colling, Ph.D., P.E., presented Ron Young, P.E., with an award of appreciation at the 46th annual Michigan County Engineers' Workshop. Colling presented the award to thank Young for 23 years of leadership and service as a representative of Michigan local agencies on the steering committee for Michigan's LTAP.

In addition to his work as engineer-manager at the Alcona CRC, Ron has served in multiple volunteer, appointed, and elected positions with several national, state, and local organizations over the years, including president of the National Association of County Engineers, director of the National Association of Counties, and member of the County Road Association board of directors, to name a few. "I was fortunate that my initial board members encouraged active involvement and participation in activities outside of the road commission. They felt that the knowledge gained was a valuable return to the county," he said. "Personally, I feel that being actively involved is the only way to keep up with and influence changing trends. It's also just plain interesting."

"Working as a county engineer has been fascinating. It's a challenging job, but it's very interesting and it's been a lot of fun."

Ronald Young, P.E., Alcona CRC (retired)

For 23 years of his 39-year career, Ron also served on the Michigan Local Technical Assistance Program (LTAP) steering committee, where he provided valuable guidance and support for the program. The LTAP effort, established in 1982 by the Federal Highway Administration as a way to help local road agencies manage roads and bridges, relies heavily on local agency involvement for direction and support. Tim Colling, Ph.D., P.E., director of the Center for Technology & Training (CTT) at MTU appreciates Ron's contributions (the CTT administers Michigan's LTAP). "As a long-term representative on the steering committee, Ron played a significant role in shaping the Michigan LTAP program over the years," he said. "Ron's involvement ensured that the program remained current and relevant for Michigan's local agencies. I can't say enough about his help, advice, and involvement; Michigan's LTAP would not be the success it is today if not for Ron."

Wayne Schoonover, P.E., county highway engineer for Ionia County Road Commission, will replace Ron as the local agency representative on the committee.

Ron was also instrumental in the development of RoadSoft®, a roadway asset management system that has been funded by MDOT and developed and supported by the CTT since 1992. Gary Schlaff, senior project manager at CTT and the lead software engineer for RoadSoft, said Ron was among the most vocal and engaged RoadSoft users from the very beginning. "When we were planning new features we could always count on Ron for advice and help," Schlaff said. "And after releasing a new update, Ron would often be our first email or phone call for comments or technical support. Among the 400 or so users we have in Michigan, he has always been among the most active."

With much more salt than pepper in his hair today, and decades of great memories from a career well spent, Ron is looking forward to having more time to work around the house and travel with his wife. "I've worked with many terrific people and I've had a great career, but I'm looking forward to the next phase," he said.

Rebuilding saves money and improves durability

By John Ryynanen, Editor
Center for Technology & Training

Last summer, Jackson County Road Commission (JCRC) Maintenance Mechanic Paul Zuck had just finished attaching a new $6,500 underbody scraper assembly to a JCRC plow truck. The old assembly—a little less than 2,000 pounds of rusting steel, loose fittings, and leaky hydraulic cylinders—lay uselessly on the garage floor. But Zuck didn't see a pile of used-up old metal to be taken apart and dragged to the recycling bin. He saw an opportunity waiting to be realized. "Like any mechanical assembly, the scraper was made up of individual pieces that simply wore out," he explained. "After a bit of poking around, I thought maybe I could rebuild the thing and save some money."

Considerable savings

He was right. Since that day, JCRC has saved over $30,000 by rebuilding underbody scraper assemblies instead of replacing them. "We've completely rebuilt ten assemblies, and we've done partial rebuilds on a few others," Zuck said. The most expensive assembly to rebuild cost just over $3,500; the average cost has been about $2,600, which is 60% less than the replacement cost of an assembly. Both figures include labor, which is typically 30 hours.

The most common wear parts on the assembly are the turntable, pivot brackets, hanging plates, moldboard hinges, and the hydraulic cylinders and connections. On the first few assemblies that he rebuilt, Zuck ordered new turntables directly from the manufacturer. Since then he has had them custom-built by a local fabricator for approximately half the cost. Other than the turntable and the hydraulic cylinders, Zuck and other JCRC mechanics fabricate all the new parts in their metal shop.

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Paul Zuck, maintenance mechanic at Jackson CRC, uses a hydraulic bottle jack to replace a spring that is part of the height adjustment system for an underbody scraper that he is rebuilding.

Improved durability

The benefits of rebuilding instead of replacing go beyond simple cost-savings. The exercise of disassembling and rebuilding the scrapers has provided Zuck and the other mechanics a better understanding of how the assemblies wear out. This understanding has enabled them to make small adjustments to increase durability and simplify maintenance. The first adjustment was to increase the size of major wear components to make them stronger. "The turntable from the manufacturer was 7/8-inch thick steel," Zuck said. "When we had it custom built, we bumped the thickness up to a full inch to make it more stable

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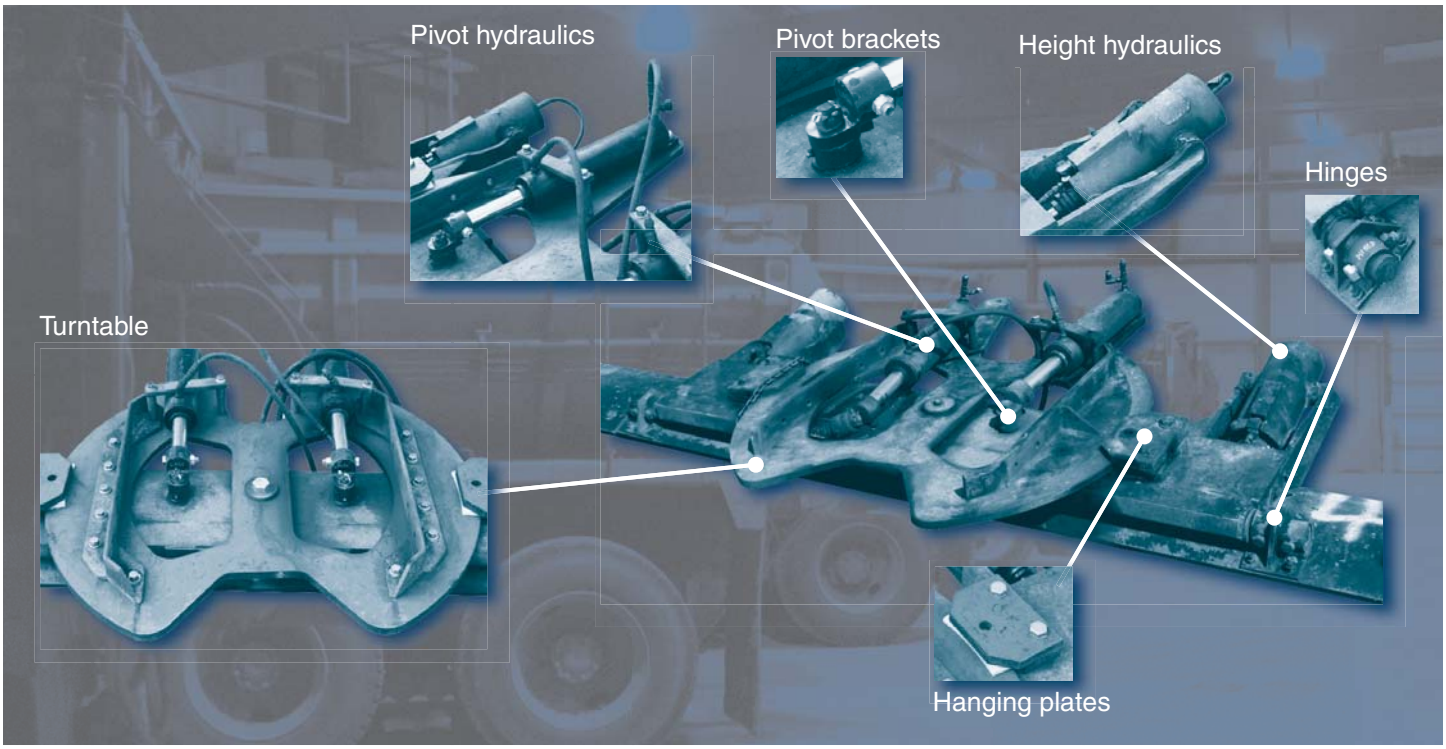

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By replacing individual components instead of entire assemblies, Jackson County Road Commission mechanic Paul Zuck cut the cost of replacing underbody scrapers by more than 50 percent.

and durable." Similarly, Zuck used slightly heavier tubing and bar stock when he rebuilt the hinge on which the moldboard pivots. The heavier stock will prevent bending.

Besides beefing up the size of components to resist wear and deformation, Zuck added an entirely new part to the assembly to prevent wear on two major components. The new part is a ½-inch thick piece of high-density plastic, which Zuck installs between the turntable and the hanging plates. "The plastic pads serve as inexpensive wear surfaces between the two components," Zuck explained. "When the assembly gets a little loose we just replace the pads instead of the more expensive steel parts."

Bob Griffis, JCRC director of operations, is excited about Zuck's ability to rebuild. "We have the equipment and the space, and Paul has the capabilities to get this kind of stuff done," Griffis said. "I'm glad he enjoys it because it has really worked out well for us."

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Paul Zuck (circled) listens as welding instructor Tom Cook explains the finer points of torch welding. "I've been doing this kind of work my whole life, but I learned a lot," Zuck said.

Instruction and Inspiration

Soon after hiring on full-time at Jackson County Road Commission, Paul Zuck attended two Michigan LTAP workshops: *Fundamentals of Hydraulic Systems for Heavy Equipment* and *Advanced Maintenance Welding*. "I've been doing this kind of work my whole life, but I learned a lot from the workshops," Zuck said. "Both instructors were great; they taught us things based on their own real-world experience."

Zuck had quite a bit of his own experience before attending the workshops. Born and raised on his family's farm in Southern Michigan, he maintained a fleet of farm equipment (on a shoe-string budget), and also worked on an 1,800 acre farm until he was 30 years old. After that, he worked as a truck driver and heavy equipment operator for 14 years, and then he owned and operated an excavating and construction business for 10 years. Zuck knows a few things about stretching a dollar. "Growing up on the farm, we didn't have a budget for replacing equipment," Zuck explained. "When something broke or wore out, we'd always find some way to fix it.

"The LTAP workshops reminded me to think outside of the box. They inspired me to consider other ways to fix things."

Your crew needs a new truck? Consider buying used

By Trevor Kuehl, Assistant Technical Writer
Center for Technology & Training

According to the automotive research site Edmunds.com®, the average new vehicle loses 11 percent of its value the moment it is driven off the lot. At five years old, a vehicle is typically worth less than 40 percent what it cost brand new. Commercial vehicles can lose value even more quickly due to heavy use and high mileage.

Rich Durfee, shop foreman for the Midland County Road Commission (MCRC), avoids this loss in value by buying used pickups for his road crews. "I can get a truck that is seven or eight years old for half the price of a new one," he said. "And the maintenance cost for the first five years I own it is almost exactly what I would spend maintaining a new truck."

Used makes sense

According to the True Cost to Own® tool on Edmunds.com, an owner of a base model 2012 Ford F-350 4WD pickup can expect to pay $32,000 to purchase it, and then pay just over $4500 for maintenance and repairs during the first five years of owning it. Compare that to the price Durfee pays for a used vehicle and the benefits are clear. "In 2005 I bought a 1999 Ford F-350 for $7000," Durfee said. "It's still running today, and I've only spent about $2,500 on repairs.

Out of four used pickups that he's purchased since 2005, Durfee has never encountered any major problems. "Our used trucks have been running just fine," he said. "All we've had to do is keep up with basic maintenance and wear items like oil changes, spark plugs, filters, and brakes." To track maintenance expenses, Durfee maintains a simple file for each vehicle.

But be careful

When it comes to buying used vehicles, Durfee stresses that experience is crucial. Durfee has been a professional mechanic for over thirty years. "I always personally conduct research on any vehicle I'm going to buy," he said. Durfee takes any potential purchase for a test drive and gives the body of the vehicle a detailed once-over before he approves the purchase. "It's easy to find affordable vehicles online or in auto magazines, but you need to get an expert opinion to avoid surprises," he said.

What to look for

When purchasing a used vehicle for his fleet, Durfee looks for the following:

- 8 years old or less
- 100,000 miles or less
- $8000 or less
- Rubber floor mats
- Manual windows
- Regular cab
- 8-foot box

"When you're buying used, less is more," Durfee explains. "The more options you have, the more you're going to have to maintain."

Evaluating products for roadway dust control

By Kevin Butler, West Virginia LTAP. This article originally appeared in the Summer 2011 issue of *Country Roads and City Streets*, a quarterly newsletter published by the WV LTAP.

The West Virginia Division of Highways (WVDOH) has approximately 14,000 miles of aggregate surfaced roadway. Dust that is expelled from these roads is a nuisance that road officials would like to minimize for citizens. Air borne dust also generates safety, health, and environmental concerns, such as reduced visibility, respiratory hazards associated with dust inhalation, blocked drainage systems, and potential damage to vegetation. Air borne dust also indicates that surface deterioration is occurring.

At the WVDOH current funding levels, it is anticipated that state owned roadways will not be paved for the purpose of dust control. The good news, though, is a variety of commercial products are available for dust control. These products work by: 1) attracting moisture, 2) binding dust particles together, 3) sealing the surface, or 4) some combination of these effects.

Chloride salts are moisture attractants, which work by drawing moisture out of the air during periods of high humidity, particularly at night. They also reduce the evaporation rate of water during hot-dry periods. Moisture in the gravel road surface tends to hold the dust on the road surface, although there is no physical bonding. Physical binders for dust control involve the application of organic or synthetic compounds that bind the dust particles together and attach them to the larger aggregate. Some of these binding materials produce a surface similar to an asphalt emulsions treatment, but at a lower cost. Surface sealants work by either adhering or agglomerating the surface particles together and often form a semi-rigid film on the road surface.

In 2010, a research project was conducted under the direction of Dr. John Zaniewski, a professor at West Virginia University and director of the West Virginia Local Technical Assistance Program. The roadway that was used for this research project was located in Wood County in the WVDOH's District 3 area. The purpose of this research project was to evaluate the effectiveness of five commercially available dust palliatives for use on secondary gravel roads maintained by the WVDOH. Dust control products included in this study were: calcium chloride, petroleum emulsion with polymer and bituminous resin pitch, lignin sulfonate, and synthetic organic fluid. Three methods of field testing were used which included a mobile dust sampling device (photo below), soil silt fractions, and moisture analysis.

Calcium Chloride

Results of field testing indicated that calcium chloride proved to be effective at controlling dust. It was also economical and easy to apply. The calcium chloride produced minimal impact to traffic and the treated roadway sections did not require any curing time before being opened to traffic. Based on visual observations, no product runoff was observed and the calcium chloride appeared to have minimal environmental effects. However, for long-term storage of this product, it is recommended that the calcium chloride solution be kept in plastic tanks to minimize corrosion.

Petroleum emulsion with polymer and bituminous resin pitch

Both the petroleum emulsion with polymer and the bituminous resin pitch had very long curing times, required multiple applications, and received complaints from passing motorists and residents living adjacent to test sections. These products splashed onto passing vehicles where pooling occurred on the roadway and were difficult to remove from the undercarriages and exteriors of vehicles. Among the tested products, the petroleum emulsion with polymer and the bituminous resin pitch created the most concern for environmental impacts. Based on visual observations, these two products were highly flowable after application. Both remained tacky for days and were also very odorous for approximately two weeks after application.

WV LTAP

A tanker truck applied five different dust control materials to gravel roads for the project. Calcium chloride was the most effective of the materials tested.

Lignin sulfonate

Lignin sulfonate is a by-product of the process involved with reducing wood pulp to paper. The sulfonate component acts to break down soil particles and the lignin acts to cement the particles together. Sulfur in the vapors released after application produces an objectionable odor that lasts while the product cures. The curing time is typically eight to twelve hours, but may be longer depending on weather conditions. Prior to complete curing, the product is susceptible to being washed away by rain, potentially creating an environmental hazard.

Synthetic organic fluid

There were no observed constructability issues with the synthetic organic fluid, and like the calcium chloride, the roadway sections treated with this fluid did not require any curing time

continued on the next page

before being opened to traffic. Additionally, no product runoff was visually observed. Since the synthetic organic fluid is a relatively new product, no storage concerns have been recorded; however the potential for creating problems associated with long-term storage should be considered.

Results

The results of this field evaluation and research project are that of the five commercial products tested as part of this research project, calcium chloride is the preferred choice for dust control. This conclusion was based on the cost, ease of application, impact on traffic, impact on the environment, and long-term storage capabilities.

For more information about this project or about roadway dust control in general, please contact John Zaniewski at: **John.Zaniewski@mail.wvu.edu**.

WV LTAP

A mobile dust collector was used to determine the amount of dust released from the road when it was driven over.

***GRS IBS* from page 1**

Low Tech, Low Time

GRS IBS is a form of accelerated bridge construction (ABC) that lowers cost, slashes construction time, improves durability, and increases safety—all at the same time. For budget-challenged State and local transportation agencies, that is a life-saver.

Rather than drilling a deep foundation, the reinforced soil method builds up the substructure in a faster, simpler way. One engineer described it as similar to building a layer cake. First, builders lay a row of facing blocks. Second, they add a layer of compacted fill (soil, etc.) to the height of the facing blocks (8 in.) Next, they add a layer of geosynthetic fabric. The process is repeated over and over until the desired height is achieved.

This low-tech approach continues as the bridge is placed directly on the GRS abutment mass. A GRS approach way is then built behind the bridge beams to transition the bridge to the approaching roadway. No joint or cast-in-place concrete is needed. The bridge extends naturally out of the roadway.

This simplified process radically reduces construction time. A GRS IBS is built in days or weeks, not months. There is no need to wait for cast-in-place concrete to dry; the substructure is immediately ready for the bridge.

On-site changes are easy to accommodate. As one engineer commented, "If I want to make it one foot wider, I put one more block in and take more fabric off the roll."

Weather is rarely a problem, since this type of construction can continue in variable conditions. And fewer delays mean faster completion.

Reduced Costs

Shortened construction time means fewer labor hours. In Defiance County, Ohio, one bridge abutment was built in just three days. Using traditional techniques such as cast-in-place construction, that same abutment would have required two to three weeks.

This lower-tech option also reduces materials costs. Inexpensive, common materials and equipment are used, and there is no need for highly skilled labor. Simpler construction also means simpler maintenance.

In all, GRS IBS costs 25 to 30 percent less than standard pile capped abutments on deep foundations. Compared to a standard Department of Transportation (DOT) bridge, there is a potential for even more significant savings; for example, a bridge in St. Lawrence County, NY realized a 60 percent savings.

Reduced Impact on Environment and Workers

The environment also benefits with GRS IBS. The technology is environmentally sensitive and results in minimal environmental impacts. The construction footprint is reduced since no deep foundation is needed. Moreover, construction can be adapted to fit the environmental needs of a variety of applications.

Workers also benefit. Because the abutments are built from the inside out, personnel are less exposed to potential roadside hazards. And simpler construction generally means fewer accidents.

Other Benefits

Shorter construction time also means fewer travel disruptions; compared to conventional construction, fewer lanes need to be closed for shorter periods of time. The joint-less construction is also a noticeable side benefit to travelers because of the smooth transition on and off the bridge.

GRS IBS is strong and durable. A recent full-scale shake table experiment showed that a GRS abutment structure can withstand a 1.0 g earthquake acceleration.

The clean, simple design of GRS IBS is modern and attractive. The realization of GRS technology will ultimately lead to widespread use and expanded applications in building better roads and bridges.

Demands on the bridge and highway system continue to grow dramatically, and budgets rarely keep pace. Many bridges are either functionally or structurally deficient; there is an increasing need for new bridges. In combining insights from the past with cutting-edge modern technologies, GRS IBS offers an effective and economical solution.

For general information about GRS IBS, including a detailed summary of the construction process and several case studies from other states, visit **www.fhwa.dot.gov/everydaycounts/technology/grs_ibs**.

To learn more about the GRS IBS initiative in Michigan, contact **Ted Burch, P.E.**, EDC coordinator – FHWA Michigan Division office, at **517-377-1844**.

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

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Federal Bridge Funds Now Available for Capital Preventive Maintenance

"Keeping good roads good" is a foundational principle of roadway asset management, and preventive maintenance is the key. The Michigan Transportation Asset Management Council (TAMC) has been providing asset management guidance and tools for Michigan's roads for over a decade. In 2009, the TAMC expanded their offering with tools geared toward bridges (see *Asset Management Guide for Local Agency Bridges in Michigan* at www.michiganltap.org/publications).

The Michigan Department of Transportation (MDOT) Local Agency Bridge Program (LABP) recently struck an agreement with the Federal Highway Administration to provide more flexibility by allowing Federal Bridge funds to be used by local agencies to perform preventive maintenance on bridges. The LABP has an annual budget of approximately $46 million, $19 million of which consists of federal funds that traditionally could not be used for preventive maintenance.

"Since 2009, preventative maintenance activities were allowed, but they were limited to funding available from the remaining budget, which consisted of state funds only," explained Keith Cooper, P.E., supervisor of LABP. "The new agreement frees up all $46 million to be used for preventive maintenance on local agency bridges."

The agreement with FHWA was reached in close consultation with the LABP local bridge advisory board (a working group made up of representatives from cities, villages, counties, and state road agencies), and the TAMC Bridge Committee, chaired by Roger Safford, P.E., MDOT Grand Region Engineer and TAMC member.

For more information, visit www.michigan.gov/mdotlap, and then select "Bridge Program" from the left menu.

Upcoming Events

Workshops and Conferences

Safety Analysis using the AASHTO Highway Safety Manual

April 3 – Auburn Hills
April 18 – Grand Rapids

Construction Pedestrian Facilities for Accessibility

April 16 – Okemos

2012 Spring Asset Management Conference

April 25 – Livonia

Introduction to Transportation Asset Management for Elected Officials

April 26 – Livonia

Bridge Load Rating and PASER Training

Multiple dates and locations are available for in-person and web-based sessions; please visit michiganltap.org/workshops for all the details.

Webinars

Meeting TAMC Investment Reporting Requirements Using RoadSoft

April 3 – 10:00 am

For more information call 906-487-2102 or visit MichiganLTAP.org