Quality Matters
Vol. VII, Issue 2 – Spring 2017
from the Quality Assurance Branch (QAB) of Highway Design

Targeting settlement

using Geosynthetically Confined Soil

Quality Matters has addressed the expensive, perennial problem of the bump between a road and bridge a few times over the years, including a focus on *GRS-IBS*. (No, that isn't an acronym for two engineering companies that recently merged!) Fortunately, the costly problem may be coming to an end.

The Geosynthetic Reinforced Soil (GRS) Integrated Bridge System (IBS) is a technology that uses geosynthetic material to strengthen the roadway section next to the bridge. Because there is no need to drive piling or cast conventional abutments, GRS-IBS ideally reduces time and cost in the construction of single-span bridges.

Recently, a variation of GRS-IBS called Geosynthetically Confined Soil (GCS) has emerged and shown some real promise in Kentucky. The KYTC Geotechnical Branch has developed a GCS design and has worked with the Kentucky Transportation Center (KTC) to test its application.

Unlike the GRS-IBS, GCS is used in tandem with a conventional integral end bent. Beginning at the base of the abutment, material is excavated to a prescribed amount. A layer of geotextile fabric is placed and 1 foot of granular embankment is compacted. The fabric must have at least 5 feet of excess length next to the abutment so that it can be wrapped on top of the rock after compaction. Then, the process is repeated with another layer of fabric and rock until reaching the roadway base layer.

Bart Asher, manager of the Geotechnical Branch, notes that settlement is often caused by poorly constructed embankments, including the zone behind bridge end bents. On numerous occasions, their staff has investigated settlement problems and found unsuitable or uncompacted material, as well as improper drainage. These problems are often caused by the contractor rushing in order to keep other operations of construction moving. Using GCS forces the contractor to take more care in constructing this zone by requiring smaller, compacted lifts.

Working together, the compacted rock and fabric have very high levels of compressive strength. Additionally, the wrap of the fabric contains the rock and stops erosion that is often caused by water between the abutment and road.

Another feature of Geotech's design is the inclusion of a 10-inch thick, elasticized foam block that is attached to the outside of the abutment and installed prior to placing the fabric and rock layers. The elasticity of the foam block allows for expansion and contraction, which creates a tight fit between the abutment and the road, thus preventing water from penetrating between the bridge and the road.

Charlie Sun of KTC has been tasked to monitor two bridges built using GCS. Settlement and crack separation measurements have been taken with both a simple tape measure and high-tech sensors buried below the surface.

Both bridges were built in the fall of 2014 and have shown positive signs that the GCS is working. The first bridge is a single span that was replaced in-situ. As of March 2017, the maximum settlement was 9/16" and maximum gap was 1/4".

The second bridge is on a new alignment and both abutments sit on large fills of 30 and 50 feet. The measurement sensors were designed to differentiate between settlement at the end bent and initial settlement from the fill. As expected on such large fill, there was significant settlement and need to patch the road ends. What the researchers found after about a year and a half, however, is that the initial settlement had stopped and there has been almost no settlement since.

In a separate effort, KTC has also completed *development of a model that predicts* which bridge projects are likely to encounter settlement issues. Designers can use this model to identify locations that might benefit the most from using GCS.

Should you decide to give GCS a try on a project, or already have, consider letting the Geotechnical Branch know about it. They will continue to monitor the sites and modify the standard drawings to include GCS.

by: Brent Sweger, PE

The reason & necessity for purpose & need

The purpose and need (P&N) statement is the foundation for project decisions and is necessary for all projects regardless of funding source. A project manager (PM) must turn to the P&N statement when identifying alternatives and ultimately determining a solution that becomes a transportation project.

Crafting a solid P&N statement begins in the early stages of project identification and evolves throughout the planning stages and preliminary design. In 2005, *KYTC issued P&N statement guidance* and instructions that continue to stand the test of time; however, misunderstanding and misapplication continues to be a problem.

So let's start with a basic definition of a purpose. Simply stated, the purpose defines the transportation problem to be solved. FHWA lists *nine categories* that are most commonly used in defining the purpose. The PM should examine that list to see which are applicable to the project.

For some projects, the purpose can often be stated in a single sentence and should be described using the expected positive outcome. For example, the purpose of the project may be *reduce congestion in the interstate corridor*. For complex projects involving multiple purposes, the statement should include each purpose. Subsequently, the statement is composed of longer or multiple sentences.

A common error is to "throw the kitchen sink at it" when developing the purpose. It's good to consider all aspects of a project, but there is no need to force fit multiple categories when they're not necessary. Reducing congestion may be the driving goal of the project; however, just because some of the alternatives have a side effect of reducing crashes, that doesn't mean that safety is required to be listed as the purpose of the project. Adding too many categories may increase the number of reasonable alternatives and expand the scope of the project unnecessarily.

Another mistake is to blindly copy the project description listed in the Highway Plan or to write a solution as the purpose. For instance, *widen the road from two to four lanes* is not a purpose of a project; rather, the purpose might be written, *reduce the recurring congestion levels along the corridor*. Notice how the focus is on identifying the problem (congestion levels) and the desired outcome (reduction of those levels).

Including solutions within the purpose occurs frequently when addressing structure projects. For example: *Replace the bridge* does not describe the transportation problem, rather a scope of work or possible solution. Instead, it could be stated, *maintain system linkage and safety along the route by addressing the structural deficiency of the bridge*. In this example, a rehab of the piers or a deck replacement may be adequate solutions to address the true problem but would have been excluded under the initial statement of purpose. When a purpose statement focuses on a solution rather than the problem, the project team's focus may become too narrow.

Think about that for a minute. What problem is the road widening intended to fix? Is there a poor level-of-service (LOS) throughout the corridor where adding a turning lane or passing lane will improve the LOS? Would adding turning lanes at a bottlenecked intersection achieve what is needed? If service vehicles such as school buses or garbage trucks are blocking traffic and causing delays, a minor shoulder widening might address the core problem. Perhaps the true purpose should be *to improve traffic flow and reduce congestion along the corridor*.

As you can see, if you don't identify the core problem when defining the purpose, potential alternatives may be left off the table. Frequently, the chosen solution isn't the most cost effective because alternatives with higher value weren't even considered. Accurately defining the purpose also supports the philosophy of bottom-up design: achieving desirable rather than maximum improvements to an existing facility with a reasonable expenditure of funds.

Another benefit of a carefully written purpose is easier completion of the need portion of the P&N statement. The need is simply the factual and numerically based data that demonstrates the problem (purpose) exists. If there is more than a single purpose for the project, then data should be included to cover each of them. This data serves as a baseline when analyzing and measuring the effectiveness of each alternative.

The data put forth in the need should be specific to allow for identifying appropriate alternatives. For example, data on specific high crash locations and types is more revealing than relying solely on an overall corridor crash assessment. Similarly, pinpointing specific chokepoints and traffic queuing locations helps home in on the best alternatives for solving traffic operation problems.

A project may also have goals and objectives that are important but not directly related to the project's purpose; the project team should be clear on the difference between them. Goals and objectives may be generated by members of the project team or through public input. For example, these could include providing pedestrian facilities, enhancing an environmental feature, avoiding an environmental impact, or improving aesthetics.

Even in an era where budget limitations are a stark reality, secondary project goals and objectives should always be considered. Those identified through public involvement, resource agency comments, or project team discussions should all be vetted to determine which are important to the success of the project and can be afforded within the project budget.

So remember, stay focused on the core problem to be addressed and provide specific data-driven support to demonstrate the existence of each problem. With this in mind, you can write an effective P&N statement.

by: Brent Sweger, PE

Roundabout lessons learned in Kentucky

The Kentucky Transportation Center (KTC) is currently studying the implementation of over 20 roundabouts throughout Kentucky. The research not only focuses on the design of roundabouts, but also examines construction, maintenance, and users' experiences. The following are some of the initial highlights from the study:

- Future capacity for a roundabout needs to be planned during the design phase; otherwise, the roundabout can be expensive to reconstruct. For example, the roundabout at the intersection of KY 33 and KY 2168 north of Danville was designed by KYTC with a single lane on the outside of the circular roadway. However, a second lane can be easily added to the inside by removing part of the central island, which ensures the cross slopes of the approach road and circulatory road match if an inner lane is later constructed. This design approach sets the outer limits of the intersection, eliminating future construction impacts to adjacent properties.

- When a roundabout is first opened to traffic, the presence of directional signage is imperative to help guide the driver through the roundabout. This became evident following the construction of a roundabout on the Cynthiana bypass. Navigating a newly opened alignment without the proper signage in place, motorists struggled to find the proper exit while in the roundabout.

- Lighting is a critical component of roundabouts. After KYTC opened a new roundabout to traffic in London, Kentucky, without operational roadway lighting, several drivers *encountering the roundabout after dark* could not see the circular roadway and ended up driving through the central island. When streetlights became operational, drivers were able to recognize and navigate the roundabout easily.

- Designing for speed reduction when placing a roundabout on a higher speed road is imperative. Kentucky's first roundabout, on Reynolds Road in Lexington, was built prior to the existence of *national design guidance*. The roadway approaches to the roundabout didn't give sufficient visual cues nor have physical changes to encourage drivers to slow down in advance. The use of successive reverse curves with decreasing radii prior to the entrance curve and visual changes to the median are techniques that could have been used to transition safely from a high-speed roadway into the low-speed operations of the roundabout.

The roundabouts study also examines balancing traffic, maintaining traffic during construction, ensuring trucks can navigate the roundabout, and including right turn bypass lanes. This study documented many roundabout success stories in Kentucky while providing valuable lessons on fine tuning roundabout design and construction. Look for the publication of KTC's study in coming months.

by: Anthony Norman, PE

Upcoming training:

- **Traffic Management Plan Development Training**
  5/31/2017
  Frankfort 8:00 a.m. to 4:00 p.m.

- **Spring Dendrology & Native Tree Identification**
  6/16/2017
  Clermont 10:00 a.m. to 3:00 p.m.

- **2017 ACEC/FHWA/KYTC Partnering Conference**
  8/15/2017 » 8/17/2017
  Louisville 12:00 p.m.

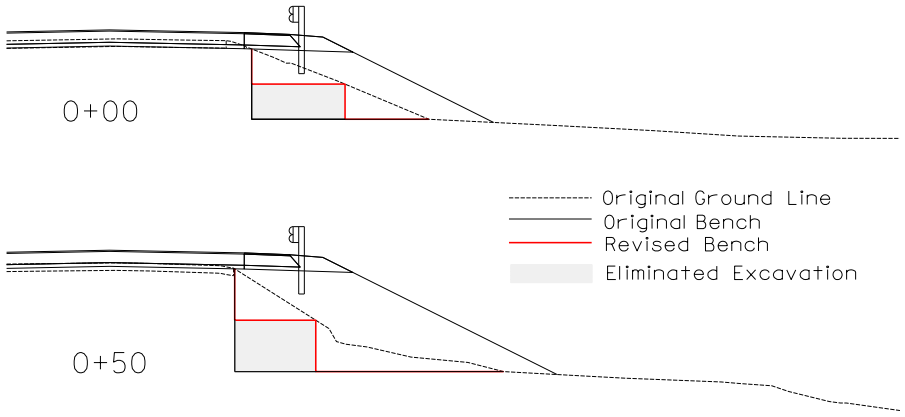
- **Roadside Design Guide**
  8/23/2017 » 8/24/2017
  Frankfort 8:00 a.m. to 4:30 p.m.

KYTC employees should register through **Kevin Martin** *for all classes.*

Consultants will only need to register through **Kevin Martin** *if the class is held at KYTC. Otherwise, consultants should contact the Kentucky Engineering Center.*

All times are local.

Height of benching



Widening a roadway often requires tying a new embankment to an existing embankment using benches to increase stability. Embankment benching (RGX-010) is a longitudinal feature shown on cross sections that form a constant shape across the slope; however, designers may be interested to know that due to safety concerns, bench heights may be excavated much shallower than designed.

To minimize potential collapse of an existing embankment during construction, bench heights tend to be excavated about the height of a dozer blade. Reducing the bench height lessens the instability of an existing embankment where traffic is maintained temporarily. Some existing embankments can be more stable than others, but contractors have learned to approach all existing embankments with caution.

With bench heights held consistently at 4 to 6 feet, construction inspectors are less likely to put themselves in potential danger when measuring bench heights to calculate excavation quantities for the day. As a bonus, reduced bench heights also create the potential to decrease bench excavation quantities by half, resulting in a lower bid quantity for the project. In the image, the red line shows the revised bench, and the shaded area shows an opportunity for potential savings if included during design.

From a geotechnical perspective, there is less concern about the size of the bench, but rather that benching be incorporated. J.C. Wilhoite, roadway section supervisor in the Geotechnical Branch of the Division of Structural Design, indicates that, in general, "the bench breaks up a potential slip plane between the new fill and the existing ground while providing space needed to properly compact the new fill." Clearly, if the existing slope to be benched is steep, bench heights will need to be taller in order to get the necessary width for a working platform. Be sure to consider the height (and width) of the bench design carefully; this detail can have significant impact on the constructability and cost of your project.

by: Mike Spain

Boot Camp Xpress training:

What makes a successful project? Why do project delivery success rates matter? To answer these questions and more, KYTC has collaborated with the Kentucky Transportation Center to develop two training courses: Project Manager's Boot Camp, an eight-day course that challenges KYTC project managers (PM) to take ownership of projects; and Boot Camp Xpress, an abbreviated two-day course for KYTC's partners in the consultant industry.

Beginning July 2017, in response to the Professional Services bulletin, KYTC will require Boot Camp Xpress for all project managers who are listed by a consultant. Boot Camp Xpress reminds consultant project managers about the Cabinet's mission statement and reinforces that KYTC project managers are responsible for the success of their project. One of the most important goals for the training is to show the consultants their success is closely intertwined with the success of the KYTC project manager. The objective is to make consultants more conscientious of the supporting role they play.

For more information, contact *Eric Pelfrey*.

by: Shawn Russell, PE

2016 Standard Drawings are *here* effective as of the June 24, 2016, letting. As a result, the Sepia List just got significantly shorter! Be sure to update plans accordingly.

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