Quality Matters
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from the Quality Assurance Branch (QAB) of Highway Design

Pass-through over Turtle Creek

Roadway alignment constraints, water elevation, loose soil and underground obstructions typically aren't the conditions you hope for when beginning a bridge replacement project, but that's what a one-lane bridge over Turtle Creek in Bracken County presented to designers and District 6 construction staff. Challenging conditions can lead to innovative solutions, though, and that's just what happened in this situation.

Roadway Alignment Constraints

Given that the road passes under a nearby railroad along one side of the bridge, the vertical profile of the deck could not be raised. Additionally, the underside bridge elevation could not be lowered due to the backwater pools from the Ohio River that cause the creek to rise. The combination of these two factors resulted in an extremely narrow vertical window where the structure could be built.

To account for this condition, designers considered two structural steel designs: a through plate girder and pony truss. A through plate girder design uses I-beams made of individually welded steel plates that support the roadway deck on the bottom flange. A pony truss allows traffic to travel between individual truss members, but the top of the truss is not tied with cross bracing. For this site, both designs required extra width for bracing at regular intervals to prevent lateral torsional buckling (flopping over) for the compression flange; both of these alternatives were very costly.

Designers then considered the pass-through concept using precast concrete beams. Differing from a conventional design in which the deck sits on top of the concrete beam, Turtle Creek's bridge deck is supported on the lower flange of the beam – a design that drove up the unit cost sub-

Continued from page 1

stantially for each beam. However, the unusual design required only two beams instead of the normal three, making it non-redundant and best used for narrow bridges.

The bridge deck was poured and tied into the beams using rebar. The lateral stiffness of the beams was increased even more by pouring the barrier wall against the beams and tying it to both the beams and the deck. As a result of the bracing requirements, the deck required hand, rather than machine, finishing.

Loose Soil

The soil deposited by backwater from the Ohio River may be an excellent substrate for gardening, but it is less than ideal for a bridge foundation.

Rock depths necessitated the use of piling, but there was not enough room to lengthen the bridge while using both spill-through slopes and H piling. Furthermore, the normal pool elevation of the water made conventional breastwall abutment construction difficult. Therefore, a design rarely used in Kentucky was chosen to overcome these obstacles.

To contain and support the abutments and wing walls, designers drove interconnected, steel sheet piles into the 30 feet of soil that sat on top of bedrock. After the crew drove the sheet piling, affixed a concrete pile cap, and placed an anchor wall and wing walls, the substructure became a solid platform for the concrete beams, and a new bridge was well on its way.

Unexpected Outcome

In addition to the innovative design approaches used in the new bridge construction over Turtle Creek, an innovative idea benefited the old bridge as well. After a serendipitous conversation between the Bracken County judge executive and the Henderson County judge executive, the historic bowstring pony truss bridge scheduled for demolition was, instead, dismantled, transported to Henderson County, and repurposed as a footbridge in a local park.

To learn more, contact Joe Van Zee of KYTC Division of Structural Design.

by: Kevin Rust, PE and Shawn Russell, PE

Survey says...

The Quality Assurance and Geotechnical branches would like to thank those who responded to our recent online survey regarding the estimation of aggregate, excavation, and fabric quantities needed to stabilize both unsuitable subgrade and roadway embankment platform foundation.

Of the 55 Project Delivery and Preservation branch managers and section supervisors invited to participate, 40 responded to the survey, representing all 12 districts. Significant findings include:

- Approximately 80 percent of respondents recommended a 2-foot depth of excavation and rock roadbed to properly construct a stable subgrade, rather than the 1-foot depth typically estimated by Geotechnical.
- Approximately 37 percent of respondents had experienced issues with significantly underestimated plan quantities of aggregate and fabric for roadway embankment platform foundation stabilization.

Due to the widespread and detailed feedback we received, the Geotechnical Branch has modified the technique for estimating aggregate, excavation, and fabric amounts in order to improve the construction process for everyone.

by: Bob Jones, PE, PLS

Farewell Anthony

After serving as the Lessons Learned Coordinator in the Quality and Assurance Branch (QAB) for 2 ½ years, Anthony Norman has joined the Developmental Branch in the Division of Highway Design. During his time with QAB, Anthony was instrumental in the development of the Value Engineering and Constructability Review databases. Anthony also assisted with post-construction review meetings, authored several articles for *Quality Matters*, and participated as a team member in value engineering studies. Just recently, Anthony made his next step in career development, starting the KYTC engineering rotation program.

If you would like to contact Anthony, his email remains the same: Anthony.Norman@ky.gov. The QAB team wishes him all the best!

Chemical stabilization

Clay soils are no surprise to crews who build Kentucky roadways, but you may be surprised to know that chemical stabilization is one of the most economical methods of subgrade stabilization available. As a matter of fact, when crews use chemical stabilization, up to 8 inches of cement stabilization can be substituted for 3 inches of asphalt base. The result: reaching the same strength at half the cost.

While the ability to reduce costs is a major incentive for using chemically treated subgrades, the increased longevity of the asphalt or concrete pavement is an even bigger incentive. Base failures are indicative of a weak subgrade. When first compacted, clay soils have a high bearing strength. However, when exposed to water, the soil absorbs moisture and forms a soft layer in the subgrade, which leads to a reduction in soil density and bearing strength.

Chemically treated subgrades are not weakened by exposure to water. A soft layer will occur under the treated subgrade as well, but when located deeper, it is impacted less by traffic stresses, which makes the soft layer less consequential. One consideration to be aware of is that chemically stabilized subgrades need time to cure before bearing strength is adequate for construction traffic. In the case of cement stabilization, the subgrade will need 3-4 days to reach adequate bearing strength. But once it does, bearing strength of the chemically treated subgrade is significantly higher, resulting in a solid working platform adequate to support heavy equipment and compact granular base and asphalt pavement. A stronger base leads to fewer failures and, subsequently, lower maintenance costs.

	Chemically Treated Subgrade	Untreated Subgrade
Construction Costs	↓	↑
Effects of Traffic Stresses	↓	↑
Bearing Strength	↑	↓
Maintenance Costs	↓	↑

The long-term benefits of stabilizing soil subgrades was the subject of a 2002 Kentucky Transportation Center study. Researchers examined roadways constructed with chemically treated subgrades across Kentucky and found that pavements lasted longer when subgrades were treated. Given the multiple benefits of chemically treated subgrades, you can expect to see more cement- and lime-stabilized subgrades on projects let in the future.

by: Shawn Russell, PE

Overlooking the obvious

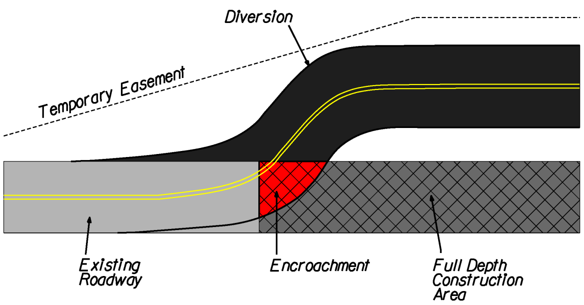
Most of us have experienced it at least once in our life: that feeling we get after pulling our house door closed as we leave for work, taking two steps toward our car while contemplating whether or not to stop for gas this morning or wait until lunch, and then realizing…

The keys are inside the house.

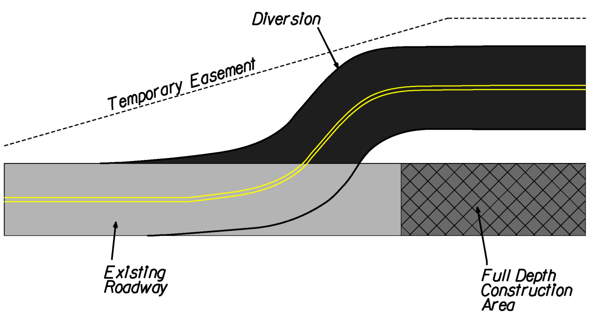
The locked house.

How could someone who's been driving to work every day for enough years to know better walk out of the house without keys? As we all know, there are a multitude of reasons we forget the obvious – we're in a hurry, our minds are focused on something else, or we simply get distracted. The truth is we're all susceptible to overlooking the obvious. Unfortunately, we're all left to deal with the consequences, as well, and when the obvious is overlooked during a road construction project, we can be sure it will cost us more than just time.

We all know that building a diversion to remove traffic from a work zone simplifies and speeds construction (as well as eases travel for the public), and we know the diversion should tie in to the existing road far outside the limits of full-depth pavement construction. It's like picking up the keys on the way out the door. It's automatic, right? As we've seen, it should be and is – unless we're distracted or in a hurry during the planning phase and overlook the obvious.



On a recent post-construction review, we learned of a diversion that came up short, tying in to the existing road within the limits of full-depth pavement construction and forcing the contractor to use part-width construction within that area. Subsequently, unit prices of materials and traffic control bid items increased as the contractor contended with the challenges of part-width construction. Pavement maintenance issues may arise in the future, as well, given the possibility of uneven settlement in the part-width construction area.



In hindsight, the district's construction staff determined that the diversion should have been extended farther up the road out of the full-depth construction area. Even with the extension's additional costs, the overall project cost would likely have been less, the traffic delay reduced, and traffic safety improved.

So, the next time you find yourself rushing through the planning stages, slow down, take time to double-check the details, and be sure you don't overlook the obvious.

by: Bob Jones, PE, PLS

Upcoming training

- **Design of ADA Sidewalk Facilities for Roadways in the Public Right-of-Way**
  3/28/2018
  Frankfort 8:00 a.m. to 4:30 p.m.
- **Design of ADA Sidewalk Facilities for Roadways in the Public Right-of-Way**
  3/29/2018
  Frankfort 8:00 a.m. to 4:30 p.m.
- **2018 KSPE Annual Convention**
  4/18/2018 » 4/20/2018
  Owensboro
- **InRoads II SS4**
  4/24/2018 » 4/26/2018
  Frankfort 8:00 a.m. to 4:30 p.m.
- **InRoads III SS4**
  5/21/2018 » 5/24/2018
  Frankfort 8:00 a.m. to 4:30 p.m.
- **InRoads Survey V8i**
  6/19/2018 » 6/20/2018
  Frankfort 8:00 a.m. to 4:30 p.m.

KYTC employees should register through ***Perry Semones*** *for all classes.*

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

All times are local.

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