



Kansas LTAP Fact Sheet

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Bottomless Culverts Worth a Look

By Aliza Chudnow

These structures can save you money and are better for the environment.

A bottomless culvert is an alternative to a common four-sided culvert. It is a U-shaped structure, installed (inverted) directly on top of the water channel, so the “floor” of the culvert is the undisturbed stream bed. This design allows aquatic organisms to pass through with ease.

Bottomless culverts have spans ranging from less than 1.5 feet to more than 35 feet. The culverts are typically supported on wide footings that distribute loads to the surrounding soil and rock.

This article will explain the benefits of building a bottomless culvert as well as some solutions to potential scour at these structures. We’ll also include comments from officials in Douglas and Johnson counties who have experience installing bottomless culverts.

Benefits

A main advantage to placing a precast bottomless culvert is its quick overall installation time. Douglas County’s engineer, Keith Browning, said “A conventional concrete culvert might take a couple of months to install, but for a bottomless culvert, it might take a few weeks and as little as one week to get the old structure out and the new culvert in.” Because the bottomless culvert is precast, once the site is prepared, the structure itself can be set in just one day, allowing traffic back on the road more quickly.

Although the price of a bottomless concrete culvert is competitive with other



Douglas County, KS

This bottomless culvert in Douglas County spans 16 ft. The floor of the culvert is the natural streambed, allowing easy passage for aquatic organisms.



options for large structures, Browning said a bottomless culvert can be easily installed by in-house construction crews, saving money on labor. And the shorter construction time creates labor advantages too. “The short construction period of three to four weeks allows our crews the ability to be accomplishing other county work during the construction season,” Browning said. “It is an efficient use of our manpower.”

A bottomless culvert’s environmentally-friendly design expedites environmental approvals. “If we used a traditional Reinforced Concrete Box structure (RCB), we would have to set it one foot below the flow line of the creek and then put in a foot of dirt so it would have a natural bottom,” Browning said. “It can be difficult getting one foot of dirt in

some RCBs.” Because aquatic organisms can pass through bottomless culverts, environmental officials favor them, Browning said.

Potential for scour

The downside to having water pass through any structure is potential scour, or erosion around the piers and abutments that can occur due to the velocity of water and turbulence during a flood event. While scour can occur at most culverts, bottomless culverts have a greater risk. Johnson County’s engineer Don Hovey explained that since bottomless culverts don’t have a concrete floor, the stream bed could erode and cause the footings to be undermined, which can then lead to the failure of the structure. A main concern for the design



Scour Research and Countermeasures for Scour at Bottomless Culverts

The Federal Highway Administration (FHWA) conducted research to validate and improve an existing methodology developed by the Maryland State Highway Association for estimating scour in bottomless culverts. Phase One of the study focused on measuring maximum scour depths at the culvert entrance and developing a procedure to approximate pre-scour hydraulic parameters. Phase Two expanded the investigation to include scour measurements at the entrance and outlets for submerged flow conditions. Results showed that scour is generally deepest near the corners of the upstream entrance to a culvert because of the contraction or narrowing of the water flow.

For more information on the FHWA case study, go to <http://www.fhwa.dot.gov/publications/research/infrastructure/hydraulics/07026/index.cfm#toc>

Contech Systems published an article by Colorado State researchers Scholl and Thornton that describes the process of scour at any structure and countermeasures that may be appropriate for a bottomless culvert. The researchers mentioned that riprap or grouted riprap might not be indicated in every case. Other options discussed include articulating concrete block (ACB) systems, concrete armor units, gabions, grout-filled bags and mattresses, and geotextile containers. (For more information, see the first link below, under "Sources.")

engineer then, is evaluating how the natural stream bed will react with the structure during all expected flows. Protective measures might be necessary to keep a bottomless culvert from scour, particularly at the entrance of the structure.

Preventing scour

Riprap can help prevent scour from happening. Hovey said that Johnson County has installed two bottomless culverts in the past two years, and so far has seen no signs of scour. "We put a bunch of riprap on the floor of the culvert because we knew we had to protect it against scour," Hovey said. "Big riprap interlocks and doesn't move, it protects the underlying substrate from moving up into the culvert." Hovey said riprap can also be used to correct an existing scour



Douglas County, KS

Douglas County uses a concrete leveling pad beneath each footing of the culvert structure to make sure the structure is level.

problem. See the sidebar above for other ideas for preventing scour at bottomless culverts.

Know your site

Browning said that before installing a bottomless culvert, you need to have good geotechnical information about the site. "It is important to hire a geotechnical firm to go out and classify the geological materials to determine whether you are dealing with rock or soil," he said.

Browning said that a bottomless culvert should only be placed when rock material or something extremely firm is fairly close to the surface. "It's important to make sure you have a leveling pad beneath the footing,"

Browning said. "We use rock and then bring a concrete leveling pad to the bottom of the footing to make sure it's all level."

Seven bottomless culverts have been placed in Douglas County. Browning,

Sources:

- Bryan N. Scholl and Christopher I. Thornton, Ph.D., P.E. Scour in Bottomless Culverts. Contech Construction Professional Development Series, December 2008. <http://www.conteches.com/Knowledge-Center/PDH-Credits/PDH-Article-Series/Scour-in-Bottomless-Culverts.aspx>.
- Bottomless Culvert Scour Study: Phase II Laboratory Report. FHWA. February 2007. <http://www.fhwa.dot.gov/publications/research/infrastructure/hydraulics/07026/index.cfm#toc>.
- FHWA Design Guideline 18: Riprap Protection for Bottomless Culverts. <http://www.fhwa.dot.gov/engineering/hydraulics/pubs/09112/page18.cfm>.
- Kansas Local Road Management Book: Definition of Scour. <http://www2.ku.edu/~kutc/pdf/files/KLRMHandbook2011.pdf>.
- Interview with Don Hovey, Johnson County, June 5, 2012.
- Interview with Keith Browning, Douglas County, June 4, 2012.



who first learned about these culverts from a vendor at the Kansas Asphalt Paving Conference, said there has been no scour issue since installing the bottomless culverts three years ago. Browning said the county plans to monitor the structures more closely than other types, especially after large run-off events. “Although the issue of scour is a concern to us, we know what to look out for,” Browning said. “In my opinion, the advantages to using a bottomless culvert outweigh the disadvantages.”

Hovey agrees with Browning, saying that although bottomless culverts are a little more expensive than cast-in-place structures, they work just as well and are quick to install. “The speed of installation is key,” he said. “Plus, during construction you don’t have to divert water from the main channel to install the floor.”

Where to purchase precast bottomless culverts

Check with your precast concrete vendor(s) to see if they carry this kind of culvert structure. Both Browning and Hovey purchased their bottomless culverts from Oldcastle Precast in Topeka. Browning said Douglas County recently purchased two more bottomless culverts from Cretex Concrete Products in Bonner Springs. Cretex’s sales director, Jason Duncan, said the company has also placed these structures in the City of Leavenworth.

If you have questions about the bottomless culverts placed in Douglas County and Johnson County, contact Keith Browning at kbrowning@douglas-county.com or Don Hovey at don.hovey@jocogov.org. ■

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