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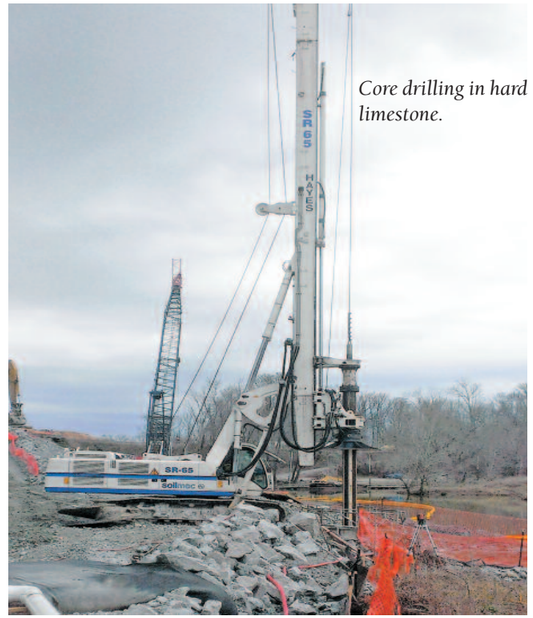
Hayes Expertise Landed The Harrods Creek Project

Aerial view of Harrods Creek Crossing.



Core drilling in hard limestone.

Hayes Drilling Crosses Harrods Creek With Ease

By Peggy Hagerty Duffy, P.E., ADSC Technical Advisor

The Louisville and Southern Indiana Ohio River Bridges project is a $2.6 billion public infrastructure endeavor consisting of two interstate bridges connecting Louisville, Kentucky, and several communities in southern Indiana. Construction of the bridges is being overseen and partially funded by the Federal Highway Administration (FHWA). The States of Kentucky and Indiana are providing public monies for the remainder of the costs.

Planning for the project has been in the works for over 20 years, as an outdated interstate system through the Louisville area has crippled regional transportation, including access for the Louisville hub of United Parcel Service, one of the company's largest. Most traffic between the states, both east-west and north-south, is required to travel through the heavily congested Spaghetti Junction in downtown Louisville, where Interstates 64, 71, and 65 meet. The new infrastructure will provide separate bridges for north and south traffic downtown, as well as an alternate bridge in the East End for access between rapidly developing parts of the communities on both sides of the Ohio River. The East End Bridge also will act as a trucking bypass and the hazardous materials route through the area.

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Concrete placement with 10" tremie pipe.

Pumping concrete at the creek bank.

The East End Bridge has included numerous obstacles and complications, and this part of the two-bridge project has accounted for many of the delays in allowing construction to start. The final alignment of the Kentucky approach extended through the historic Druminard Estate and was noted as an adverse environmental effect on the Environmental Impact Statement filed prior to construction. Opponents of the project used this factor as a reason to stall construction, but a plan eventually was formulated to construct a hard rock tunnel under the estate. This tunnel would connect to an intermediate bridge over Harrods Creek that would in turn lead to the main bridge span.

Five teams were invited to present proposals on the projects, which were divided between the two states. Kentucky is responsible for the Downtown Bridge, and Indiana is administering construction of the East End Bridge. Both bridges were designated as Design-Build jobs, with limited preliminary structural and geotechnical information. The Indiana Finance Authority chose to set the job up as a public-private partnership (P3). A joint-venture between Walsh Construction of Chicago, Illinois, Vinci Concessions of New York, New York, along with Bilfinger Berger PI International Holdings of Mannheim, Germany, was awarded the contract for the East End Bridge in December, 2012. The group, WVB East End Partners, began work in the spring of 2013.

Harrods Creek Crossing

The Harrods Creek crossing is a significant portion of the approach to the East End Bridge on the Kentucky side. This bridge would be a significant structure on most sites, but is just one part of the 1.4-mile approach, and a small part of the East End Bridge project as a whole. In addition, the dramatic hard rock tunnel just to the east has stolen much of the thunder from what is a challenging portion of the alignment due to hydrologic and geotechnical factors.

ADSC Technical Affiliate Member, Jacobs Engineering Group of St. Louis, Missouri, devised a foundation plan for the crossing using large diameter drilled shafts. Stantec's Louisville, Kentucky, office performed the geotechnical exploration, which encountered hard, thickly bedded limestone at relatively shallow depths. Each leg of the bridge piers was designed to be supported by four 72-inch drilled shafts socketed between 18 feet and 22 feet into limestone

WVB East End Partners has performed many of the tasks on this enormous project in-house. However, the tricky nature of the Harrods Creek crossing and the extremely tight overall project schedule led them to look to a specialty subcontractor with experience in difficult drilling. ADSC Contractor Member, Hayes Drilling Inc. had teamed with Haydon Bridge on several large diameter shaft projects in the past. The Haydon/Hayes team initially provided pricing to Walsh for the original design of the Harrods Creek bridge. During the negotiations, Haydon/Hayes was performing work near Radcliffe, Kentucky, on a bridge for the P&L Railroad, which consisted of 32 shafts, 96 inches in diameter with 90-inch diameter rock sockets. Sockets ranged from 20 to 25 feet long, with unconfined compression strengths of up to 22,000 psi

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Another shaft completed within tolerance and on location.

for the limestone penetrated. Walsh was invited to visit the project and observe the drilling and construction of the bridge. Impressed with the entire operation of this project, Walsh re-visited their design, and ultimately changed Harrods Creek to mirror the P&L bridge.

Experienced operators were key to successful rock coring.

Hayes Drilling has been constructing drilled shafts in the Ohio River Valley for many years. They have extensive experience with coring the hard limestone and dolomite present throughout the area. They also have installed many large diameter shafts, including numerous projects within flood zones.

Setting

The Harrods Creek basin is a highly complex geologic environment with complicated geomorphology. Frequent flash flooding within the creek, back charging from the Ohio River during high river events, and historic deposition by the river prior to construction of the McAlpine Locks and Dam, all combine to produce stratigraphy that changes frequently from location to location over short distances. Even though the work was scheduled to take place in the summer months to reduce the risk of high water events, Hayes' drilling plan was required to include contingencies for possible flash flooding and scour.

Permanent casing was critical to job completion.

Changes in the Work Plan

The first concern that arose during meetings with Haydon Bridge officials was the list of tolerances given to Hayes. Location tolerances were not to exceed 1-inch, and plumbness was not to vary from the vertical more than ¼-inch per foot, 6-inches maximum per total length. Haydon created a template for the shafts to provide the control needed to maintain such low tolerances. Four H-pile spuds were driven at each shaft location, and the template was lowered over the spuds. The shaft then was drilled using a ADSC Associate Member, Soilmec 625/SR65 drill rig until the sides would start to collapse. A casing was advanced from that point to rock using an HPSI vibratory hammer and the template as a guide.

WVB East End Partners representatives informed Hayes personnel part way through the job that the tolerance specifications had been misinterpreted, and the 1-inch tolerance referred to the reinforcing steel cage. Use of the template was abandoned after that point to expedite completion of the shafts.

Given Haydon/Hayes' experience with large-diameter shafts, they proposed to the project team that 90-inch sockets under 96-inch shafts could be used instead of the 72-inch shafts so that fewer shafts would be required. The number of shafts for the crossing decreased from 32 to 16, which cut a significant amount of money out of the overall project cost.

Hayes' final cost-saving modification involved elimination of a cofferdam proposed to be constructed around the four shafts to be drilled in Harrods Creek. Hayes representatives knew they could achieve the same conditions by installing four 12 foot diameter casings 20 feet deep around the shaft locations and linking

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On schedule and nearing completion.

them with a rip rap causeway. Haydon Bridge and WVB East End Partners approved this method that would provide savings in both the project budget and the schedule.

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The final plan agreed upon by all parties stated that Hayes would advance each excavation using an auger until the shaft sides began to collapse. Casing (96-inch in diameter and ¾-inch thick) then would be placed in the shaft and vibrated down to the top of rock. Coring equipment would be used to remove a 90-inch diameter rock socket to varying depths as shown on the plans.

Construction

Led by Superintendent Brent Francis, shafts were constructed using methods developed by Hayes Drilling, and work progressed on schedule. Shaft lengths varied from 17 feet to 64 feet, and sockets were 18 feet to 22 feet long, as per design.

The 1,706 cubic yards of concrete initially were classified as "mass concrete," and internal cooling devices were planned. But WVB East End Partners and Haydon Bridge representatives re-evaluated their methodology at the start of construction and instead proposed a high-fly ash mix design with a low water-cement ratio to maintain an internal temperature of 160ºF. This alternative course of action was approved by the project engineers, and a significant complication was avoided. Concrete was designed for a 28-day compressive strength of 5,000 psi, which has been achieved in those cylinders tested to date.

Casing was spiral-welded steel and was provided by ADSC Associate Member Skyline Steel. It was important to have reliable casing to advance the excavations using the methods outlined during the planning stages.

The site area was small, therefore Hayes had limited space for lay-down and staging. In addition, access to the project was via a single entrance from a narrow, two-lane road with heavy construction traffic from the adjacent portions of the East End Bridge project.

Some of the deeper shaft excavations reached practical refusal before rock was encountered. Slurry could not be used to install the casing in these shafts because of local regulations prohibiting the use of slurry within 1,000 feet of a water supply well. Hayes began the project attempting to install casing without slurry in these instances, but significant problems were encountered. Hayes pursued a more lenient interpretation of well-head protection rules after large amounts of time and money were needed to help advance casing into several shafts where refusal was encountered above the rock surface. Polymer slurry ultimately was approved for the job, and the work pace resumed at the original productive rate.

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All pumped water was filtered using multiple measures to ensure sediment was not discharged into the watershed. These measures included turbidity curtains, sediment bags, sediment retention ponds and the introduction of flocculent through a manifold system.

Rock removed from the sockets was thickly bedded and hard. Hayes employees were familiar with rock in the vicinity, and they knew removing cores from the large-diameter sockets would be difficult. They decided to remove a smaller core from inside the socket to effect removal of the larger volume of rock. Many of the cores still were withdrawn in large pieces. Other contractors on the site were impressed that such large chunks of rock could be extracted from the shafts in whole form.

Monitoring and testing are rigorous throughout the many pieces of the LSIORB project, and the Harrods Creek crossing was no exception. The Louisville branch of Patriot Engineering conducted routine monitoring, assisted by representatives of the Indiana Finance Authority. A mini-SID camera was required to make passes over the completed socket after cleaning was done in order to confirm that suitable socket conditions were present. The camera was used initially even when the sockets were dry and hand-cleaning was performed. Project quality control officials eventually agreed that use of the camera in dry circumstances was not necessary, particularly when hand-cleaning was being completed. Examination of the sockets using the min-SID still took place when water was present in the shaft excavations.

Cross-hole sonic logging was conducted in every hole, increasing the need for care in lifting the reinforcing steel cage and placing concrete. Test results indicated that no significant flaws or defects were present in the shafts.

Conclusions

Hayes Drilling completed the 16 shafts for the Harrods Creek crossing within the project schedule, even though delays outside of their control introduced a 6-week delay in the middle of the job. Construction began on March 1, 2014, and all shafts were completed by July 19, 2014. No significant flooding events were experienced during the length of the crossing foundation construction.

Perhaps the most obvious takeaway from the project by Haydon and WVB East End Partners was the value of experienced operators when constructing drilled shafts in difficult conditions. They were amazed that Hayes personnel had completed the job without breaking a single kelly bar, even given the large diameters of the shafts and the hard rock in the sockets. Myers responded by saying that excessive crowd will break even the strongest bars, a fact known by good operators. "You have to know how to let the tool do the work!" he said. "Inexperienced operators often break kelly bars when drilling large diameter holes in hard limestone."

It is likely that a number of construction professionals on this massive project were shown the value of utilizing a skilled specialty subcontractor, rather than self-performing simply because they have purchased or leased equipment. Hopefully, these same individuals will remember this benefit and engage an ADSC Contractor Member the next time they are looking for efficient, cost-effective quality project results.

Hayes' outstanding performance led to an invitation to perform additional work on the Downtown Bridge.

Myers credits the skills of his crews for completing the field work on time and with a quality product. He cites the expertise of Hayes Drilling with reworking the project plan to save the project time and money. The owner was happy, and Hayes put another profitable job under their belts. Myers grinned when he said, "You have no difficulties on a project when you do excellent work." It is likely that a number of construction professionals on this massive project were shown the value of utilizing a skilled specialty subcontractor, rather than self-performing simply because they have purchased or leased equipment. Hopefully, these same individuals will remember this benefit and engage an ADSC Contractor Member the next time they are looking for efficient, cost-effective quality project results.

ADSC

Project Team

Owner:	WVB East End Partners Walsh-Vinci-Bilfinger Joe DeFiore, Project Manager (Walsh-Vinci Construction, A Joint Venture)
Bridge Contractor:	Haydon Bridge Company Marshall Haydon, Project Manager Dave Pape, Site Superintendent Kevin Wolfe, General Superintendent
Foundation Subcontractor:	Hayes Drilling Company Craig Myers, Project Manager Brent Francis, Superintendent
Quality Control:	Patriot Engineering and Environmental Mike Vaught, Project Manager