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Pervious pad for motorcycles at OSU

The Ohio State University (OSU) has joined the many colleges and universities that are gaining experience in the use of pervious concrete pavement. Selected as a "starter site" to evaluate performance, two administrative divisions of OSU, the Department of Facilities Operations and Development, and the Department of Transportation and Parking, cooperated on the design and construction of a motorcycle parking pad paved with pervious concrete.

The motorcycle pad is located on the north end of the main campus in Columbus, OH, on Neil Avenue (within sight of Hitchcock Hall, the Civil Engineering building). Decker Construction Company, of Columbus, constructed the 8 ft by 50 ft parking pad.

Plans called for removal of the existing street pavement (asphalt and base layers) to a depth of 40 in., and replacement with a stormwater recharge bed (which consisted of 28 in. of No. 2 coarse aggregate, and a 4 in. choker course of No. 57's) and capped with 8 in. of pervious concrete. The plan also called for an installation of three monitoring ports with the intent to let OSU engineers and senior civil engineering students evaluate the performance of the pervious concrete.



OSU's facilities engineers, as well as engineering students, can monitor performance of pervious concrete at this motorcycle parking pad

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Unique bridge rising in Columbus



Finishing touches being put on west pier for an inclined arch bridge of Main Street over the Scioto River in Columbus

A state-of-the-art, signature bridge is beginning to take shape over the Scioto River in downtown Columbus. This showcase bridge will replace the aging Main Street Bridge built in 1937. The new bridge is referred to as an inclined arch. The main span

will consist of a single steel arch situated on one side of the 40 ft wide vehicular roadway with an 18 ft - 7 in. wide pedestrian/bikeway on the other side of the arch. The 400 ft long, 10 degree leaning arch will support transverse steel floor beams which in turn will support the deck and pedestrian walkway using a combination of compression struts and tensioned hangar cables.

When completed in 2009, this will be one of only five such bridges ever constructed in the world and the first in the United

States. The City of Columbus wanted a unique structure to showcase the downtown area and so they appointed Dr. Spiro Pollalis, professor at the Harvard University, Gradu-

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HOW'S YOUR BMP?

For post-construction stormwater management, will your chosen best management practice (BMP) capture, detain, cleanse and discharge water as well as pervious concrete pavement with detention?

To compare for yourself, you can begin by downloading (free) the Specifier's Guide for Pervious Concrete Pavement with Detention, at www.ohioconcrete.org, or call 614/891-0210 to request a copy.



Forming inclined face as pour progresses to assure full consolidation of concrete for pier footing

ate School of Design, to conceptualize the design. The Ohio Department of Transportation (ODOT), in partnership with the City of Columbus, chose the design team of DLZ Ohio, of Columbus, and HNTB Corporation, of Cleveland, for the final design.

The bridge is actually a three span structure. The main arch span is 400 ft long and has 131 ft - 6 in. spans on each end. The arch will rise from massive concrete piers at each end to a height of 80 ft. Even though it is a steel structure, there is plenty of cast-in-place concrete supporting it (about 19,000 yd³). The abutments are founded on six 6 ft diameter drilled shafts 80 ft deep and the piers (which support the arch) are founded on nine 5 ft-6 in. diameter drilled shafts 80 ft deep into bedrock.

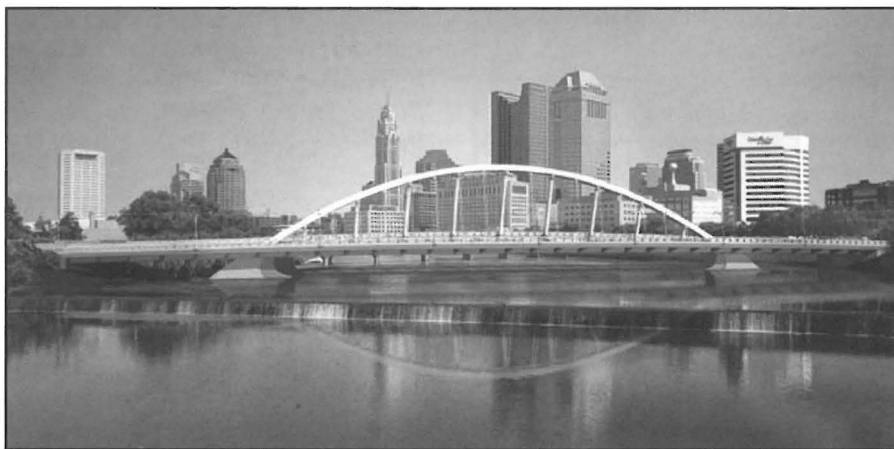
Each pier is resting on a footing on top of the drilled shafts. The piers were a forming challenge. The river sides of the piers have

a curved vertical face (similar to the shape of a snow plow blade). The bank sides of the piers have a relatively flat incline which will blend in with the profile of the arch. The sides are inclined outward (wider at the top than at the bottom.) The two 14-ft thick monoliths are heavily reinforced with No.18 bars, and each required about 920 yd³ of concrete. Due to the massive amount of concrete, tubes for cooling the fresh concrete with water pumped from the river, were incorporated into the pour.

For this project, cast-in-place concrete strength requirements range from 4,000 psi to 6,000 psi, depending on the specific element of the bridge. All concrete is specified to be QC/QA (Quality Control/Quality As-

surance), meaning that the contractor/concrete producer can choose their own mix designs as long as the required strength, air content and permeability is met.

Bids for this project were opened in June of 2006 with a completion date of June 2009. Kokosing Construction Company Inc., of Fredericktown, OH, won the job with a bid of \$45 million. ODOT District 6 is providing construction inspection and administration on the project. Other players on the team include Janssen & Spaans Engineering, of Indianapolis, who is the Construction Engineer, and Dick Corporation, of Cleveland, providing Construction Management services to ODOT. Concrete for the project is being supplied by Anderson Concrete Corp., of Columbus, with concrete testing performed by CTL Engineering, Inc., also of Columbus.



The single steel arch of Main Street Bridge will incline 10 degrees from vertical toward the viewer of this artist's rendering

200 foot, single span bridge with concrete girders



Casting a concrete girder in Columbus

Mr. Clyde Willis, PE, PS, the Scioto County Engineer, has now replaced two aging steel truss bridges without using another truss and without using piers in the stream. His solution was to build the new bridges with prestressed, spliced concrete girders, and cast in place concrete decks.

By his design, the bridge superstructure is made up of four prestressed, spliced concrete girders. The girders are actually 199 ft -6 in. long and are spaced at 8 ft centers. The girders are bulb tees 8 ft-7 in. deep with a 5 ft-1 in. wide top flange and a 2 ft- 2 in. wide bottom flange. Each is cast with 4 ducts

to accommodate draped post-tensioning strands.

Each girder line is comprised of two girder sections which are spliced in the field after erection. One section is 122 ft -3 in. long and the other is 70 ft- 3 in. long. The girders are erected end-to-end and supported on temporary shoring at the splice point. A cast-in-place concrete closure pour is made and after necessary strength gain is achieved, the ends are post-tensioned together. After the girders are erected and tensioned, an 8 ½ in. thick reinforced concrete deck is cast on galvanized steel stay-in-place forms.

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200 ft Single Span Bridge, Continued from Page 4

The latest project, County Road 48 (Arion Rd.) over Scioto Brush Creek, is also unique because the substructure is founded on 14 in.-square prestressed concrete piling. This was one of the first bridge projects in Ohio to utilize prestressed concrete piling. The advantage of the concrete piling over conventional steel piling is its availability from local precasters and the ability to install lengths up to 65 ft without splicing.



No piers in the stream required with 200 ft long spliced concrete girders

The Arion Road project was a design-build project with CJ Mahan Construction, of Grove City, OH, as the contractor and Janssen & Spaans Engineering, Inc., of Indianapolis, IN, as the designer. Ready mixed concrete for the girders was supplied by Anderson Concrete Corp., to the Prestress Services Industries yard in Columbus. Ready mixed concrete for the abutments and deck was supplied by Hanson Aggregates Davon, Inc. (Chattin Ready Mix) of Piketon OH.

LEED program, Continued from page 6

“With \$4.1 billion targeted for school facilities under Governor Strickland’s Tobacco Securitization plan, the Commission’s action means that more than 250 buildings will be registering for LEED Silver Certification within the next two years.”

Use of pervious concrete pavement, such as the recent installation for a sidewalk at the new Bowsher High School, in Toledo, may help other OSFC- funded school projects attain LEED credits. The work was performed by Smith Paving and Excavating, Inc., of Norwalk, OH, with concrete supplied by the Kuhlman Corp.

New Parking Lot Show piece, Continued from page 7

The pervious concrete parking lot is a storm water management system that captures the “first flush” of storm water, provides cleaner runoff, filters and treats pollutants by naturally occurring microbes, lowers the heat island effect and prevents the hotter runoff water from damaging ecosystems. Storm water will pass through the 6 in. thick section of pervious concrete and into the aggregate storage layer. From there, the water may percolate into the subgrade or flow to an existing storm sewer via a 4 in. diameter perforated pipe underdrain. According to Mark Pardi, one of Anderson’s engineers, “A pervious concrete parking lot like this could help an architect, who is seeking Leadership in Energy and Environmental Design (LEED) certification for his design project, to attain four LEED credits and help achieve six others.”

Anderson’s new concrete parking lot has three drive aisles of conventional concrete, 20 ft wide by 80 ft long, and six lanes of pervious concrete for parking stalls, 20 ft wide by 80 ft long. All of the pavement was



Pleasant contrast of buff colored pervious concrete parking stalls and bright white drive aisles of conventional concrete (with striping of Anderson orange)

placed over a 6 in. layer of open graded clean coarse aggregate for stormwater storage. A geotextile fabric placed on the subgrade will allow some water to pass into the soil, but prevent fines from contaminating the aggregate storage layer.

Burgess & Niple, LTD., of Columbus, performed the design and layout for the new concrete parking lot and adjoining concrete walks and curbs.

City crew installs, Continued from page 7

a drainage rate of between 3 and 5 gal. per min., for each square foot of sidewalk. By their design, water detained beneath the pervious concrete pavement, will percolate from the aggregate layer into the sandy subgrade, or flow directly into a rain garden constructed between the sidewalk and the street.

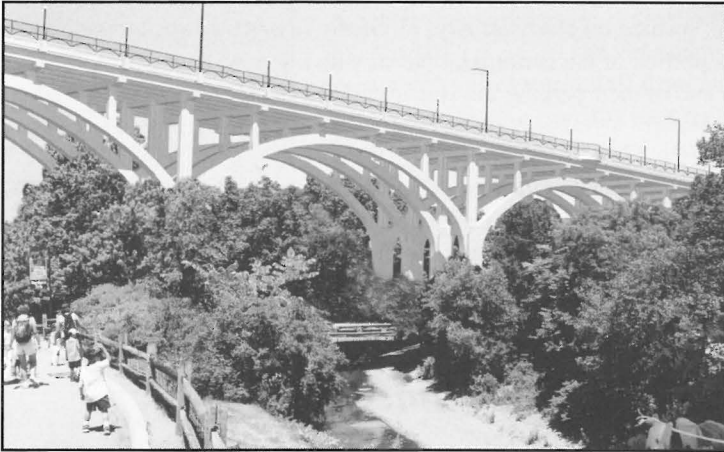
Ernst Enterprises, Inc., of Dayton, supplied the concrete from their plant in West Carrollton, OH. As produced, the mix actually had about 22 percent voids. Ernst used chemical admixtures to assist in the placement on that warm summer day (August 23rd), that included a retarder and superplasticizer, by Euclid Chemical Co. Prior to placement, City personnel received a short training session on proper pervious concrete placement and used rollers provided by ORMCA for pervious concrete pavements.



Storm water from parking lot will be detained beneath pervious concrete walk then percolate into subgrade or flow into rain garden between walk and curb

At this writing, the City of Moraine was scheduled to host a Southwest Ohio Pervious Concrete Demonstration and Contractor Certification Course, on October 25, 2007.

High-tech concrete for a high bridge in Cleveland



Artist's rendering of Fulton Road Bridge from the Cuyahoga County Engineer's website www.cuyctyengineers.org

The Ohio Department of Transportation (ODOT) District 12 is currently administering construction of a 1,561 ft long, concrete arch bridge that will tower about 110 ft over the Cleveland Metroparks Zoo, and two active railroad lines. Aesthetically speaking, the new bridge will be a same-site replica of the open spandrel deck concrete arch bridge that had been admired by Zoo visitors since 1932. Major unseen differences are ongoing in the concrete technology being used to build the new structure.

The Cleveland office of Michael Baker Jr., Inc., designed the contemporary precast

concrete arch structure that will be the new Fulton Road Bridge. With a deck width of 81 ft (four lanes of traffic, two bike lanes and two sidewalks), the new bridge is replacing a structurally deficient and functionally obsolete 75-year structure whose 63 ft wide deck had been reduced to two lanes of traffic due to safety concerns. The new structure will have eleven spans (six are arches) and four arch ribs per arch span. About 20,000 yd³ of cast-in-place concrete will be required for the drilled shaft foundations, substructure and superstructure. That work will include high-strength, self-consolidating, mass concrete with maturity monitoring for the arch pier thrust blocks.

This is District 12's first project to use the ODOT Quality Control/Quality Assurance Supplemental Specification 898 *QC/QA Concrete for Structures*. Kokosing Construction Company, Fredericktown OH, is

the project's general contractor. Concrete testing is being performed by the Cleveland office of Ohio-based, CTL Engineering, Inc., with CTL Group, of Skokie IL, as their subconsultant for mass concrete.

CTL Engineering is providing the quality control testing services for Kokosing, including: quality control plans for QC/QA, laboratory concrete testing and concrete maturity testing, concrete mix design verification, concrete maturity curve development, mass concrete thermal control plans and QC/QA concrete testing in the field.

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Each arch pier thrust block will require about 500 yd³ of high strength self consolidating mass concrete.

Large arch to new residential development



Installing a precast concrete arch for River Run development in Powell

When access across a picturesque, rock lined stream, was needed for creation of a new residential community in the wooded hills of Powell OH, the developer chose a large concrete arch.

River Run residential development was designed for Cugini and Capoccia Builders, of Lewis Center. Entrance to the site was to be gained from Jewett Road by crossing Bartholomew Run, approximately 40 ft above its flow line. Due to the pristine setting of the surrounding area, there was a need to not disturb the existing rock channel stream bed. The preferred crossing solution was a concrete arch type structure.

The arch itself is a 78 ft wide, sectional, precast concrete structure with a 54 ft span and a 20 ft rise.

Thirteen 6-ft wide arch sections were furnished in two parts. The wall thickness of each arch section is 12 in., but thickens to 18 in. at the top where the two halves are connected with a cast-in-place concrete closure pour.

Construction first involved excavating into the rock channel banks (above the stream bed) and a sub-footing constructed with cast-in-place concrete. This was followed by a 3 ft thick and 6 ft- 6 in. wide cast-in-place foundation wall constructed with a 9

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Arch segments were permanently united at the top by a 6 ft wide 12 in thick closure pour

Large arch, Continued from Page 5

in. deep keyway on top. Foundations for precast wingwalls of the arch had pedestal walls with heights of 10 ft. Approximately 445 yd³ of cast-in-place concrete was used for foundations.

The arch section halves were delivered and set in place with the use of two cranes. The sections were supported on temporary falsework at the center of the stream. After they were set in place and supported, a 6 ft wide x 12 in. deep closure pour was cast across the top of the boxed out recesses at the top of the arches. The closure pour encapsulated reinforcing steel protruding out of the precast sections. After the closure concrete reached design strength, the shoring was removed, the joints were waterproofed, and backfilling with granular material proceeded. Backfilling is critical for a

structure of this type. It must be placed in lifts and uniformly compacted. The fill on both sides of the arch must also be brought up simultaneously to equalize the pressure on the arch segments.

When completed, anyone driving into the development will not be aware of the immensity of this structure, unless they park and purposely walk down the rather steep embankments.

The designers for this project were Bauer, Davidson & Merchant, Inc. (BD&M), of Lewis Center. Buckeye Ready-Mix, LLC, of Reynoldsburg, supplied the foundation concrete, the closure pour concrete and the grout for the keyways. The arch structure



Completed concrete arch structure merges well with natural surroundings

(known as a BEBO arch) was provided by CONTECH Bridge Solutions from their plant in Huber Heights, OH. Trucco Construction, of Powell, was the general contractor for this project.

High Tech Concrete, Continued from Page 5

For the mass concrete work, CTL Engineering performed specialized material testing (adiabatic temperature rise, thermal expansion, elastic modulus, compressive and split tensile strengths) used to develop the thermal control plans including performance-based temperature difference limits. CTL Group designed the thermal control system and wrote the thermal control plans.

Mass concrete is being used for the arch pier footings, the arch pier bases above the footings and the arch pier thrust blocks. The project's seven arch pier footings average over 500 yd³ each of QSC1M, 4,000 psi mass concrete. Five of the arch piers have four pier bases each below the thrust blocks, one for each arch rib, averaging over 100 yd³ each of QSC1M, 4,000 psi mass concrete. Each of the seven arch piers has four arch pier thrust blocks. Internally, the thrust blocks are highly congested structures, heavily reinforced with large diameter steel bars, plus post-tension tendon ducts, mass concrete cooling tubes and block-outs for intentional voids. Each thrust block averages over 90 yd³ of QSC3MSCC, 7,000 psi self-consolidating (SCC) mass concrete.

The thermal control plans for mass concrete require that the internal and external concrete temperatures be monitored and controlled until the internal temperature is within a 35 degree temperature difference limit of ambient temperature. Pre-cooling of the fresh concrete and internal cooling of the hardened concrete is used to keep the internal temperature below a maximum 155° F

and to reduce the temperature control period. A higher, performance-based, temperature difference limit can further reduce the temperature control period based on the actual strength of the concrete in-place. Maturity testing is being used to estimate the strength of the concrete in-place at any given time.

After the mass concrete work, there will be many small but critical closure placements for the arch segments, followed by the spandrel frames above the arches, and then the deck, to be of cast-in-place concrete. The precast, post-tensioned concrete arch segments for each of the six spans require sixteen arch closures of less than 2 yd³ each of QSC3 concrete designed for 7,000 psi at 7 days of age. The arches require twelve struts for each of six spans with two closures for each strut for 144 closures of less than one yd³ each of QSC2, 4,500 psi concrete. More than 50 placements of QSC2 concrete are needed for the spandrel frame between the arches and the deck, which along with the arches will give the bridge its open, airy appearance. Six placements



Congestion of reinforcing steel, post-tension tendon ducts and mass concrete cooling tubes made SCC a necessity for the thrust block pours on new Fulton Road Bridge

will be required to complete the concrete deck, and will total 4,600 yd³ of QSC2, 4,500 psi concrete. Finally, concrete sidewalks on both sides of the bridge with lookouts above the zoo, and ornamental fence and parapets, will complete the structure.

The bridge is expected to be completed and open to traffic by mid-December 2009.

SS 898 classes of concrete for the Fulton Road Bridge:

Class	Compressive Strength (28 day)	Permeability	Description
QSC1	4,000 psi	2000 coulombs	Mass Concrete
QSC1M	4,000 psi	2000 coulombs	
QSC2	4,500 psi	1500 coulombs	
QSC3	7,000 psi at 7 days	2000 coulombs	Mass Concrete, SCC
QSC3MSCC	7,000 psi	2000 coulombs	