Slag Cement Association 2015 Project of the Year Awards

The Slag Cement Association (SCA) presented the 2015 Project of the Year Awards on April 18, 2016, during the Technical Session, "Use of Slag Cement in Notable Structures, Part 2," at The ACI Concrete Convention and Exposition – Spring 2016, in Milwaukee, WI. The awards recognize projects for excellence and innovation in concrete using slag cement. Nine projects received 2015 Awards in the categories of Architectural Design, Durability, Green Design, High Performance, Innovative Applications, and Sustainability.

Architectural Design

Children's Hospital of Richmond

Children's Hospital of Richmond at Virginia Commonwealth University (VCU) is a multi-story, 640,000 ft^2 (59,500 m^2), high-tech outpatient pavilion for pediatric services. As an oasis for children, the new space features a James River theme incorporating naturalistic elements of light and green space.

Slag cement was used at 60% of total cementitious material content for the 11,000 yd^3 (8400 m^3) of mass concrete in the mat foundation. Slag cement was also used at 40% in 3500 psi (24 MPa) pumped structural lightweight concrete and in low-permeability, 5000 psi (35 MPa) pumped structural concrete for the parking garage. Mass concrete specifications required strengths of 5000 and 7000 psi (48 MPa) and included maximum and differential temperature limits of 160 and 35°F (71 and 19°C), respectively. The mixture needed to have a self-consolidating consistency to move through 6 to 7 ft (1.8 to 2.1 m) of congested reinforcement with limited external consolidation. Concrete was placed in four placements using three concrete plants to supply the required 300 to 400 yd^3/h (229 to 305 m^3/h) within the time constraints of driver hours of service regulations and downtown overnight road closures. All concrete met 28-day strength requirements, temperature specifications, and not a single load was lost due to delivered quality.

Project credits: Children's Hospital of Richmond at Virginia Commonwealth University, Owner; HKS, Inc., Architect; Dunbar, Milby, Williams, Pittman & Vaughan, PLLC, Engineer; Skanska USA Building, Inc., Construction Manager; Cleveland Cement Contractors, Contractor; Vulcan Materials Company, Concrete; and LafargeHolcim, Slag Cement.

Children's Hospital of Richmond, VA, at VCU

Jade Signature

Designed by architects Herzog & De Meuron, Jade Signature in Sunny Isle Beach, FL, provides an inspiring example of architectural use of concrete to create a unique living space in this beautiful beachfront environment. Slag cement was used in deep soil mixing, the mat foundation, and the superstructure.

Deep soil mixing allowed for the efficient construction of the belowground parking area. The in-place soil was mixed with a slag cement:portland cement slurry that contained 80 to 90% slag cement. This mixture proportion was used to solidify the entire base of the project and allowed for the parking garage to be constructed in very difficult, high water table conditions.

Rendering of Jade Signature, Sunny Isle Beach, FL

Arlington River Bridge on University Boulevard, Jacksonville, FL

The mat foundation required high-strength, 10,000 psi (69 MPa) mass concrete with 60% slag cement. The 9800 yd^3 (7500 m^3) of mass concrete was placed in 18 hours. In the superstructure, virtually all of the concrete contains slag cement used at between 50 and 60% to achieve specified strengths from 3000 to 8500 psi (21 to 59 MPa), depending on the application.

Project credits: Fortune International Group, Owner; Herzog & De Meuron, Architect; McNamara/Salvia, Inc., Malcolm Drilling, and Capform, Inc., Contractors; Supermix Concrete, Concrete; and Lehigh Cement Company, Slag Cement.

Durability

Arlington River Bridge on University Boulevard

The Arlington River Bridge on University Boulevard in Jacksonville, FL, replaced an aging bridge with a new two-lane concrete bridge that has 6.5 ft (1.9 m) wide sidewalks, 4 ft (1.2 m) wide bicycle lanes, decorative lighting, and architectural railings. The Florida Department of Transportation (FDOT) required uninterrupted vehicular traffic and pedestrian access to the mainland and continued marine traffic during construction. Therefore, the project entailed construction of a temporary bridge, demolition of the existing bridge, construction of the new permanent bridge, and removal of the temporary bridge.

To enhance sustainability and durability in this saltwater environment exposed to constant tidal action, 60% slag cement was used in a ternary concrete mixture with 30% portland cement and 10% fly ash. Used in the bridge deck as well as the architectural railing, this concrete mixture design exceeded FDOT's specified surface resistivity criteria and strength requirements. Durability and strength objectives were achieved at a reduced environmental footprint because slag cement is a recycled material. Slag cement provided consistent concrete performance and a lighter color concrete.

Project credits: Florida Department of Transportation, Owner; Parsons Transportation Company, Civil Engineer Consultant; Aracadis, Engineer; Superior Construction Company, Contractor; Argos Ready Mix, LLC, Concrete; and Argos USA, Slag Cement.

City of Clyde Waste Water Treatment Plant Flow Equalization Basin

The City of Clyde, OH, installed a 1 million gal. (118,000 L) flow equalization basin at the city's wastewater treatment plant. The basin's inside dimensions measure 120 ft long x 100 ft wide x 14 ft deep (36 x 30 x 4.2 m). During high incoming flow events, excess flow is screened in the combined sewer overflow (CSO) diversion chamber and is directed to the basin

by gravity. Plant personnel can drain the basin by gravity using the plant's supervisory control and data acquisition (SCADA) system. An automated tipping bucket flushing system is used to flush accumulated solids and debris from the basin floor.

The monolithic placement of a 1950 yd^3 (1300 m^3) mat foundation for the bottom of the equalization basin was 4 ft thick x 105 ft wide x 125 ft long (1.2 x 32 x 38 m). Slag cement helped reduce thermal stress in the mass concrete. Slag cement was used at a 40% replacement level in the mat foundation basin floor and at a 25% replacement in basin walls. The aggressive environment this wastewater treatment application entails requires a durable concrete. Use of slag cement in basin floor and walls met specified strength criteria, provided desired sulfate resistance, reduced permeability, and reduced susceptibility to alkali-silica reaction (ASR).

Project credits: City of Clyde, OH, Owner; GGJ, Inc., Engineer; Adena Corporation, Contractor; Huron Cement Products Co., Inc., Concrete; and St Marys Cement Inc. (U.S.), Slag Cement.

Wastewater Treatment Plant Flow Equalization Basin, Clyde, OH

Green Design

Heritage Cooperative Agricultural Campus and Research Farm

The Heritage Cooperative Agricultural Campus and Research Farm in Marysville, OH, is built on a 277 acre (112 ha) site. It includes an express unit grain terminal, which holds 1.5 million bushels of grain; a 30,000 ton (27,000 tonne) dry fertilizer warehouse; and a 10,000 ton (9000 tonne) liquid nitrogen fertilizer storage with distribution services 24 hours a day, 7 days a week. Over 20,000 yd^3 (15,000 m^3) of concrete, with nearly all of it containing slag cement, was used—including 5600 yd^3 (4300 m^3) for slipformed silos that took 7 days to complete, working 24 hours per day.

The wall forms were on a timer and moved 1 in. (25 mm) every 4 to 6 minutes. Consistent stiffness and setting time were needed to maintain that pace of construction. The slag cement concrete mixture actually allowed the contractor to speed up the slipform construction process. Prior to construction, the owner was concerned that they would have to paint the silos to achieve desired uniformity in color. However, the slag cement concrete mixture provided an attractive, uniform, light color without painting.

Project credits: Heritage Cooperative, Owner; Hogenson Construction Company, Architect; Sunfield Engineering, Engineer; Hogenson Construction Company, Contractor; Ohio Ready Mix, Inc., Concrete Supplier; and St Marys Cement Inc. (U.S.), Slag Cement.

Heritage Cooperative Agricultural Campus and Research Farm, Marysville, OH

Tilikum Crossing Bridge

At 1700 ft (518 m) in length, Tilikum Crossing, in Portland, OR, is referred to as the "Bridge of the People," and is the first bridge of its kind in the United States. A cable-stayed bridge, with two piers in the water and two on land, Tilikum Crossing is designed to carry light-rail trains, buses, street cars, cyclists, and pedestrians, but not automobiles.

Slag cement was used in the high-performance concrete on the bridge to increase durability. The mixture proportions for the girder sections required 3500 psi (24 MPa) at 18 hours and 8000 psi (55 MPa) in 56 days. There were no low strength tests on this project. The mass concrete contained 50% slag cement to lower heat of hydration. The use of slag cement contributed to achieving the lighter color desired by the designer without using white cement. The reliable supply and performance of slag cement consistently provided specified concrete plastic properties. In addition, use of slag cement reduced the carbon footprint of the project, contributing to achieving the desired green design, sustainable development objectives for this mass-transit centered structure.

Project credits: TriMet, Owner; Donald McDonald Architects, Architect; T.Y. Lin International Group, Engineer; Kiewit Infrastructure West Co., Contractor; Ross Island Sand & Gravel, Concrete; and Ash Grove Cement Company, Slag Cement.

Tilikum Crossing Bridge, Portland, OR

432 Park Avenue, New York, NY *(photo courtesy of Citizen59, Wikimedia Commons)*

High Performance

432 Park Avenue

Topping out at 1396 ft (425 m), 432 Park Avenue, New York, NY, is the tallest residential building in the Western Hemisphere. While 432 Park Avenue is second in overall height to One World Trade Center, it is the tallest building in New York City when measured from rooftop height. The structure is reinforced cast-in-place concrete. Architecturally exposed white concrete columns and a central shear wall core support the building. Other than its height, this building is unique due to its slenderness ratio of 15:1.

To provide the required concrete performance for the structural design, 14,000 psi (97 MPa) concrete was specified for the foundation and part of the superstructure. High-performance concrete criteria included heat reduction in the mass concrete placements, high strength for structural performance, superior rheology for pumping concrete, and a reduced environmental footprint to achieve sustainable design objectives. A high-performance concrete mixture, with a cementitious material content of 55% slag cement, 30% portland cement, 11% fly ash, and 4% silica fume, was developed to meet demanding specification and construction requirements. Laboratory strengths of over 18,000 psi (124 MPa) were achieved with this mixture. This high-performance concrete design represents a new era of building design where optimizing the use of supplementary cementitious materials (SCMs) can enable the construction of tall slender buildings in large cities with scarce and valuable lot space.

Project credits: McGraw Hudson, Owner; SLCE Architects, Architect; WSP Global, Engineer; Lend Lease, Contractor; Jenna Concrete, Concrete (foundation), Ferrara Brothers Concrete, Concrete (superstructure); and LafargeHolcim, Slag Cement.

Innovative Applications

I-79/I-70 South Junction

The I-79/I-70 South Junction Interchange Improvement Project in South Strabane Township, Washington County, PA, eliminated a severely curved connector ramp and replaced it with a large nine-span flyover bridge and new ramp system. The existing curved ramp had been the site of numerous accidents.

To improve safety, an innovative box culvert redesign alternative to the "as-designed" rehabilitation of the two mainline bridges carrying I-70 over the ramp to I-79 South eliminated the requirement for mainline crossovers on a curve during reconstruction. This innovative alternative solution not only enhanced construction efficiency but it also improved traffic flow and safety during construction and simplified future planned mainline reconstruction of I-70.

Innovative design and construction solutions were complemented by use of slag cement at a 50% replacement level in both self-consolidating concrete (SCC) and mass concrete mixtures. SCC was used for drilled shafts, while mass concrete was defined as any concrete element with a minimum dimension of 6 ft (1.8 m) or greater, including drilled shafts and pier caps. The 50% slag cement mass concrete mixture aided in meeting the thermal control plan for mass concrete placements and allowed discontinuing temperature monitoring of mass concrete elements earlier than expected. The 50% SCC mixture met specified flow, penetration, segregation resistance, visual stability index, strength, permeability, and freezing-and-thawing durability performance requirements.

Project credits: Pennsylvania Department of Transportation, Owner; HDR Engineering, Project Engineer; Mackin Engineering, Engineer (culvert redesign); Golden Triangle Construction, Contractor; Golden Triangle Construction, Concrete; and Essroc Italcementi Group, Slag Cement.

Sustainability

JFK International Airport Runway 4L-22R Reconstruction

The $267 million Runway 4L-22R Runway Safety Compliance and Reconstruction Project, at JFK International Airport, New York, NY, consisted of rehabilitating the existing asphalt runway with a concrete overlay. The existing runway was milled approximately 6 in. (150 mm) deep; then a 2 in. (50 mm) leveling course of asphalt was used prior to the placement of the 18 in. (454 mm) concrete overlay. A full-depth 18 in. concrete pavement was used to widen the runway by 50 ft (15 m) and add an extension of 700 ft (212 m) for a final 12,700 x 200 ft (3900 x 61 m) runway with 40 ft (12 m) wide shoulders. This rehabilitation and widening project enhances the efficiency of the airport and 4L-22R will handle about 25% percent of the annual operations.

Concrete specifications for this project required a minimum flexural strength of 700 psi (5 MPa) at 28 days with a maximum cementitious material content of 550 lb/yd^3 (296 kg/m^3). The specifications also required a low chloride permeability as measured by the rapid chloride permeability test. The Port Authority Materials division recommended using slag cement as part of the mixture proportions because slag cement increases flexural strengths, reduces the concrete permeability, and makes the concrete more resistant to ASR. To achieve the concrete pavement slipform construction requirements and meet the contract specifications, a Type IS (40) cement was used in the concrete mixture. ASTM C595/C595M Type IS (40) designates a portland blast-furnace slag cement that contains 40% slag. Laboratory mixture proportion testing yielded a 28-day flexural strength of 1300 psi (9 MPa). This concrete mixture met performance requirements for constructibility, strength, durability, and smoothness—all at a reduced environmental impact.

Project credits: Port Authority of New York and New Jersey, Owner; Port Authority of New York and New Jersey – Materials Division, Engineer; Tutor Perini Corporation, Contractor and Concrete; and Lehigh Cement Company, Slag Cement.

SCA represents companies that produce and ship over 90% of the slag cement (ground-granulated blast-furnace slag) in the United States. Through a program of promotion, education, and technology development, SCA communicates the performance and sustainable benefits of this cementitious material to stakeholders throughout the construction industry. More information is available at **www.slagcement.org**.

I-79/I-70 South Junction Interchange, Washington County, PA

JFK International Airport – Runway 4L-22R Reconstruction, New York, NY