Slag Cement Association 2014 Project of the Year Awards

The Slag Cement Association (SCA) presented the 2014 Project of the Year Awards during the meeting of ACI Committee 233, Ground Slag in Concrete, at The ACI Concrete Convention and Exposition—Spring 2015 in Kansas City, MO. The awards recognize projects for excellence and innovation in concrete using slag cement. Nine projects received awards in the categories of Architectural Design, Durability, Green Design, High Performance, and Sustainability.

Architectural Design

I-95 Pawtucket River Bridge

The Interstate 95 Pawtucket River Bridge project entailed replacing three separate structures with a bridge to carry I-95 northbound and southbound lanes and the on- and off-ramps to George and School Streets. Inspiration for the bridge's art deco design came from other landmark structures in Pawtucket, RI, built during the Great Depression, such as City Hall, McCoy Stadium, and Shea High School. The new bridge's four pillars feature representations of art deco wings on the eagles chiselled atop the tower at City Hall. The bridge, illuminated at night with colored light-emitting diode (LED) lighting, displays a graceful arch over the Pawtucket River.

Slag cement was used in all 25,000 yd^3 (19,100 m^3) of concrete required for this $81 million bridge project. For mass concrete placements, mixtures used 50% slag cement to control the heat of hydration and thermal cracking. The high-performance concrete for the bridge deck and all other regular and high-strength mixtures required 40% slag cement for increased durability, strength, and reduced permeability—all important performance characteristics for concrete exposed to harsh New England winters. The slag cement also made the concrete lighter and brighter, enhancing the architect's vision and improving the brightness and reflectivity of the lights installed on the bridge, enabling it to win the 2014 Illuminating Engineering Society 2014 Illumination Award of Merit. Another national recognition was the 2014 American Transportation Under Budget Award from the American Association of State Highway and Transportation Officials (AASHTO).

I-95 Pawtucket River Bridge, Pawtucket, RI

Project credits: State of Rhode Island, Owner; Northeast Collaborative Architects, Architect; Abernathy Lighting Design, Lighting; Commonwealth Engineers & Consultants, Inc., Engineer; S&R and Pihl A Joint Venture LLC, Contractor; Cardi Materials LLC, Concrete; and Lafarge North America, Slag Cement.

Durability

I-96 Reconstruction

The I-96 Reconstruction project near Livonia, MI, entailed closure of 7 miles (11 km) of the eight-lane freeway, six full-service interchanges, and on- and off-ramps. In addition to full-depth pavement reconstruction, a total of 37 bridges were either rehabilitated or replaced. New LED lighting was added to brighten the freeway and provide better visibility and energy efficiency. Work was completed in 5.5 months—approximately 4 weeks in advance of schedule.

I-96 Reconstruction, Livonia, MI

Pinellas Bayway Bridge, St. Petersburg, FL

Akron Children's Hospital Critical Care Tower, Akron, OH

Slag cement was used in concrete mixtures for the pavements and bridges. The pavement portion of the project used 42,000 tons (38,100 tonnes) of portland cement and 20,000 tons (18,100 tonnes) of slag cement. Over 30% slag cement was needed to provide mitigation of potential alkali-silica reaction (ASR) as required by the Michigan Department of Transportation (DOT) concrete specifications. This mixture met required flexural and compressive strengths. Use of slag cement resulted in a lighter appearance for enhanced night-time visibility. The consistency and performance reliability of the mixture also contributed to rapid completion of the project.

Project credits: Michigan DOT, Owner; HNTB and Parsons & Brinckerhoff, Engineer; Dan's Excavating, Inc., Contractor; Ajax Paving Industries, Concrete Supplier; and St Marys Cement, Slag Cement.

Durability

Pinellas Bayway Bridge

The Pinellas Bayway Bridge provides a 65 ft (20 m) clearance bridge structure that replaces a 50-year-old, two-lane drawbridge with a new four-lane fixed-span bridge that accommodates an increased flow of traffic. The new Pinellas Bayway not only makes travel from St. Petersburg, FL, to St. Petersburg Beach easier by car but it includes a 12 ft (3.5 m) wide pedestrian walkway separated from traffic by a barrier wall. This aspect of the bridge was celebrated as part of the grand opening ceremonies in October 2014 with a "Bayway Bridge Bash" that culminated in a sunset 5K run/walk on the multi-use trail.

Slag cement was used in concrete mixtures for footings, columns, decks, and barrier walls. A mixture of 50% slag cement and portland cement provided reduced permeability and increased durability as required by the Florida DOT for this saltwater marine exposure, and met the specified 5500 psi (38 MPa) compressive strength requirement. Slag cement provided consistent concrete performance and a lighter-colored concrete.

Project credits: Florida DOT, Owner; URS Corporation Southern, Engineer; Orion Marine Group, Inc., Contractor; Argos Concrete, Concrete; and Argos Cement USA, Slag Cement.

Green Design

Akron Children's Hospital Kay Jewelers Pavilion

The Kay Jewelers Pavilion at Akron Children's Hospital is a $200 million expansion of its Akron, OH, campus to meet the current and future needs of children and their families. The project includes 63,000 ft^2 (5850 m^2) of slab-on-ground and 337,000 ft^2 (31,300 m^2) of 15 in. (380 mm) flat-plate concrete structural frame. The project was designed using LEED Silver Design concepts from the USGBC LEED for Healthcare, incorporating points from Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Innovation, and Design Process.

The engineering team worked with Essroc, Euclid Chemical, Baker Concrete Construction, and Mack Concrete to develop

a concrete mixture containing slag cement for increased durability, performance, and environmental sustainability. Use of slag cement contributed toward achieving LEED Silver status and provided consistent and reliable strength development that enabled completion of the concrete frame construction ahead of schedule.

Project credits: Akron Children's Hospital, Owner; Hasenstab Architects and HKS Architects, Architects; Thorson Baker & Associates, Inc., Engineer; Baker Concrete Construction Contractors, Contractor; Mack Concrete, Inc., Concrete; and Essroc Italcementi Group, Slag Cement.

Green Design

Alta Bates Summit Medical Center Patient Care Pavilion

The Alta Bates Summit Medical Center's Patient Care Pavilion, Oakland, CA, campus is a state-of-the-art hospital that provides 230,000 ft^2 (21,400 m^2) of space for 238 medical and surgical beds. The Patient Care Pavilion building consists of an 11-story patient care tower and a two-level basement utility plant with an additional rooftop central utility plant. It was built adjacent to the existing fully operational urban hospital campus (Merritt Pavilion). A combination of low-CO_2 concrete and other recycled building products was used to achieve LEED Silver designation.

Over 80% (more than 15,000 yd^3 [11,500 m^3]) of the concrete contained 50% or more of supplementary cementitious materials, designated as EF50 mixtures. All of the EF50 mixtures contained slag cement at 30% replacement factors and above in combination with Class F fly ash and portland cement. Enhanced performance characteristics included highly pumpable concrete in the self-consolidating concrete wall mixtures, reduced heat generation in mat slab mass concrete mixtures, and improved placement characteristics around highly congested reinforcing bar configurations. In addition to the LEED Silver designation, the project exceeds California Title 24 Energy Standards by 16% and meets all requirements for the Green Guide to Healthcare and Sustainability Practices.

Project credits: Sutter Health, Owner; Devenney Group LTD., Architect; Degenkolb Engineers, Engineer; DPR Construction, Contractor; Central Concrete Supply Co., Inc., Concrete Supplier; and Lehigh Southwest Cement Co., Slag Cement.

High Performance

Richard O. Jacobson Building

The Richard O. Jacobson Building, Rochester, MN, is a state-of-the-art cancer treatment center consisting of two floors cast-in-place below grade and three floors above that are structural steel with composite decks. The building is designed for an additional 16 stories in the future. Of the approximately 32,000 yd^3 (24,500 m^3) of concrete, 50% is being used for radiation shielding around four treatment gantries and fixed beam room. The treatment equipment weighs approximately 120 tons (109 tonnes) and is supported from both the walls and the floors of the mass concrete with embedded steel plates cast into the concrete for equipment support. Some of the steel plates were 4 in. (100 mm) thick, 4 ft (1.2 m) wide, 7 ft (2.1 m) long, and weighed 4574 lb (2070 kg).

Alta Bates Summit Medical Center Patient Care Pavilion, Oakland, CA

Richard O. Jacobson Building, Rochester, MN *(photo courtesy ©Dean Riggott Photography)*

Slag cement was used at 40% in combination with 30% Class C fly ash and portland cement in mass concrete placement mixture designs. The specified compressive strength was 5000 psi (35 MPa) at 28 days. The mixture controlled thermal stress and met concrete density requirements for radiation shielding. The largest mass concrete placement consisted of 5280 yd^3 (4030 m^3) of concrete. Much of the concrete was placed during the summer months in temperatures up to 90°F (32°C). This added to the need to control the setting time of the concrete to reduce shrinkage and cracking.

Project credits: Mayo Clinic, Owner; AECOM, Architect and Engineer; Gilbane Knutson, Contractor; Knutson Construction Services Rochester, Inc., Concrete Contractor; Rochester Ready Mix, Concrete; and Lafarge North America, Slag Cement.

San Francisco–Oakland Bay Bridge, Eastern Span, San Francisco, CA

Illinois Tollway I-90 Westbound Mainline Paving Upgrades, Rockford-Elgin, IL

High Performance

San Francisco–Oakland Bay Bridge, Eastern Span

The Eastern Span of the Bay Bridge was built to provide an earthquake-resistant replacement for the existing 1930s-era steel span bridge. The first-ever, single-tower, self-anchoring suspension bridge project spans Oakland, CA, on the east with Yerba Buena Island in the center of San Francisco Bay. The bridge project took 13 years from design to completion in 2014 and was over $6.4 billion in total cost.

The Bay Bridge project entailed a number of rigorous requirements such as concrete durability, CO_2 reduction, strength, and pumpability. To meet these requirements, Central Concrete engineered more than 40 specialty mixtures—optimized to deliver the aggressive performance specified for this large-scale, technically challenging project. The mixtures were also designed to reduce the Bay Bridge's carbon footprint by using 25 to 50% supplementary cementitious materials. Slag cement was an integral part of the multiple mixtures to help reduce the overall carbon footprint, increase the concrete strength, increase durability, reduce shrinkage, reduce heat of hydration and creep, and increase ease of placement of the concrete. A majority of the concrete was a high-performance 8000 psi (>55 MPa), 56-day mixture with a 0.035 low-shrink design and stringent creep requirements. That mixture included slag cement at a 30% replacement factor and achieved strength requirements prior to 56 days and enabled the concrete supplier to maintain the stringent construction schedules.

Project credits: Caltrans, Owner and Architect; American Bridge/Fluor JV, Engineers; C.C. Myers, Inc., Conco, Flatiron Construction Corp., and MCM Construction, Inc., General Contractors; Condon Johnson & Associates, Inc., Murga Strange and Chalmers, and Vanguard Construction, Subcontractors; Central Concrete Supply Co., Inc., Concrete; and Lehigh Southwest Cement Co., Slag Cement.

Innovative Applications

Illinois Tollway I-90 Westbound Mainline Paving Upgrades

As part of a 15-year, $12 billion capital program "Move Illinois: The Illinois Tollway Driving the Future," the Illinois Tollway commissioned about 60 miles (96 km) of three-lane-wide highway upgrades along the Jane Addams Memorial Tollway (I-90) between Rockford, IL, and Elgin, IL. I-90 was rebuilt and widened and concrete was selected to incorporate innovative technology to achieve sustainable development objectives. Specifications included an extensive new array of performance testing for submittals and encouraged use of non-portland-cement recycled cementitious materials components along with inclusion of recycled aggregates.

Slag cement was used in approximately 20 miles (32 km) for an innovative two-lift composite concrete pavement, as follows:

- Bottom/base lift: The lower lift (8.25 in. [209 mm]) was a "black-rock" mixture containing coarse fractionated recycled asphalt pavement (RAP) as 15% of the coarse aggregate. The mixture also contained 40% of slag cement with Type IL(10) cement; and
- Top lift (3 in. [76 mm] thick): The design was for an Illinois DOT PV mixture with 75% Type IL(10) portland-limestone cement with 25% slag cement.

Both mixtures consistently provided required fresh and hardened concrete properties, enabling paving to progress without incident and on time. This was the first major use of two-lift paving in Illinois tollway construction, the first use of "black-rock" in a base lift for two-lift construction, the first use of ASTM C595/AASHTO M 240 Type IL portland limestone cement in Illinois highway and tollway construction,

and the first extensive project application employing the new submittal system incorporating a broad range of performance testing.

Project credits: Illinois Tollway, Owner and Engineer; William Charles Construction and Curran Contracting, Primary Contractors; F.H. Paschen, S.N. Nielsen, Inc., and K-Five Construction Corp., Paving Contractors; Ozinga Ready Mix Concrete, Concrete; and Holcim (US), Inc., Slag Cement.

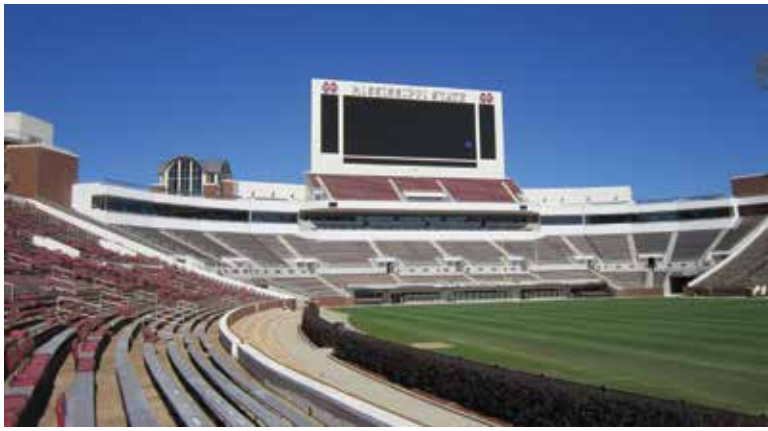
Sustainability

Davis Wade Stadium Expansion and Renovation

The expansion and renovation of Davis Wade Stadium (DWS) at Mississippi State University (MSU), Starkville, MS, included expansion of the stadium north end zone, along with construction of a new concession concourse below the west side seating. The end zone expansion added 6255 seats, increasing total seating to 61,337 and making DWS the largest football stadium in Mississippi. The project scope included over 23,000 yd^3 (17,600 m^3) of concrete, in 11 different mixture designs for various applications in the project. The MSU Construction Materials Research Center (Isaac L. Howard, Chair, and Jay Shannon, Graduate Research Assistant) became part of the project team, assisting with the development and performance monitoring of innovative, sustainable mixture designs. This collaboration provided data that have supported related materials evaluation studies and has produced a peer-reviewed journal article.

Slag cement was used in nine of the 11 mixture designs, at cement replacement rates ranging from 15 to 50%. Fly ash (Class C) was also used at replacement rates from 15 to 25% in all of the mixture designs that used slag cement; thus, most mixtures were at a 50% total cement replacement while drilled piers were at 70%. These concrete mixtures provided outstanding late-age strengths with minimal retardation of setting or delay of early strengths. Constructibility was very good in all respects; the pumpable concrete yielded clean formed surfaces with minimum bug holes and finishability of flatwork was excellent. Slag cement was not only used for many different concrete applications—in some concrete, it was used in combination with ASTM C595 Type IL(10) portland-limestone cement containing 10% ground limestone.

Direct comparisons (Type IL versus Type I cement) of otherwise identical concrete mixture designs with 30% slag cement and 20% fly ash replacement not only showed improved strengths with Type IL (especially early ages), but also helped to document excellent constructibility, favorable placing and finishing qualities, and reduced permeability of the Type IL mixture with slag cement. Use of ternary and quaternary mixtures containing slag cement met sustainability objectives of reducing the environmental footprint of concrete mixtures while achieving application-specific performance objects for mass concrete, sulfate resistance, low permeability, high ultimate strength, adequate early strength, setting time, flatwork finishability, and aesthetics.



Davis Wade Stadium Expansion and Renovation, Starkville, MS

Project credits: Mississippi State University Athletic Department, Owner; LPK Architects, P.A., Architect; Pritchard Engineering, Inc., Civil Engineer; Walter P Moore, Structural Engineer; Harrell Contracting (now part of Roy Anderson Corp.), Contractor; MMC Materials, Inc., Concrete; and Holcim (US), Inc., Slag Cement.

For more information about SCA, visit **www.slagcement.org**.