WACA 2017 CONCRETE CONSTRUCTION AWARDS

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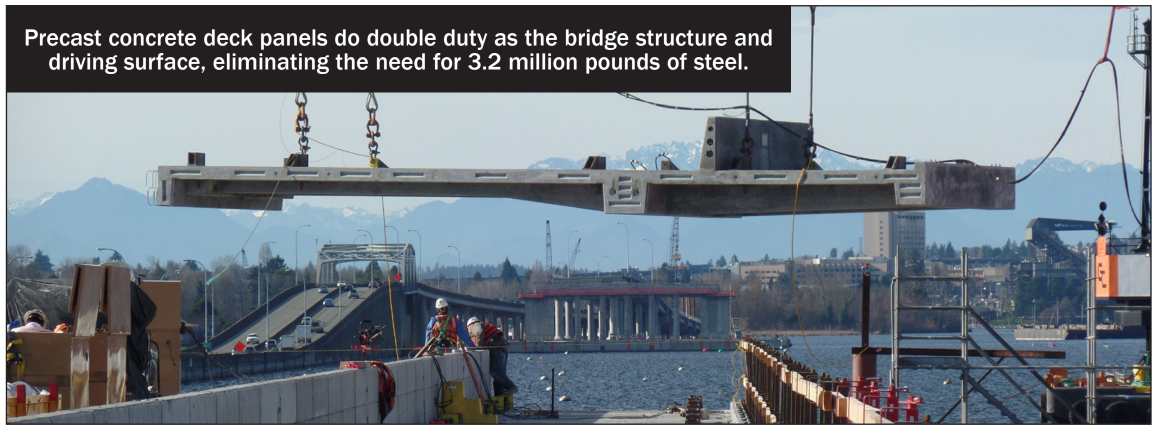
PUBLIC WORKS: BRIDGES

STATE ROUTE 520 FLOATING BRIDGE AND LANDINGS PUBLIC WORKS BRIDGES

Location: Medina
Owner/developer: Washington State Department of Transportation
Team: Kiewit/General/Manson, A Joint Venture, general contractor; Belarde Co., concrete contractor; Helix Design Group, architect; KPFF Consulting Engineers, structural engineer; CalPortland, and Cadman, ready-mix suppliers

GRAND AWARD



Precast concrete deck panels do double duty as the bridge structure and driving surface, eliminating the need for 3.2 million pounds of steel.

PHOTO COURTESY OF WACA

To maximize durability and reliability, the state Route 520 floating bridge uses concrete and steel in four distinct structure types: approaches, transitions, high-rise spans and low-rise spans.

For the approaches, more than 27,000 cubic yards of concrete were placed to erect twin three-span, 630-foot-long, cast-in-place segmental bridges founded on spread footings. These structures connect the bridge to land, as well as support the four 190-foot-long steel-girder transition spans with bridge decks cast in place from 1,300 cubic yards of concrete.

Ready-mix concrete allowed the use of cast-in-place balanced cantilever bridges, eliminating more than 27,000 square feet of trestle and falsework. Using spread footings reduced the number of piles required to build the bridge by 75 percent and preserved 95 percent — or 7,860 square feet — of permanent lake bed habitat.

This design also allowed the team to move one of the piers out of the lake. The sleek bridge produced from this type of concrete reduced shading of the shallow-water habitat by 79 percent.

For the next segment, the 2,130-foot-long floating high-rise structure, 12,000 cubic yards of concrete form the columns and crossbeams that support the 90-foot-long precast girder spans.

From the high-rise, vehicles move to the mile-long low-rise structure that crosses the lake. Here, concrete elements replaced the steel bracing and framing suggested in the original concept design.

Instead, the design-build team used segmental precast concrete deck panels to form both the structure and driving surface, eliminating 3.2 million pounds of steel. The 776 panels were formed by the team in a nearby casting yard using more than 45,200 cubic yards of 6,500-psi concrete.

To provide additional flotation and stability for the large, longitudinal pontoons supplied by the project's owner, the team installed supplemental pontoons, similar to outriggers on a canoe.

The team constructed 44 supplemental pontoons in a casting basin in Tacoma using 44,000 cubic yards of 7,500-psi concrete. These pontoons are 100 feet long, 50 to 60 feet wide, and 28 feet tall.

The pontoons were towed to Lake Washington, where they were joined with the longitudinal pontoons to form the foundation for the floating bridge.

The pontoon concrete needed to flow up to 30 linear feet to meet the tight schedule, so the team generated a 28-inch-spread mix composed of fly ash, microsilica, a high-range water reducer and a shrinkage reducer. Careful thermal control, external vibrators, watertight forms and the high-tech concrete were used to meet the goal of casting concrete with no cracking greater than 0.006 inches.

These high-quality, state-of-the-art mix designs, combined with the 3.5 million man hours spent designing and constructing the project, will ensure the bridge meets the demands of its 75-year design life.

TILT-UP STRUCTURES

MATILDA BUILDING


The building was constructed using three-story tilt-up wall panels with the fourth-floor walls stacked on top.

PHOTOS COURTESY OF WACA

Location: Spokane
Owner/developer: Ferdinand CJF LLC
Team: Divcon, general and concrete contractor; Ron Joseph Architecture, architect; DCI Engineers, structural engineer; Central Pre-Mix Concrete Co. (doing business as Oldcastle Materials), ready-mix supplier

The Matilda Building is an 88,000-square-foot tilt-up structure near Gonzaga University. It contains three floors of upscale apartments over one floor of retail.

The project also includes a 14,000-square-foot parking garage composed of cast-in-place concrete columns and walls; tilt-up walls and spandrels; post-tensioned tilt-up spandrels; and cast-in-place, post-tensioned elevated slab and beams.

The owners wanted to create a long-lasting building with brick details that would fit seamlessly into its surroundings.

The building was designed as a four-story tilt-up structure that is 300 feet long, 80 feet wide, 54 feet tall, and contains three different slab elevations on the main floor created by two 18-inch steps. Combine this with a major north-south arterial on the west side of the property and a rental house at the northeast corner, and you have a fairly compact site that created challenges for a concrete tilt-up building of this size.

After some analysis it was determined that it would be safer and more economical to create a three-story tilt-up wall panel with the fourth-floor walls stacked on top. The architectural-grade tilt-up panels with embedded brick were cast on the building slab, over the top of the cast-in-place elevator pits, as well as on nearly 22,000 square feet of casting slab.

The three-story panels were erected and braced to the outside of the building using helical anchors to allow for structural steel installation while minimizing the impact on the general public by keeping the crane operations out of the street.

Structural steel installation started once the three-story panels were erected, and the team then started working on building the fourth-floor panels on the previously used casting slabs. Once the fourth-floor slab was poured, the fourth-floor panels were erected and braced to the cast-in-place inserts in the fourth-floor slab.

The use of concrete slabs on metal deck at all elevated floors provided the owner with a solid floor system that created a great sound barrier between the apartment levels as well as the retail level. Two large shear walls were created by stitching together multiple three-story, 12-inch-thick concrete panels and tying them together at the fourth floor with a single-story, cast-in-place wall.

Cast-in-place walls, columns and tilt walls were used at the main floor. Site-cast spandrels were utilized at the second floor and roof.

Two of these spandrels were 60-foot-long, post-tensioned concrete panels that span over the covered exterior parking. A post-tensioned, cast-in-place slab with post-tensioned beams was placed for the elevated parking deck.


The owners wanted a long-lasting structure that would fit seamlessly into its surroundings.

Washington Aggregates and Concrete Association

2017 Excellence in Concrete Construction Award Winners

GRAND AWARD
Public works: Bridges
State Route 520 floating bridge and landings
Medina

Tilt-up structures
Matilda Building
Spokane

Cast-in-place structures: Parking garage
Special applications: Technical merit (tie)
Costco Wholesale parking garage
Issaquah

Cast-in-place structures
Tower 12
Seattle

Public works: Renovations
U.S. 195 PCCP rehab
Spokane

Public works: Infrastructure
Sustainable merit
Elliott Bay Seawall
Seattle

Residential concrete
Nelson residence
Amboy, Clark County

Artistic and decorative concrete
Northwest Trek — Kids' Trek
Eatonville, Pierce County

Pervious concrete
Fort Lewis North Athletic Complex
Joint Base Lewis-McChord

Concrete paving
Sea-Tac Runway 16C-34C reconstruction
SeaTac

Community Award
USS Arizona Memorial dock replacement
Honolulu, Hawaii

Special applications: Technical merit (tie)
Hanford Site contaminated pipeline remediation
Richland

Special applications: Resiliency
Ocosta Elementary School replacement
Westport

ON THE COVER

The new state Route 520 floating bridge was the grand winner at the Washington Aggregates and Concrete Association's annual Excellence in Concrete Awards. The project also won the bridges category for public works.
PHOTO COURTESY OF WACA

DJC TEAM

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CAST-IN-PLACE STRUCTURES PARKING GARAGE • SPECIAL APPLICATIONS: TECHNICAL MERIT (TIE)

COSTCO WHOLESALE PARKING GARAGE

Location: Issaquah
Owner/developer: Costco Wholesale Corp.
Team: Ferguson Construction, general and concrete contractor; MG2, architect; Engineers Northwest, structural engineer; Cadman, ready-mix supplier

Hidden among the trees next to Pickering Barn on the Costco Wholesale corporate campus in Issaquah sits a new eight-level, post-tensioned concrete parking garage. The garage has 2,575 stalls and used over 26,000 cubic yards of ready-mixed concrete.

The new garage sits on 528 16-inch-diameter, concrete-filled steel piles averaging 100 feet in depth.

Originally the garage was designed for seven levels, with five to be construcQted in 2014 and two in a future expansion. After the completion of level five, the decision was made to increase the garage from seven levels to eight. This created a unique structural challenge, as the foundation was only designed to support the original seven levels.

What makes the project unique from other parking garages is the use of lightweight post-tensioned concrete. By changing the top three decks from a traditional 6,000-psi concrete to lightweight concrete, the weight was reduced from 150 pounds per cubic foot to 118 pounds.

A great concern in incorporating lightweight concrete was the ability to make early strengths for stressing in order to maintain schedule. In addition, there were concerns for pumping over great distances as well as the finishability with porous aggregate.

Cadman delivered over 7,400 cubic yards of lightweight concrete without any issues. The performance and engineering of the mix design exceeded all expectations.

Strengths exceeded the 3,000-psi requirement at three days, allowing for an early two-day stress, improving the overall stressing schedule. Improving on the schedule was especially important given that the parking levels below the top decks were occupied during construction.

Twenty-eight-day strengths averaged over 7,700 psi. The lightweight design pumped, placed and finished with ease.

The aggregate used was expanded shale from Colorado. It is believed this may be the first post-tensioned lightweight structure on the West Coast.


Costco used lightweight, post-tensioned concrete to build an extra level on this parking structure.

PHOTO COURTESY OF WACA

CAST-IN-PLACE STRUCTURES

TOWER 12

Location: Seattle
Owner/developer: Continental Properties
Team: PCL Construction Services, general and concrete contractor; MG2, architect; Cary Kopczynski & Co., structural engineer; Cadman, ready-mix supplier

Tower 12, named after the Seattle Seahawks' 12th Man, is a 34-story, 492,000-square-foot residential tower at Second Avenue and Virginia Street in downtown Seattle.

The building has 314 apartment units, 7,000 square feet of ground-level retail, four levels of parking above grade and five levels below. The project broke ground in early 2015 and was slated to finish in April.

Tower 12's structural system has four main components: high-strength concrete and reinforcing bar, an innovative seismic core, performance-based seismic and wind design, and an optimized post-tensioned slab design.

Tower 12 utilized high-strength concrete and reinforcing bar to improve performance and constructability. A specified concrete compressive strength of 14,000 psi was used in columns up to the sixth level to reduce column sizes and improve the interior layout.

This synergistic use of high-strength concrete and rebar resulted in smaller columns and boundary elements, which enhanced interior design flexibility and increased the leasable floor area. It also allowed column sizes to be kept constant nearly full height, which maximized formwork productivity and helped maintain a rapid construction schedule.

The seismic system consisted of an innovative combination of coupled shear walls and ductile moment frames at the core, and included multiple link beams to effectively dissipate seismic energy. The unique core design enhanced seismic system ductility without the need for wall hinging. Seismic performance was improved without compromising constructability.

The structural engineer used a modified performance-based design with a nonlinear time history analysis to cycle the building's seismic performance through a suite of input earthquake ground motions. The state-of-the-art core minimized the floor area required for wall structure and reduced the wall-reinforcing requirements, resulting in a more constructible system.

Due to the tower slenderness and shape, a wind tunnel test was performed to provide wind pressures for cladding design and to mitigate wind accelerations. The core stiffness and reinforcement were tuned to resist wind tunnel forces and provide acceptable levels of building acceleration.

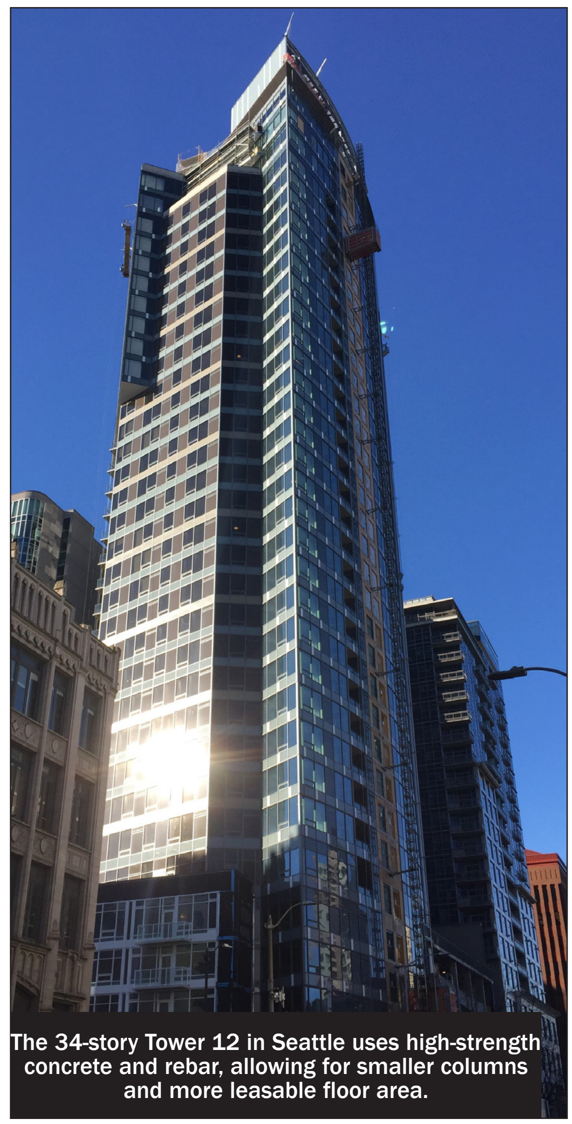

The 34-story Tower 12 in Seattle uses high-strength concrete and rebar, allowing for smaller columns and more leasable floor area.

PHOTO COURTESY OF WACA

PUBLIC WORKS: INFRASTRUCTURE SUSTAINABLE MERIT

ELLIOTT BAY SEAWALL

Location: Seattle
Owner/developer: Seattle Department of Transportation
Team: Mortenson/Manson Joint Venture, general and concrete contractor; Parsons, structural engineer; APS Architectural Precast Structures, McMillen Jacobs Associates and Oldcastle Precast, precast elements; Stoneway Concrete, ready-mix supplier

The Seattle Department of Transportation's Elliott Bay Seawall project is a $210 million replacement of the southern 3,500 feet of the seawall supporting Alaskan Way along the waterfront in Seattle.

Encompassing about 27,000 cubic yards of Portland cement concrete, this project replaced the old timber-supported wall with a new structure composed of 434 segments consisting of precast concrete face panels supported by a precast concrete cantilever structure (Z panels) anchored in place using large, cast-in-place, mass-pour slabs (CIP panels).

In addition to supporting the new seawall, the Z panels carry light-penetrating sidewalk panels (LPS panels) perched over Elliott Bay, intended allow ambient light to the sea-life habitat bench constructed in front of the new seawall.

After excavation and demolition of the existing wooden structure behind a sheet pile wall, ground improvement was done. This consisted of injecting Portland cement slurry into the existing mud to construct columns of a mud-Portland cement mixture that provided a stable base to rest the new seawall structure.

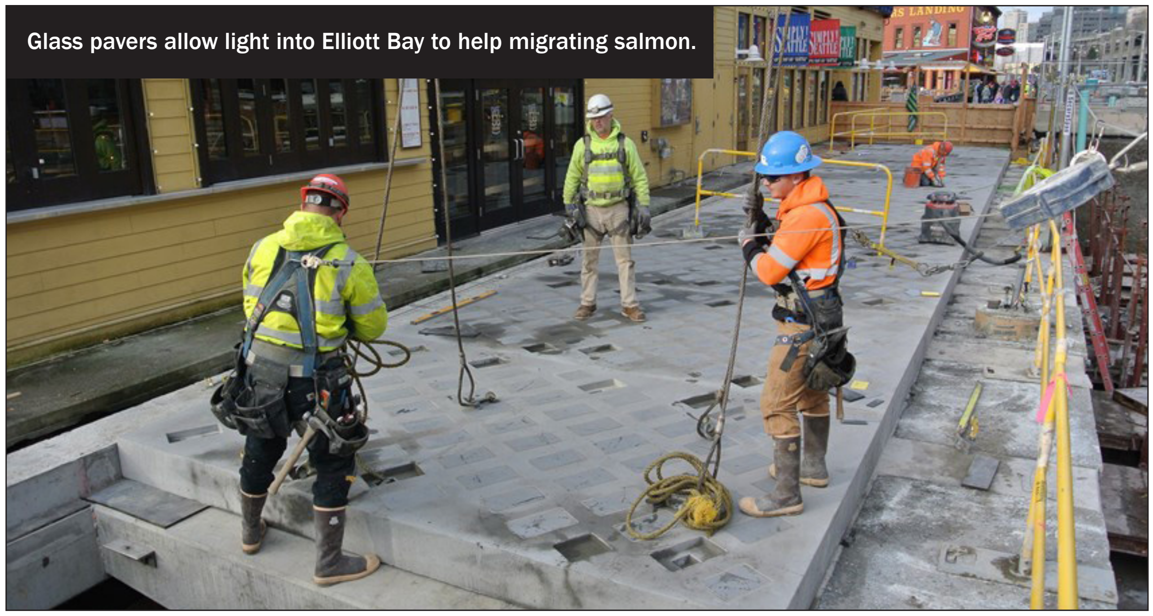

Glass pavers allow light into Elliott Bay to help migrating salmon.

PHOTO COURTESY OF WACA

After improvements to the surface utilities were made, the CIP panels were cast in place. These were mass pours of concrete used as a foundation for the Z panels as well as anchors to keep the Z panels from tipping due to the cantilevered sidewalk.

After curing, the area in front of the CIP panels was excavated to make room for the face panels and restored marine habitat. The precast seawall face panels were then placed, followed by large bags of loose rock (marine mattresses) on the seaward side at the foot of the face panels. The marine mattresses provided stability for the toe of the panels, protection from wave action and habitat for the marine creatures of Elliott Bay.

Z panels were then placed on top of the CIP panels to support the landward side of the face panels and provide structure for the overhanging sidewalk. Steel was added and more concrete was poured between the Z panels to anchor the face panels to the structure as well as tie the Z panels together longitudinally.

The Z panels/CIP panels were backfilled and the LPS panels were placed on the cantilevered structure. Lastly, the surface area was restored in anticipation of the waterfront restoration project.

The project was executed with the environment in mind. Work involved disposal of contaminated soils, extensive use of pozzolans in the concrete mixes, restoration of the marine habitat, and installation of the structurally complex, overhanging LPS panels.

PUBLIC WORKS: RENOVATIONS

U.S. 195 PCCP REHAB

Location: Spokane
Owner/developer: Washington State Department of Transportation
Team: Wm. Winkler Co., general and concrete contractor; Spokane Rock Products, ready-mix supplier

This Washington Department of Transportation project included rehabilitation of 8.8 miles of the two southbound lanes of U.S. 195 between East Excelsior Road and Interstate 90 in Spokane.

The original 8-inch prestressed concrete cylinder pipe (PCCP) was constructed in phases from 1953 to 1964 and was experiencing severe failures. Minimal maintenance and repair had been performed over the 50-plus years of service life.

Work included removal and replacement of 14,400 square yards of Portland cement concrete panels, including base reconstruction; 4,200 square yards of panel jacking with chemical grout; 112,900 square yards of Portland cement concrete pavement grinding; 214,600 linear feet of joint repair and reconstruction; 29,300 square yards of micro-milling bituminous paving; 2,900 square yards of asphalt shoulder reconstruction and 58,400 square yards of slurry seal; 128,200 linear feet of pavement marking; associated tasks and significant traffic control.

U.S. 195 is the main traffic corridor for southbound traffic from Spokane to Pullman, and it was essential to maintain one lane of traffic throughout the course of construction. The fast-track, 80-day working schedule required multiple phases and types of work to occur simultaneously.

Logistics of removing and transporting existing materials while importing new materials for reconstruction was difficult while maintaining high volumes of traffic through the project area. The topography of the roadway compounded access to and from the project location.

Existing asphalt patches were milled and removed from the concrete road. Approximately 3,250 cubic yards of high early strength concrete was utilized for PCCP panel replacement at numerous locations along the roadway.

Once panels were replaced and others chemically grouted to grade, the entire roadway was ground to strict compliance. Severe wheel-path ruts were ground smooth to adjacent surfaces. At the same time, 40.6 miles of pavement joints were reconstructed, including spall repair, cleaning, routing and resealing.

While some of the PCCP timestamped from 1953 to 1964 were removed, approximately 88 percent of the existing PCCP was rehabilitated for additional service life well beyond the current 50-plus years of operation. This project is a testament to the sustainability of concrete pavements, exemplifying the advantage of life-cycle costs.

RESIDENTIAL CONCRETE

NELSON RESIDENCE


Concrete industry veterans Josh and Laura Nelson built an ICF house with slab-on-grade flooring and radiant heat.

PHOTO COURTESY OF WACA

Location: Amboy, Clark County
Owner/developer: Josh and Laura Nelson
Team: Design Doctors Construction, general contractor; Alite Construction, concrete contractor; Vision Designs, architect; Banton Engineering, structural engineer; CalPortland, ready-mix supplier

Josh Nelson has been in the concrete industry his entire working life, and his wife, Laura, works at Lakeside Industries.

So when it became apparent that the manufactured home they lived in was actually meant to be temporary, the Nelsons decided concrete was going to be the main material used to build their permanent home.

The Nelsons wanted a low-maintenance, one-level home that would be secure and energy efficient. They elected to go with an ICF home with radiant heat in the slab on grade.

Using an experienced engineer, the Nelsons went about selecting a general contractor, but also did a significant amount of work themselves. Once the 22 yards for the footings were in, Josh assembled a crew of various ready-mix people he had worked with over the years.

The first day they assembled almost half of the house. After they went back to their day jobs, the general contractor completed stacking the walls, inserting the rebar and erecting the bracing system.

When pour day came, it took about five hours to place the 59 yards in the 6-inch-thick walls. A proven pea gravel mix was placed at about a 7-inch slump. Vibration was used where needed, mostly around doors and windows.

Once the walls cured and the bracing was removed, rock was placed and compacted to support the slab.

An EZ Floor system was used, providing insulation, vapor barrier and a plastic tube placement system in one step. The interior slabs would take another 58 yards, this time using a 6.5-sack mix with super plasticizer to allow placement at a 7-inch slump. The slab was then water cured — that is, until the well went dry in the late September heat.

Since the Nelsons love the look of concrete, they did not go for any colors or fancy polishing on the interior slabs — just a hard trowel finish, and they applied a water-based sealer to enhance and protect the natural beauty of the slab.

As the general contractor got the house dried in with the roof on and completed the interior finishes, the Nelsons placed another 58 yards in exterior concrete using a large rock six-sack mix with air and mid-range water reducer for the driveway.

The patio, porch, and walkways used a mix with a higher sand content for a sand finish. This included a broadcast of silicon carbide.

Silicon carbide is one of the latest techniques in decorative concrete to add pizazz to concrete, bringing out a real sparkle effect that changes with different lighting. It also makes the surface non-slip, which is important in the wet Northwest.

Attached to the structure is a large covered patio. Sustainable features include the ICF walls, slab-on-grade radiant heat with abundant insulation, low-maintenance concrete floors, and a reflective concrete driveway with simple decorative effects on the walkway surfaces.

The Nelsons now have twice the house with half the energy bills they had when living in the old manufactured home.

ARTISTIC AND DECORATIVE CONCRETE

NORTHWEST TREK — KIDS' TREK

Location: Eatonville, Pierce County
Owner/developer: Metropolitan Parks of Tacoma
Team: Lake Tapps Construction, general contractor; Turnstone Construction, concrete contractor; Miles Sand & Gravel, ready-mix supplier

Playing outdoors is in a kid's nature, and the new themed environment at Northwest Trek offers a rich bounty of natural play experiences.

Built on a half-acre in a Northwest forest, the Kids' Trek play area features include a 20-foot tall concrete tree based on an ancient Western red cedar with climbing nets, tunnels and slide poles inside. As children enter the tree a concrete great horned owl senses their arrival and sounds out a hoot.

The use of concrete allowed for precise tolerances to be followed in many of the play elements, enabling physically challenged children to climb and slide and play safely — an empowering experience. As children follow the themed concrete paths throughout the project they discover botanical impressions stamped into the concrete flatwork, and animal tracks that tell an enriching story about our Northwest environment.

Spilling through the play area is a stream featuring a beaver's dam, waterfalls and river otter sculptures made out of a rich concrete mix. Concrete in this instance, with its strength and cleanable surfacing, allowed the owner to pass a rigorous inspection regimen required by the county health department.

Other concrete sculptures include a mountain goat on a rock-textured concrete cliff, a cougar and her cub at the play area entrance, and a welcoming beaver at the stream's waterfall. A concrete rock cave, climbing wall and slide round out the play features in the heart of the play experience.


The 20-foot tall concrete tree is based on an ancient Western red cedar. It has climbing nets, tunnels and slide poles inside.

PHOTO COURTESY OF WACA

PERVIOUS CONCRETE

Pervious concrete helped eliminate the need retention ponds, leaving more space for playfields.

PHOTO COURTESY OF WACA

FORT LEWIS NORTH ATHLETIC COMPLEX

Location: Joint Base Lewis-McChord
Owner/developer: U.S. Department of the Army
Team: Total Site Services and Garco Construction, general contractors; Global Contractors, concrete contractor; U.S. Department of the Army, architect and structural engineer; CalPortland, ready-mix supplier

The new Fort Lewis North Athletic Complex has four all-weather turf baseball fields, two full-size basketball courts and two all-weather turf soccer fields. The entire complex is lighted for nighttime activities.

The complex had an issue with putting in a retention pond, which would diminish the amount of field area. The solution for this problem was pervious concrete. This pavement technology creates more efficient land use by eliminating the need for retention ponds, swales and other stormwater-management devices. In doing so, pervious concrete has the ability to lower overall project costs on a first-cost basis.

By capturing stormwater and allowing it to seep into the ground, porous concrete is instrumental in recharging groundwater, reducing stormwater runoff, and meeting Environmental Protection Agency stormwater regulations. In fact, the use of pervious concrete is among the best-management practices recommended by the EPA — and by other agencies and geotechnical engineers across the country — for the management of stormwater runoff.

The pervious concrete surface totaled 62,000 square feet. There were also 74,000 square feet of broom-finished concrete pavement, two full-sized color-stained concrete baseball courts and 4,000 square feet of colored and stamped concrete entrances.

CONCRETE PAVING

SEA-TAC RUNWAY 16C-34C RECONSTRUCTION

Location: SeaTac
Owner/developer: Port of Seattle
Team: Scarsella Bros.-Acme, A Joint Venture, general contractor; Acme Concrete Paving, concrete contractor and ready-mix supplier; Port of Seattle, architect and structural engineer

Old runway concrete was recycled on site to provide base course material for the new runway.

PHOTO COURTESY OF WACA

The Port of Seattle's Runway 16C-34C reconstruction, aka the Sea-Tac middle runway project, consisted of full demolition and reconstruction of the airport's middle runway and several sections of adjoining taxiways.

In addition to the new Portland cement concrete pavement, asphalt shoulders and stormwater system, the project included a new LED lighting system and an automated foreign-object debris detection system.

The new middle runway, originally built in 1969, was more than 9,200 feet in length. The new runway and adjoining taxiways consisted of nearly 205,000 square yards of 18-inch Portland cement concrete pavement, placed upon a 4-inch asphalt base on top of an 8-inch recycled concrete base.

The recycled concrete base was processed on site from the existing runway and taxiway demolition. Crushing equipment was set up in the middle of the project site, where chunks of old runway pavement were broken down into base course material.

The recycled-concrete base course was placed beneath the new runway, taxiway, shoulder and blast pad sections, providing an exceptionally sturdy construction surface while meeting federal drainage requirements. Having the recycled-concrete crushing and stockpiling operation on site was also extremely helpful in increasing production for base course placement and grading, as well as reducing truck traffic in and out of the site.

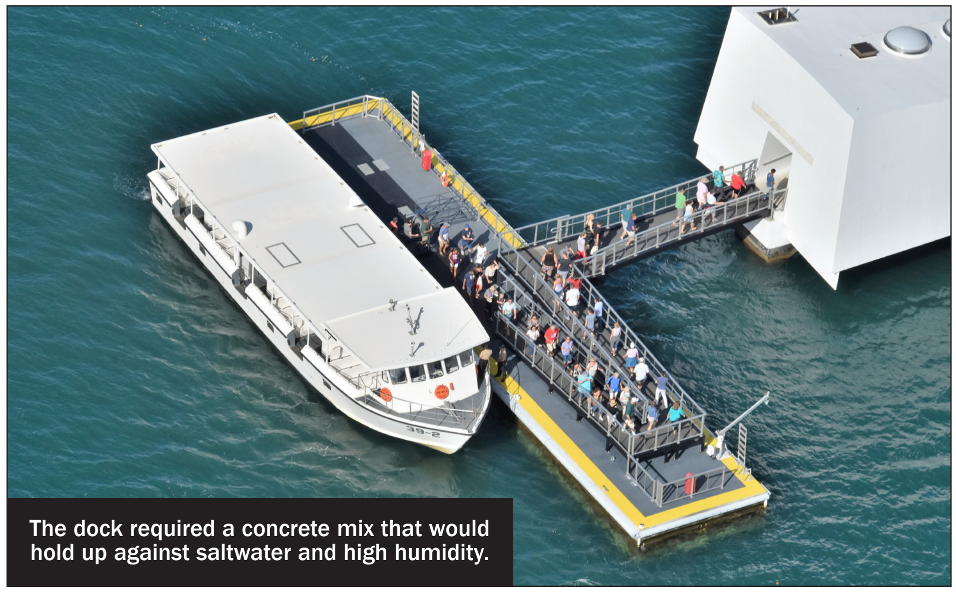
Demolished asphalt pavement sections and old steel embedded in the demolished concrete were sent to recycling facilities. Additionally, 20 percent of the old asphalt was reincorporated into the new asphalt mix for the shoulders and blast pad areas.

Paving of the runway and new taxiway sections began in late June 2015 and was completed in four months.

Contractors also performed several panel replacements for the Port of Seattle under a contract change order around the airport's busy terminal area. Due to the locations of the replacements, many of the panels were placed using a rapid-setting concrete mix that allowed for aircraft traffic merely four hours after placement.

COMMUNITY AWARD

USS ARIZONA MEMORIAL DOCK REPLACEMENT



The dock required a concrete mix that would hold up against saltwater and high humidity.

PHOTO COURTESY OF WACA

Location: Honolulu, Hawaii
Owner/developer: National Park Service
Team: Hawk Contracting Group, general contractor; Bellingham Marine Industries, concrete contractor; Redpoint Structures, structural engineer; Ferndale Ready Mix & Gravel, ready-mix supplier

After 25 years of service, the receiving dock for guests at the USS Arizona Memorial needed to be completely replaced.

The National Park Service in partnership with the U.S. Navy commissioned contractors to replace a weathered and worn floating dock area that had received millions of guests over its lifetime. Concrete was the obvious product of choice.

In the marine float environment, consistency in the weight of the overall design plays a key role in the function of a float. Floating concrete systems must provide ample strength and durability while maintaining a uniform weight and density to ensure balance, consistent freeboard and longevity to the entire float system.

Tolerances for mixes are unusually tight, and mix specifications are closely monitored to deter any variances from design. Unlike most projects, each and every load is measured to verify the unit weight, air volumes and mix consistency requirements are met.

In addition to the tight tolerances, a tertiary blend of cement, fly ash and silica fume were combined to densify the mix characteristics, and high-grade aggregates were acquired to produce a concrete mix resistant to chemical attack from the high humidity and saltwater environment. These aggregates contribute in providing key characteristics to the concrete properties, making it highly resistant to chemical attack, durable, long lasting and dependable.

The 75th anniversary of Pearl Harbor Day supplied a reason to fast-track the project. The contractor the needed materials onsite by midsummer 2016 in order to finish the project on time and within budget. The materials were produced in Washington in the spring, then shipped by barge in time for the deadline.

In late December, U.S. and Japanese dignitaries attended a ceremony to commemorate the events of Dec. 7, 1941. President Barack Obama and Japanese Prime Minister Shinzo Abe met to honor those killed on that fateful day when Japan attacked the U.S. This was the first time a prime minister from Japan had visited the USS Arizona Memorial.

SPECIAL APPLICATIONS: RESILIENCY

OCOSTA ELEMENTARY SCHOOL REPLACEMENT

Staircases leading to the elevated roof platform are bolstered by 14-inch-thick, heavily reinforced concrete.

PHOTO COURTESY OF WACA

Location: Westport
Owner/developer: Ocosta School District
Team: Integrity Structures, general contractor; Vision Concrete, concrete contractor; TCF Architecture, architect; Degenkolb Engineers, structural engineer; Bayview Redi-Mix, ready-mix supplier

The new Ocosta Elementary School has the first vertical tsunami evacuation structure in the U.S. The elevated platform is capable of holding approximately 1,000 to 1,500 people.

That is important because if the Cascadia subduction zone — a 700-mile-long offshore fault in the western Pacific Ocean — were to produce a large earthquake, the resulting tsunami would be expected to slam into Westport and other parts of Washington's outer coast. The people on the northwest coast would have about 20 to 30 minutes to get to safety.

Vertical-evacuation structures have to meet a lot of criteria, including being able to withstand the forces of an earthquake and, obviously, a tsunami. The foundation has to be strong and the structural supports need to be able to handle the forces of water and debris crashing into them.

The building must be constructed on deep pilings in case the tsunami scours out the foundation. The "vertical shelter" portion of Ocosta Elementary School is accessible from four staircases, one at each corner of the structure. The staircases are bolstered by 14-inch-thick, heavily reinforced concrete.

Even if the walls are ripped away, the cores should remain intact through both the quake and the tsunami, according to Cale Ash of Degenkolb Engineers, who designed the structure.

This was a significant and challenging construction project. It was a team effort involving project managers, supervisors and administrative staff, along with a team of hardworking subcontractors and suppliers.

We trust that the concrete structure will stand tall and save many lives should a serious earthquake and tsunami occur. Integrity Structures, TCF Architecture and the engineers who designed this school believe it will serve as a model for other evacuation structures.

SPECIAL APPLICATIONS: TECHNICAL MERIT (TIE)

HANFORD SITE CONTAMINATED PIPELINE REMEDIATION

Location: Richland
Owner/developer: Washington Closure Hanford
Team: Columbia Energy, engineer; American Rock Products, ready-mix supplier

Contaminated waste lines containing elemental mercury at the Hanford site's 300 Area were filled with a sulfur-amended grout mix to help minimize the potential for mercury releases during excavation and segmenting of the lines for disposal.

Regulators were interested in utilizing sulfur to amalgamate mercury, which resulted in specifying a grout mix containing elemental sulfur. American Rock Products, along with Columbia Energy and Washington Closure Hanford technical staff, designed a non-segregating, flowable, sulfur-amended grout mix suitable for injecting into abandoned waste lines.

Mix-design efforts were carried out on small-volume test batches using powdered and pelletized sulfur along with different cement and slag contents before selecting a slag-based mix that incorporated powdered sulfur. Because of the sensitive nature of the remediation work, a flow testing was performed near the batch plant to demonstrate the ability to pump the mix a minimum of 500 feet through a 2-inch-diameter line.

Flow testing was successfully completed in 2013. The bulk sulfur was obtained in super sacks and added to the mix trucks dry at the plant, and then the trucks were batched with the remaining materials. Prior to injecting the sulfur grout into the contaminated lines, engineering designs were completed to define the injection and vent locations and connection details.

Approximately 2,900 feet of buried waste lines with residual radiological and mercury contamination were successfully filled with the sulfur grout mix between August and September 2014. The waste lines ranged from 2 to 6 inches in diameter and were filled in segments.

A standard pump truck was used to inject the grout into the lines at a controlled rate. Rupture discs were used on the grout-injection assemblies to prevent the grout pump from exceeding the design pressure rating of the grout delivery lines and fittings used to connect to the buried waste lines in the event of a line blockage.