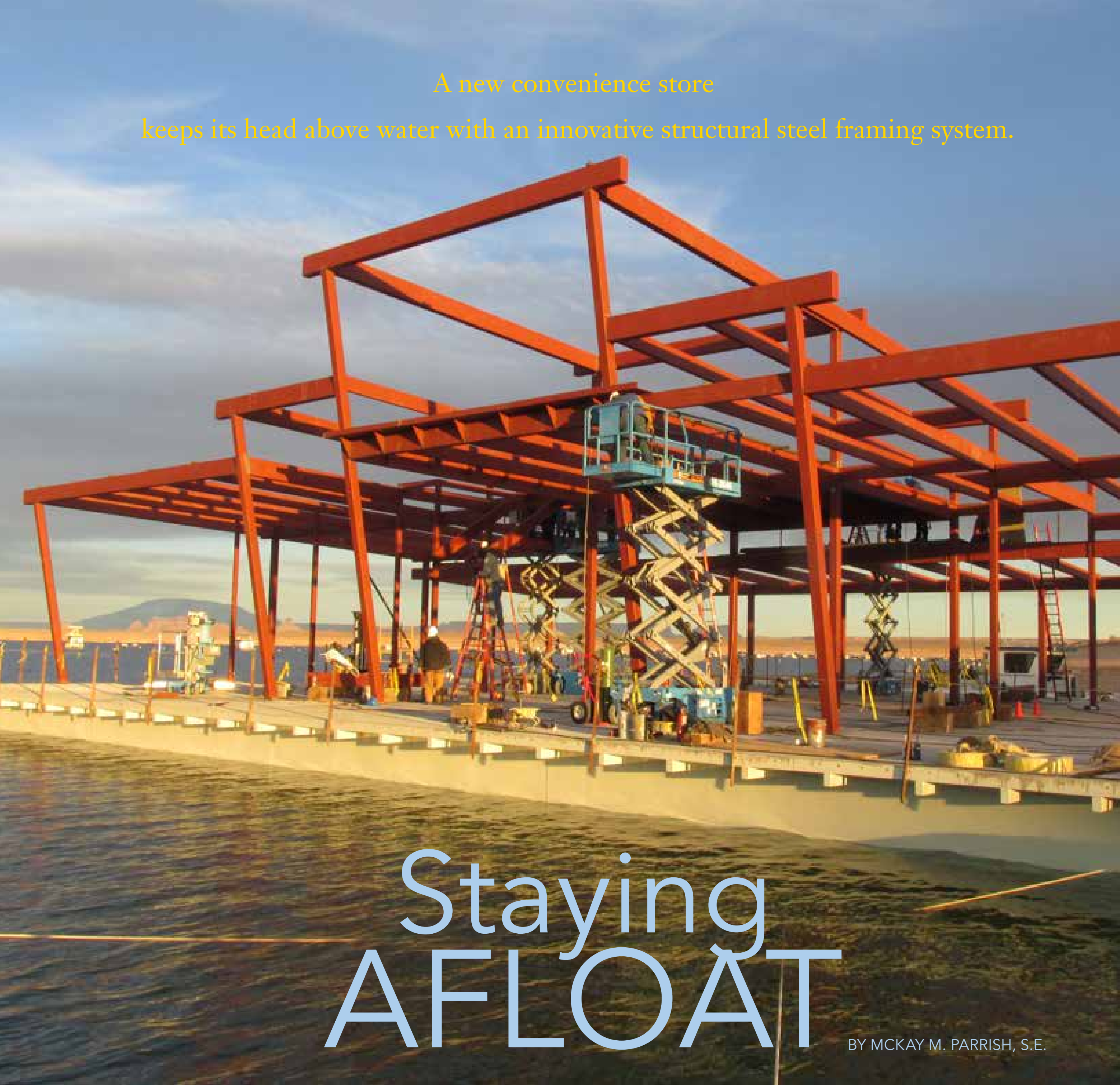

A new convenience store keeps its head above water with an innovative structural steel framing system.

Staying AFLOAT

BY MCKAY M. PARRISH, S.E.

McKay Parrish (mckayp@arwengineers.com) is a project structural engineer with ARW Engineers.

HEADING DOWN to the corner store for a gallon of milk is a bit of a different experience at Lake Powell's Wahweap Marina.

That's because the store floats. Situated between the marina's docks and houseboats, the 6,655-sq.-ft building—which houses the Wahweap Marina Store, a restaurant and office space—is supported by a 10,144-sq.-ft floating platform. The structure is topped with a 1,425-sq.-ft covered deck on the second floor that allows visitors to relax and drink in their surroundings.

The facility has been designed to accommodate the constantly changing water level of the lake (Wahweap Marina is located toward the south end of the lake, just south of the Arizona-Utah border near the beginning of the Grand Canyon). The floatation portion of the structure consists of wide-flange and HSS

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The 6,655-sq.-ft building houses the Wahweap Marina Store, a restaurant and office space.

The floatation portion of the structure consists of wide-flange beams and HSS that are designed as a truss system to evenly distribute loads throughout the platform.

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beams that are designed as a truss system to evenly distribute loads throughout the platform. This "T" shaped floatation system is approximately 8 ft deep in the middle section and 5 ft deep in the side sections. The side walls and bottom of the floatation's structural hull are covered with ¼-in. and $^{5}/_{16}$-in. steel plates and angles, and the top of the flotation structure consists of a sloping 7½-in. suspended concrete slab on metal deck. The lower section of the hull houses all of the mechanical equipment and also doubles as a storage room. The upper structure consists of exposed HSS beams and battered columns that project away from the building and provide the lower deck with shade. The upper patio area is constructed with a 4½-in. suspended concrete slab on metal deck with a covered steel roof system above, and wood-sheathed steel stud shear walls provide lateral resistance for wind and wave loads.

The battered columns consist of HSS8×8×$^{3}/_{16}$ sections that extend from the lower deck to the upper canopy roof. The architectural design pushed for an exposed structure, so the HSS8×8 columns around the perimeter of the building are offset from the exterior shear walls to show off these beams and columns. The four columns supporting the upper deck and roof canopy are designed as cantilevered columns that are braced at the low roof; they cantilever to the high roof to avoid the use of bracing that could have obstructed views from the upper deck. All roof framing members consists of exposed HSS beams that range in size from HSS12×4 members to HSS16×8 members.

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▲ The store floats on Lake Powell's Wahweap Marina in northern Arizona, near the eastern end of the Grand Canyon.

Most of the lower hull float framing consists of continuous W8×18 or W8×24 beams that are full-pen welded at the joints. The traditional and Vierendeel truss configurations used in the hull consist of W8 beams that form the top and bottom chords, with HSS4×4 and HSS5×5 posts at approximately 8 ft on center and matching diagonal HSS members where needed. The truss systems occur at approximately 6 ft on center and are designed to align directly beneath the column locations so that the truss system can be used to evenly distribute the structures loads.

Launching a Building

As the structural engineer, ARW Engineers' role went beyond the typical goal of providing practical and economic structural solutions to satisfy the owner's and architect's overall vision for the project. They were also tasked with providing solutions for including fluctuating water levels, determining construction sequencing of the float system with launching and ballasting restrictions, designing deeper hull sections in the lower float structure for better accessibility to storage and mechanical units and integrating exposed beams with cantilevered decks.

Typical building projects begin with geotechnical reports and foundations designed to mitigate any potential settlement in the structure. But the Wahweap Marina Store is anything but typical. Instead of ordering geotechnical reports and determining seismic loads, the project team and owner focused on working together to determine how they could best move the building during construction so it could be launched into the water.

One unique aspect of this building system is the trusses in the hull section. Unlike structures built on soil with independent footings supporting individual columns, the truss members were designed to carry multiple columns and act together with adjacent trusses to distribute loads evenly over the built-up plates below; this allowed the localized "settlement" beneath each individual column to be minimized. The structure is designed to accommodate a fluctuation in the storage dead loads and live loads each day; as buoyancy pressure beneath the truss system increases as water depth increases, the pressure used to analyze the truss system changes as well. The upper level buildings loads are not equally distributed over the structural float, and this requires a ballasting system to keep the building from tipping toward the entrance where the structure is heaviest due to the second-level framing.

The decision of how the floatation platform and upper structure would be built and launched played a vital role in this process. The marina is located in a remote part of Lake Powell that is surrounded by cliffs. The boat launch ramps are the only access to the waterfront, and clogging up the boat ramps during the summer months was not an option. Consequently, different methods of constructing the floatation system off-site were discussed and after reviewing the additional time and material required to construct the float in sections, it was decided that a portion of the parking lot and one of the ramps would be dedicated to the accelerated construction of the facility during the winter.

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VCBO Architects

The facility has been designed to accommodate the constantly changing water level of Lake Powell; it is supported by a 10,144-sq.-ft floating platform.

Once the steel-encased floatation system was built and launched, the middle 8-ft-deep storage section was so buoyant without the steel and concrete structure above that it literally supported the side sections and suspended them above the water. The contractor was directed to fill the deeper float section with water so that the suspended W-2 deck and concrete topping could be poured without causing damage to the truss members. The suspended concrete floor was poured in such a way that the structure did not lean or cause torsion in the structural members.

The new store is located at the same site as the original facility, which was constructed in the early 1960s and had experienced a number of additions and renovations over its 50-year life (it contained little or no storage space, had deficient mechanical systems and only had a small convenience store, hence the replacement). The construction process undertaken with the new structure allowed the majority of the new facility to be constructed away from the site and then moved into place after the existing building was disconnected from the docks and removed. This allowed for the ongoing service to the marina visitors with minimal disruption.

Previous, similar projects with this client had incorporated the use of long cylindrical tanks that can be filled with water (as needed) to buoy up and/or ballast the floatation system—similar to what is used on a pontoon boat. Any piping beneath these structures is exposed to severe weather conditions and erosion.

For this project, the owner requested that a mechanical room and storage room be placed beneath the structure and that all of the ducts and piping be placed within this space. They also required approximately 28 in. of freeboard between the water and the top of the deck to allow for neighboring docks to be attached at similar levels and to allow boats to pull up to the walkway. Creating too deep of a storage area would produce too much buoyancy, making it difficult to tie the platform into surrounding structures. Innovative approaches were used in the design of the deeper storage section so that the forces were transferred throughout the structure to increase its stiffness and meet the required buoyancy objectives. The T-shaped section was designed to mitigate any warping or twisting of the platform with the changing loads.

The project, which uses approximately 300 tons of (floating) structural steel, opened for business in time for the 2013 high season. ■

Owner
Aramark, Wahweap Marina

General Contractor
Lake Powell Construction, Page, Ariz.

Architect
VCBO Architects, Salt Lake City

Structural Engineer
ARW Engineers, Ogden, Utah