OPEN CELL SHEET PILE™ TECHNOLOGY
The OPEN CELL™ sheet piles are vertically arranged driven flat sheet pile-composed structures that act as a horizontally-tied membrane to retain soil. The OPEN CELL bulkhead features a vertical flat sheet pile anchor wall (tail wall) to restrain a curved flat sheet pile arch face.

STRUCTURAL STABILITY & MODELING:
At left and above are models representing analysis of an OPEN CELL structure. Rigorous geotechnical analysis – performed on every structure we design – can include multiple methods involving both classic analysis and numerical methods that have provided consensus of results.

PATENTS:
PND has spent years testing, observing, and refining the OPEN CELL system and holds all related information to be proprietary. The OPEN CELL system is patented, holding U.S. Patent No. 6,715,964 B2; U.S. Patent No. 7,018,141 B2; U.S. Patent No. 7,488,140 B2; and U.S. Patent Application No. 12/879,997.
OPEN CELL SYSTEM COMPONENTS:
The OPEN CELL system utilizes flat sheet piles and either extruded connectors or welded connectors. The simplicity of the design and durability of the materials allow PND to adapt the OPEN CELL system to many uses and conditions.

STEEL QUANTITY ESTIMATES:
The graph below represents estimated steel quantity per foot of bulkhead wall height. Wall height is measured from ground- or mud-line to top of a driven sheet pile. (See isometric view on opposite page.)
OPEN CELL structures number more than 215 completed structures across North America, as of April 2015.

OPEN CELL structures outside North America, and projects currently in planning phases, are not shown.
When the City of Owensboro, Kentucky, began the redevelopment of its downtown waterfront on the Ohio River, two objectives were desired: stabilize a chronically sloughing bluff and create more park area. Complications with the proposed tie-back combiwall with numerous A-frame piles and deep excavations resulted in bids that exceeded available funding.

The City Engineer reassessed the situation and allowed value-engineered alternative design bids from contractors. One of the bidders, Richard Goettle, Inc., used the OPEN CELL system as a substitute earth retention system, offering nearly $13 million in cost savings, reducing the amount of steel by 30%, as well as saving six to eight months of wall construction time.

The revised wall design was able to keep the concrete fascia, pavilion, and overlooks desired in the original concept. PND completed the design of the new OPEN CELL bulkhead wall to the acceptance of the City. Goettle installed the 1600-foot-long, 40-foot-high sheet pile wall in six months in 2009.
The OPEN CELL VCDF...

- Reduces or eliminates contaminant migration under the containment structure.
- Is constructible in poor soil conditions and deeper water.
- Provides a vertical face and the ability to dredge directly in front of the containment wall.
- Eliminates seepage through the containment structure.

Conventional Confined Disposal Facilities (CDF) are typically constructed using an earthen or rock dike, but these structures are porous and permeable. Flow through the OPEN CELL bulkhead decreases to a point where a “watertight barrier” is formed, thus preventing containment transport.

A VCDF, employing OPEN CELL technology, will require less space for dike construction and can therefore have a larger dredged material capacity for the same areal footprint when compared to CDFs using conventional dikes.

USACE: ALTERNATIVE CONTAINMENT METHOD REVIEW

The OPEN CELL system had been reviewed by the U.S. Army Corps of Engineers (USACE) to determine its acceptability as a Vertical Confined Disposal Facility (VCDF). The USACE Environmental Laboratory at the Engineer Research and Development Center in Vicksburg, Mississippi, concluded in its final report that the OPEN CELL system, “...can be effective for controlling environmental risk for containment of dredge material.”

The USACE report is available at www.pndengineers.com
PND provided planning, design, and construction observation for new Iraqi naval pier facilities, a seawall, and supporting infrastructure at Umm Qasr Naval Base in Iraq. PND teamed with West Construction and CCI Alaska, Inc., for this design-build project for the U.S. Army Corps of Engineers. Umm Qasr is located at the southern tip of Iraq on a waterway leading to the Persian Gulf.

The new naval facilities consist of two piers: Pier 1 utilizes the OPEN CELL SHEET PILE bulkhead system; Pier 2 is a floating dock with a gangway, located just south of Pier 1. The piers form the nucleus of a new dock facility to moor Iraqi Naval vessels responsible for security for Gulf region shipping and the adjacent Port of Umm Qasr commercial shipping activities. The new facility provides operational and maintenance support for patrol ships that were recently purchased by the government of Iraq. Pier 1 has a height of 45 feet, is 1,200 feet in length, and created over seven acres of usable uplands staging area for the Navy.

OWNER: IRAQI NAVY
Award: Winner AGC 2011 Aon Build America - International
PND was retained by Kelly-Ryan, Inc., to value engineer components of the False Pass Small Craft Harbor project. PND designed a 180-foot-long sheet pile bulkhead dock utilizing the OPEN CELL system. Kelly-Ryan realized significant savings in cost and time to construct this option over the U.S. Army Corps of Engineers’ original design. In addition to the bulkhead, PND designed a bridge to allow a 70-foot breach in the causeway for fish passage. The abutments of the bridge utilized the OPEN CELL system. Services included coordination with the USACE, final design, and construction assistance.

OWNER: U.S. ARMY CORPS OF ENGINEERS

PND provided engineering services to Gulf IntraCoastal Constructors, a Joint Venture, (Kiewit) for an OPEN CELL bulkhead wall for the U.S. Army Corps of Engineers’ Levee Project. The bulkhead wall was used as a temporary barge dock and loadout facility along the Intracoastal Waterway. Our services for the project included concept development, final design, and construction assistance.

Corps of Engineers’ Levee
Crushed Limestone
Sand Fill
In situ Clays
Distances are approximated.
PND provided the owner of this facility with design of an OPEN CELL bulkhead structure for deep excavation development. This project allows construction of a railroad car dump structure and conveyor system to feed the adjacent power plant with coal delivered by train.

Total excavation at the site was nearly 70 feet, with an average of 52 feet of vertical retaining wall. Excavation of inside walls was completed in two weeks. The hole remained open for around six months, during construction of the interior hopper system.
The Dutch Harbor Marine Terminal was designed as a 100-year facility in a highly active seismic area and provides a dramatic advance in seafood trans-loading and cold storage technology for Dutch Harbor, the largest seafood producing port in the United States. The OPEN CELL SHEET PILE dock facility was determined to be 50 percent less expensive than the competing dock design and was developed from concept design to completed construction (quarry development, sheet pile and fill installation) within a nine-month period. The dock provides 46 feet of draft and created over three acres of usable uplands. Existing materials are characterized by soft soils over shallow bedrock.
PND provided design and construction support services for an OPEN CELL bulkhead system in support of the overall design effort for the Victoria Island Alternative Intake project and pump station that provides water to residents of the Contra Costa Water District (CCWD).

The 42-foot-high, 540-foot-long OPEN CELL bulkhead structure was proposed as a solution, offering extremely high seismic resistance with controlled wall deflection and lower overall installation cost compared to the original concept. The sheet piles for the bulkhead were driven from land and backfilled to final grade; then a contractor-designed cofferdam was constructed into the waterway to allow excavation within the new bulkhead. To engage the OPEN CELL sheet piles to full deflection and lateral movement, 8 feet of earth surcharge was placed over the top of the bulkhead and surrounding area to accelerate vertical settlement of the peat layer. The intent of preloading the bulkhead was to fully engage the sheet interlocks and effectively apply the full capacity load to the wall, in excess of design seismic loads.
PND Engineers, Inc., founded in 1979, is a full-service engineering firm that provides civil, marine, geotechnical, structural, and construction inspection services for a wide range of projects. The OPEN CELL SHEET PILE technology was devised, tested, and patented by the company’s founders. Since its development in 1981, it has been utilized in more than 215 structures.