PORT SECURITY PREPAREDNESS

Abstract

Since 1980, PND Engineers, Inc. has been researching and developing a new port bulkhead system that has the capability to handle extreme vertical and lateral loads, harsh environmental conditions and is highly resistant to terrorist sabotage. The system termed the OPEN CELL™ bulkhead is simple in its components and construction thus resulting in costs often 25% to 50% lower than commonly used platform docks and tied-back sheet pile systems. Lower cost, but stronger and more secure are the OPEN CELL bulkhead hallmarks.

Discussion

First poor seismic performance and now terrorist damage potential has pointed toward needed improvements in strength of structures and materials used in construction — ports are no exception.

Many ports are fronted by structures of various types ranging from platform docks to steel bulkheads constructed of various materials, all supporting critical machinery such as container cranes without which the country would grind to a halt.

A number of deficiencies have surfaced regarding the susceptibility to terrorism and natural events of key port structures including:

1) Platform dock underside access is difficult to control. (Figure 1)
2) Critical platform dock supporting piles are easy to destroy using various relatively small charges.
3) Concrete piles and superstructures (Figure 1) are particularly vulnerable to blast demolition.

Figure 1
4) Treated timber structures are extremely susceptible to underside fires.

5) Tied-back steel bulkheads are dangerously susceptible to collapse from seismic events due to small tie rod failure from stress, soil settlement and also corrosion.

6) Sheet pile wall tie-back connects are often exposed on the dock face and can be easily destroyed, causing outward wall collapse.

7) Relatively small efforts can isolate critical supports for destruction on common docks thus causing significant damage with no way of achieving rapid repair.

8) Most dock structures are vulnerable to terrorism damage not only from blasting but also by using ships for ramming critical points.

9) Many ports in the United States are beginning to age and may eventually be rendered unusable because of increasing requirements for greater drafts of ships, and larger cranes, thus modern upgrades can accomplish significant security improvements.

10) Pipelines can be buried the entire length of earth-filled bulkheads, whereas they are often exposed on traditional platform docks.

For new or replacement dock structures, what is needed is a dock system that addresses in part the seismic and terrorism potential while providing an economical yet stronger system than is currently in common practice.

Since 1980, PND has been researching and developing a new system termed the OPEN CELL bulkhead which possesses all the features desired lacking in the previous discussion. Research, testing and prototype observation has progressed with time involving over 150 structures to the point where the system should be considered on any new port. The need for security now emphasizes the use of this structure type.

One quote from a demolition expert is as follows: “The OPEN CELL sheet pile structure is virtually indestructible. The curved design of the cells and the massive bulk of the fill behind them leave no opening for attack. The only way to take it out would be with a massive bomb which would be difficult to conceal and deploy.” That quote is from Paul Fuhs, who for several years was an underwater demolitions diver in Dutch Harbor, Alaska.

**What are OPEN CELL bulkheads?**

OPEN CELL bulkheads are flexible steel sheet pile membranes supported by soil contact with embedded sheet pile tail anchor walls. This concept creates an integral reinforced soil system. The result is a structure that can withstand large settlement and support a variety of loads. In effect, viewed from above the structure becomes a series of U-shaped horizontal membranes that require little toe embedment for stability. The OPEN CELL bulkhead is constructed of only three components including: flat sheet piles, connector wyes and anchor piles.

![Diagram](image)

Compared to alternative structures, several cost savings are realized from this land-based construction: reduced sheet pile area, greater construction tolerances, minimal pile penetration, and simplified backfilling procedures. Figure 3 and Figure 4 show typical installation and construction.
PND has had the opportunity to observe and to provide consulting services on bulkhead and dock projects that have developed problems. In fact, some of this experience led to development of the state-of-the-art OPEN CELL system in the early 1980's.

An alarming number of port structural failures have been documented, some of which are shown in this paper. Many failures are associated with tie-rod wall systems, overloads and corrosion. It is almost impossible to compact soils beneath tie-rods sufficiently to prevent settlement. When settlement occurs due to weak soils, construction methods, seismic events or other factors, tie-rods will often fail. Loss of fill through wall cracks has plagued other systems. The OPEN CELL system addresses soil settlement problems and is unaffected by even severe settlement, seismic action or overload.

Bulkhead structures historically have had problems with corrosion of small connecting components, and collapse due to failing components such as tie-rods and bolts. Closed cell bulkheads specifically are large-diameter flat sheet pile assemblies often 70' to 80' in diameter. This size is sensitive to large loadings such as from earthquakes or ship impact; failures were noted in the 1964 earthquake.
The OPEN CELL bulkhead was created to specifically avoid all the aforementioned problems by using small cells, usually 30' wide, with resulting low stresses and no small or sensitive components. To date, 25 years-plus experience with performance including vessel impact and many earthquakes, demonstrates the flawless performance of the OPEN CELL bulkhead concept. This structure type is also insensitive to toe scour.

**Security and other advantages of OPEN CELL bulkheads**

By design, as noted above, the OPEN CELL sheet pile structure is virtually indestructible and, in that context, directly addresses port security issues. In addition, OPEN CELL bulkheads present numerous other advantages over traditional docks, including:

- Appearance
- Health and Cleanliness
- Protection of Utilities
- Control of Runoff
- Marine Habitats
- Minimal Maintenance
- Safety
- Low Cost
- Ease of Construction