

## Evaluating the Condition of Seawalls/Bulkheads

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Seawalls and bulkheads (walls) provide shoreline stabilization for many coastal and waterfront properties throughout Florida and the Caribbean. The walls provide an economical approach for vertical shoreline stabilization, allowing owners to maximize upland property area, as opposed to other shoreline stabilization methods such as revetments or natural wetlands/mangroves. Existing walls were constructed of many different structural configurations, and at various time periods. Coastal and waterfront properties are in high demand in Southern Florida and the Caribbean with an increasing coastal population. Developers and property owners are looking to rehabilitate existing properties, and the condition of a coastal seawall or waterfront bulkhead can significantly impact the total cost of property development. Also, many waterfront property owners may have experienced problems with their existing structures, or have concerns regarding the structural integrity of their walls.

This perspective will explain:

- **Difference between Seawall & Bulkhead**
- **Introduce Elements of Wall Design**
- **Present Materials of Construction with a Discussion of Material Performance**
- **Address Special Regulatory Issues with Seawalls**
- **Discuss Wall Structural Evaluation Methodology**
- **Present Frequently Asked Questions Regarding Seawalls and Bulkheads**



Typical bulkhead under construction



Typical coastal seawall



# Seawall vs. Bulkhead?

Many people refer to all vertical shoreline structures as "seawalls," but there is a difference between a seawall and a bulkhead.

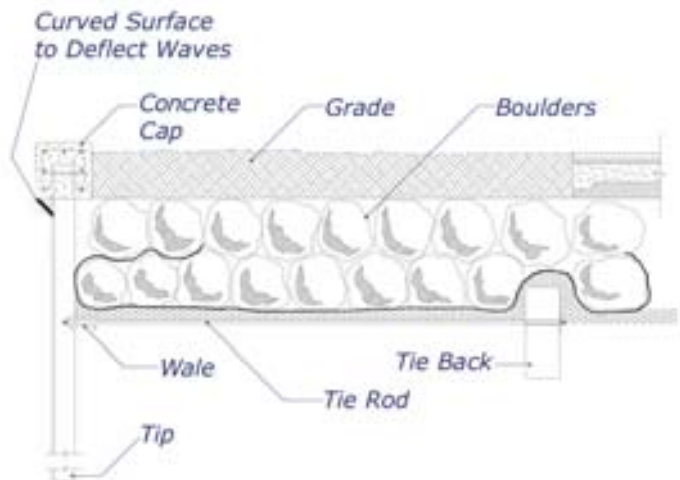
**Seawall:** structure that provides shoreline protection from waves but also retains soil.

**Bulkhead:** vertical shoreline stabilization structure that primarily retains soil, and provides minimal protection from waves.

Seawalls are typically located on the coast fronting beaches, and are subject to storm surges with pounding surf, eroding shorelines and wave overtopping from coastal storm events. Some localized waterfront properties may be subject to significant wave activity, even though they are not exposed to ocean waves. A coastal engineering study can provide seawall design information to ensure that they are designed properly to withstand the dynamic loading and overtopping effects of waves. The "rule of thumb" in bulkhead design is to account for wave impacts if the significant wave height at a project site is expected to be in excess of three feet (1 meter). Unfortunately, many existing walls on the coast were simply designed as bulkheads, and did not account for coastal storm impacts.



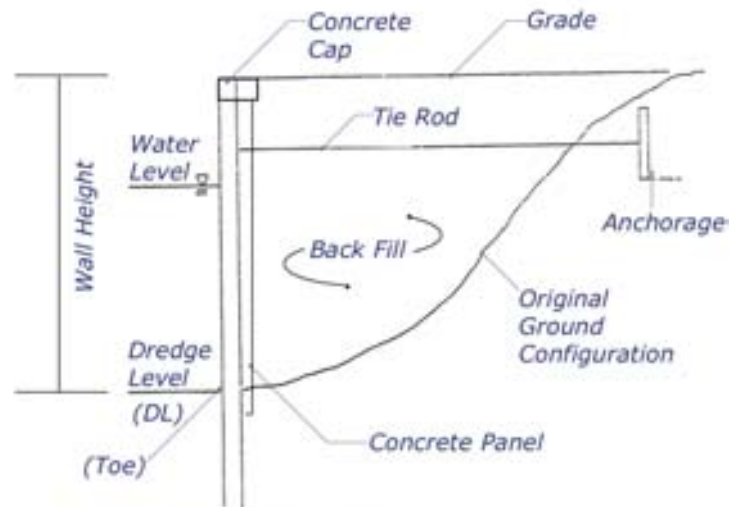
Typical oceanfront seawall



Cross-section of typical seawall: Note use of boulders against wave overtopping



Typical Concrete Bulkhead



Typical bulkhead cross section



# Elements of Wall Design

Prior to evaluating a bulkhead or seawall, the following design considerations need to be addressed to be able to properly assess the condition.

Topography: elevations, grading, etc.

Soil Properties: unit weight of soil, clay vs. sand, etc.

Embedment/Stability: depth of wall for stability

Water Table: differential water levels behind and in front of walls can introduce additional loading on the wall

Wall Material Properties: strength and performance in the marine environment

Surcharge: live loads behind the wall such as vehicles

These additional design considerations need to be addressed for seawalls:

- Wave Forces**
- Toe Scour**
- Wave Overtopping**
- Storm Surge**

If a wall is damaged or deteriorated, the original design may not have accounted for the above-listed design considerations. Original or "as-built" plans can provide a wealth of information including the age of the structure and many of the design elements listed in the above paragraphs. The deteriorated condition of a wall may also be an indication that the wall is in need of maintenance, or that it has fulfilled its service life.



Failed bulkhead due to inadequate embedment of wall.



Deteriorated concrete pile/panel bulkhead. Note storm sewer outfall through bulkhead.



# Materials of Construction

Seawalls and bulkheads are constructed of similar materials. The material of the wall must be properly identified prior to assessing the condition. The following table presents common wall construction materials with comments regarding availability, construction issues, and general performance in the marine environment:

Material	Comments
Concrete	Pile/panel and sheet piling configurations common in South Florida. Most common wall material in South Florida due to the locally available aggregate; provides service life of 30+ years if correct mix design and proper marine structural design implemented.
Steel	Steel sheet piling commonly used for bulkheads/seawalls. Material provides excellent strength characteristics for high wall exposure applications. Provides interlocking seal, and generally easy to install, even in harder substrate. Must be properly coated and maintained for long service life of 25+ years.
Aluminum	Sheet piling provides good corrosion resistance, but lighter sections allow for minimal exposed wall height. Recognize corrosion potential of dissimilar metal hardware, do not use in waters with low Ph or backfill with clay-mucky soils. Difficult to install in hard substrates.
Timber	Not often used in South Florida, but occasionally seen on inland waterways. Timber pile/wale/sheet system is common structural configuration. Generally economical material, but limited strength characteristics for high wall heights. Preservative treatment is essential for marine organisms. Difficult to install in hard substrates.
Vinyl/ Plastic	Relatively new economical product with service life of 50+ years. Available in different colors. Limited strength characteristics for wall heights. Difficult to install in hard substrates.



Damaged timber seawall



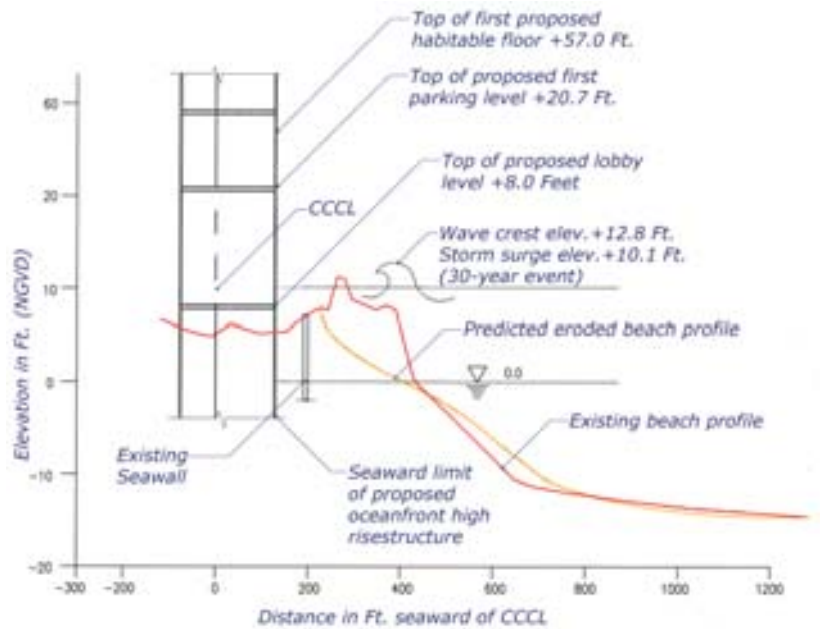
Typical vinyl sheet pile bulkhead (Picture courtesy of Materials International)



# Seawall - DEP Requirements

Seawalls on the coast of Florida come under the jurisdiction of the Florida Department of Environmental Protection (DEP). In addition to evaluating the structural condition of a seawall, the DEP has special requirements for seawalls at or near the Erosion Control Line (ECL). A coastal engineering analysis is required to determine if an existing seawall will be affected by a 30-year coastal storm event. If the existing wall is within the 30-year Erosion Projection, then the property owner must "provide scientific and engineering evidence that the armoring structure (seawall) has been designed, constructed, and maintained to survive the effects of a 30-year storm and provide protection to existing and proposed structures from the erosion associated with that event." The DEP requires certification by a professional engineer that the seawall was designed, constructed, and is in adequate condition to meet the following criteria:

1. The top of the seawall must be at or above the predicted maximum wave crest elevation, considering the eroded beach profile, of the 30-year design storm.
2. The seawall must be stable under the 30-year design storm including localized scour, with adequate penetration and toe protection to avoid settlement, toe failure, or loss of material from beneath or behind the armoring.
3. The seawall must have sufficient continuity or return walls to prevent flanking under the design storm from impacting the proposed construction.
4. The seawall must withstand the static and hydrodynamic forces of the 30-year design storm.



Coastal engineering analysis

## Structural Evaluation

The American Society of Civil Engineers (ASCE) Underwater Investigations Standard Practice Manual was released in 2001 and provides guidance for the evaluation of walls. Procedures are also applicable for above-water structures. Most bulkheads are along the waterfront, and should be evaluated above and below the water, whereas seawalls typically are not exposed to water on a regular basis.

The following topics are covered related to structural bulkhead/seawall evaluation:

- **Qualifications of Inspection Personnel**
- **Types and methods of inspections**
- **Typical forms of deterioration**
- **Condition Rating**
- **Frequency of Inspection**

A comprehensive report is essential to document a proper bulkhead or seawall evaluation. All of the above items should be included along with photographs and sketches of the observed configuration with notes regarding deterioration. Comparison of previous reports provides an indication of the rate of deterioration.



Repair recommendations, along with construction cost estimates, should be included to provide the property owner with sound engineering advice so they can plan for maintenance or repairs as necessary. The report should be sealed by a registered professional engineer experienced in the evaluation of in-service marine structures.

## FAQ Regarding Bulkheads and Seawalls

*Can I raise the grade of my property with the existing bulkhead?*

The bulkhead must be evaluated by an engineer to determine if the structure can withstand the additional loads from fill and structural modifications. Deterioration can severely weaken the structural capacity of the bulkhead, and the bulkhead was most likely designed for the existing conditions.

*What is the best material for bulkheads and seawalls?*

Material selection is site-specific and dependent on design conditions. Concrete (if designed appropriately) generally provides a long service life, but it is not favorable from a first-cost basis. Vinyl sheet piling and other composite materials, where applicable, should be considered due to their resistance to the harsh marine environment and 50+ year service life.

*How long can I expect my wall to last?*

Answers to this question are generally subjective. An experienced marine structural engineer can provide general assumptions as to the "expected remaining service life" of a marine structure. Comparisons with observed deterioration over time can also provide an indication of material performance. Certain non-destructive and/or partially destructive



Exploratory excavation to evaluate condition of the tie backs.



Underwater photograph of steel sheet piling



materials testing can provide additional information for the assessment.

#### *What regulatory permits are required?*

Bulkheads typically require an environmental resource permit from several agencies including the county environmental resource management agency, the DEP, and the U.S. Army Corps of Engineers. Depending on the jurisdiction, the local water management district may also issue a permit. Seawalls require a permit generally from the state agency such as the DEP.

#### *How often should I inspect the wall?*

The ASCE Manual provides guidance for the frequency of inspections. Generally, seawalls and bulkheads should be evaluated every 5 to 6 years.

#### *How do I repair my wall?*

A qualified marine structural engineer should be consulted to evaluate the existing wall and to determine if rehabilitation or replacement is required. Options can generally be provided to provide an economical approach to meet budget constraints.

#### *Who can build a wall?*

Marine structures are specialized structures, often requiring water-based construction equipment and techniques. The costs for waterfront construction are generally higher than for upland structures such as buildings. Bulkhead or seawall work should be reserved for a qualified and experienced marine contractor.

## Conclusions

1. There is a difference between a bulkhead and a seawall.
2. Bulkhead and Seawall design is site-



specific and the design elements of a particular structure should be understood prior to evaluation.

3. Bulkhead materials of construction exhibit various forms of deterioration in the marine environment. Proper material identification is essential to assess structural performance.

4. Seawalls in Florida come under the jurisdiction of the DEP, and require coastal engineering studies to assess predicted performance.

5. ASCE recently released a standard practice manual to provide guidance for the above/below water assessment of marine structures.

6. Bulkhead and seawall evaluations should be conducted by qualified personnel under the supervision of a licensed professional engineer.

## References

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MIL-HDBK-1025/6, General Criteria for Waterfront Construction, Department of the Navy, Naval Facilities Engineering Command, May, 1988.

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