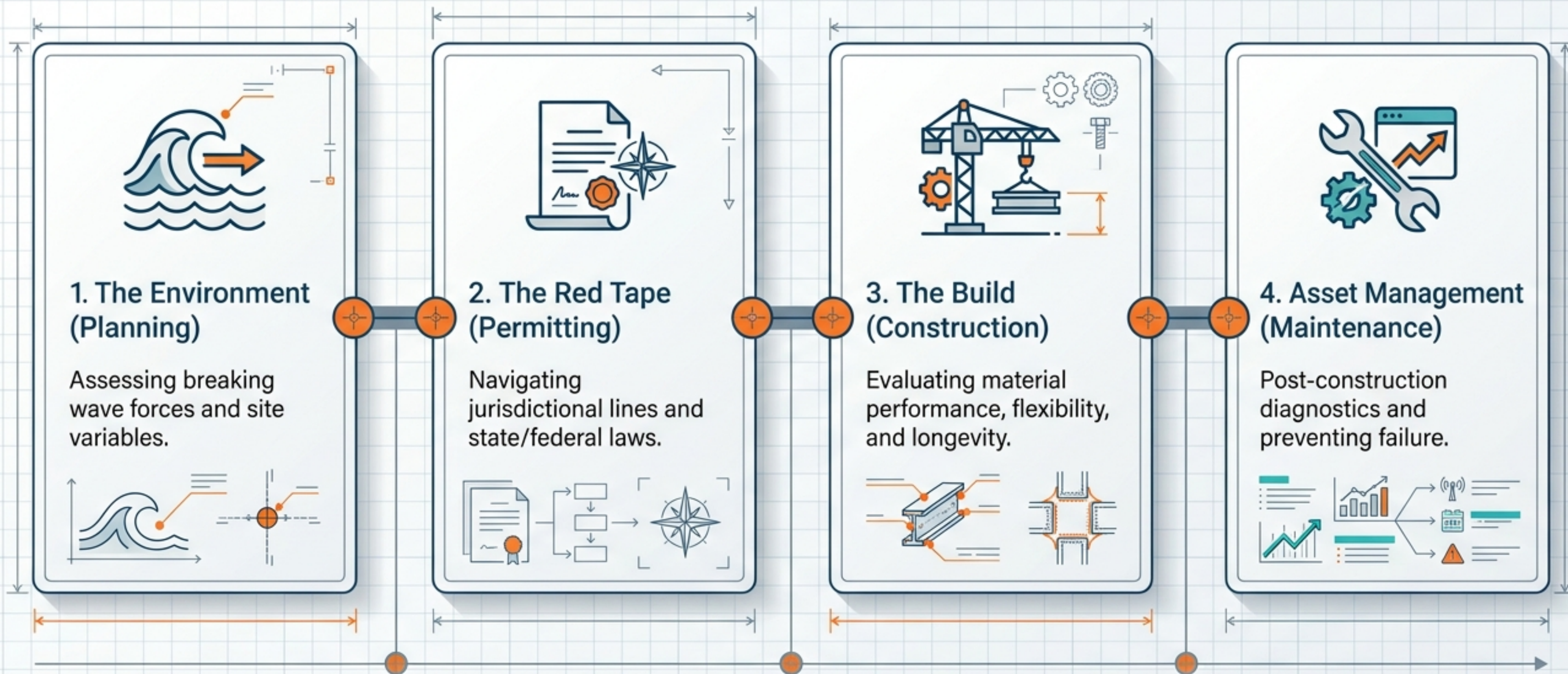


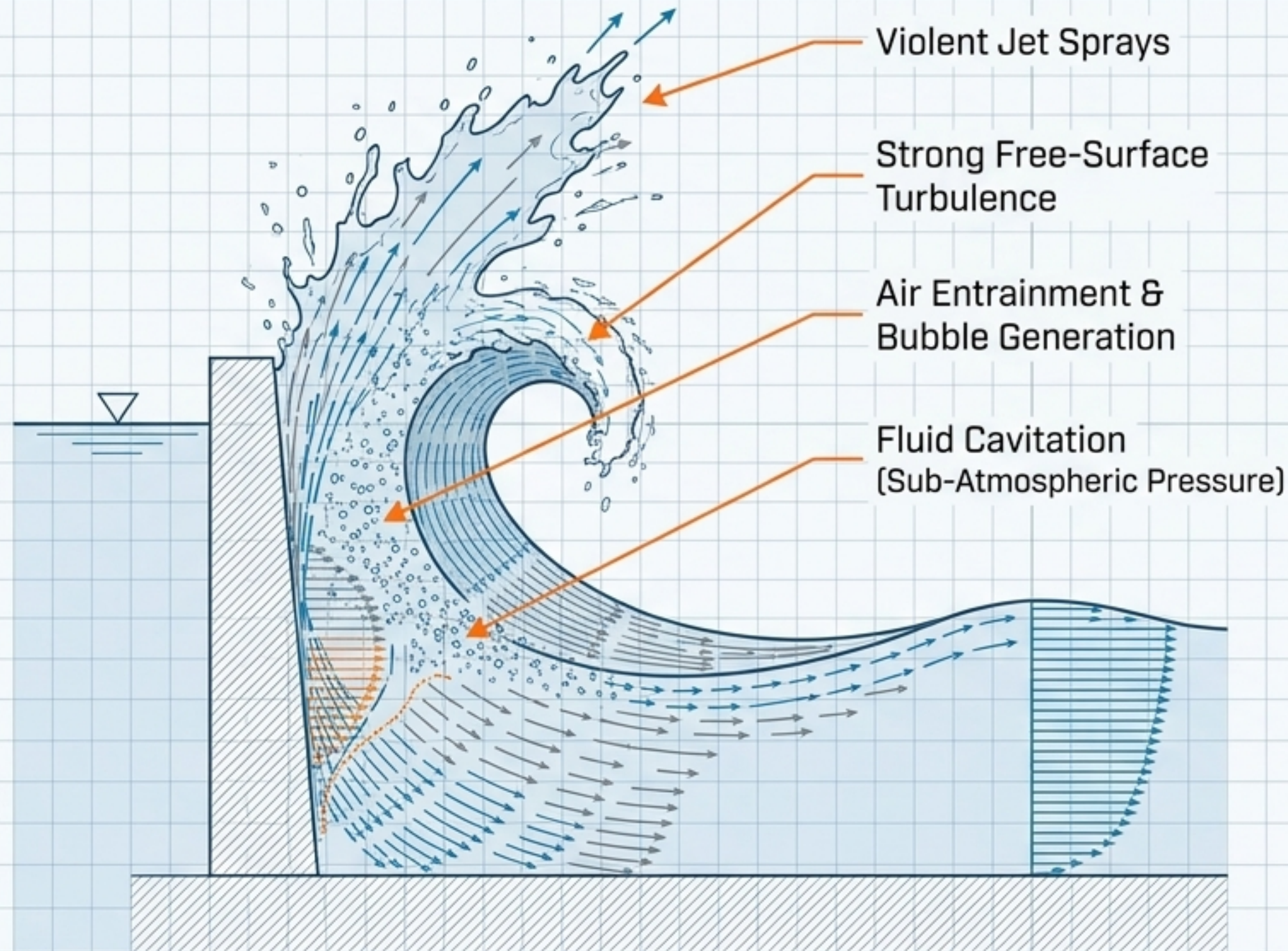
From Planning and Permitting to Construction and Maintenance



The Engineer's Blueprint



The Wave Impact Model



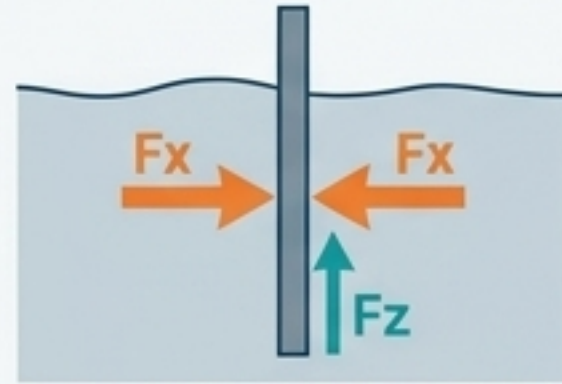
- Breaking waves produce short-duration, extremely high impulsive hydrodynamic loads.
- Field data shows impact pressures reaching over **383 kPa (8,000 lbs/sq ft)** for a 3m incident wave.
- The acoustic limit (water hammer pressure) combined with air aeration dictates maximum destructive force.



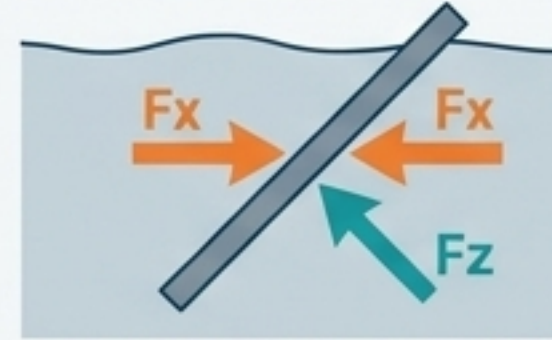
Force Variables: Submergence and Angle

Full Submergence

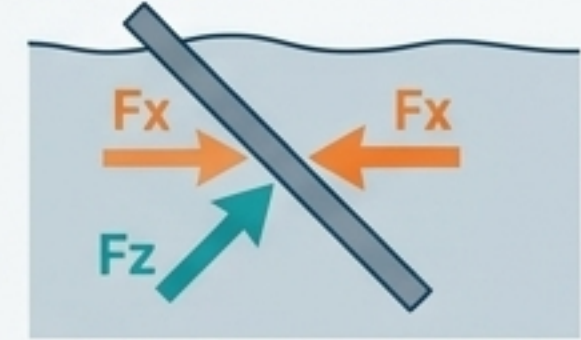
0° Vertical



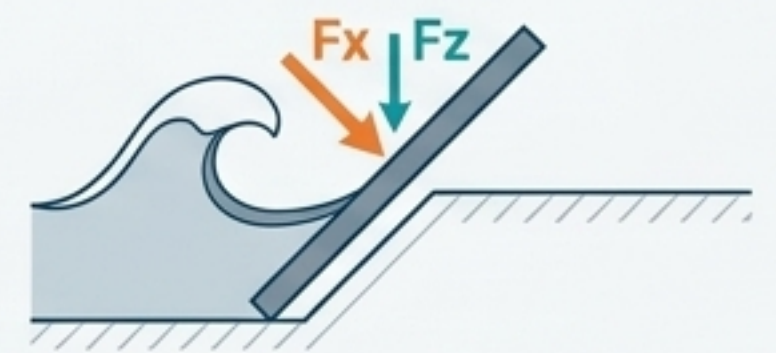
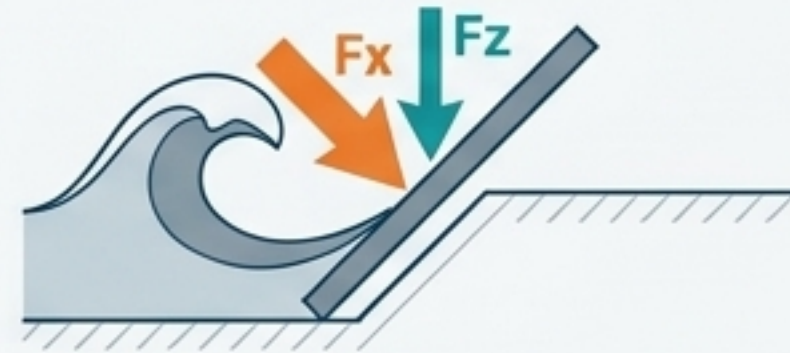
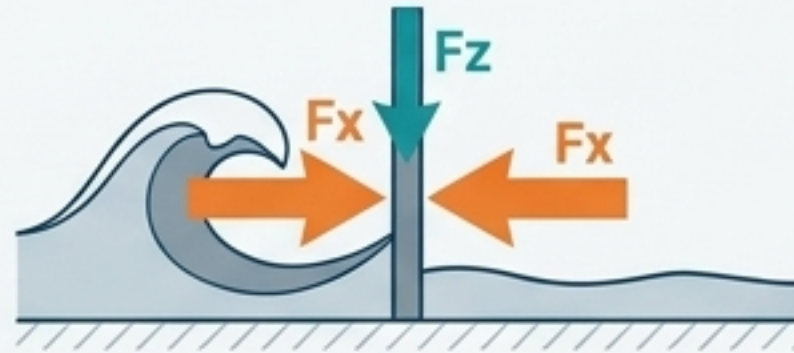
+45° Forward



-45° Away



No Submergence



The Submergence Rule

No submergence yields the highest impact forces against the structure.

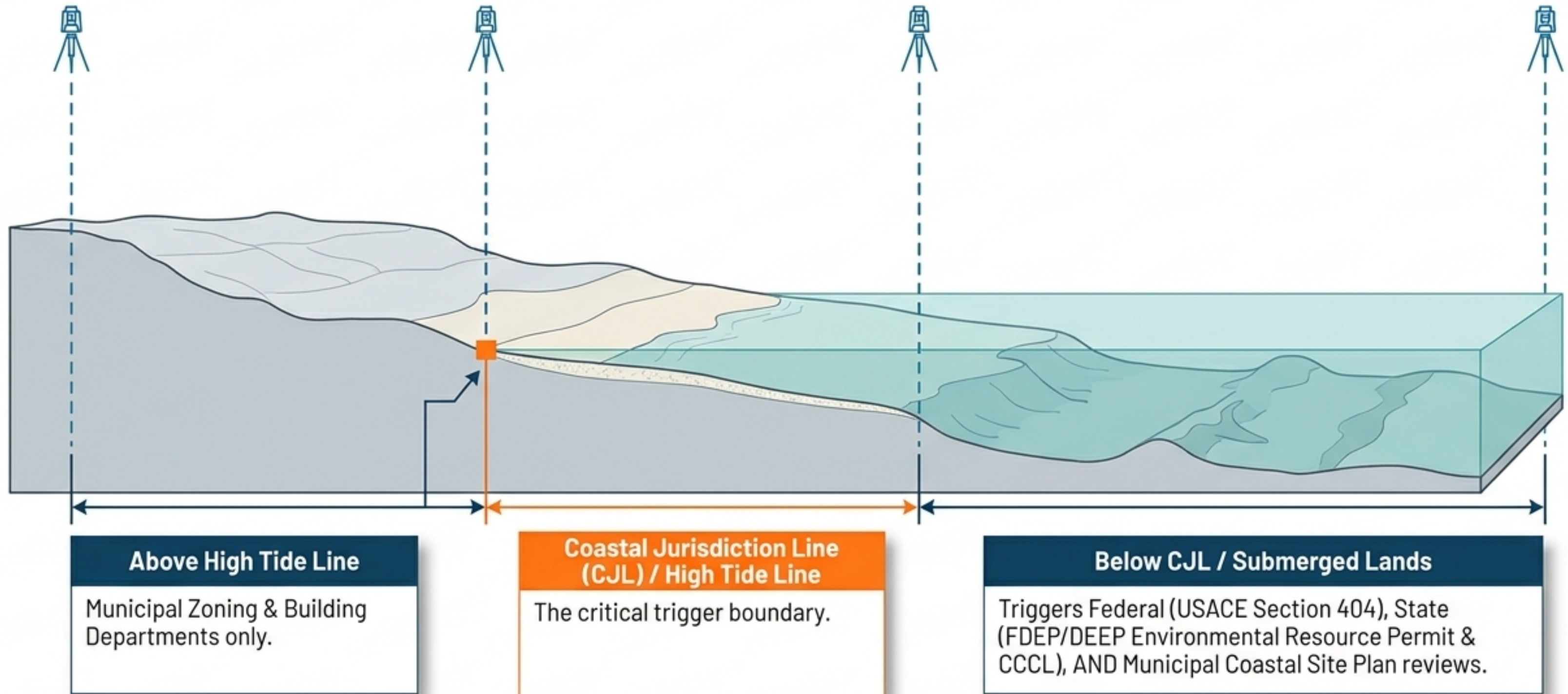
The Angle Factor

Plate angles of 0° and +45° (toward the wave) generate significantly higher forces than -45° (away).

The Volatility of Breaking Waves

Random air entrainment causes individual impact forces to vary by up to 70% from the average, requiring high safety margins.

The Jurisdictional Map



Regulatory Matrix: Permit Decision Tree

	Agency Level	Permit Type	Trigger / Purpose
1	State (FDEP / DEEP)	Environmental Resource Permit (ERP) Coastal Construction Control Line (CCCL)	Required for activities impacting wetlands/surface waters or building waterward of the CCCL.
2	Federal (USACE)	Section 404 Permit	Required for breakwaters or seawalls placed directly in navigable waters.
3	Local (City/County)	Building & Zoning Permits	Ensure compliance with local codes. Required for almost all seawalls.

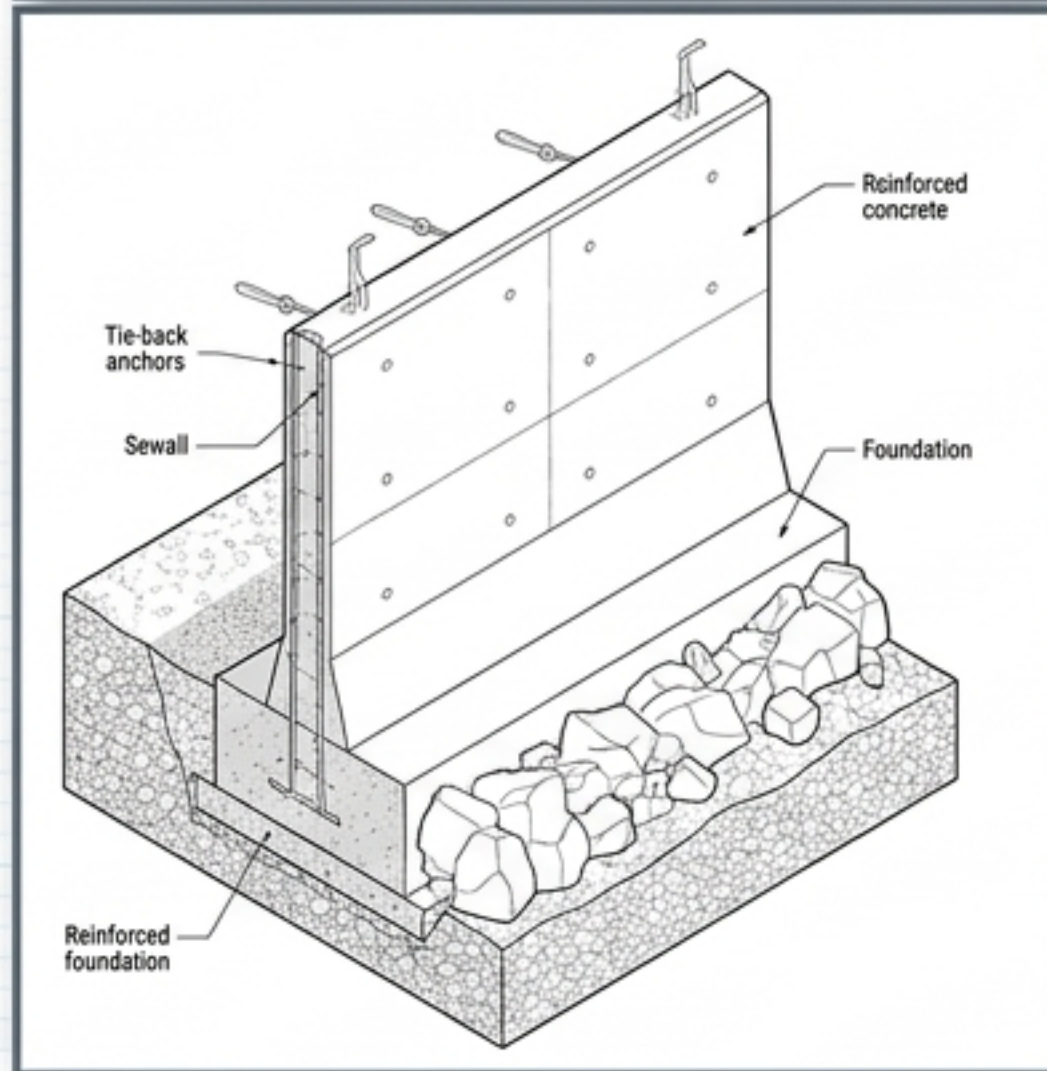
Consultant's Note

Average complete project costs range from \$1,000 to \$2,000 per linear foot. "Living Shorelines" designed primarily to restore tidal wetlands may qualify for exemptions from strict "necessary and unavoidable" restrictions.

The Shoreline Spectrum

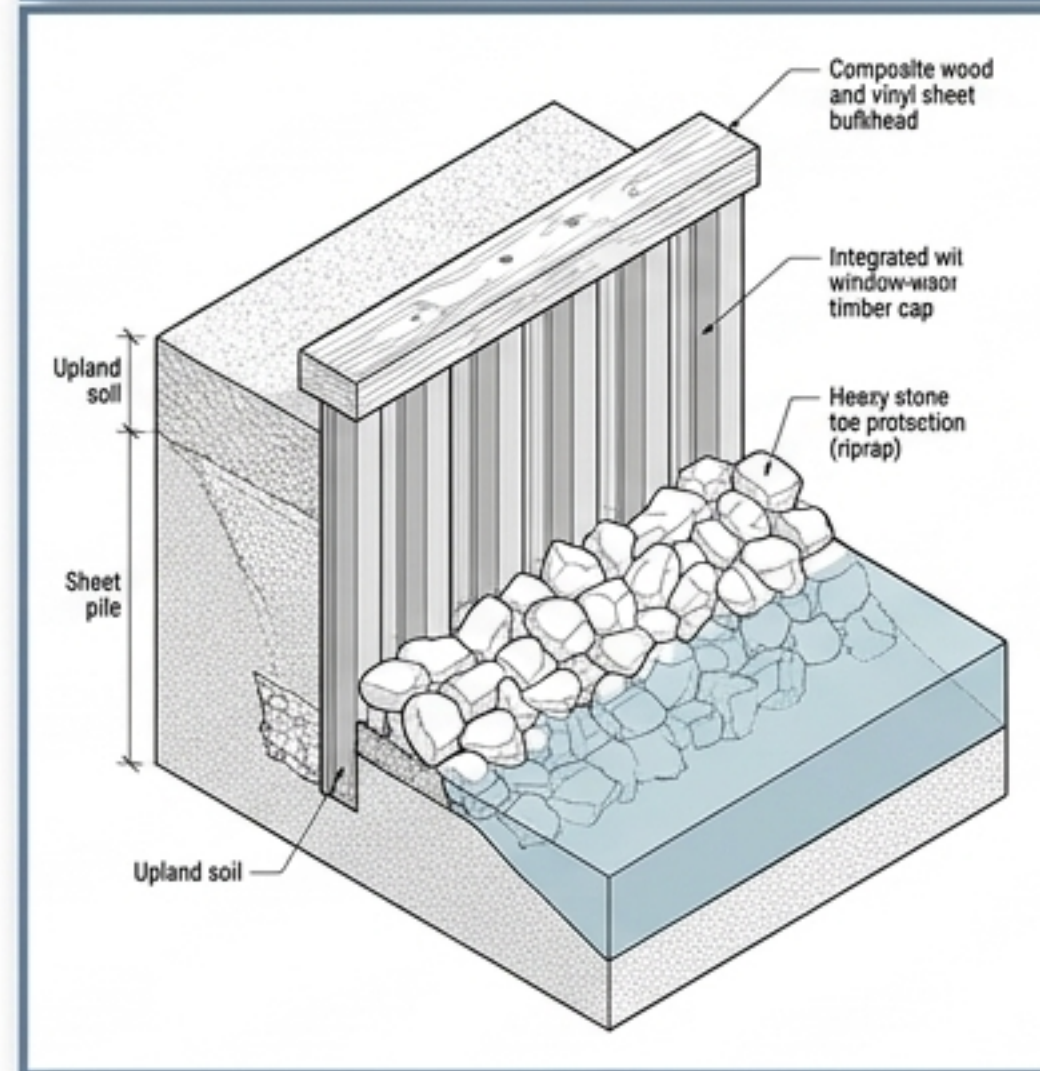


Hard Armor (Seawalls)



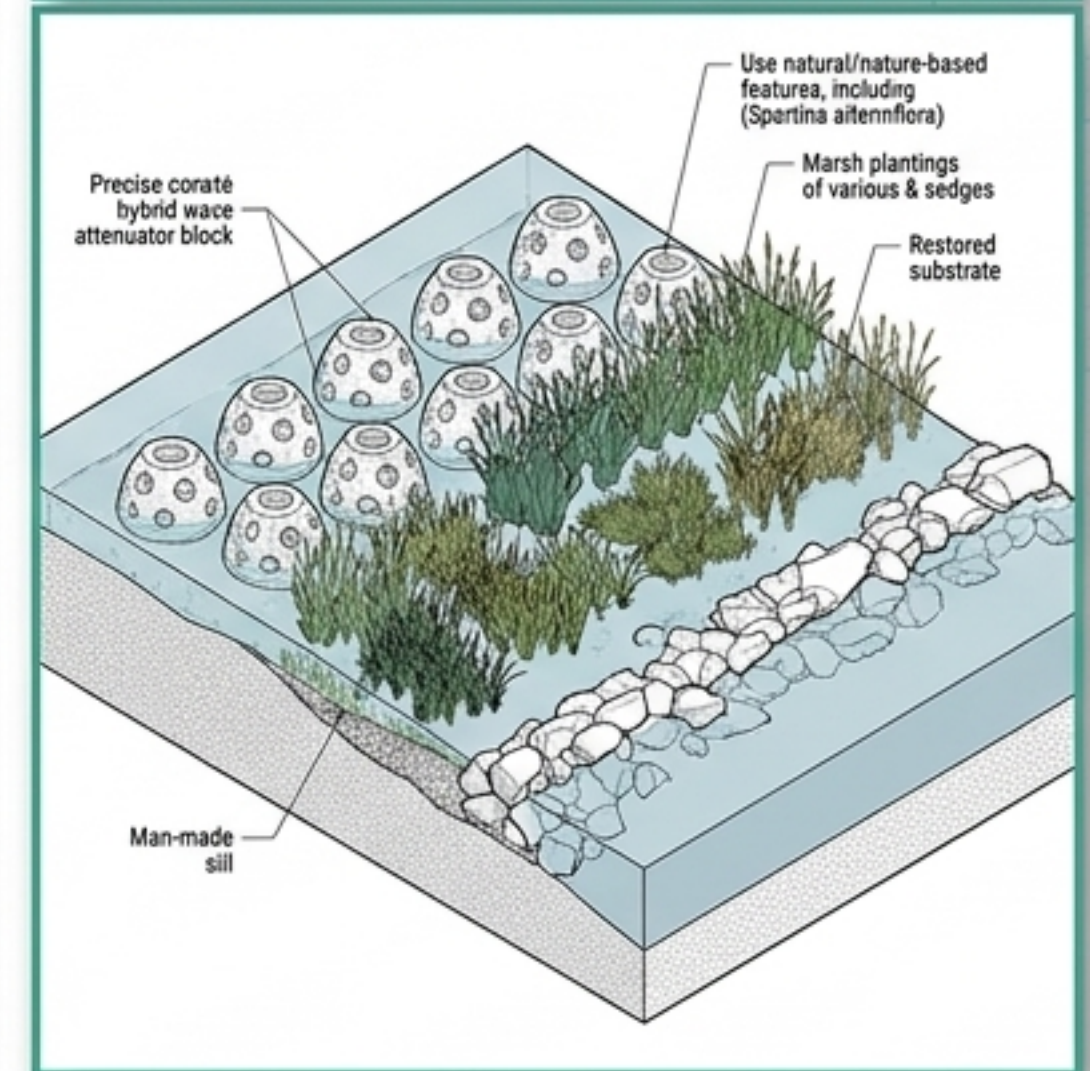
Massive structures designed primarily to intercept heavy wave action.

Hybrid / Bulkheads



Primarily retain and prevent sliding of the upland earth; wave protection is secondary.

Soft Stabilization (Living Shorelines)



Use natural/nature-based features. Effectiveness depends on fetch, ice, and surge. Often requires man-made sills for initial establishment.

Engineering Philosophy: Rigid vs. Flexible

Rigid Masses (Concrete Monoliths)

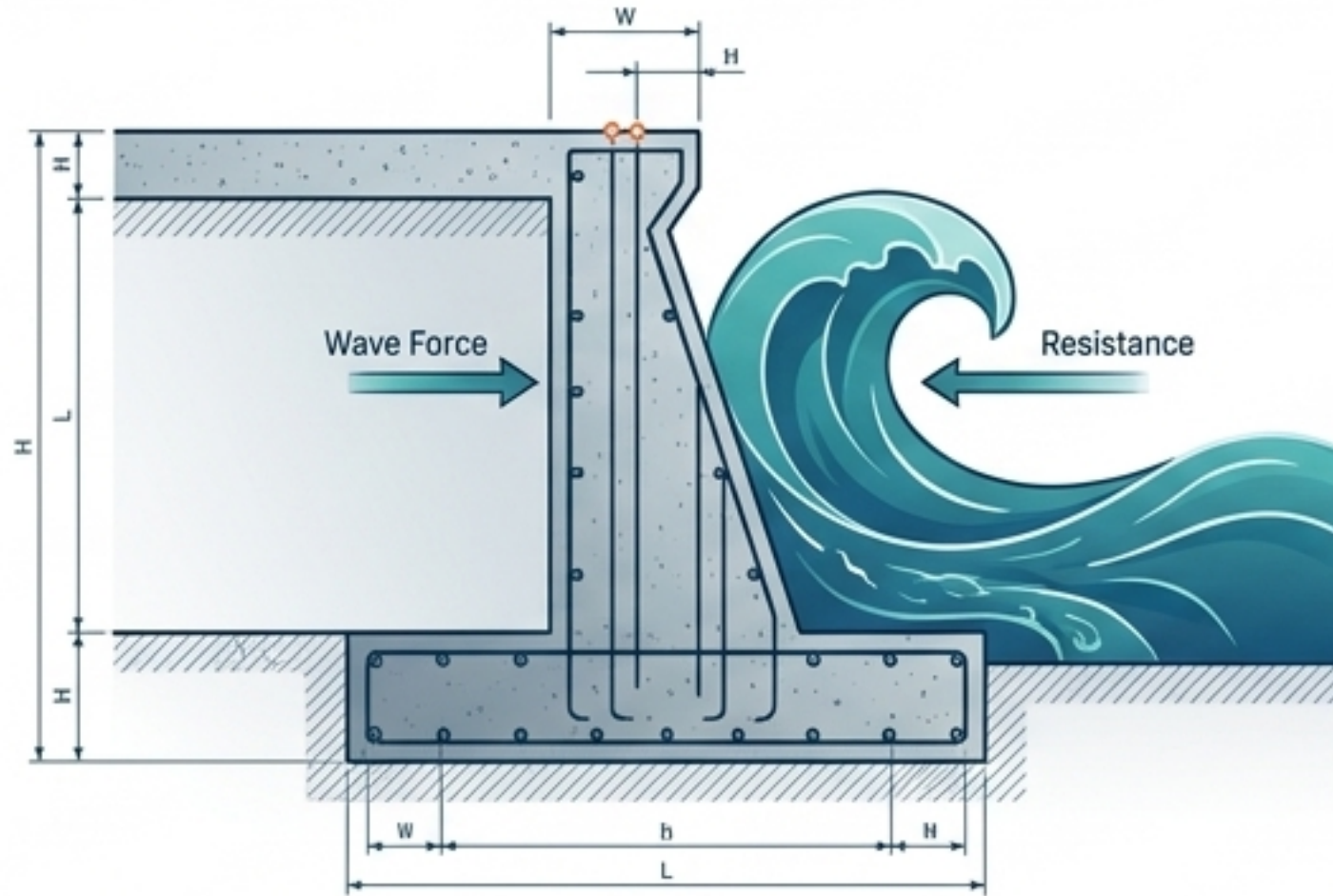
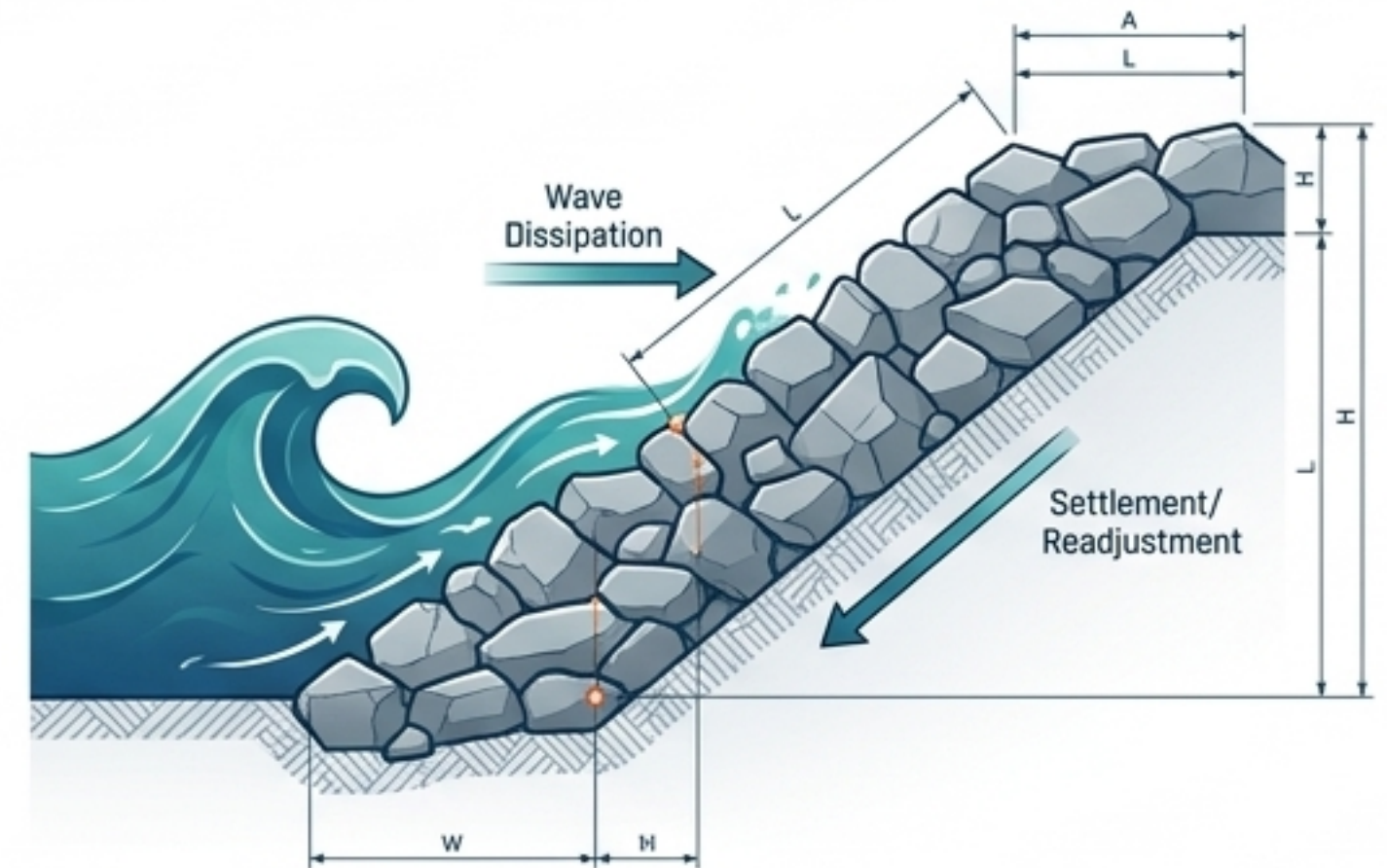


Exhibit superior initial strength against massive wave forces. However, they lack flexibility and cannot easily accommodate differential settlement or toe scour, which can lead to premature, catastrophic failure.

Flexible Aggregates (Random Rock/Armor Units)

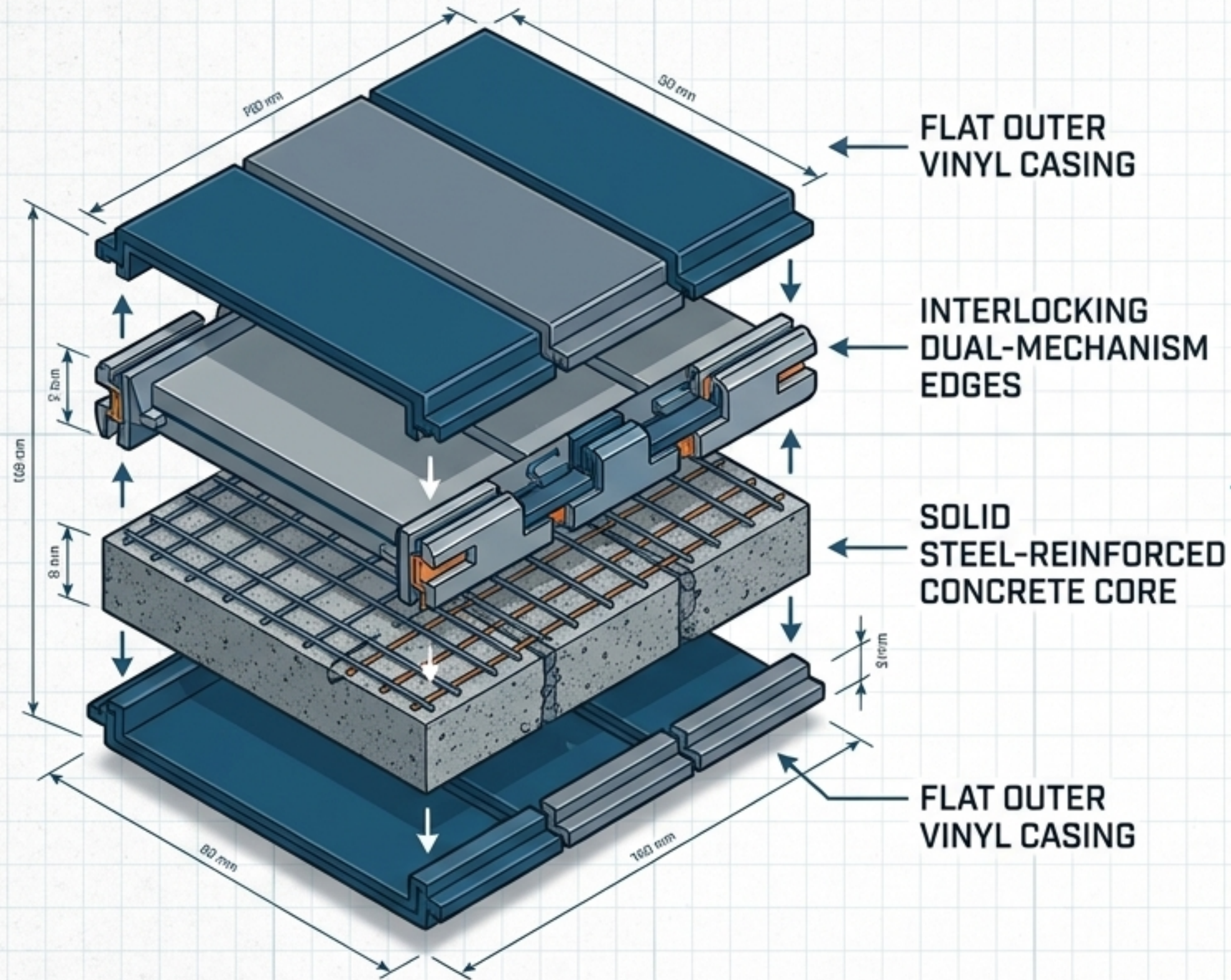


Experience natural settlement and readjustment under wave attack. They maintain reserve strength beyond design conditions and typically do not fail catastrophically if minor damage occurs.

The Material Master-Matrix

Material	Estimated Lifespan	Pros	Cons
Concrete	30+ years	Extremely strong, flat surface.	Requires heavy equipment; salt-water erodes internal steel causing rust/cracking; joints can separate.
Corrugated Vinyl	50+ years	Will not rust, crack, or rot; lightweight installation.	Cannot be driven into hard rock; height limitations; single interlock; corrugated surface creates wave noise.
Hybrid Systems (Truline)	50+ years	Combines concrete strength with vinyl protection. Flat acoustic surface.	(Detailed in next structural view)

Structural Evolution: The Hybrid Closed-Cell System



THE HYBRID ADVANTAGE

Protects the structural integrity of steel-reinforced concrete by encasing it entirely within long-lasting, salt-water-resistant vinyl.

INSTALLATION FLEXIBILITY

Can be installed in rocky soil conditions using a pin-pile method, overcoming traditional vinyl depth limits.

ACOUSTIC PROFILE

Unlike corrugated vinyl, the smooth, flat outer surface allows water to roll off quietly, reducing environmental wave noise.

The Anatomy of Failure

1. Toe Undermining (Scour)

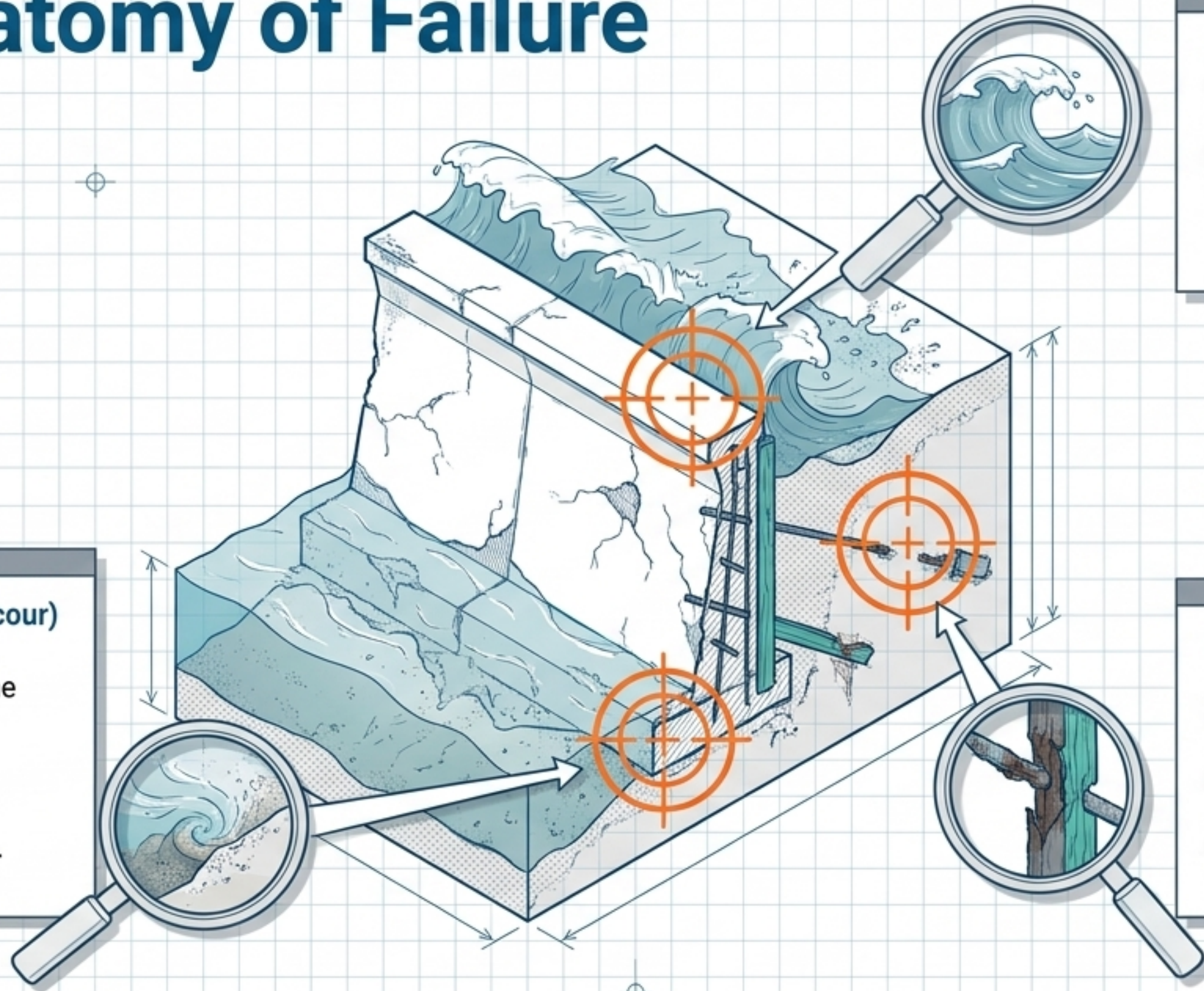
Wave energy reflects downward, eroding the soil/sand directly beneath the base of the wall, removing foundational support and causing collapse.

2. Overtopping

Wave heights exceed the wall cap, causing water to crash behind the structure, severely eroding the retained upland soil from the top down.

3. Anchorage Failure

Salt-water corrosion or rotting compromises the tie-backs, deadmen, or timber supports anchoring the wall to the land, causing outward bowing.



Post-Construction Diagnostic Checklist

Concrete Cap & Panel Checks

- ☐ Inspect for cracked or crumbling concrete caps.
- ☐ Check for rust bleeding on the surface (indicates internal steel corrosion).
- ☐ Look for joint separation between precast panels.

Wood & Bulkhead Checks

- ☐ Probe for rotted timbers or marine borer damage.
- ☐ Check alignment for leaning or bowing (indicates tie-back failure).

Erosion & Soil Checks

- ☐ Inspect upland yard for sinkholes or unexplained depressions.
- ☐ Check drainage systems for blockages.
- ☐ Map underwater erosion/toe scour and evaluate riprap displacement.

The Dynamic Seawall System

Materials Dictate Maintenance:

Concrete demands monitoring for steel corrosion, while hybrid/vinyl systems shift focus to toe scour and upland drainage.

Environment

Site Forces Dictate Structure:

Wave impact pressures (up to **8,000 lbs/sq ft**) and submergence levels define the engineering baseline (Rigid vs. Flexible).

The Synthesis:
A successful coastal defense is not a static object—it is a continuous response to a dynamic environment.

Maintenance

Permitting

Materials

Location Dictates Red Tape:

Proximity to the Coastal Jurisdiction Line determines whether the build triggers municipal, state, or federal oversight.