The Art of Coastal Resilience

SHOTCRETE RESTORATION AT THE GERALDINE R. DODGE ESTATE

By Dana Alan Lilly

OVERVIEW

This article details the technical restoration of a historic seawall in Rockport, Maine, designed to withstand intense Atlantic wave action. The project showcases how modern engineering can preserve coastal history while enhancing structural integrity.

The Geraldine R. Dodge Estate, situated on a prominent granite outcropping in Rockport, Maine, has long stood as a testament to coastal architecture. However, the relentless energy of the North Atlantic had, over decades, severely compromised its primary line of defense: A historic granite seawall. The restoration of the seawall required a delicate balance between modern high-performance materials and the preservation of the rugged Maine aesthetic.

The technical challenge was twofold: Managing the extreme kinetic energy of wave impacts and addressing the hydrostatic pressures behind the seawall that typically lead to structural failure in coastal barriers. Our solution used a specialized dry-mix shotcrete application. The dry-mix process was chosen for its high velocity and superior compaction, which results in a significantly less permeable and more durable finished product compared to traditional form-and-pour concrete.

PHASE I: SUBSTRATE PREPARATION AND MECHANICAL ANCHORING

Before any material was applied, the existing granite ledge had to be meticulously prepared. We utilized high-pressure water blasting to remove salt deposits and organic growth.

Fig. 1: Cleaning the bottom of the seawall at low tide by fresh water blasting and securing a new "through drains" and placement of new galvanized 2 x 2 WWF, tied to epoxy set 6 in. galvanized anchor bolts on a 2 ft x 2 ft pattern

Fig. 2: The final stages of completing the backside drain system up to the top of the seawall

Fig. 3: The same procedure as in #1 was all in preparation of the dry-mix shotcrete placement at various thickness to provide a reasonable looking non troweled finish

Fig. 4: While working with the 8 ft (2.4 m) tides at various levels the shotcrete placement begins from bottom to top and over the wall down the backside to the newly installed filter fabric and crushed stone backside drainage feature to capture and safely remove the overwash drainage from extreme tides

To ensure a strong bond between the geological substrate and the shotcreted concrete shell, we installed a comprehensive anchoring system. This involved drilling and epoxy-setting 3/8 in. (10 mm) stainless steel threaded rods 6 in. (150 mm) deep into the bedrock. These were placed on a 12 in. (300 mm) grid, creating a mechanical 'key' that prevents delamination under the immense 'pulling' force of retreating waves.

PHASE II: HYDROSTATIC PRESSURE MANAGEMENT

One of the leading causes of seawall failure is the buildup of water behind the wall. Without relief, this pressure eventually pushes the wall outward. We integrated a series of 2 in. (50 mm) PVC weep holes and a backing drainage composite mat. This allows groundwater and overwash to cycle back to the sea without compromising the structural integrity of the wall.

PHASE III: THE SHOTCRETE MIX DESIGN

The shotcrete materials were a critical component of the project's success. We utilized a pre-bagged dry-mix enriched with 8% silica fume. The addition of silica fume reduces the permeability of the concrete to near-zero levels, which is essential in significantly delaying chloride-ion penetration and the subsequent corrosion of internal steel reinforcement.

We also incorporated synthetic macro-fibers throughout the mixture. These fibers provide three-dimensional reinforcement, offering superior toughness and crack control compared to traditional wire mesh, which is prone to corrosion in saltwater environments.

Technical Highlights

SUBSTRATE ANCHORING

To ensure a permanent bond between the new shotcrete and the existing ledge, we utilized 3/8 in. (10 mm) stainless steel threaded rods set 6 in. (150 mm) deep on a precise 12 in. (300 mm) grid.

HYDROSTATIC RELIEF

A critical component of the design is an integrated drainage system. This allows water trapped behind the seawall to escape safely, preventing the pressure build-up that often leads to blowouts or collapses.

HIGH-PERFORMANCE SHOTCRETE MATERIALS

We employed a dry-mix shotcrete material specifically designed for harsh marine environments. The mixture is enhanced with silica fume for low permeability and synthetic macro-fibers for superior crack resistance and toughness.

ARTISTIC FINISHING

Beyond structural strength, the project required an aesthetic touch. Our finishers used hand-sculpting techniques to mirror the natural stone textures and contours of the Maine coastline, making the restoration virtually invisible.

PHASE IV: ARTISTIC SCULPTING AND FINISH

Because the Dodge Estate is a historic property, a standard concrete finish was unacceptable. Our team of expert finishers used hand-sculpting tools to replicate the natural fissures, textures, and color variations of the surrounding Maine granite. By varying the nozzle distance and employing specialized carving techniques during the initial concrete set, we created a facade virtually indistinguishable from the natural coastline.

CONCLUSION

The finished structure now provides a high-strength, low-maintenance shield for the estate. This project serves as a case study for ‘Coastal Resilience’, proving that we can harden our infrastructure against rising sea levels and increased storm intensity without sacrificing the natural beauty of our historic shorelines.

Dana Alan Lilly *is a Senior Projects and New Business Development Director with over 45 years of experience in strategic planning and global project management. He has directed multi-billion-dollar civil, marine, and oil/gas installations across the US, Middle East, Africa, and the Russian Federation. Dana is an expert in EVG 3D Panel systems and high-performance shotcrete technologies, focusing on sustainable and resilient infrastructure.*