Unique Solutions for Repair of a Seawall and Lighthouse Structure

By Hamid Vossoughi

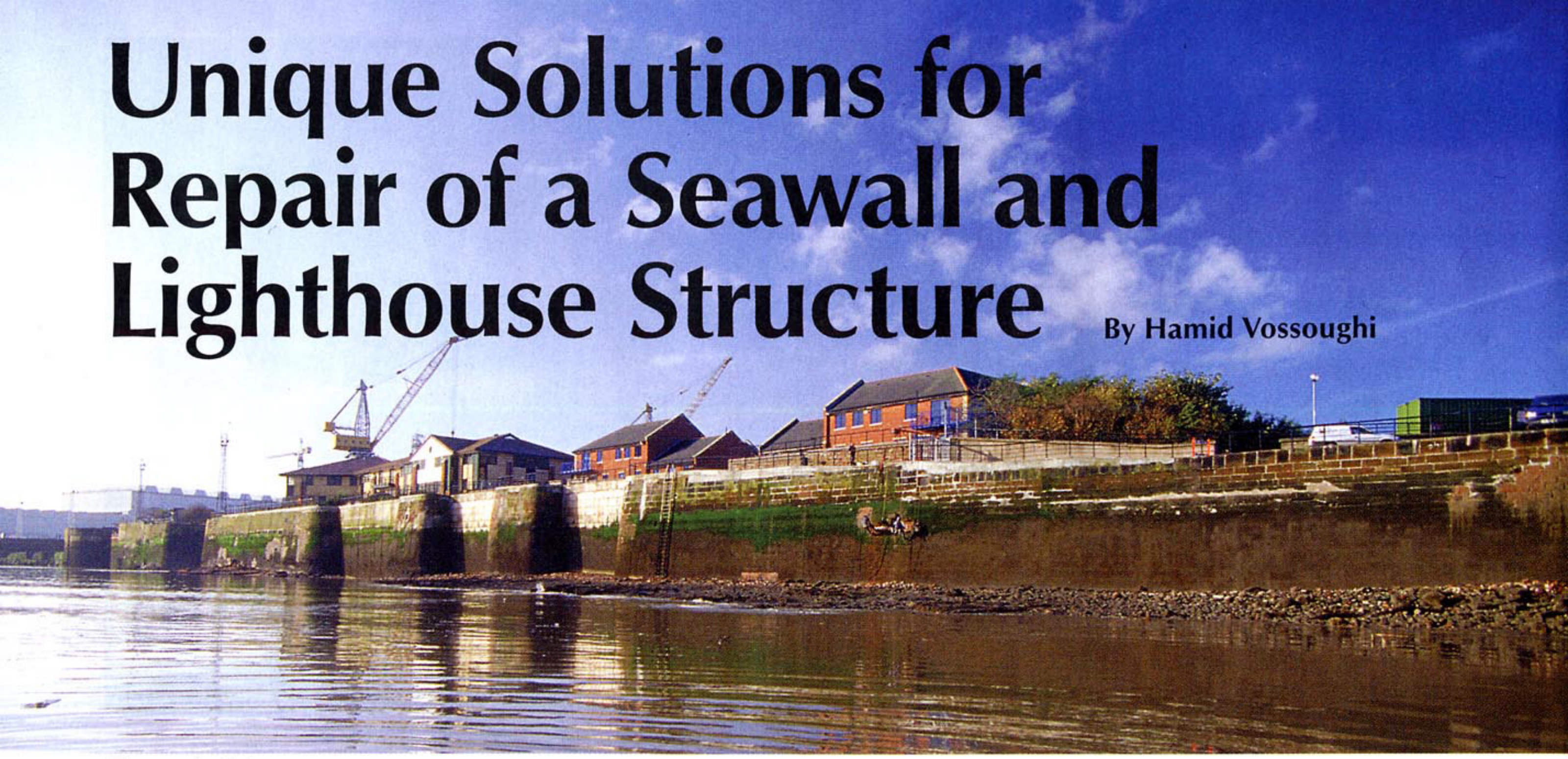

Figure 1: Priory Wharf seawall

Repair and maintenance of coastal and maritime structures such as piers, lighthouses, and seawalls provide unique challenges due to their proximity to bodies of water. Limitations in access to the project sites, changes in the tide, and exposure to wind and breaking waters all impose constraints that must be dealt with.

Two recently completed projects required flexibility and efficiency in dealing with such circumstances to successfully accomplish the scope of work. Both projects were located in the Metropolitan Borough of Wirral on the west coast of the United Kingdom. Wirral is a peninsula southwest of the city of Liverpool, with the River Mersey to the east (of the peninsula) and the River Dee to the west.

Figure 2: New Brighton lighthouse

Project Sites

Seawall—The seawall project site is the Priory Wharf and Pacific Road Seawall (Fig. 1), stretching over half a mile along the coastal line of the city of Birkenhead. The seawall is about 36 ft (11 m) high, with a recorded 27 ft (8.3 m) maximum tide. A pedestrian walkway separates the seawall from the densely populated residential properties beyond, overlooking the Liverpool skyline.

Lighthouse—The lighthouse project site is the New Brighton Lighthouse (Fig. 2) at a location known as Perch Rock, overlooking the entrance to the Liverpool Harbor at the northernmost tip of Wirral, in the city of Wallasey. The lighthouse was rebuilt in 1827 after the original structure, built in 1683 on a wooden foundation, was damaged by ships and washed away. The lighthouse was the first built in the United Kingdom and is a listed historical structure. It is located about 700 ft (213 m) from a fort on the mainland and is accessible by foot during low tide. The lighthouse is about 90 ft (27 m) tall and, similar to the seawall, exposed to a 27 ft (8.3 m) tide.

Scope of Work

Seawall—The seawall is primarily constructed of sandstone blocks that are over 16 in. (40 cm) deep. The existing condition and distress in previously repaired areas (Fig. 3) was monitored and documented during low tides by town engineers. The scope of work included investigation of the existing conditions at 37 randomly located repair areas totaling 800 ft^2 (74 m^2) and nondestructive testing with a boroscope to document the underlying condition of the wall. Following the investigation phase, the defective areas had to be replaced with new 8 in. (20 cm) thick matching sandstone blocks anchored to the backup, and the failed mortar joints in the rest of the repair areas had to be repointed.

Lighthouse—The lighthouse is constructed with interlocking granite blocks and coated with a volcanic material forming a hard layer on the exterior surface of the blocks. With improvements in navigation technology, operation of the lighthouse was stopped in 1973 and the lighthouse has been neglected. The scope of work here included stripping of the various layers of delaminated coatings, crack repointing, and complete recoating of the lighthouse façade, totaling 5000 ft^2 (465 m^2). The metal railing and lantern copper roof of the lighthouse was also stripped and painted.

Figure 3: Previously repaired area

Project Constraints and Unique Access Solutions

Seawall—Due to the narrow width of the walkway along the wall, the multitude of mobilization and demobilization required at many locations along the wall, and the fire department restrictions on blocking public ways, the use of conventional access such as swing staging or boom trucks was not practical.

Lighthouse—The required scaffolding and other traditional means of access—extending to the base of the lighthouse, below the tide line, away from the shore (Fig. 4)—were deemed cost prohibitive.

Access Solutions—The solution for access to both project sites was what is called Industrial Rope Access (Fig. 5). This technique combines specialized technical skills and equipment, originated in mountaineering and caving, and further developed for industrial use to safely access structures by descending and ascending, as well as laterally maneuvering on suspended or tensioned ropes. Using a double rope system, each with separately redundant secured anchors, in combination with full body harness, a technician is fully supported in tension or suspension in such a way that fall from height is prevented or restricted. Use of a seat

Figure 4: Project site at high tide

is not necessary but recommended for extended periods of work for the technician's comfort. In the United Kingdom, rope access techniques are utilized in accordance with Health and Safety Executive (HSE), which is the British equivalent to OSHA. In Europe, rope access has been in use for the past 20 years and is often used as an alternate means of access to the traditional methods.

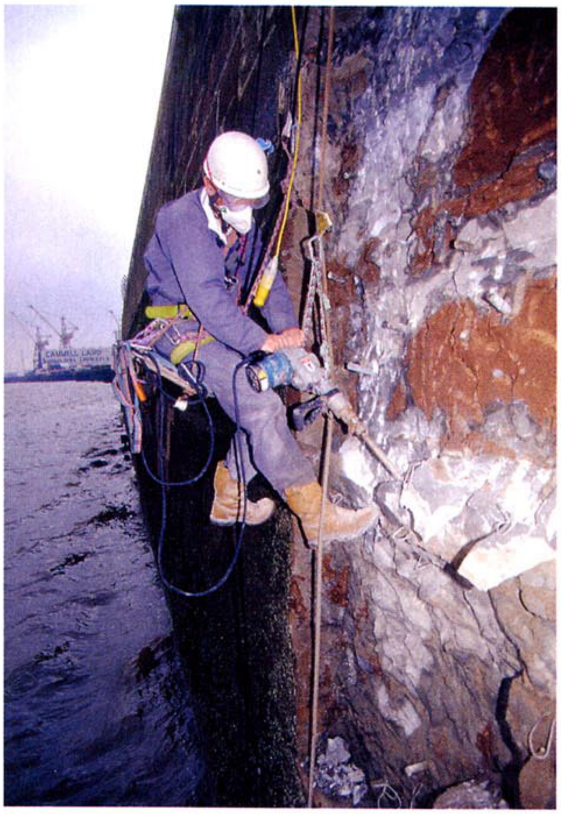
Figure 5: Technician utilizing Industrial Rope Access techniques

Due to the flexible nature of rope access and the lightweight required equipment, this technique provides many advantages in comparison to traditional means of access. Several of these advantages are:

- Ease of access—fast and easy access to structures with minimal equipment requirements;
- Speed of setting up and vacating sites—rope access systems can be set up and dismantled quickly, maximizing production, while accommodating project constraints;
- Flexibility and versatility—because of the speed and flexibility of this system, project mobilization and demobilization is minimized, thus reducing costs and lead times; and
- "Hands on" approach—rope access allows close tactile positioning and a more time-effective area coverage than other forms of access.

Repairs

Seawall—Our preliminary investigations identified hard grout backup and lack of anchorage between the previously repaired masonry and the backup. Demolition of the repaired areas required minimal effort, except at the larger areas where sequencing of the demolition and partial shoring was required. However, preparation of the backup, including removal of the randomly placed reinforcing


Figure 6: Rebuilding of the seawall


Figure 7: Containment net positioning

steel as wall anchorage, required more effort. The replacement stones, salvaged from a demolished structure; pre-bagged special repair mortar; and stainless steel anchors epoxied to the backup were used for the repair work. Stone blocks were lowered by a hoist and placed into position by the technicians (Fig. 6).

Lighthouse—Due to environmental requirements for containing the debris, the lighthouse was shrouded with containment netting (Fig. 7), draped similar to a curtain with steel rings to effectively position the netting along the height of the structure. The delaminated coating was power-washed, stored, and disposed of. Stripping and coating of the lighthouse was performed in five segments. Cracks and uneven surfaces were prepared with pumpable quick-set repair mortar, and minimal patching and dutchman repair of the blocks was required. Silane-based coating was used to coat the surface of the lighthouse (Fig. 8).

Figure 8: Completed project

Access Creates Successful Projects

Access is an integral part of inspection, maintenance, and repair of any structure. The criteria for selection of access are widely varied and, in part, depend on the characteristics of the structure, site and project constraints, and the economics of the project. Advantages offered by rope access can make this technique an attractive and viable option for many applications. The flexibility provided by rope access on both projects allowed us to sequence and perform the repairs economically, in harmony with the site constraints and project requirements.

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