The Challenges of Retrofit Plaza Deck Waterfproofing

By Gary W. Whittemore, CDT

A Case Study – John F. Kennedy Presidential Library and Museum

Creating a leak-free building is one of the greatest challenges in our industry. Fixing leaks after the fact is even more challenging, especially on plaza decks. Plaza decks incorporate extensive overburden systems, depending on their use. If there is a leak, the waterproofing membrane may be buried under tons of reinforced concrete, heavy pavers or pavement, soil, and plantings. The removal and replacement of such overburdens represent a significant cost to the building owner.

Even the most successful waterproofing systems require maintenance or replacement at some point during the life cycle of the building. A waterproofing system is made up of multiple components, and the failure of one component can lead to the failure of the entire system. The fix is expensive – many times more than the original cost. The situation is further compounded because the building is likely to be occupied and in use at the time of the repair.

Every building is unique, based on the owner's design and performance criteria. Many times the building is not built exactly per plans and specifications because of changes implemented during the construction process. These changes may or may not be documented, or the documentation may no longer exist. This makes it especially challenging to determine and understand leak causes in waterproofing applications. Consultants are continually challenged during their investigations to determine leak causes and develop plans to remediate problems that they cannot see without extensive and sometimes intrusive investigations.

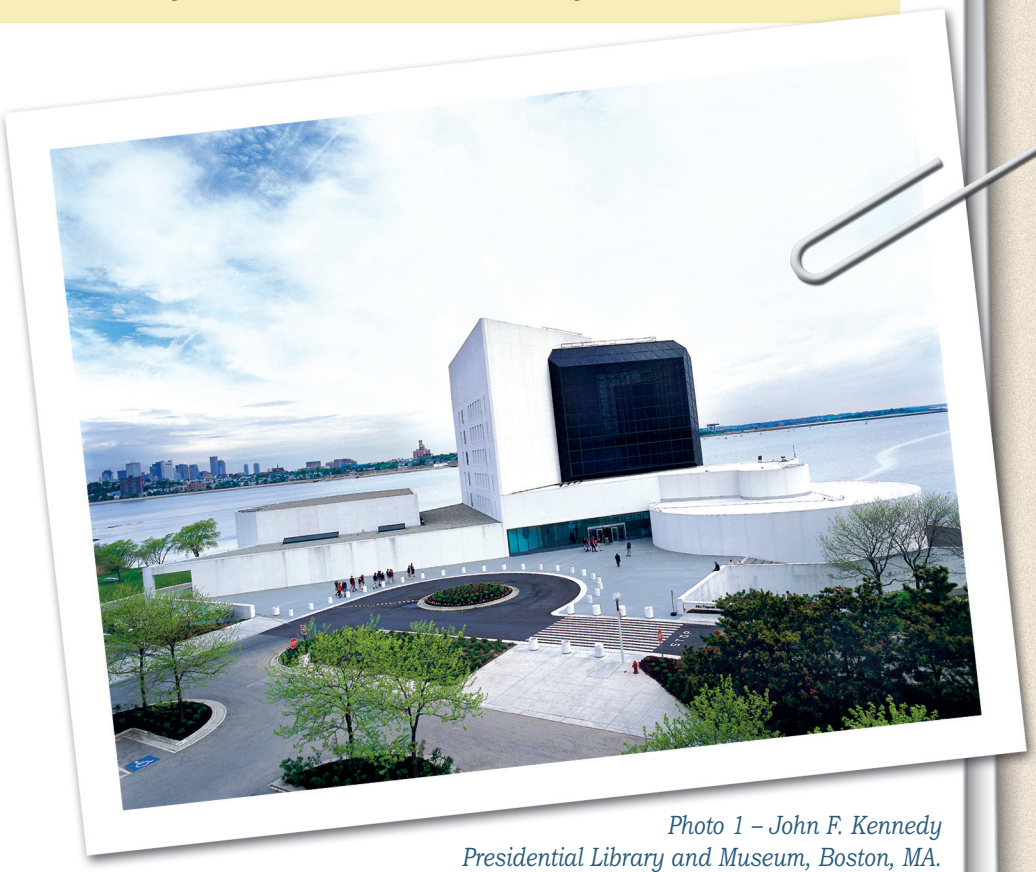


Photo 1 – John F. Kennedy Presidential Library and Museum, Boston, MA.

The Challenges at the JFK Library and Museum

One of Boston's most dramatic architectural buildings, the John F. Kennedy Presidential Library and Museum, sits on Columbia Point with a panoramic view of the city to the north and Boston Harbor to the south, east, and west (see *Photo 1*). Designed by I.M. Pei and Partners of New York and constructed in the late 1970s, the library is a unique combination of concrete and glass – a striking tribute to our nation's 35th president. The 12,542 sm (135,000 sf) building is a library, museum, and archive that houses, protects, and exhibits manuscripts, photographs, and other irreplaceable relics from the Kennedy era.

Over 200,000 people visit the library and museum each year, so when the plaza decks and elevated roof decks started to leak and granite pavers around the main entrance began to lift and heave, the National Archives and Records Administration (NARA), owners of the building and its contents, called in Simpson Gumpertz & Heger Inc. (SGH) to investigate the problem and propose repair options.

The plazas and elevated roof decks in need of repair cover exhibit space, offices, a theater, storage rooms, and the library stack rooms. Work would take place over areas housing JFK's Oval Office desk and the complete collection of JFK's presidential papers. NARA insisted the building remain open during the repair, and the architectural look of the building was to remain intact. Work was not allowed at night or during special events.

The Investigation and Decision to Re-waterproof

David Adler, Jim Myers, and Dan Zadrozny conducted the initial investigation to determine the cause of the plaza paver heaving and multiple leaks through the 2044-sm (22,000 sf) plaza and elevated roof decks. Jeffrey Brouillard took over the project to generate the remedial design and to provide construction administration services.

The original design of the main plaza deck included a 200 to 300-mm (8 to 12 in.) structural slab with a fluid-applied waterproofing membrane and protection layer, 100 mm (4 in.) of extruded polystyrene insulation, 150 mm to 300 mm (6 in. to 12 in.) of gravel fill, 100 mm-thick (4 in.) concrete topping slab, and 1.2 m x 1.2 m x 50-mm (4 ft. x 4 ft. x 2 in.) granite pavers hard set on to the concrete slab with grouted joints. The structural slab is sloped 1.2° (1/4 in. per ft.) to five drains located in a center planting area surrounded by a circular driveway.

Investigation revealed that heaving of the granite pavers was a result of water trapped on the concrete topping slab under the paver system. The drains in the planting area were clogged, resulting in the water being trapped on the membrane directly over the structural slab. The trapped water corroded the electrical conduits servicing the plaza lighting fixtures, causing leakage inside the building. Leakage was also experienced along the perimeter where the plaza abutted the exterior pre-cast concrete wall panels of the building.

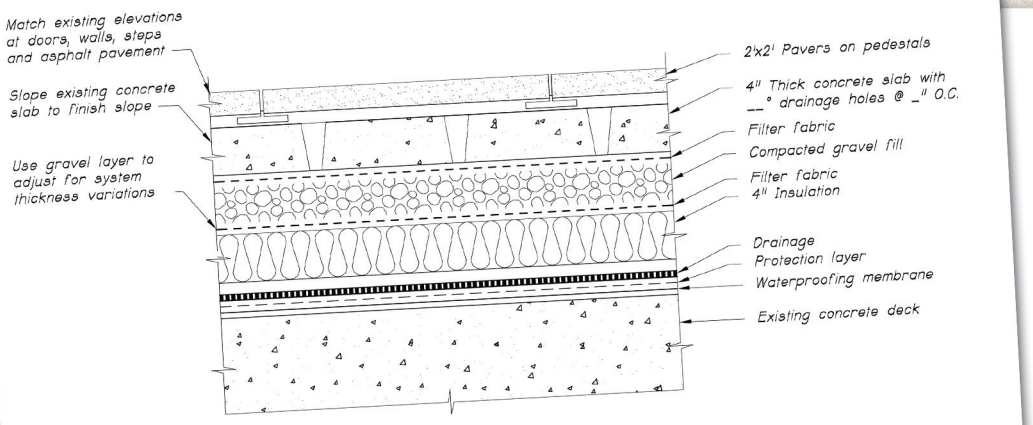
The decision was made to remove the existing plaza deck assembly down to the waterproofing layer, re-waterproof the plaza with a sheet membrane, and design a plaza deck system that promoted drainage yet maintained the aesthetics of the building.

Developing a Retrofit Plan

The facility staff made it clear that there could not be any leakage during construction or after completion. SGH was challenged to develop a retrofit plan that would maintain watertightness and allow the library to remain open to the public during the retrofit process.

NARA initially requested that a large tent structure be installed over the plaza deck as a means to provide protection during the demolition and replacement process. This idea had its challenges since the library is located on the ocean and is subject to harsh weather and unpredictable winds. The cost to install, anchor, and secure a tent structure for a project of this size was quickly determined to be prohibitive.

After much discussion, NARA decided that a more conventional approach was feasible. Since the existing assembly incorporated a waterproofing layer on the structural deck, it would be possible to remove the overburden to the membrane level without damaging the waterproofing membrane. The 100 mm (4 in.) of extruded polystyrene insulation would protect the membrane during the heavy demolition operation. Once the demolition was complete, the insulation could be carefully removed with minimal disruption of the membrane. Incidental damage to the existing membrane could be temporarily patched. By utilizing the existing waterproofing membrane and patching damaged areas, the building would be watertight until the new waterproofing layer was installed. The contractor would be limited to demolishing areas that could be covered with new waterproofing membrane on the same day.



Detail 1 – Roof level wall flashing.

Plaza Deck Design Challenges

Because of the architectural significance of the building, the appearance of the entranceway and the surrounding exterior walls could not be altered. As a result, SGH was challenged to design a plaza assembly that would provide long-term performance and meet the aesthetic requirements of the NARA.

The project team designed a new plaza assembly that incorporated a 2 mm- (.080 in.) thick loose-laid, reinforced PVC waterproofing membrane with containment grids adhered to the existing structural slab. The containment grids acted as waterstops, limiting potential spread of water under the membrane. A 611 g/m^2 (18 oz/yd^2) nonwoven polypropylene geotextile leveling layer was used in the areas between the grids to provide a cushion between the old and new waterproofing. The waterproofing membrane was protected with a 1-mm (0.040 in.), high-density polyethylene (HDPE) sheet. Drainage was integrated into the design by installing drainage composite over the protection sheet, followed by 100 mm (4 in.) of extruded polystyrene insulation.

Filter fabric was placed over the insulation, followed by a gravel leveling layer and a second layer of filter fabric. The thickness of gravel layer varied, depending on the existing conditions and flashing elevations. A 100 mm (4 in.) wire-reinforced concrete slab was poured over the filter fabric to provide adequate support for the paver and pedestal system. The slab was periodically perforated to allow drainage through the assembly. Since the original pavers could not be salvaged for reuse, the owner selected 600 mm x 600 mm x 50 mm (2 ft. x 2 ft. x 2 in.) granite pavers resulting in a cobblestone appearance with 3.2 mm (0.125 in.) open joints to facilitate drainage. The system was reinforced near the drive lanes to withstand inadvertent vehicle traffic. (See *Detail 1*.)

NARA also required supporting data to justify the design team's waterproofing material selection. Typically, the government mandates that specifications include three material manufacturers. Given the stringent requirements of the project, the design team convinced NARA that a proprietary specification for a reinforced PVC sheet membrane provided the best technical solution for the project. The best value would be derived through the competitive bid process between contractors.

Waterproofing the Plaza Deck

Demolition work commenced in June 2002. The contractor carefully removed the overburden as planned to expose the existing waterproofing membrane. Electrical conduits for plaza lighting were removed and plugged to minimize the number of penetrations through the structural deck.

The existing waterproofing membrane was completely removed only in areas where the 300-mm (12 in.) containment grid strip was installed. The grid strip was set in a two-part liquid urethane

Photo 2 – The reinforced PVC waterproofing system was installed in a containment grid configuration to isolate any water that might breach the system.

Photo 3 – A reglet was cut into the existing custom pre-cast concrete panels to terminate the waterproofing membrane and allow water to weep from the vertical caulk joints.

Photo 4 – Granite pavers were installed to complete the installation on the complexly-shaped elevated roof decks.

adhesive and allowed to cure overnight. The open area was covered with membrane at the end of each day with the edges hot-air welded to the grid strip to maintain a watertight seal. Membrane overlaps were also hot-air welded to achieve a reliable watertight seam between the sheets (see *Photo 2*).

The existing waterproofing membrane was terminated behind the exterior, custom-manufactured, pre-cast concrete wall panels along the perimeter of the deck. This presented a significant challenge because the concrete panels could not be removed or cut. Since the quarry that provided the aggregates was no longer in operation, replacement panels could not be obtained should a panel be damaged. A detail was developed that allowed the new waterproofing membrane to be terminated on the panels. A reglet was cut to receive a metal counterflashing, which was designed to weep water that ran down the vertical caulk joints between each panel (see *Photo 3*). Custom stone pavers were installed to conceal the metal counterflashing, retaining the original appearance of the plaza.

Existing drains were routed and restored for re-use. Four of the drains were located at the perimeter curb of the circular driveway. The fifth drain was in the center of the planted garden. All drains are now accessible for cleaning and maintenance.

As an added safety measure during the retrofit, the library installed plastic sheeting over the Kennedy artifacts for protection and installed moisture sensors in storage areas. The moisture sensors will sound an alarm in the event of accidental leakage.

Waterproofing the Elevated Decks

The contractor also replaced the waterproofing systems on four elevated roof decks utilizing the same design. The building's shape and deck locations proved challenging at times (see *Photo 4*). On one deck, the equipment, materials, and construction debris had to be hoisted over a 4.3-m (14 ft.) high parapet. Another deck was accessible only from a 12-story high external stair tower.

Parapet walls were another source of leakage. The original flashing was terminated on top of the parapet wall and was not covered with metal. NARA was very concerned about the aesthetic impact of metal along the parapet wall. The design team was faced with developing a detail that provided watertight protection yet did not disrupt the look of the building.

White reinforced PVC membrane was used on all exposed flashings. The flashing membrane covered the top of the parapet wall and was terminated 50 mm (2 in.) down the exterior wall to ensure watertightness. Metal edging was custom fabricated from PVC-coated metal to complete the detail. The library staff was consulted to select the color of the PVC-coated metal to best match the exterior walls (see *Photo 5*). A flashing strip of membrane was hot-air welded to the PVC metal to complete the detail.

Revisiting the Decks

The work was completed in June 2003, a year after commencement. A recent inspection of the decks indicates they are watertight and performing as designed. This year marks the 60th anniversary of the end of World War II, and the library is celebrating with a special exhibit of John F. Kennedy's military service in the U.S. Navy. The exhibit features a large selection of materials never before seen by the public – some on temporary loan from the Kennedy family. The watertightness of the decks plays a vital role in preserving the priceless artifacts of the Kennedy era.

Photo 5 – Custom fabricated, PVC-coated metal is installed to complete the parapet wall detail.

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Gary W. Whittemore, CDT, has been with Sarnafil Roofing and Waterproofing Systems for five years. He currently serves as the product manager for the U.S. waterproofing division based in Sarnafil's corporate office in Canton, MA. Prior to this position, he was the national retail and strategic accounts manager for the roofing division. Before joining Sarnafil, Whittemore held various waterproofing sales and product management positions during a 20-year career at W. R. Grace & Co. Whittemore holds a BA from Columbia University. He and his wife Lisa and two teenage sons reside in East Walpole, MA.