5-24-2019

Maine Cultural Building Atrium Envelope: Invasive Investigation Report

Building Performance Advisors, LLC

Atrium Envelope: Invasive Investigation Report

Building Performance Advisors LLC
104 Prospect Street ▪ Portland ME 04103
207-536-4500
www.buildingperformanceadvisors.com

PROJECT:	**Maine State Museum & Archives Building**
CITY, STATE:	Augusta, ME
OBSERVER:	Matt Losquadro, PE
OTHER ATTENDEES:	Ben Cawley, G. Drake Masonry Clayton Langley, G. Drake Masonry
DATE:	24 May 2019

I. PURPOSE AND SCOPE

Building Performance Advisors (BPA) performed a limited invasive investigation of the atrium roof enclosure of the Maine State Museum and Archives facility at 230 State Street in Augusta, Maine. The purpose of this investigation was to determine the as-built conditions of the atrium's roof structure, including the interior granite panels, located at the south wall of the atrium addition (1987), to visually assess the components' current condition, and to identify sources of possible water intrusion and deficiencies in the existing thermal barrier. Repair recommendations are included within this report.

The scope of the investigation included the removal of two exterior pre-finished fiber-cement panels on the south side of the atrium above the lower roof. The removed panels and sheathing exposed a concealed space between the atrium roof and a gypsum soffit above the entrance doors to the library, museum and archives from the atrium. The panels selected for this investigation included the second panel from southwest corner of the atrium roof spanning the original parapet wall (herein referred to as the west panel), and the sixth panel from the southeast corner (herein referred to as the east panel).

This report represents the opinions of the evaluating professionals based solely upon visual inspection of the building components revealed during this investigation. The conclusions presented herein are held with confidence and, where possible, opinions are supported by positive knowledge and proof. Additionally, the conclusions and recommendations presented in this report are based on the facts and circumstances as they existed on the date of the inspection. Changes in any of those facts and/or circumstances may affect the findings, conclusions and recommendations.

II. OBSERVATIONS AND DISCUSSION

1 Atrium Roof

1.1 General Condition

The adhered EPDM roof of the atrium appears weathered and in poor overall condition. Several areas of ponding water and billowed membrane suggest the underlayment has been physically distorted due to chronic saturation, and is no longer flat and secure to the roof structure beneath. Drawings dated 11/13/1987 indicate the roof membrane is applied directly to tapered rigid insulation, which is installed over a layer of 4" rigid insulation and the concrete roof deck.

According to the museum staff, recurring leaks have been observed at the southeast corner of the atrium. Repairs performed in 2005, which included the removal and reinstallation of the third granite panel north of the southeast corner, have failed and are allowing water to enter the interior space of the atrium attic. The patch along the termination of the rubber roof over this third panel has failed and is likely permitting water to intrude behind the reinstalled panel (Photo 2). The liquid rubber applied near the southeast corner of the roof has also failed (Photo 3), as have the sealant joints between panels. The termination bar of the ballasted roof below this panel shows evidence of a previous repair, although less than half of this termination bar was re-caulked. The unrepaired section of the termination bar is another likely source of water intrusion in this corner of the atrium (Photo 4).

Atrium construction drawings dated 11/13/1987 show the roof membrane terminated into a 1" x 3/8" groove cut into the top edge of the 1-1/4" granite veneer fascia panels. Existing termination bars (not shown on the original drawings), mechanically attached along the top edge of the fascia, secure the membrane to the panels at the roof perimeter. The membrane securement exhibits signs of systemic failure (Photo 5).

1.2 Recommendations

The adhered EPDM roof of the atrium is approximately 32 years old and is beyond the limit of its expected useful service life. It should be replaced before existing deficiencies worsen over time and further deteriorate the atrium structure and interior finishes. An alternative termination detail of the new single-ply membrane roof along the north, east and west walls should be utilized to improve the protection of the roof edge from future water intrusion. Installation of metal flashing with a vertical leg overlapping the top of the granite is suggested, as a cost-effective way to protect the roof edge against water entry.

Replacement of sealant in the vertical joints between the exterior granite fascia panels along the north, east and west walls of the atrium roof is scheduled for completion in June 2019 (Photo 6).

2 Atrium / South Wall

2.1 Existing Construction

The south wall of the atrium, which extend from the main roof up to the atrium roof, was built with 1/4" prefinished fiber-cement panels (approximately 4' wide x 8' high) over 5/8" gypsum board sheathing (upper 6') and pressure-treated plywood (lower 2'), attached to a 6" metal stud wall with R-19 fiberglass batt insulation. Absent in this construction detail and not shown on the 1987 drawings is a weather-resistive barrier (such as #15 tar-paper or Tyvek) between the panels and the gypsum sheathing. A vapor-permeable moisture barrier should have been applied over the sheathing to prevent air and water intrusion through defects in the exterior wall cladding, as well as to inhibit the condensation of water vapor against the outer surface of the sheathing.

The top of the south wall is protected with a galvanized steel drip-edge style flashing covered with the single-ply roof membrane and secured with a continuous metal clip

fastened to the fiber-cement panels with rivets at 12" on center. The galvanized flashing has rusted along the entire length of the south wall (Photo 8).

2.2 *Invasive Investigation - Findings*

The invasive investigation included removing two fiber-cement panels and backup gypsum sheathing from the south wall of the atrium to gain access to the concealed space along the south side of the atrium. Visual observations were made in areas directly inside the concealed space near the two access areas. The majority of the space could only be assessed from a distance, or could not be seen at all.

As noted in BPA's Building Envelope Observation Report dated August 5, 2016, most of the fiber-cement panels along the south wall of the atrium roof structure have cracked vertically near the center of each panel, and the sealant joints between panels have failed adhesively along the height of each panel. These deficiencies provide opportunity for uncontrolled air and water intrusion into the concealed space along the south side of the atrium. Water damage to the soffit above the interior entrance doors clearly indicates that moisture passes through the roof and/or wall assemblies above, where the invasive investigation was performed.

Water stains were observed on the exterior surface of the gypsum sheathing behind the east panel where the fiber-cement panel was removed (Photo 11). Staining was also found on the inside face of the exterior wall sheathing (Photo 10). Photos 15 & 16, provided by BREM in an email to BPA dated Dec 17, 2018, show the result of this moisture accumulation in the concealed space above the southwest corner of the atrium lobby. The areas of saturation and water damage in the atrium space are directly below the areas shown in BPA photos 9 through 11. Moisture from above the atrium soffits has migrated behind the interior granite panels and manifested on the interior surface of the porous stone.

The fiberglass batts installed in the steel stud-frame backup wall have sagged or completely fallen out of the wall in the areas accessible to view. The paper-faced batts most likely fell out of the spaces between studs due to the weight added when the fiberglass became saturated with water from leakage through the wall cladding and/or the roof. Photo 9 shows evidence of the chronic accumulation of moisture in the concealed space above the atrium soffits.

What appears to be a polyethylene vapor barrier was observed to be present on the inside face of the knee wall constructed directly above, and in the same plane, as the clerestory windows at the top of the west wall of the atrium lobby (Photos 17 & 18). The same detail is presumed to exist in the concealed space over the windows of the east wall; this could not be visually confirmed. This detail would be an effective vapor barrier if it were continuous around all four walls of the atrium exterior envelope from the roof deck down to the interior soffits of the lobby. However, the vapor barrier appears to exist only along the inside faces of the knee walls on the east and west sides of the atrium, and these walls terminate approximately six feet north of the south wall. The incomplete vapor control layer permits water vapor to travel freely throughout the concealed space above the atrium ceiling.

Inadequate vapor management in the exterior envelope assemblies of the atrium combines with uncontrolled temperature and relative humidity in the concealed space to produce conditions which will allow water vapor to condense on building materials in the space. Condensation of water vapor occurs when the temperature of air is lower than its dew point. When air is cooled, relative humidity increases until at a particular temperature (called the dew point) the air becomes saturated. Further cooling below the dew point will induce condensation of the excess water vapor. Condensation problems are most likely to occur when temperatures frequently dip to 35°F or colder over an extended period. It is likely that condensation is a secondary source of moisture that has damaged building materials inside the concealed space.

2.3 Recommendations

The exterior wall systems in the atrium currently lack a weather-resistive barrier, an effective thermal control layer, and adequate vapor management. The exterior cladding on the south wall is also damaged beyond its ability to function as a protective barrier. BPA recommends that the exterior walls be rebuilt to provide all four control layers required in an exterior envelope assembly: (1) protection from the effects of daylight and precipitation; (2) a weather-resistive barrier; (3) a thermal control layer; and (4) effective vapor management.

The existing fiber-cement panels on the south wall of the atrium attic can be cost-effectively replaced with a new pre-finished panel system. Fiber-cement panels with factory-applied coatings, aluminum composite (ACM) panels, and metal panel systems are appropriate options for use on the wall, which is not visible from public spaces on grade around the building.

A vapor-permeable air/moisture barrier should be installed on the exterior wall sheathing behind the new panel system, to prevent water intrusion and uncontrolled air leakage. DuPont “Tyvek” remains the product most frequently used for this purpose; however, there are multiple products in common use that will effectively protect the building. Both sheet membranes and fluid-applied systems are readily available.

Thermal insulation should be installed at all exterior wall surfaces, and the exterior wall insulation should be installed so that it abuts the roof insulation tightly to eliminate any gaps in the thermal barrier. New mineral fiber insulation can be installed in the stud framing and/or on the face of the backup wall behind the new cladding system.

The interior surfaces of the atrium roof enclosure may be air-sealed with spray-applied closed-cell polyurethane foam (SPF). Industry standards classify a minimum thickness of 1 inch of SPF as a vapor retarder. Spray-applied polyurethane foam insulation will provide a thermal barrier with an initial rating of approximately R=6 per inch. The existing polyethylene vapor barrier on the knee walls over the clerestory windows of the east and west walls could be incorporated into the SPF application, eliminating the need for SPF on these two walls. The knee walls would have to be extended to the south wall (or to the east west walls respectively) to provide a continuous vapor barrier.

3 Interior Granite Panels

3.1 Observations and Drawing Review

The far west and far east granite panels on the south wall of the atrium over the original entrance doors to the museum lobby were added during the atrium construction in 1987. They were installed at the location of the original stairs that were removed from the east and west ends of the atrium and are significantly wider than the original panels. Lateral bracing was observed along the top edge of these two panels (Photo 14); no lateral bracing was observed at any of the original stone panels. This lateral bracing appears adequate to prevent movement of the top edge of these two panels.

Drawings indicate 5" x 3-1/2" x 1/2" angles secured to the inside face at the bottom and midpoint of the new granite panels. The lower angle is supported by an existing 3-1/2" x 3-1/2" x 3/8" continuous steel bracket attached to the building structure. The midpoint angle rests on a 1/2" plate with an adjusting slot and anchor bolt to position the panel flush with the adjacent panels. These structural supports could not be visually confirmed during this inspection, and it is unclear if the original panels are supported in the same manner.

3.2 Recommendations

Confirmation of the panels' structural support could most likely be accomplished by removing one or more of the recessed lights in the soffit above the museum lobby to allow inspection at close range using a fiber-optic video inspection camera.

III. PHOTOGRAPHS

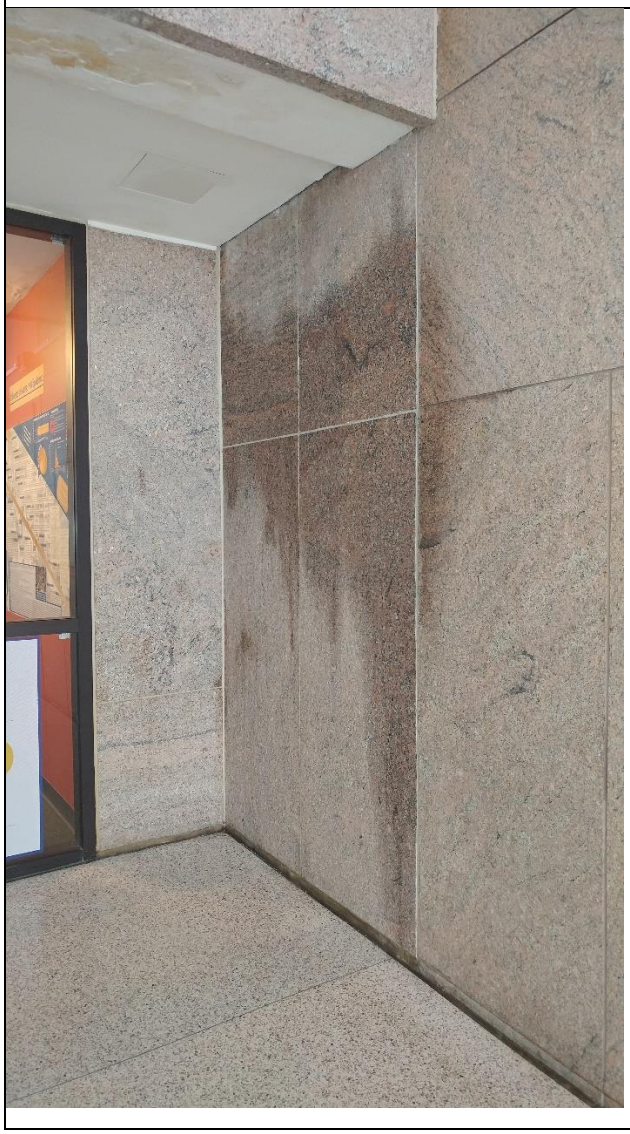
	**Photograph 1.** View of exposed adhered EPDM and sloped roof glazing system over atrium at main building entrance.
	**Photograph 2.** Failed patch over granite facia panel removed and reinstalled in 2005, SE corner of atrium roof.

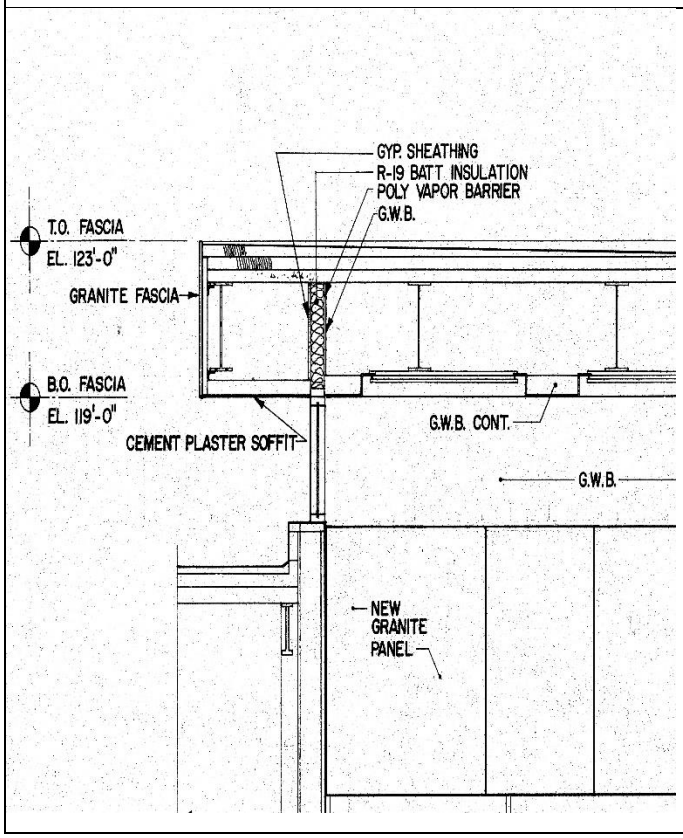
	**Photograph 3.** Close-up view of failed liquid rubber repair material, SE corner of atrium roof.
	**Photograph 4.** Insufficient application of repair caulk to termination bar of the ballasted roof below the replaced granite facia panel, SE corner of atrium roof.
	**Photograph 5.** Termination bar likely installed to secure failing edge of atrium roof membrane along north, east and west walls.

	**Photograph 6.** Typical failed urethane sealant joint between granite facia panels. Joints scheduled to be replaced in May, 2019.
	**Photograph 7.** Contractor removing west panel of atrium south wall.
	**Photograph 8.** West panel removed, fiberglass batt partially removed, revealing roof insulation, 6" metal stud wall, and absence of moisture barrier between panel and gypsum sheathing. Also visible is rusted galvanized roof flashing over top edge of south atrium wall.

	**Photograph 9.** View of fallen unfaced fiberglass batt insulation. Insulation also absent from adjacent stud bay. Evidence of standing water over atrium ceiling, SW corner.
	**Photograph 10.** Sagging fiberglass batt insulation and evidence of moisture on inside face of gypsum sheathing over SW atrium corner.
	**Photograph 11.** Removal of east panel. Evidence of moisture intrusion on exterior surface of gypsum sheathing.

	**Photograph 12.** Contractor removing gypsum sheathing from east panel location. Stained and sagging fiberglass batt insulation show signs of water intrusion.
	**Photograph 13.** Removal of fiberglass insulation and small section of rigid insulation at east panel reveals lead-coated copper flashing over original masonry parapet wall, granite coping stone, lead T-flashing and top edge of original 3" thick granite panel in atrium over entrance doors to museum lobby.
	**Photograph 14.** Top edge of stone panel above archives entrance door was exposed to view during the investigation. A steel angle inserted into the top of the panel provides lateral bracing of the panel, which was installed when the atrium was constructed. The structure providing vertical support of the stone could not be seen from within the concealed space behind the south atrium wall.

	**Photograph 15.** This photograph provided by BREM shows water intrusion at the top edge of the stone panel in the preceding photo. The staining is located directly below the area exposed to inspection and shown in photo 9 above.
	**Photograph 16.** This photograph provided by BREM documents water damage at the gypsum soffit above the archives entrance, and saturation of the stone cladding on the west wall. These areas are directly below the space shown in photo 9 above.

	**Photograph 17.** View of the south end of a knee-wall located directly above the head of the clerestory windows on the west side of the atrium. Plastic sheeting, visible in this photo, was apparently intended as a vapor barrier. It terminated at the end of the kneewall, and the abutting wall surfaces were not constructed with a vapor barrier membrane, rendering the plastic sheeting ineffective.
	A reproduction of the detail included on the original construction drawings for the atrium. The detail includes a note identifying a "poly vapor barrier", which corresponds with the polyethylene sheet seen in photo 17 above. The "new granite panel" noted in this detail refers to the panel installed above the library entrance in the atrium. Photos 15 and 16 show a similar panel at the far end of the south wall.

End of Report.