
Building Envelope and Failure Analysis: A Case Study of a Masonry Veneer Failure Due to Air Leakage

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ABSTRACT

In recent years, the culprit of defects to buildings has been quickly assumed to be inadequate materials used inappropriately. The quick diagnosis often leads to blaming a particular material or product, and until the problem is properly assessed, perceptions of the material design may be unduly scrutinized. Whether or not the properties of the material are cause for damage to the assembly, the immediate response should always be confirmed with further investigation.

In the assessment of a recent prominent gallery, it was suspected that a masonry material was suffering premature deterioration. The owner was inclined to believe the simplistic assessment of preliminary investigators that the problem was limited to the composition of a single building material. Investigation of the situation revealed that it was not the material but in fact the substandard construction of the building air barrier assembly that had led to the deterioration symptoms. After intrusive masonry openings were conducted and freeze-thaw testing of the existing cladding units was performed, it became clear that the major reconstruction and expansion of the building that had occurred a few years earlier was the source of the damage. This expansion of the facility had added considerably to the total envelope area and had resulted in numerous intersections between new and old envelope elements. Air barrier defects were found at the junction of nearly every envelope element. In particular, the junctions of new windows to new masonry elements were found to be a consistent location of air barrier defects.

These widespread air barrier defects, combined with an art gallery environment where the relative humidity was being maintained at 50% and a positive interior pressure, resulted in huge quantities of water being introduced into the interstitial spaces of the exterior cladding by condensation. This water absorbed into the masonry units, making the units prone to freeze-thaw damage. The degree of moisture exposure to the masonry units would have resulted in the failure of most common masonry cladding materials. The material structure of this particular block system, being manufactured to simulate limestone, has the abnormal property of spalling inward during the occurrence of freeze-thaw damage, hence the confusion when compared to traditional clay masonry veneers.

The operations staff for the building continued to increase the positive internal pressure in attempts to control the desired interior conditions during winter. The increased pressure further worsened the moisture load upon the envelope by introducing more condensation into the interstitial spaces of the exterior cladding and accelerating the masonry deterioration.

The case study presented here provides a perspective on several lessons learned from the investigation and repairs. A small element of the overall envelope resulted in complete replacement of a large percentage of the cladding and excessively high operating costs. The relative benefit of air barriers versus vapor barriers is explored. The role of constructability issues such as erection sequencing, trade delineation, and trade responsibility are examined in relation to the envelope defects and resulting damage. Alternative designs are compared to the base condition in relation to cost, constructability, trade responsibility, operating costs, envelope performance, and long-term maintenance. Simple cost benefit scenarios are presented.

Although the real problem was ultimately discovered, the material that the structure was composed of was deemed to be faulty before further investigation had been completed. In the litigious environment that surrounds the construction industry, hasty judgments can cause serious (and sometimes unnecessary) financial burdens. Empirical evidence and in-situ assessment are always required to confirm professional instincts and, in this case, a perceived freeze/thaw problem with manufactured architectural block was, in fact, damage caused by significant defects in the air barrier system.

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