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Building Envelope Air Barriers

Introduction

A building envelope's airtightness is a major factor in said building's overall energy performance. Uncontrolled air movement through the envelope will significantly increase the energy required to heat, cool, and humidify a building. In addition to increased energy use, uncontrolled air movement can lead to water migration into wall cavities, poor indoor temperature and humidity control, and compromised fire and smoke control measures. Uncontrolled air movement can also lead to condensation, which can cause mold, spalling of masonry, and general deterioration of assembly components.

Requirements for Air Barrier

Section C402.5.1 of the International Building Code (IBC) requires building envelopes to include a continuous air barrier to control air leakage in and out of all conditioned spaces within a building. The air barrier must be sufficiently durable to withstand damage during construction and last the life of the building. It must be sufficiently supported to resist positive and negative air pressure loads. All discontinuities and penetrations must be sealed and made airtight.

The air barrier type, material, and location within the assembly must be selected and specified as part of a comprehensive envelope design based on climate, energy modeling, daylight modeling, thermal comfort modeling, and heat transfer analysis. The construction documents must clearly identify all components of envelope assemblies on sections and plan details, specifically joints, interconnections, and penetrations. The air barrier material must have an air permeance not to exceed 0.004 cfm/sf at 0.3" wg [0.02 L/s.m2 @ 75 Pa][1] when tested in accordance with the American Society for Testing and Materials (ASTM) E 2178. The air barrier material of each assembly must be joined and sealed to the adjacent air barrier material in a manner which accommodates differential movement.

In buildings undergoing renovations, the state and condition of the existing air barrier should be determined. Destructive investigation may be required and undertaken based on an analysis of the cost and potential benefit of such an undertaking and the sensitivity and criticality of the facility's function. Problem conditions, such as gaps around windows or unsealed penetrations, should be corrected. It may be possible to seal small gaps and penetrations with spray polyurethane foam or another injectable expanding sealant. Note that air-permeable material like fiberglass insulation will not suffice as an air barrier.

Air Leakage Testing

To ensure the airtightness of the envelope, the project specifications should require that the construction contractor's testing agency demonstrate performance of the continuous air barrier by the following tests:

1. Test the completed building in accordance with ASTM E 779 and ASTM E 1827. Testing shall occur when the air barrier installation is complete and repairs to the air barrier, if needed, are finished. If the building fails the airtightness test, corrective action must be taken until the building passes a subsequent test.

2. Inspect the completed building using infrared thermography. Perform inspections in accordance with ASTM C 1060. Determine air leakage pathways using ASTM E 1186. If the building does not pass the fan pressure test, perform corrective work as necessary to achieve the whole building air leakage rate specified in (1) above, then complete a second thermal scan.

Resources

ASTM E 779 *Standard Test Method for Determining Air Leakage Rate by Fan Pressurization*
This test method measures air-leakage rates through a building envelope under controlled pressurization and de-pressurization.

ASTM E 1827 *Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door*
These test methods describe two techniques for measuring air leakage rates through a building envelope in buildings that may be configured to a single zone.

ASTM E 1186 *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*
These practices cover standardized techniques for locating air leakage sites in building envelopes and air barrier systems.

ASTM E 2170 *Standard Test Method for Air Permeance of Building Materials*
This test method is to determine the air permeance of building materials at various pressure differentials, with the intent of determining an assigned air permeance rate of the material at the reference pressure difference (ΔP) of 75 Pa.

ASTM C 1060 *Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings*
This practice is a guide to the proper use of infrared imaging systems for conducting qualitative thermal inspections of building walls, ceilings, roofs, and floors, framed in wood or metal, that contain insulation in the spaces between framing members.

Reference

[1]USACE Engineering and Technical Bulletin, Building Tightness and Air Barrier Continuity Requirements, No. 2012-16