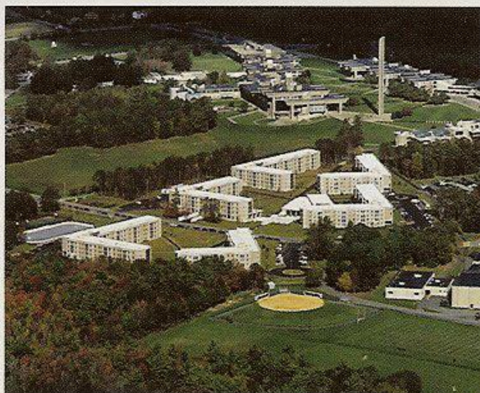
University housing presents rigorous test for design, installation of air-barrier system

By Len Anastasi, Lennel Specialties Corporation



(Above left): An aerial view of the new dormitories at the University of Massachusetts-Dartmouth. Photo courtesy of Eagle Eye Aerial Photography
(Above right): A ground-level view of the completed dorms. Photo courtesy of ADD Inc.

The new dormitory buildings at the University of Massachusetts in Dartmouth, MA, presented a major design challenge because the building program is one of the largest projects to include an air-barrier system since the adoption of the landmark 2001 Massachusetts Commercial Energy Code. This code requires air barriers in all newly built commercial buildings, as well as in many types of new residential buildings of more than 10,000 square feet of floor space.

The project consisted of six four-story buildings constructed with load-bearing masonry structures and masonry veneers. Adding to the challenge was the highly aggressive schedule under which the project was to be designed and completed.

Key decisions facing design firm ADD Inc., Cambridge, MA, during the design phase included which air-barrier assembly to use in the exterior wall and how to integrate the barrier system into the other assemblies for building enclosure. Jeff Wade, AIA, CSI, and ADD principal, was charged with the task of making the decisions on class of air barrier, type of air-barrier product, and materials and details to be used to complete the assembly.

Wade could consider the two recognized classes of air barriers—vapor-permeable and air/vapor combination system. He chose an air/vapor barrier system because all four "wetting potentials" that would result from the difference between the interior and exterior environments would be restricted to the exterior of the water barrier—or drainage plane—if an air/vapor barrier system were used.

Within the two classes of air barriers are the key types of barriers—sheet membrane, fluid-applied barrier, and spray polyurethane foam.

The multitask approach

In the air/vapor barrier system used, the liquid barrier product is applied to the exterior face of the CMU back-up wall and performs the functions of air barrier, vapor barrier, and water barrier. Due to the air-barrier material's function as a vapor barrier and the project's location in a predominantly cold, humid climate, the thermal barrier (insulation layer) had to be located on the predominantly cold side of the vapor barrier. This necessitated installation of insulation in the masonry cavity (see Fig. 1). In so doing, liquid-water penetration, moisture transport via airflow, and vapor migration due to diffusion are all intercepted by the air/vapor barrier.

When weather conditions dictate, the wetting potential created by dew-point conditions will occur within the thermal barrier, which is located on the exterior side of the water barrier, thus preventing condensation from accumulating within the back-up wall. Any moisture that exists or accumulates due to any of these four wetting potentials will be properly channeled to the exterior of the building (see Fig. 2).

It was decided that the most effective thermal barrier for this project would be a continuous layer of extruded polystyrene in the wall cavity. ADD specified a fluid-applied membrane air/vapor barrier due to the number of penetrations resulting from the "eye & pintle" type of anchor system commonly employed to attach masonry veneer to CMU backup exterior walls. Any gaps or breaks associated with the anchor-system penetrations were filled during application of the liquid-applied barrier material, with no additional touchup required. This presented an advantage over the use of a sheet-membrane barrier, where gaps and breaks in the surface caused by the anchor system penetrations would have to be individually sealed following

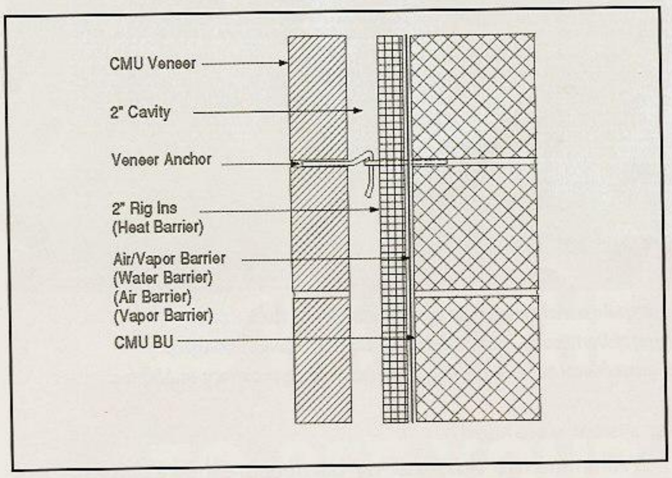


Fig. 1: Insulation in the masonry cavity

membrane installation.

The liquid-applied air-barrier system chosen, Air-Shield LM from W.R. Meadows Inc., was installed by Lighthouse Masonry. Any gaps or breaks associated with the anchor-system penetrations were filled during the normal application process of the liquid-applied barrier material, with no additional touch-up required.

The company's project manager, Michael Boussy, said the single-component, water-based material requires no complicated or expensive spray equipment, cures without use of chloride co-spray systems, and adheres without damage to insulation. The material also provides "bridging" of small gaps in the cement block caused by unfilled head joints and shrinkage of mortar joints. Back-brushing can be employed to fill remaining gaps.

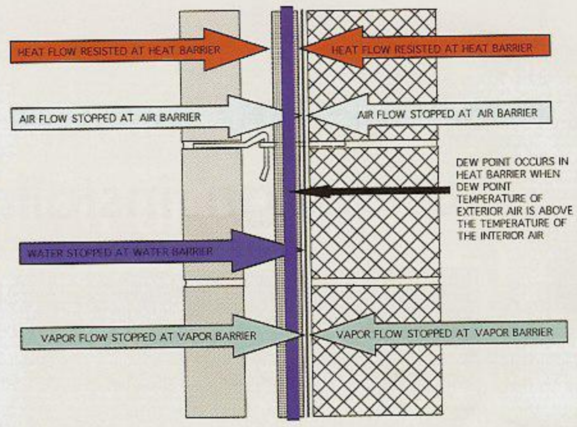


Fig. 2: Channeling of wetting potentials to the exterior of a building

Details, details

As with any air-barrier application, the devil is in the details—as in tie-ins and integration with other assembly elements to ensure a continuous barrier system. ADD's Wade said the firm has devoted considerable time and effort developing an internal reference of standard air-barrier detailing guidelines based on the type of barrier material.

Adding to the challenge is the reality that each project requires adaptation of details based on the type of construction, roofing system, and window system selected.

For the U-Mass Dartmouth project, the air-barrier system required detailing of window and door perimeters, internal corners, external corners, and wall-to-foundation and wall-to-roof interfaces using a self-adhering sheet membrane air-barrier material furnished by the manufacturer of the fluid-applied air-barrier material. This transition membrane assembly was installed before installing the fluid-applied membrane.

Once the exterior masonry veneer was completed, the windows were installed and the connection from the self-adhering sheet membrane transition strip to the window and door was completed with a combination of spray polyurethane foam, sealants, and mineral-wool insulation.

The connection of the opaque wall air barrier to window and door frames presents one of the more problematic issues in designing and constructing air barriers. A variety of means and methods can be employed, however, to make for successful detailing and installation. First and foremost, the detail should be as simple as possible to reduce or eliminate installation failures. Second, the detail should be capable of lasting as long as the expected life of the wall and the window. And third, the detail should account for the fact that the joint also has to be insulated,

Installation of air barrier in progress at the dormitory buildings at the University of Massachusetts-Dartmouth Photo courtesy of ADD Inc.

and the insulation should align with the thermal break in the window to prevent condensation from forming on the interior of the frame.

For this project, a combination of sheet membrane, spray-polyurethane, and silicone sealant materials was used to tie the window assembly to the air/vapor barrier. Silicone sealant was applied on the interior side, between the window frame and the air/vapor barrier. A secondary silicone sealant was applied on the weather side between the windows and the CMU as a rain barrier. Spray polyurethane foam was used to provide added insulation and a thermal break between the window frame and the wall cavity.

Roofing wrinkles

Also important is the wall-to roof junction. Most sheet-roof membranes, such as the material used in this case, also are air barriers, and some meet the definition of a vapor barrier. They must therefore be tied into the air and/or vapor barrier in the above-grade vertical wall. In this project, a fully adhered sheet roofing system was used and was adhered to the wall assembly air/vapor barrier at the termination of the roofing system.

Massachusetts' building code requires a vapor barrier in the roofing system as well as in the exterior walls and slab-on-grade.

But the code lists exemptions where the vapor barrier can be omitted. The roof vapor barrier presents a rather new concept to design and construction professionals. Accordingly, misinterpretations of the code have arisen with regard to these barriers.

When using a fully adhered roofing system, the roofing assembly will meet Exception 3 in the code, and therefore will not require a vapor barrier. For mechanically fastened or ballasted roof systems, the insulation-fastener penetrations of the vapor barrier can be the source of moisture problems in the roofing system. These penetrations will allow air from the interior of the building to be drawn up into the roofing system when the roof membrane billows due to negative wind pressure. The vapor barrier, as installed, will impede the drying of any moisture that accumulates in the roof system.

For mechanically fastened or ballasted roofing systems, it is best to install a decking material on the metal deck and then apply either a self-adhering or fluid-applied air/vapor barrier membrane to the decking. The roof insulation and roof membrane can then be installed on top of the air/vapor barrier. The air/vapor barrier membrane selected for this application should self-seal around fastener penetrations when put under compression by the decking and the insulation.

Air-barrier science: A work in progress

Real and perceived issues have accompanied the design and construction of air-barrier systems, and the U.S. construction industry has been seeking to sort out and work through these issues for the past four or five years. This has resulted in a growing knowledge base that is producing increasingly effective air-barriers. This is the case in Massachusetts and Wisconsin, where they are required by code, and in other regions where designers and builders have come to realize the benefits of the technology in terms of reducing energy use and controlling moisture.

Additional educational and technical information on air barriers is available from the Air Barrier Association of America (ABAA). The association's website is located at www.airbarrier.org.

JAC