Public Housing Breaks the Mold

JOSEPH LSTIBUREK

Multifamily public and low-income housing have particular problems when it comes to moisture and air pollutants. In this first of a two-part series, we look at one particular type of multifamily construction: midrise housing.

by John Snell and Betsy Pettit

Sick buildings are a growing concern in all sectors of the building industry. As homes become tighter and more energy efficient, other performance factors, particularly moisture and ventilation problems, often become apparent. Each day, building scientists and public health researchers learn more about the link between poor home performance and poor occupant health. These health problems cannot be taken lightly; for example, Cleveland's public housing stock is the epicenter of recent mold-related deaths among children.

In our work in the fields of energy efficiency and forensic architecture, we have investigated building problems in more than 200 subsidized housing developments. Based on our experiences with this housing stock, we find that moisture problems are the major cause of suspected health-related building problems in subsidized housing, and that adding controlled mechanical ventilation is one of the easiest and least expensive means of reducing or resolving many of these problems.

In many of the homes we've seen, specifically midrise and Veterans Era (post-World War II) housing, high surface humidity due to a lack of ventilation coupled with thermal bridging is a large factor in mold growth. Other factors include high occupancy rates per ft^2, and occupant behavior. We conclude that proper mitigation in these buildings can improve home comfort and safety, and can improve the health effects of the occupants.

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This "cold climate mold" often occurs where you have lots of framing members but no insulation, such as in corners of rooms.

However, in some cases—such as where thermal bridging is a problem—the mitigation efforts can be extensive, since adding ventilation alone is typically not sufficient. Finally, we feel that it is essential that building mitigation work and energy efficiency improvements be done properly, so as not to exacerbate existing moisture problems.

The Medical Impact of Moisture

Medical costs to treat housing-related health problems are extraordinary: $500–$800 per emergency room visit, and $1,000–$2,000 per overnight stay; and an average asthma-induced hospital stay lasts for three and a half days. In Boston, aggressive health center–based medical interventions have reduced the number of emergency room visits from chronic health problems such as asthma. Outpatient service costs, however, have increased sixfold. Another concern is the long-term effect on children of the medication used to treat asthma and related bronchial inflammation.

Health care providers need to understand potential housing interventions that can reduce their patients' exposure to potential environmental health hazards. In addition, they need appropriate mechanisms to "prescribe" housing interventions. Rhode Islands' Lead Paint Center initiative provides an interesting model for future Medicaid-reimbursed housing interventions. Under this program Rhode Island Medicaid pays the cost to replace apartment windows for patients with clinically diagnosed high lead levels. Chronic moisture and health problems are closely associated with poor housing conditions in subsidized housing; occupants of such housing could benefit from a similar type of reimbursement program.

Standards Must Be Set

Our findings from the examples we present in the following pages are consistent with subsidized housing conditions we have inspected throughout the United States. Based on our experience, we propose that the major health-related building problems in subsidized housing can be traced back to water damage and poor environmental control. In order to ensure that publicly funded housing provides healthy environments for its occupants, minimum performance standards must be set. Standards must be set and tested for compliance in the following categories:

- rainwater and groundwater control;
- thermal bridge control;
- foundation wall, crawl space, and slab insulation;
- window thermal resistance;
- forced water and steam distribution systems; and
- fresh air supply and distribution.

These performance standards must be measurable and achievable within the trade base. Long-term solutions will require a collaborative response from housing, public health, and urban planning institutions and agencies, beginning with systematic surveys of existing conditions.

We support tax or other incentives for developers, housing managers, and energy service companies to build healthier housing and upgrade existing housing to higher standards, such as DOE's Building America or the American Lung Association's Health House building programs. In order to develop appropriate long-term solutions to housing-related chronic health problems, legislators and government agencies need to fund targeted, integrated health and housing research and technology transfer initiatives that will help shape appropriate legislative responses to these problems. HE

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Part I: Midrise Housing

Midrise housing is housing that is at least three stories high. The design and construction of midrise housing varies significantly from that of low-rise housing. For example, steel frame wall and metal pan or solid concrete floor assemblies dominate midrise construction, while wood frame wall and wood underlayment floor assemblies dominate low-rise construction. One of the problems with midrise construction is that it is more difficult to diagnose air flow patterns and moisture migration in these large, multistory buildings.

The following two case studies describe a four-story development (constructed in 1990) located in Roxbury, Massachusetts, and a seven-story development (constructed in 1980) located in Holyoke, Massachusetts. The moisture problems in these structures included condensation caused by moist air transport against cold surfaces, as well as thermal bridging and rain intrusion through the building skin.

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At Roxbury Corners, we performed a rain leakage test to determine if rainwater was leaking into the walls.

Family Housing, Roxbury Corners

The major complaint at Roxbury Corners Apartments was mold growth. Mold was growing in every apartment, but primarily in the ground floor apartments and in the lower levels of the stairwells. Roxbury Corners is four stories high, with steel frame construction. The exterior cladding is brick veneer over gypsum board. The apartments range in size from two to four bedrooms and from 950 to 1,300 ft^2. A central gas-fired boiler located in the basement heats the apartments via hydronic baseboard fin tube radiators. Rooftop fans exhaust air from the kitchens and bathrooms. Test results from air depressurization indicated extremely leaky (5–6 ACH at 50 Pa) construction details for multifamily apartments of this type, age, and construction.

Investigators concluded that the mold growth occurred at Roxbury Corners because warm, humid air drawn into the building during the summer was condensing on cold surfaces, especially at metal studs. Basement level apartments are susceptible to this problem because they experience substantial heat loss to the ground at the below-grade portions of the perimeter walls and the bottom plates of the interior

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After the rain leakage test is performed on the building exterior, field engineers removed sections of the interior wall to see if water had leaked into the walls. Because it had not, we knew that condensation was the cause of the mold growth.

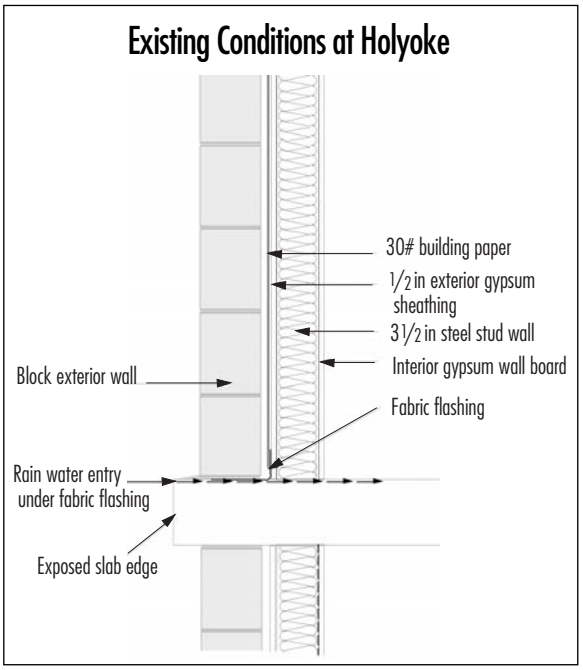

Figure 1. Rainwater entered the building, driven by wind, under the fabric flashing at the exterior balcony.

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At Holyoke, the rain leakage test determined that rain water was indeed the moisture source.

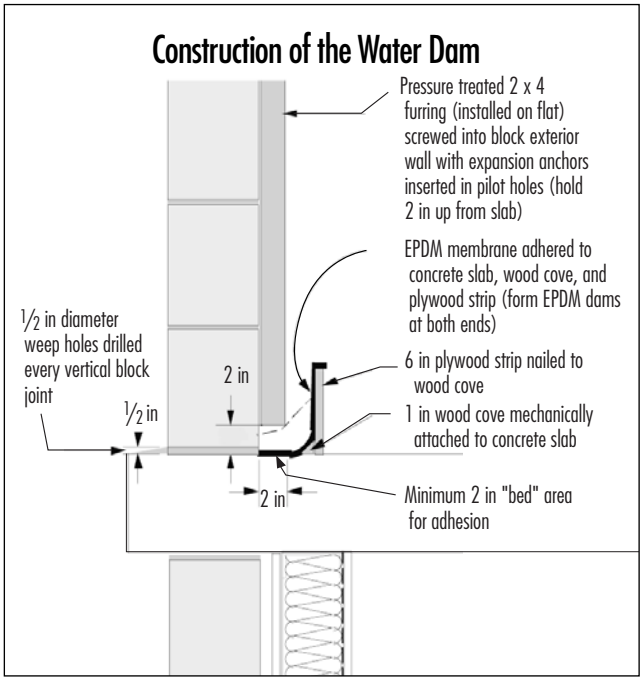

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Figure 2. The existing stud wall and insulation were removed from the inside, and weep holes were drilled to allow the water to drain out.

walls. Warm, humid air enters into the hollow wall framing cavities and is cooled by the concrete foundation assembly. The mold growth occurs as a result of thermal bridging, which leads to a rise in the relative humidity of the air adjacent to the wall surface. The proposed solution to this problem was to increase the temperature of all cold surfaces, and to air seal at floor/exterior wall junctions and at interior unit perimeter walls to control air movement through the building.

Increase the surface temperature of cold surfaces. This measure required significant remediation and mitigation efforts in the lower-floor apartments. Investigators recommended reconstructing the lower apartments by adding rigid thermal insulation to the exterior walls in order to eliminate the thermal bridging. This required management to strip the damaged gypsum board and place rigid insulation between the metal framing and the concrete foundations at the perimeter.

The building management carried out these recommendations. All of the apartments were inspected afterwards; the inspection included opening the walls and confirming that they are mold-free. The tenants at Roxbury Corners also no longer report mold growth in their homes.

Elderly Housing, Holyoke

The major cause of moisture problems at this development (constructed in 1980) was water infiltration through the building skin. The complaints were about visible sources of water infiltration, mold, window condensation, window deterioration, and interior paint and gypsum wallboard damage.

Holyoke's midrise development includes seven stories of small studio and one-bedroom flats that range in size from 600 to 800 ft^2. The building structure consists of a concrete frame with block infill walls and metal studs with gypsum board on both sides. A gas-fired central boiler heats water that circulates through the building to individual fan coil units. Exhaust fan systems in the kitchen and bathroom had been installed; however, they did not extract measurable quantities of air. Water leakage tests performed at the site documented water leakage through the facade. Air leakage tests documented fairly airtight construction (2 ACH at 50

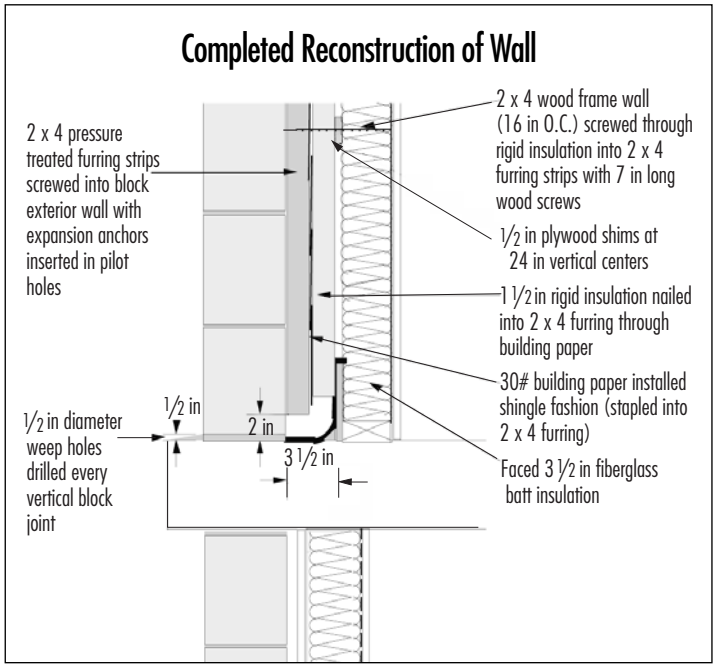

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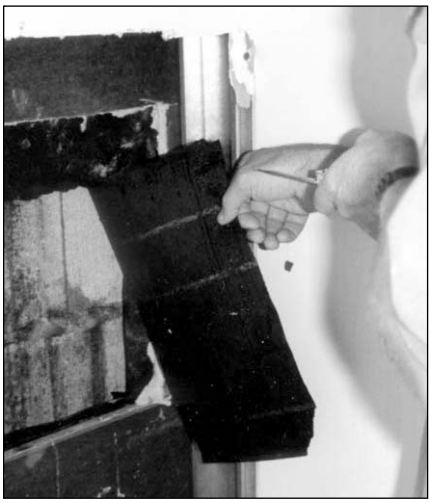
Figure 3. Once the water dam was installed, the interior wall was reconstructed. With the moisture source removed, the mold disappeared.

Pa, 1½ square inches leakage/100 ft² surface area).

Water leakage test results showed that rainwater was entering at the slab edge of each floor under the fabric flashing. At the same time, thermal bridging at the ceiling/exterior wall intersection was increasing the surface relative humidity in these locations high enough to support mold growth.



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When the wall section at Holyoke was removed, water (and mold) were found within.

The recommended solution was to reduce the interior vapor pressure and reduce water infiltration through the exterior building envelope.

Reduce the interior vapor pressure. Install higher-capacity individual exhaust fans in each apartment.

Reduce building envelope water infiltration. Upgrade the building envelope. Figure 1 shows how water entered through the wall. Figure 2 shows a detail of the water dam and drainage path design recommended for locations where water entered the building. Figure 3 shows details of the solution to eliminate the thermal bridge effect of the exposed concrete frame. After these recommendations were implemented, water stopped entering the apartments.

Part II of this article, Veteran's Era Housing, will appear in the next issue of ***Home Energy****.*