Research Report

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Infiltration of Moist Air

- Moist air from outdoors can work its way into frame and concrete masonry walls with cavities and cause moisture problems.
- The continuous layer of concrete in the Reward iForm™ acts as an air barrier and reduces the potential for moisture problems.

Infiltration of moist air from outdoors can cause serious moisture problems in conventional walls. Moisture that works its way into frame and concrete masonry walls can condense and cause moisture problems within the cooler wall cavities. This can cause indoor air quality problems and damage to wood and metal. Severe problems can occur in cavities because the moisture problem is hidden and can go unnoticed for a long time. The continuous layer of concrete and lack of cavities in the Reward iForm wall greatly reduces the potential for these types of problems.

Air Infiltration. When the moisture content of outdoor air is greater than the indoor air, as in warm humid climates, infiltration and depressurization can bring moisture into walls. This also occurs in milder climates during warm and humid summers, and in coastal climates that are humid year around. The effect of natural air infiltration on a building's performance is multifaceted. Air leaks into or out of the building envelope through gaps between building materials. The amount of leakage is dependent on the size of the gaps and pressure differences due to building height, indoor-outdoor temperature differences, and wind pressure. Air leakage increases as pressure differences increase.

Stack pressure or the "chimney effect" causes a slight positive pressure at the top-most ceiling, and a negative pressure at the ground-level floor. The higher the ceiling height or number of stories, the greater the pressure differential. The net result is that outdoor air is drawn into the conditioned space at the floor, and conditioned air is pushed out of the conditioned space at the ceiling. Heating and cooling systems that depressurize buildings cause infiltration also. When a system is operating and exhausting air without adequate intake, it will depressurize the building and air can be drawn into the building through cracks, joints, and building materials.

Wind pressures can greatly increase the air infiltration and resulting moisture problems. Information presented in ASHRAE[1] indicates that for a two-story wood-frame house with 8-ft ceilings, a 20-mph wind can easily double the air infiltration. Wind-induced air infiltration is dependent on the dimensions of the building, the type and locations of air leakage, the wind speed, local terrain features, and the difference between the indoor and outdoor temperatures. Wind-driven rain can also force moisture into cavities of frame wall systems.

The continuous layer of concrete within a Reward iForm Wall System has no measurable air permeability or leakage and minimizes the potential for infiltration. Therefore, Reward iForm walls do not require any additional air barrier, such as Tyvek.® This attribute of the Reward iForm saves energy and reduces potential

1 *ASHRAE Handbook of Fundamentals*, Atlanta, GA. www.ASHRAE.org

REWARD WALL SYSTEMS

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moisture problems compared to frame wall systems where air barriers must be properly installed.

Air Movement in Wall Cavities. Infiltration of moist air in frame and concrete masonry walls often results in moist air moving within wall cavities. This moist air circulating in cavities can condense in cold spots and contributes to moisture problems. Although air barriers are installed to minimize air movement through the insulation, joints and wall penetrations are often not sealed. Air movement can often be felt at electrical wall outlets or below the baseboard on exterior frame walls. The Reward iForm does not have cavities for air movement.

Whole building infiltration. Air infiltration for buildings with Reward iForms is significantly lower than for conventional frame buildings. In residential construction, air infiltration for Reward iForm has been measured as low as 0.09 air changes per hour. Numerous studies show typical residential values in the range of 0.20 to 2.0 ACH with most between 0.25 (tight) to 0.75 ACH (leakier). No data is presented in either reference regarding the type of construction materials; however, it is assumed that this is representative of conventional residential construction in the U.S. because a vast majority is frame construction.

Most air leakage is[2]:

- Between the sill plate and foundation
- At cracks at the bottom of the gypsum wallboard
- Into the attic at the top plates of walls
- At electrical outlets
- At utility penetrations

A building with Reward iForms greatly reduces the potential for leaks in the first four locations listed above. The Reward iForm sits tightly on a foundation wall and does not have the sill plate leaks found in conventional buildings. Air cannot move through Reward iForm walls into the attic as it can in other walls. Electrical wiring and outlets can be placed in the EPS insulation where they do not penetrate the concrete air barrier.

In all wall systems, penetrations through the wall need to be sealed and caulked to prevent air infiltration. These penetrations, or utility access ports, allow access between outside and inside to accommodate, air intake and exhaust vents; and electrical, gas, sprinkler, telephone, or water lines or pipes. Joints at window and door openings must also be sealed.

Since residential construction with Reward iForm walls has low infiltration and reduced heating and cooling loads, an air-to-air heat exchanger (heat recovery ventilation system) is recommended to bring in fresh air and minimize depressurization. Requirements in ASHRAE Standard 62.2-2003[3] should be implemented. For nonresidential buildings, requirements of ASHRAE 62.1[4] should be implemented.

2 *ASHRAE Handbook of Fundamentals*, Atlanta, GA. www.ASHRAE.org
3 *ASHRAE Standard 62.2, Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*, ASHRAE, Atlanta, GA. www.ASHRAE.org.
4 *ASHRAE Standard 62.1, Ventilation and Acceptable Indoor Air Quality in Buildings Except Low-Rise Residential Buildings*, ASHRAE, Atlanta, GA. www.ASHRAE.org.

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Moisture can condense within the cavities of frame walls and go unnoticed. (Photo courtesy of Construction Technology Laboratories, Inc.) Whereas a building built with Reward iForm consists of a solid monolithic wall of EPS and concrete preventing moisture infiltration because it has no wall cavaties.

Due to manufacturing processes, EPS thickness, EPS type and the uniqueness of the Reward iForm, this analysis, information and report is only to be used with Reward iForm and is not to be used with any other ICF system

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