Research Report

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Moisture in Concrete

- Moist concrete will gain strength with time and will not deteriorate due to moisture as unprotected steel and wood will
- Concrete in the Reward iForm™ wall will dry to the inside and outside
- Moisture in concrete generally will not cause deterioration in the finished Reward iForm wall if interior and exterior finishes are vented or vapor permeable

Building materials contribute significantly to moisture inside buildings, known as "moisture of construction," during the first years after construction. Concrete contributes moisture since it starts as a wet and saturated material. Wood and materials stored outdoors are also contributors. Many concrete and frame buildings have noticeable condensation the first year after construction that will subside in subsequent years. Dehumidification and adequate ventilation can help alleviate condensation due to moisture of construction.

Some materials such as wood or steel are damaged by moisture. Concrete is not damaged by moisture. It actually gains strength in the presence of moisture, and continues to gain strength as long as it does not dry to below 80% RH.

Drying mechanisms. Concrete is initially saturated and dries in two ways. First, some of the water is consumed in hydration where cement (a powder) combines with water. This hydration process gives concrete its strength. As long as water and cement particles are available in the mix, the concrete will continue to hydrate. By this process, water will be consumed and the concrete will continue to gain strength.

Secondly, in the Reward iForm wall, the concrete will dry to each side through the expanded polystyrene insulation as long as the finishes on each side are vented or have low permeance[1]. Moisture migrates to the outside through the EPS and permeable or vented exterior finish material. Moisture migrates to the inside through the EPS and gypsum wallboard where it is then removed by the mechanical ventilation system. On the interior, a vapor retarder is not recommended in the continental U.S. and vinyl wallpaper should be avoided. Low permeance and unvented exterior finish materials should also be avoided. Brick veneer should be vented and/or have weep holes. Vinyl siding or other exterior finish materials should have a permeance greater than 1.0 perms. The drying will continue until the concrete reaches an equilibrium moisture content with the EPS insulation and the indoor and outdoor air.

Cast-in-place concrete is estimated to release 146 pints per cubic yard of concrete during the first two years after construction[2]. Assuming a uniform rate of release for one year for exemplary purposes, 15 pints of water can be expected to be released daily on each side of the wall. Moisture released to the inside will increase the relative humidity of the interior space if adequate ventilation is not provided. This is not a new phenomenon as concrete basements have been built in a variety of structures for decades.

1 Gajda, J. and VanGeem, M. "Moisture in ICF Walls," PCA SN 2190a, Portland Cement Association, Skokie, IL, 2002. www.cement.org,
2 ***Moisture Control in Buildings***, ASTM Manual Series MNL 18, Heinz Trechsel, editor, ASTM, West Conshohocken, PA, 1994, p.176. www.astm.org

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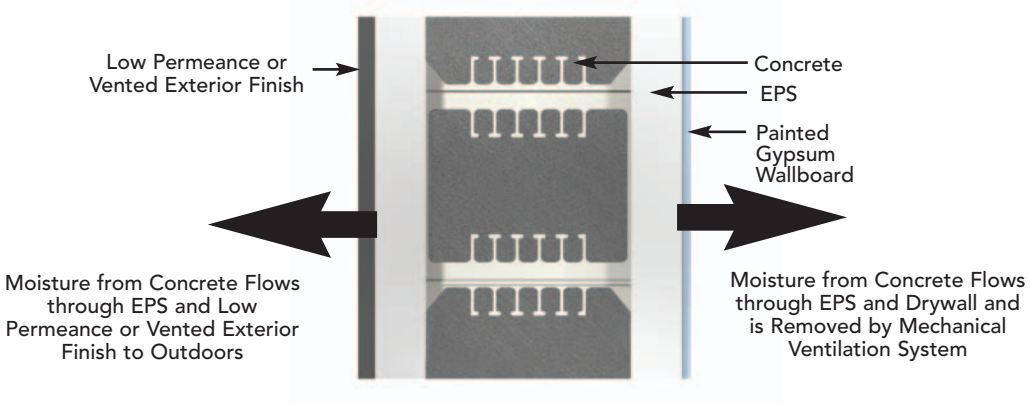
Drying begins immediately after the concrete is placed; therefore, some drying occurs before occupancy. Most of the drying takes place in the first two years. The walls will dry most readily during the winter heating season. The walls will also dry during the summer cooling season, but to a lesser extent. A dehumidifier may be helpful in lowering indoor relative humidities during the first two summer cooling seasons.

Ventilation. The leakiness of traditional construction has been relied upon as the primary source of fresh air ventilation. Since a structure 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, remove moisture, and the keep relative humidity in the air less than 50%. Requirements in ASHRAE Standard 62.2-2003[3] should be implemented for residential construction. Relative humidities in nonresidential buildings should also be less than 50%, and requirements in ASHRAE 62.1[4] should be implemented.

If humidities are higher than 50% after the first two years and an air-to-air heat exchanger is working properly, then the air conditioning system may be oversized. In this case the air conditioner may not be cycling on long enough to remove moisture generated by the occupants in the building.



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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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.