HUNTSMAN

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Location:
Northern Massachusetts

Building Type:
New Residential Construction

Behind the Building:

Builder: Jensen Development Corporation

Architect: MZO Group

Mechanicals: J&J Mechanical

Pool House Size: 2,000 square feet

Home Construction Type: Wood Frame

Climate Zone: 5

Common Sense:

- SPF air barrier keeps moist air from cold surfaces
- SPF vapor retarder lowers diffusion rates in a potentially high humidity environment
- Highly-insulated structure
- Elimination of thermal bridging

A Big Splash

Closed Cell Spray Polyurethane Foam (SPF) Meets the Challenge of an Indoor Pool in a Cold Climate

MZO Group of Boston, Massachusetts was tasked with a challenging problem: design and build an indoor, heated pool in a cold, snowy Massachusetts environment, a scenario which could lead to moisture problems. To add to the challenge, the pool house had to be isolated from the rest of the newly constructed home along a shared 35 ft. common wall.

The design goal was to isolate the pool house from both the outdoors and the interior of the home as much as possible. "I aimed to build a structure that you could turn upside down and it still wouldn't leak," said Eric Gjerde, architect from MZO Group. To do this, MZO group utilized a "belt and suspenders" approach with redundant safeguards against moisture problems.

Building this structure required a well-thought out design from architectural, heating, ventilating and cooling equipment (HVAC) and building science perspectives. Throughout the project, Jensen Development Corporation, the homebuilder, and J&J Mechanical, the HVAC contractor, worked closely with MZO Group to ensure all systems were going to work well together.

Design Considerations

Designing a heated indoor pool in a wood frame structure for a cold climate presents a unique set of challenges, as the potential for high humidity air to condense on a cold surface and cause mold or rot is high. When designing the pool house, there were several design requirements MZO Group had to consider:

- Continuous air barrier system
- Highly insulated wall assemblies
- Continuous vapor retarder
- Elimination of thermal bridging

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To help meet these requirements, MZO Group selected closed cell SPF, because it is the only insulant that can serve as an air, moisture and thermal barrier. SPF is the "belt" in the design, meeting the first three design requirements, while 1-inch of polyisocyanurate board was used for the final requirement — eliminating thermal bridging from the studs. "Closed cell SPF is a great choice because it has the highest R-value per inch, serves as an air barrier and moisture retarders and increases the structural performance of traditional light frame wood construction," said Gjerde.

The "suspenders" are a redundant self-adhered waterproofing membrane and moisture retarder between the polyisocyanurate board and the interior gypsum. A mold and moisture-resistant gypsum board was used and painted with a moisture-resistant epoxy coating. The exterior was sheathed in plywood, a less moisture sensitive alternative to oriented strand board (OSB). The sheathing was then covered in a weather-resistive barrier and finished with cedar shingles.

Air Barrier and Vapor Retarder

Because of the potential for high humidity from the pool interior, both an air barrier and vapor retarder are critical. Here's why: Moisture vapor is transported via two different mechanisms into wall assemblies: **air movement** and **diffusion**. Air movement is typically the larger source of moisture problems, as a 1-inch hole @ 70°F and 40% relative humidity will allow 90 times more water into a wall via **air leakage** than a 4 foot x 8 foot gypsum board will via **diffusion**. Thus, an air barrier not only improves energy efficiency, it also serves as the first defense against moisture problems.

The vapor retarder is the second line of defense, protecting against moisture problems due to the moisture diffusion mechanism. With any design, the vapor retarder should be on the "warm" side of the insulation, as designed here. This prevents moisture diffusion to the cold side of the assembly. In designing an assembly, each potential condensing surface should either be warmer than the dew point or sufficiently protected from seeing moisture via diffusion or air infiltration. While multiple vapor retarders are typically discouraged, these three layers are locked into a solid air tight assembly preventing a moisture-trap scenario.

Insulation

High humidity air means a high risk of condensation on walls and windows. To eliminate condensation, the structure was super-insulated with R-values approximately twice the code requirements. Each cavity was filled to its entire depth to avoid any air space within the system. Not only will the super-insulation eliminate the condensation potential, it will significantly reduce the heating bill for an otherwise energy-intensive building.

As the relative humidity of the indoor air rises, the difference in temperature between the air and the wall surface at which condensation occurs narrows. With conditions of 78°F and 80% humidity, a surface temperature of 71°F will cause condensation. Therefore, it was critical to strengthen the thermal weak spots in the wall. To eliminate thermal bridging at the studs, foil-faced 1-inch polyisocyanurate board was used on the interior of the studs adding R-6.5. For the glazing, high performance U = 0.28 windows were utilized.

Mechanicals

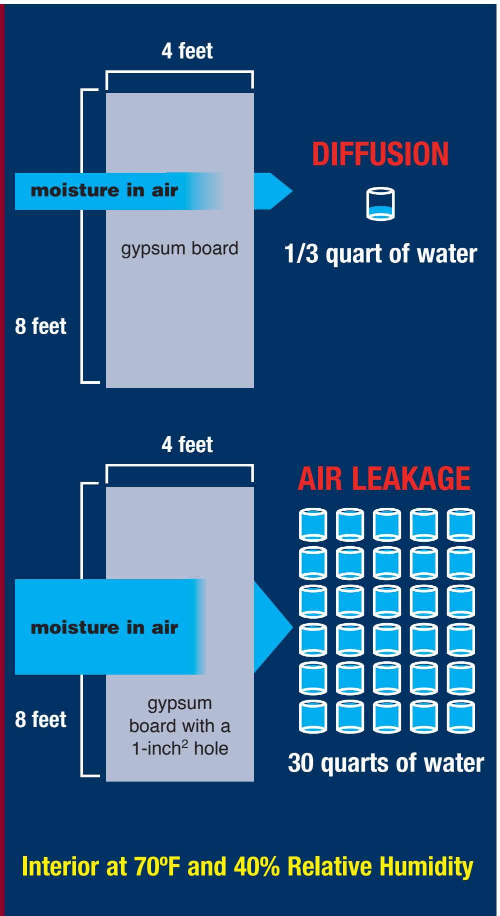
The pool house's HVAC system was a stand-alone system, disconnected from the main house. Supply registers were placed above the windows to keep warm air flowing over the surface, preventing condensation. Because of the air tightness of the structure, controlled mechanical ventilation (at rates defined by ASHRAE Standards) was provided via a heat recovery ventilator (HRV). Lastly, the design team set out to control humidity by installing a separate dehumidification system decoupled from the heating and cooling systems. The target relative humidity range was 50-60%.

Occupant Behavior

The builder coached the homeowner on how to keep the relative humidity down and lower the run time and energy usage of the dehumidification system. First, to minimize evaporation the pool cover should be used when the pool is not in use. Next, the pool water temperature should be set 1 to 2°F lower than the pool house air temperature and kept lower than 80°F to slow the evaporation rate.

Conclusion

By managing the moisture hazard on multiple levels, MZO Group designed an enclosure that will ensure the client's indoor pool will last a long time. By providing an excellent air barrier, along with a moisture vapor retarder to the warm side of the insulation, the probability that moisture will enter the wall assembly where it could condense and cause mold or rot is minimized. The proper amount of insulation and high quality windows ensure condensation does not occur on the interior surfaces. By "designing the indoor space like it was outdoors," bringing in the mechanicals contractor early in the design, and ensuring high quality, detail-oriented work by sub-trades, Jensen Development Corporation and MZO group have designed and built an outstanding structure that will withstand the challenges of this difficult environment.



The above diagram highlights water transport via diffusion and air leakage. *Source: Energy & Environmental Building Alliance (EEBA)*

Vaulted ceiling assembly being installed

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