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SEALED ATTICS IN HOT AND HUMID CLIMATE

Converting attics into a semi-conditioned space in hot climates by closing soffits, gable and ridge vents is a positive design approach in reducing the moisture loads in houses and buildings. This can be achieved by moving the insulation from the floor of the attic to the underside of the roof deck. The usage of SEALECTION 500, the low air permeable spray foam insulation, sprayed to the underside of the roof decks and sealing all vents, is an excellent approach in air leakage control. This design prevents the moisture laden air from the outside to enter into the attic and subsequently into the houses and building. In the state of Florida this design approach has been conducted for more than a decade and thousands of residential and commercial constructions have used the conditioned attic without any energy penalty when compared to the vented attics with air distribution ducts.

Myth of the Vented Attics

There are two myths related in venting attics in hot and climates:

- The air movement through the attic should reduce the cooling load. Have you ever visited any vented attics during the day and find the temperature of the attic is lower than the outside air? The radiant heat from the roof deck increases the attic air substantially. Moving the entire air distribution system out of the attic and into conditioned space is a good concept. However, this is not a typical building practice and is often impractical or impossible due to design and cost constraints.

- Venting shall remove moisture from the attics. In the hot-humid climate, the best solution to eliminate the potential for moisture condensation in attics may be to keep the moisture out of the attic altogether, by sealing the attic from the outdoors. TenWolde et al (1993) recommended that the roof cavities of manufactured homes not be ventilated in hot-humid climates due to conditions that could be conducive to mold and mildew growth (monthly mean surface relative humidity above 80%). A later report by Burch et al (1996) came to the same conclusion, stating that their computer modeling results for Miami, FL "indicate that ceiling vapor retarders and roof cavity vents should not be installed in homes exposed to hot and humid climates."

Understanding Attic Ventilation

Ventilation is one of the most effective ways to deal with humidity problems in Northern climates (heating zones), but ventilation can be one of the major causes of humidity problems in southern humid climates (Lstiburek 1993). The problem of condensation in attics in hot-humid climates is caused by humid outdoor air coming in contact with cold surfaces in the attic. Although worse in coastal areas, this problem is not confined to coastal areas. The most offending cold surfaces are usually supply ducts, but they can also be ceiling drywall and metallic

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penetrations through the ceiling if low interior set points are maintained. In much of Florida, it is not uncommon to have an outdoor air dew point of 24C (75F), and an attic air dew point of 29 C (85 degrees F). When an attic surface temperature is lower than the attic air dew point, condensation will occur. The attic air dew point can be higher than the outdoor air dew point because moisture stored in the wood roof framing structures at night is released during the day. This moisture adsorption-desorption process is driven by the relative humidity gradient between surfaces and the air in contact with those surfaces. Relative humidity of air at a surface is that of air in equilibrium with the surface moisture content of the material. The result of this attic moisture adsorption-desorption mechanism is summarized as follows:

Night time:

*high attic air relative humidity due to air exchange with outdoors
lower air relative humidity at the surface of wood framing materials
resulting in moisture being adsorbed by wood framing materials
the attic air dew point temperature will be similar to outdoors

Daytime:

* lower attic air relative humidity due to sensible heat gain by solar.
* higher air relative humidity at the surface of wood framing materials
resulting in moisture being desorbed by wood attic framing materials
* the attic air dew point temperature will be elevated above outdoors

The greatest problem with attic condensation will occur during the daytime when the air conditioning (cooling) system operates for long periods, causing supply ducts, supply diffusers, and ceiling areas near supply diffusers to remain cold. With normal supply temperatures between 10 C and 13 C (50 degrees F and 55 degrees F), and attic air dew point temperatures up to 29 C (85 degrees F), it is easy to see how condensation can occur. Increasing the duct insulation and sealing is a positive approach. However, due to workmanship and lack of quality control the solution to condensation on ducts cannot be achieved by this approach. Cold air leaking from supply ducts, creating cold surfaces in the moist attic environment, can also cause condensation related problems.

In residential construction, the challenge of achieving a continuous air barrier and insulation at the interior ceiling level is especially difficult. The air barrier, used to isolate the living space from the attic, is usually the taped drywall, while insulation placed on top of the drywall. Typically, the ceiling is not a single horizontal plane, but a series of horizontal planes, vertical planes (knee walls), and sloped planes, all intersecting to create the ceiling. Field inspections repeatedly show how the continuity of the air barrier and insulation is compromised at knee walls, pony walls, dropped ceilings, framed soffits or mechanical chases, recessed lights, fireplace flues or chimneys, and penetrations for plumbing, electrical, and space conditioning, etc. In reality, it is often impractical to try to maintain a good air barrier and insulation continuity at these locations.

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Air-tight recessed lights rated for insulation contact, foam sealing of penetrations, and full-depth blown insulation to cover the variations in ceiling plane can help to alleviate the problems, but at significant added cost.

The most cost-effective approach to insulate and air seal attics is to spray SEALECTION 500 to the underside of the roof deck rather than using loose fill insulation or fiber glass batts on the floor of the ceiling. Due to the nature of the SEALECTION 500 spray polyurethane spray foam, air sealing of the attic openings also prevents the ingress of wind driven rain. The last hurricane season (2004) in Florida showed that houses with sealed attics showed a reduction in roof top blow off. The location of air conditioning equipment and the air distribution system can also extend the life of the equipment. In coastal areas, the reduction of salt air intrusion should have a positive impact on the life of the mechanical equipment. The repairs of the mechanical systems (electrical, plumbing, HVAC) in the cooler attic is a blessing for the repair trades.

Additional information can be found in the following references:

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