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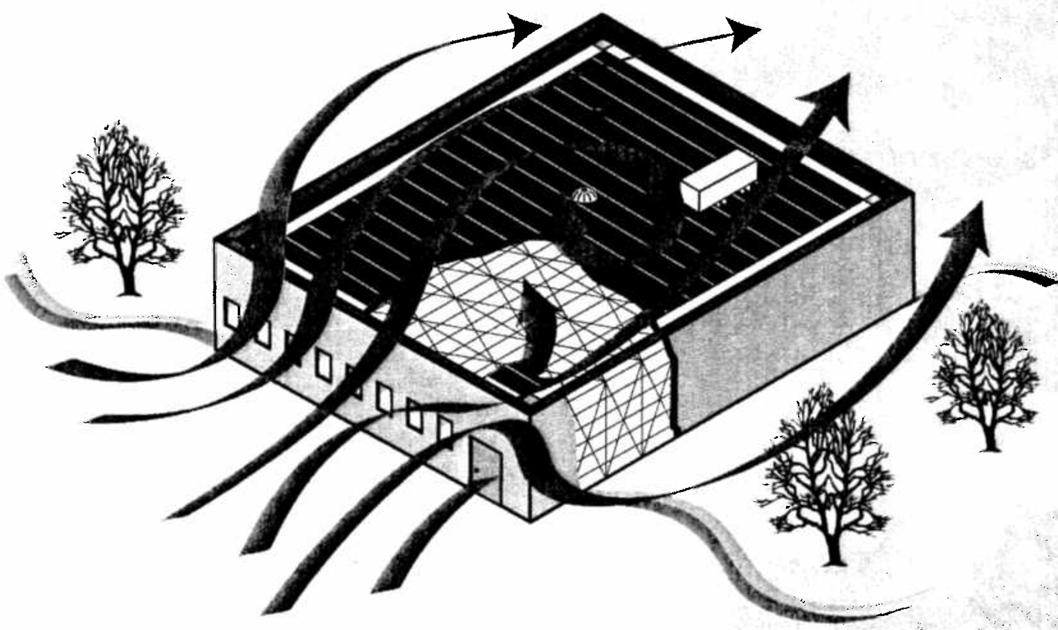

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# SOLAR DRIVEN MOISTURE IN ABSORPTIVE CLADDINGS: MYTH OR REALITY?

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## INTRODUCTION

Adhered manufactured masonry veneers, which are directly attached to a substrate via mortar without a drainage or ventilation gap, are becoming increasingly popular in residential and light commercial construction. In typical applications the masonry veneer is installed over a bed of lath-reinforced mortar over a water-resistive barrier (i.e. building paper or polymeric membrane).

Numerous moisture problems and failures have been reported (Rymell 2007) for such applications over wood- or steel-framed walls. Inward solar vapor drives and the lack of a well-defined drainage and ventilation space have been implicated as the root causes for these moisture problems. In some cases a small drainage space is provided by a second layer of building paper with appropriate flashing and weep holes at the bottom. However, the control of inward vapor drives is more problematic, as two layers of building paper are highly vapor permeable, and both the mortar and the masonry unit can store significant amounts of rain water. During sunny weather following rain, water vapor stored in the masonry can be driven into the sheathing and into the stud-bay, resulting in condensation on air-conditioned interior surfaces and wood decay. This problem can be intensified in air-conditioned buildings with vapor retarders on the interior side of the insulation (polyethylene vapor retarder, vinyl wall paper, etc.).

One proposed solution to avoiding the risk of such moisture problems with adhered manufactured masonry veneers is the use of a vapor impermeable air-gap membrane. A rigid polyethylene membrane with a 3-dimensional structure (dimples and grooves) controls inward vapor drives, but will also allow water vapor in the stud-space or wood framing to dry to the exterior.

## EXPERIMENTAL PROGRAM

This paper reports on field measurements collected from over a year of monitoring two types of wood-framed walls side-by-side with manufactured adhered stone veneer, one with an air gap membrane and another installed following standard practice. The objective of this study was to compare adhered veneer walls using a rigid polyethylene dimple sheet in place of building paper as the water-resistive barrier. No penetrations through the test assembly were installed with the goal of reducing bulk rain penetration problems. Each type of wall was faced either north or south in a test hut located in South-western Ontario. The walls were constructed with OSB sheathing, R 19 fiberglass batt insulation, an interior poly vapor barrier, and drywall finish and air barrier. The temperature, RH, and the wood moisture content was measured in more than a dozen locations in each wall and recorded on an hourly basis. Details of the instrumentation can be found in Straube et al (2002). Monitoring began in July, 2007.

## BOUNDARY CONDITIONS

The interior and exterior climatic conditions were both measured during testing. The exterior temperatures and relative humidity are shown below in Figure 1.

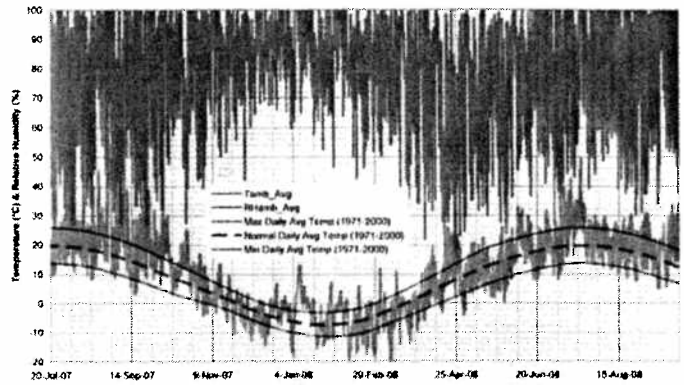


Figure 1: Exterior Temperature and RH during testing.

The interior climatic conditions were controlled during testing; the relative humidity was kept between 40% and 50% for most of the testing period.

The drying potential of the two different wall design approaches was evaluated using a wetting apparatus to inject a known volume of water on the backside of the OSB sheathing. To simulate a small but steady leak into the stud space (i.e. from improper flashing or leaky window) 1.5 ounces of water were injected for 4 days each morning and evening.

## TEST RESULTS AND ANALYSIS

In order to allow for comparison of the performance of adhered manufactured stone veneer walls with a polyethylene air-gap membrane or with two layers of conventional building paper, the moisture content of the sheathing, moisture content of the framing as well as the relative humidity in the stud space were analyzed.

Figure 2 shows the sheathing moisture contents of the north orientation walls. The measured data shows that the moisture content in the sheathing was higher in all three sensor locations in the test wall with building paper than in the wall with the dimpled air-gap membrane. The moisture content in the sheathing was greater than 16%, and approached 20% during the month from October to May during the test period. The sheathing moisture contents exhibited on the south oriented test walls also showed improved moisture performance due to the air gap membrane.

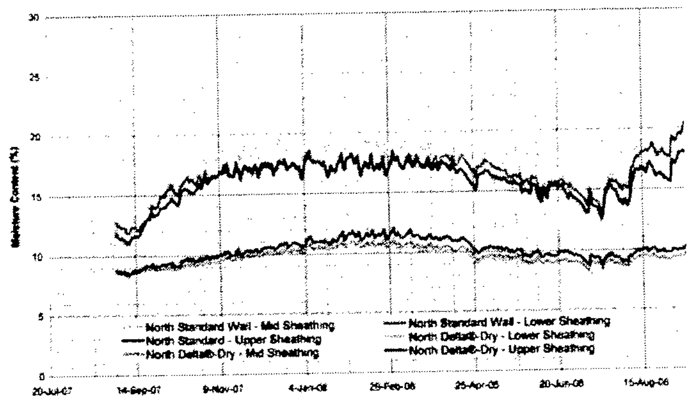

Figure 2: Sheathing moisture content comparison (north orientation).

Figure 3 shows the analysis of the intentional wetting event. All sensors show a response to the water injection within 24 hours.

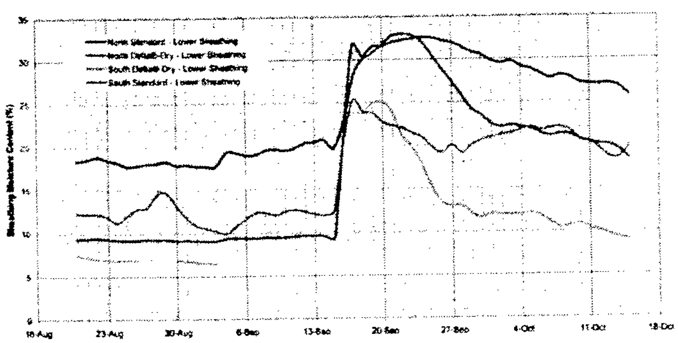

Figure 3: Sheathing moisture content after intentional wetting.

On the north orientation both test walls show a maximum moisture content of 33% approximately one week after the first injection. On the south orientation both walls show a maximum moisture content of 25% approximately 3 days after the first injection. The wall with building paper on the north orientation remains above 26% moisture content after four weeks after the wetting event, while the wall with air-gap membrane dried down to 22% within two weeks. The drying rate than changes and the wall continue to dry more slowly. The results on the south orientation walls are similar. The analysis of the above results convincingly shows that the air-gap provides ventilation for outward drying at a much faster rate than with traditional building paper.

Figure 4 shows that during the summer months the moisture content in the framing of standard wall on the south orientation was significantly elevated. The elevated moisture content levels in the framing indicate that the relative humidity in the stud-cavity is likely also elevated. The air gap membrane walls on the north and south orientation show no significant increase in moisture content caused by inward vapor drives. Note that no readings are plotted during the winter months since the framing is too dry for the sensors to accurately measure.

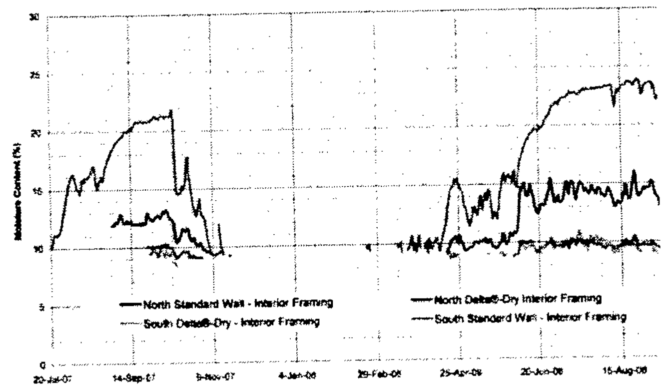

Figure 4: Framing moisture content comparison.

**CONCLUSION**

The results show that inward vapor drives and summer condensation can be a real concern for typical adhered veneer walls, even when installed in cold climate locations with fully functional drainage.

The air gap membrane controlled inward vapor drives well and resulted in lower wood sheathing moisture contents at all times than the comparison walls with standard building paper. During normal operation, the standard walls with building paper on the north and south orientation did both cross the generally accepted moisture content threshold where moisture related problems may occur.

The wall with air-gap membrane behind the adhered manufactured stone veneer also exhibited faster outward drying after an intentional wetting event of the OSB sheathing than the walls with standard building paper. This is caused by the air-gap which enables ventilation that transports the moisture out at a faster rate than diffusion in the standard walls.

**REFERENCES**

Rymell, R. (2007): "Development of a Rainscreen System for Adhered Manufactured Stone". *Proc. 11th Canadian Building Science & Technology Conf.*, Banff, March 2007.

Straube, J., Onysko, D., Schumacher, C. (2002): "Methodology and Design of Field Experiments for Monitoring the Hygrothermal Performance of Wood Frame Enclosures". *Journal of Thermal Env. & Bldg. Sie.*, Vol. 26, No. 2, Oct. 2002.