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Controlling Vapor Flow in Mass Walls in Hot-Humid, Mixed Humid and Warm Marine Climates

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Stucco is often installed directly over concrete masonry units (CMUs) that are insulated on the interior. In cold climates, the concern is interior vapor migrating outward. In hot-humid, mixed-humid, and warm marine climates, the concern is exterior vapor migrating inward. In dry climates, exterior vapor migrating inward is typically not an issue – except where moisture of construction is not managed, such as cast-in-place concrete walls that are "finished" while the concrete is "too" wet and impermeable interior finishes are installed, such as vinyl wall coverings.

The focus of this paper is interior* insulation options for stucco over CMUs** constructed in International Energy Conservation Code (IECC) Climate Zones 1A, 2A, 3A and 3C. In Climate Zones 4 and higher a different approach than described here is required. In cold climates inward vapor drive is significantly less than in hot-humid and mixed-humid climates and is coupled with outward vapor drive.

The focus of this paper is also on stucco claddings rather than metal claddings. Metal claddings are unable to store moisture and are typically "drained" - "non-reservoir" drained claddings. "Non-reservoir" drained claddings are straightforward to address – only a drainage gap or space or "screen" coupled with a fluid-applied exterior water control layer is required. If rainwater is not absorbed and drained on the exterior portion of the wall assembly very little water is available for inward vapor flow (Figure 1).

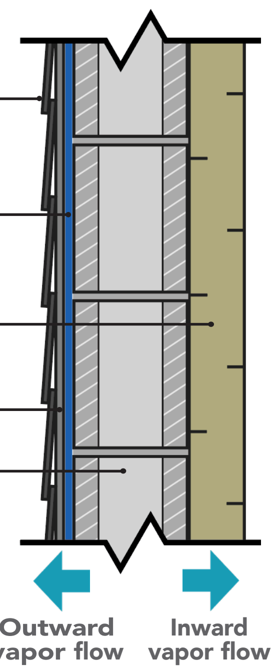

Figure 1: Metal Claddings - "Non-reservoir" drained claddings only require a drainage gap or space or "screen" coupled with a fluid-applied exterior water control layer. If rainwater is not absorbed and drained on the exterior portion of the wall assembly very little water is available for inward vapor flow.

* If CMU "block walls" are insulated on the outside, inward vapor drive is a minor concern. The "vapor control layer" is installed on the outside of the CMU "block walls" when using such systems. It is not always possible or practical to insulate on the outside. Cost, tradition, hurricane performance and skilled trades are factors that need to be considered.

** In this wall assembly the "water control layer" is the exterior painted stucco. The "air control layer" is also the exterior painted stucco. One "vapor control layer" is the exterior paint on the stucco. We shall soon see that we will need an additional "vapor control layer" on the inside of the CMU "block wall". The "thermal control layer" will be the interior insulation.

Not all interior insulations perform the same way on the interior of a stucco clad CMU "block wall". Some insulations are able to control or limit interior vapor flow, while other insulations are not able to control or limit interior vapor flow. Such insulations require additional components or layers to control or limit interior vapor flow.

Stucco renderings on block walls leak. There are always pathways for rainwater entry. The walls get wet. The key issue is how wet do they get and how do they dry? Can the wetting and drying be controlled? They tend to dry in both directions. And the drying can be managed depending on the material choices.

Figure 2 describes the typical rainwater wetting mechanism. Rainwater enters the stucco. Rainwater is absorbed by the stucco. Rainwater also gets past the stucco into the block mass wall. Rainwater is absorbed by the block mass wall. Rainwater drains down the block wall cavities.

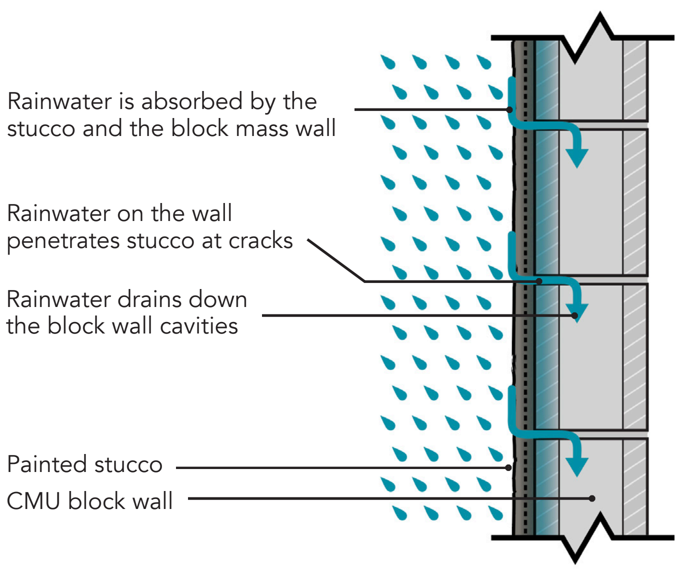

Figure 2: Water Pathways - Rainwater enters the stucco. Rainwater is absorbed by the stucco. Rainwater also gets past the stucco into the block mass wall. Rainwater is absorbed by the block mass wall. Rainwater drains down the block wall cavities.

The issue is complicated when air conditioning and solar radiation are taken into account. Vapor flow, excluding air transport, is due to a temperature gradient ("warm to cold") and due to a concentration gradient ("more to less"). In a rain wetted stucco CMU "block wall" the water in the exterior stucco and exterior side of the block wall is at a higher concentration than the water vapor in the outside air.

When the sun is shining on the wall the water in the exterior stucco and exterior side of the block wall is also warmer than the water vapor in the outside air. As such there is outward vapor flow (Figure 3).

The interior is also air conditioned. Air conditioners are also dehumidifiers. So the water vapor in the interior air is colder than the water in the exterior side of the block wall. The water in the exterior side of the block wall is also at a higher concentration than the water vapor in the inside air. As such there is also inward vapor flow (also Figure 3).

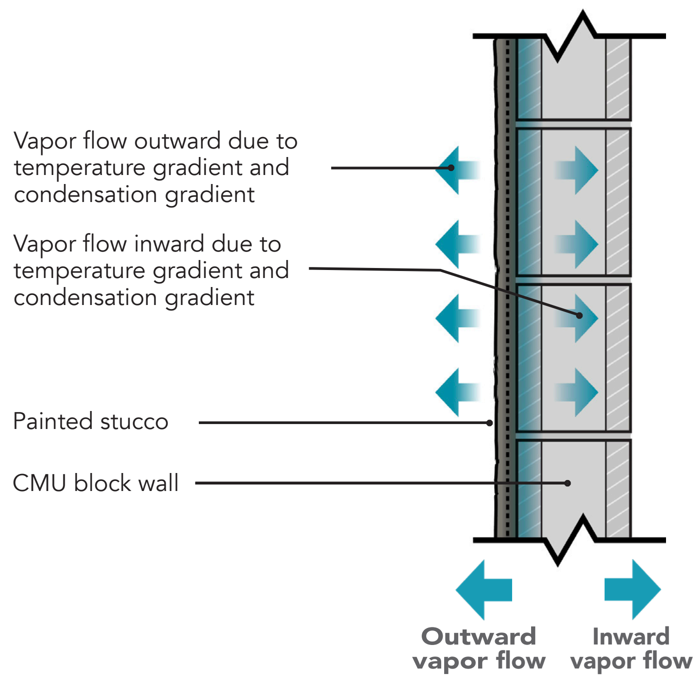

Figure 3: Vapor Flow Excluding Air Transport – Vapor flow outward and inward due to temperature gradients and concentration gradients.

Several steps should be taken to address these moisture flows. The first is to reduce the rainwater absorption by painting the stucco or by adding polymer modification to keep it from absorbing water. However, when stucco is painted or when polymer modification is used, it is important not to reduce the stucco and walls ability to dry to the exterior.

With respect to paint the paint should be "liquid water closed" but "vapor open" – hydrophobic and vapor permeable. The hydrophobic coatings are quite common. However, it is difficult to manufacture a hydrophobic coating that is both vapor permeable and able to span cracks in the stucco. When paint is formulated to be able to span cracks the paint typically becomes less vapor permeable.

If the paint on the stucco is too impermeable it bubbles, blisters and peels (Photograph 1). The paint on the stucco needs to be greater than 10 perms "wet cup" or it will bubble, blister and peel.

Photograph 1: Impermeable Paint - If the paint on the stucco is too impermeable it bubbles, blisters and peels. The paint on the stucco needs to be greater than 10 perms "wet cup" or it will bubble, blister and peel.

The second step to address moisture flows is to control the rate of inward vapor flow so that it does not damage interior finishes or cabinets installed on the interior of exterior walls. Inward vapor flow can be "throttled" – slowed down – by the permeance of the interior insulation (Figure 4).

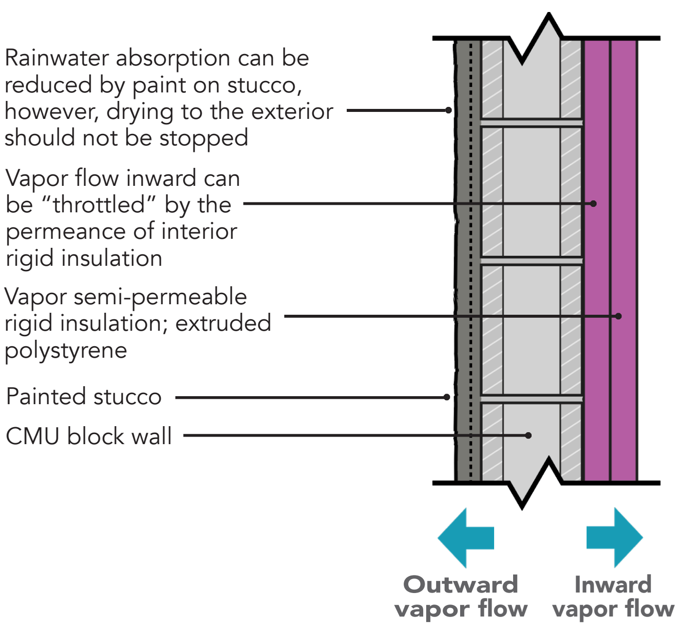

Figure 4: "Throttling" Inward Vapor Flow - Reduce rainwater absorption by painting stucco with a paint that is "liquid water closed" but "vapor open" – hydrophobic and vapor permeable - greater than 10 perms "wet cup". Reduce inward vapor flow - "throttled" – slowed down, but not stopped – by the permeance of the interior insulation.

Extruded polystyrene (XPS) rigid insulation can be installed on the interior of stucco clad CMU "block walls". The inward vapor flow rate through the rigid insulation out of the CMU block wall needs to be "slower" than the vapor flow rate through the interior lining – painted gypsum board. Painted gypsum board is typically greater than 10 perms "wet cup". The extruded polystyrene is about 1 perm "wet cup" when it is 1 inch thick (approximately R-5). Expanded polystyrene (EPS) as well as closed cell spray polyurethane foam (ccSPF) can be used.

The interior vapor flow does not need to be completely stopped – but could also be completely stopped if the interior insulation controls condensation at the interface of the interior side of the CMU and the interior insulation. If the inward vapor flow is completely stopped with a vapor barrier such as foil faced polyisocyanurate rigid insulation the thermal resistance of the foil faced rigid insulation should be R-5 or greater. With R-5 or greater the temperature of the "condensing surface" is controlled ("warmed") and condensation is limited.

Rigid, semi-rigid and low density mineral wool, such as ROCKWOOL stone wool insulation, fiberglass batts and cellulose insulation are vapor open and can be used if the inward vapor flow out of the CMU "block wall" is "throttled" or "slowed" or "reduced". An interior coating can be installed on the interior surface of the CMU "block wall" (Figure 5).

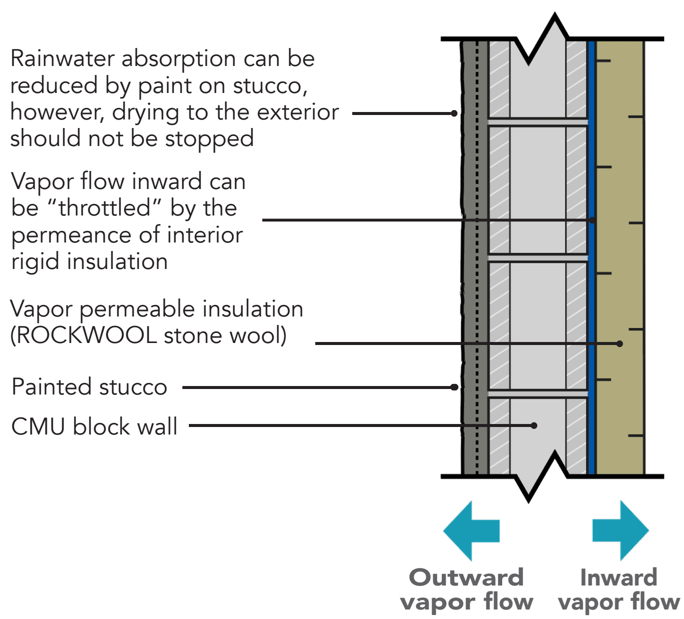

Figure 5: Interior Coating "Vapor Throttle" - You can install an interior coating on the interior surface of the CMU block wall. This interior coating should be less than 5 perms "wet cup" but more than 1 perm "wet cup".

This interior coating should be less than 5 perms "wet cup" when vapor open insulation such as cellulose, fiberglass and mineral wool are installed on the interior of the wall (Figure 6 and Figure 7).

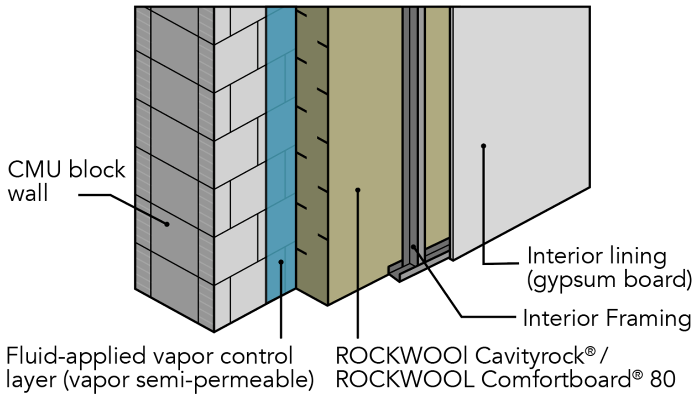

Figure 6: Rigid Mineral Wool/Rigid Fiberglass Insulation - You can use vapor open insulation such as mineral wool and fiberglass board insulation on the interior of the wall in conjunction with an interior coating acting as a "vapor throttle". Note the continuous rigid insulation approach. No thermal bridge. The framing is on the inside of the continuous rigid insulation.

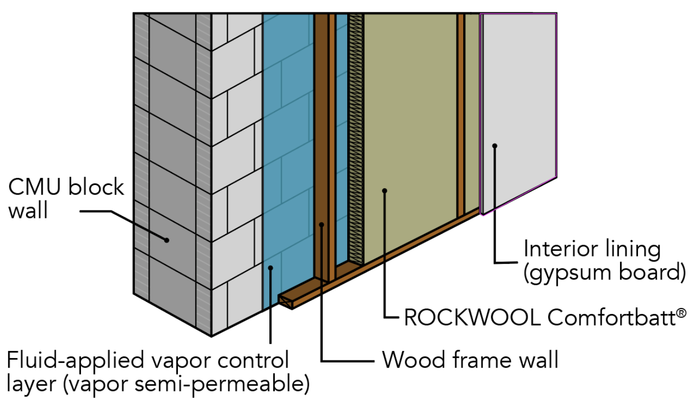

Figure 7: Cellulose, Fiberglass and Mineral Wool Cavity Insulation - You can use vapor open insulation such as cellulose, fiberglass and mineral wool cavity insulation on the interior of the wall in conjunction with an interior coating acting as a "vapor throttle".

With these approaches no vapor closed interior wall coverings such as vinyl wall coverings or alkyd paints should be applied or installed. Fabric wall coverings can be used as they are vapor open.

In addition, it is always recommended that a "seat" is installed in concrete slab at the perimeter to handle rainwater draining down the CMU block cores (Figure 8). The "seat" acts as flashing directing the rainwater to the exterior of the wall.

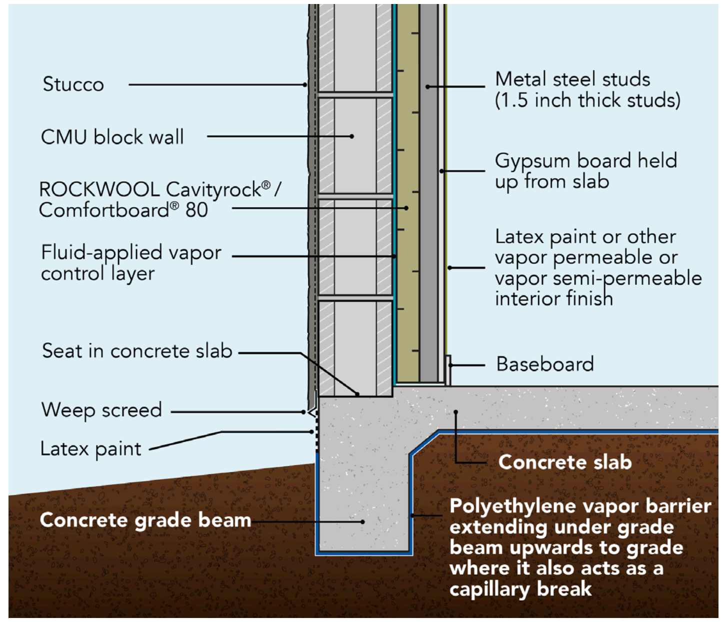

Figure 8: Concrete "Seat" - It is always recommended that a "seat" is installed in concrete slab at the perimeter to handle rainwater draining down the CMU block cores. The "seat" acts as flashing directing the rainwater to the exterior of the wall.

Rainwater entry at window openings also needs to be controlled. The window opening should be drained to the exterior (Figure 9, Figure 10 and Figure 11).

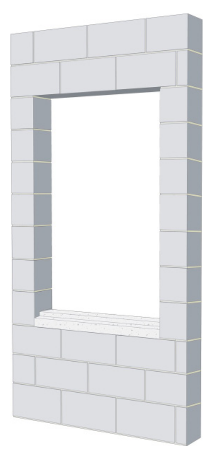
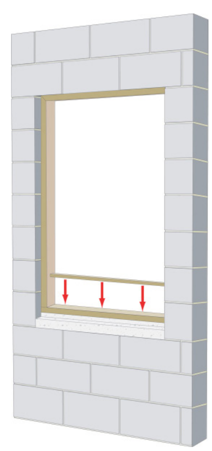
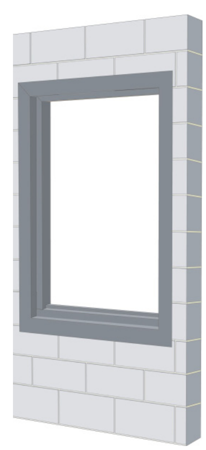

Figure 9 (Left): CMU "Block Wall" Window Rough Opening. Note the "tiered" concrete rough opening sill.

Figure 10 (Center): CMU "Block Wall" Window Rough Opening. Note the wood "rough buck' lining with a "back dam" wood strip.

Figure 11 (Right): CMU "Block Wall" Window Rough Opening. Note the fluid applied coating around the entire perimeter of the rough opening.

A fluid applied coating should be installed around the entire perimeter of the rough opening (Photograph 2). At the head of the window opening the fluid applied coating is applied over the "wood buck" at the underside of the CMU block at top of the window rough opening. When this is coupled with a concrete lintel the assembly acts as a "dam" and a "gutter" to prevent water from draining into the window from the wall at top of the window opening.

Photograph 2: Fluid Applied Flashing - You absolutely must use a fluid applied coating around the entire perimeter of the rough opening.

Finally, if the CMU is replaced with cast-in-place concrete or precast concrete (Figure 12) the concrete itself acts as the "vapor throttle". It is typically not necessary to add an interior vapor throttle to the interior if the interior insulation and interior finishes are vapor open. However, there is a significant amount of moisture in the concrete when it is placed. This moisture needs to dry to both the exterior and the interior prior to interior finishing.

Alternatively, the inside of the concrete can be lined with a coating to "throttle" the inward flow of moisture in the concrete - less than 5 perms "wet cup" - if the interior of the wall is insulated and finished before the concrete is "dry enough". This prevents the interior finishes from being damaged as the assembly continues to dry to the interior.

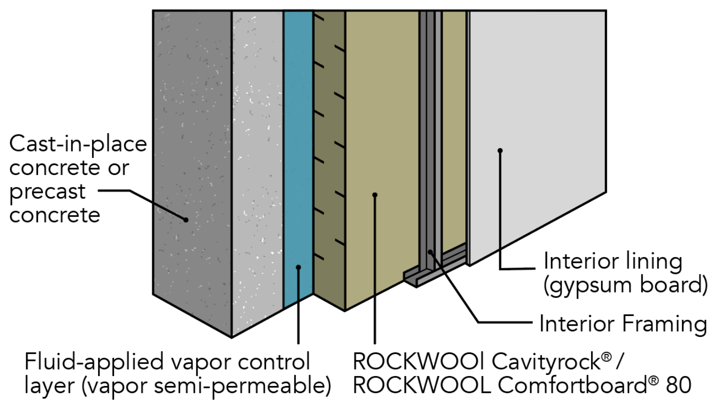

Figure 12: Cast-In-Place Concrete or Precast Concrete – Note the interior coating on the interior surface. This interior coating should be less than 5 perms "wet cup" but more than 1 perm "wet cup".

For more information about exterior wall solutions for hot-humid climates (climate zones 1-3), access **ROCKWOOL's Technical Bulletin** at rockwool.com.

To get in touch with the ROCKWOOL Technical Services team, visit **rockwool.com/north-america/contact/** or call at 1-877-823-9790

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