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MEMORANDUM

Date: February 24, 2006
From: Richard Keleher
Subject: **Porous Fill over Vapor Barrier Under Slabs on Grade**

ACI 360R is in error. I am going to crib from Joe Lstiburek's website, in his article, "Investigating and Diagnosing Moisture Problems:" I have not included the Figures; if you want to see them, go to http://www.buildingscience.com/resources/moisture/Investigating_Moisture_Problems.pdf, page 4.

"Now on to a very odd and clearly bad practice that has sometimes even been established in building codes. It is common, west of the Mississippi, to place slab foundations over a sand layer installed over a polyethylene vapor barrier. You rarely see this east of the Mississippi.

"The sand layer becomes a reservoir for water in the liquid state that enters the sand layer by gravity flow from the top, sides and bottom (Figure 6). Where does this liquid water come from? We often wet cure these slabs. We wet them from the top with sprinklers; we sometimes even pond water on top of them. We often over irrigate perimeter plantings (see above). Plumbing pipes leak. Even in the desert it sometimes rains during construction. The sources of liquid water are many. The liquid water that inevitably finds its way into the sand layer is both held in the sand layer and redistributed within the sand layer by capillarity (Figure 7). Additionally, due to capillary suction, the liquid water cannot drain out of the sand layer. The only mechanism of drying of the sand layer is upwards through the concrete slab by vapor diffusion (Figure 8).

"Moisture diffuses upwards through the top surface of the concrete slab as well as through floor surface treatments and leads to mold and other microbial contamination problems.

"The rate of wetting of the sand layer by the gravity flow liquid water wetting mechanism is several orders of magnitude greater then the rate of drying of the sand layer by the vapor diffusion drying mechanism. The sand layer becomes a water reservoir that continually supplies water for the upward flow through the concrete slab by vapor diffusion. A couple of hours of liquid water gravity wetting yields a couple of years of diffusion drying.

"Picture the sand layer as 'blotter paper' that once wetted does not let water drain out of it. The only method of drying available to the 'blotter paper' is evaporation. In the case of the sand layer the only method of 'evaporation' is upwards through the concrete slab due to the presence of the polyethylene vapor barrier under the sand layer.

"So why would anyone want to put sand over plastic under concrete? The following 4 reasons are generally cited for using a sand layer over a polyethylene vapor barriers:

1. The sand layer controls bleed water with high w/c ratio concrete slabs
2. The sand layer reduces curl with high w/c ratio concrete slabs when top-side curing is not controlled
3. The sand layer reduces plastic shrinkage cracking with high w/c ratio concrete slabs
4. The sand layer protects the polyethylene vapor barrier from punctures

"The first three reasons are based on sound technical arguments. However, each of the first three are based on the condition that the sand layer be prevented from getting wet during the construction process and beyond and are typically associated with floor slabs that are placed 'after the building is enclosed and the roof is watertight.'

"Additionally, the first three are based on the condition that wet curing such as ponding or continuous sprinkling will not occur or that joint sawing using wet methods or power washing will not occur. The first three are also conditional on slab and foundation designs that will not be sensitive to ground water wetting from local water tables and local irrigation.

"In other words, the first three reasons are based on conditions that are rarely realized in the real world.

"The fourth reason, 'puncture protection,' is based on incorrect physics. A sand layer is not necessary to protect

polyethylene vapor barriers. Vapor diffusion is a direct function of surface area. Rips, holes, tears and punctures in sheet polyethylene vapor barriers constitute a very small surface area of vapor transmission compared to the total floor slab area. If 95 percent of the surface area of the slab is protected by a vapor barrier, then that vapor barrier is 95 percent effective. This holds true only if air flow or air leakage is not occurring through the vapor barrier. Where concrete is in direct contact with the polyethylene vapor barrier this is the case. Airflow is not occurring. The concrete slab is an 'air-barrier' and the polyethylene is the 'vapor barrier' – and an effective vapor barrier even if the polyethylene has numerous punctures.

In this example the water enters the sand layer under the slab in the liquid form by gravity. The water is redistributed in the sand layer by capillarity and migrates upward by vapor diffusion.

This leads to rule number four: Never place concrete on a sand layer installed over a polyethylene vapor barrier. Always place concrete in direct contact with plastic vapor barriers. Use a low water-to-cement ratio concrete, less than 0.45, and top cure the slab with damp burlap, just like the old wise concrete types used to."