

# THINGS YOU

BY MARK J. BATES

# SHOULD KNOW



*Reroof application.*

Cellular lightweight insulating concrete roof decks have been in use for over four decades. After all this time, it is unfortunate that many professionals in the roofing industry become confused when trying to distinguish various types of lightweight insulating concrete. It's a common misconception that cellular insulating lightweight concrete has the same restrictions as aggregate-based insulating concrete systems (vermiculite/perlite).

The cellular concrete process combines a cement slurry (water and cement) and protein and/or synthetic foam solution in a special on-site batch plant to form millions of tiny air cells. The resulting product is poured in place on the roof deck. The foam keeps the cement particles in suspension around the cells until it hardens into the finished honeycomb, monolithic, concrete substrate that is lightweight but remarkably strong and durable.

Cellular lightweight insulating concrete roof decks may be used in conjunction with expanded polystyrene insulation board to achieve slopes, add thermal efficiency, and to keep excessive loads off the supporting structure. A typical installed cellular roof deck weighs from four to six pounds per square foot.

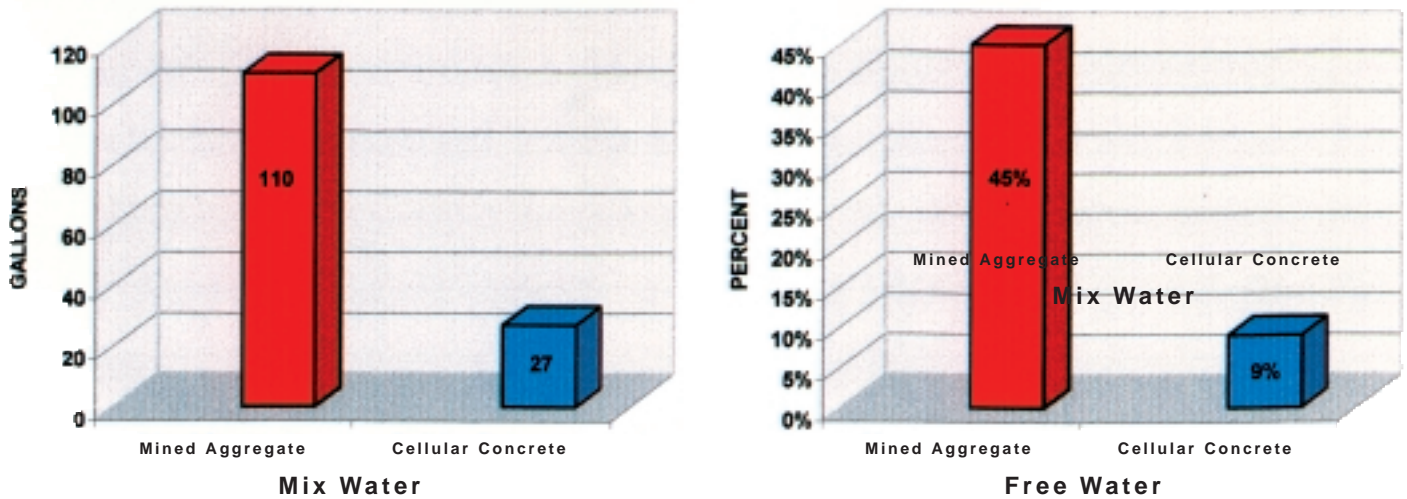
Cellular insulating concrete can be placed over galvanized metal decks, which should have a minimum gauge of 26. Cellular decks are also poured over structural precast concrete panels, poured-in-place concrete construction, and reroof applications. Cellular decks will not rot or decay; when properly installed, a cellular deck may be the last roof insulation a building owner should ever have to buy.

I am routinely asked to respond to several issues and myths within our industry. The following are questions that merit answers. You may find some of the answers surprising and quite different from articles you have read in the past. This article gives first-hand knowledge that relates to cellular concrete performance characteristics.

## **Why don't cellular concrete manufacturers require perforated or slotted metal decks?**

Moisture retained and absorbed by mined aggregates (perlite and vermiculite) has been recognized as a hindrance to the use

## CELLULAR INSULATING CONCRETE MOISTURE CONTENT COMPARISON



of insulating concrete roof decks. This is not a problem for most cellular concrete decks. Cellular concrete mix designs are batched with lower levels of mix water.

Example: Cellular concrete mix designs use as little as 27 gallons of water in a cubic yard of concrete vs. 110 gallons for mined aggregate concrete. Of the 27 gallons of water, only 9.25 percent is free water that is not used for the hydration of the cement. For mined aggregates, 45 percent is free water. This water needs to get out of the system. Slotted or perforated metal roof decks help remove this large amount of free water from mined aggregate systems. Cellular concrete is just the opposite; cellular concrete does not have large amounts of free water that need to be removed.

In recent years, however, manufacturers of cellular foam concentrates have allowed the use of a vented metal deck if the opening is at a maximum 0.50% opening—not the typical 1.50% opening used for mined aggregates. This is not to remove mix water; the reason is that many times these decks are exposed to adverse weather conditions (rain) for prolonged periods of time—weeks, even months. In this type of environment, water is sometimes allowed to enter the system. By venting the underside of the deck, it will help remove excess rainwater. The best way to keep this from happening is to begin roofing as soon as possible, typically after 72 hours.

4-Color  
Crowe Building Corp.  
Pick-up from 7/99, page 13

### How long should membrane installers wait after a rain event before proceeding with the installation of roof membranes?

For true closed-cell materials, rain on the concrete deck will not absorb water from the top down. If any moisture was absorbed, it would move from the bottom up through capillary action. An open cell would be just the opposite.

The question of how long to wait after a rain cannot be answered by establishing a waiting period based on a predetermined period of time. The decision for determining when surface conditions are favorable for membrane application after a rain can easily be made by the membrane installer and made as a result of simple observation. The membrane installer may use the following guideline to base his field decisions on.

After a rain, the deck surface must be allowed to return to its natural color. With warm temperatures and proper sun and wind conditions, this will happen rapidly to the general field area of the deck. Shadowing may persist slightly longer along cracks. These observations also apply to morning dew, frost, fog, or drizzle conditions. Membrane application should not begin until discoloration along cracks no longer appears. Should shadowing along cracks persist at deck low points, a core cut should be made to determine if any standing water exists within the EPS. If water is observed in core cuts (usually only as a result of very heavy or prolonged periods of rain), it must be removed by vacuuming. The



roofing contractor should contact the roof deck contractor and/or foam concentrate manufacturer for vacuuming instructions and procedures. Standing water (found in core cuts) should always be removed. Once removed it will not affect the roof or roof deck performance. Water removal from under the deck and membrane installation may occur simultaneously. Any small amount of moisture left in the system will be used in the hydration process. This method of removal may also be used on existing cellular decks.

## Does Cellular Concrete Crack?

Whether it's a mined aggregate or cellular concrete, you will experience some cracking. Cellular mix designs use large amounts of cement and, as such, are subject to the drying effects of wind and sun. In certain climatic situations, installations are subject to surface cracking. The cracking is a result of rapid drying of the top surface. These surface cracks should not have any adverse consequences on the system. Standard rigid insulation board systems allow for 1/4" openings at all butt ends of board. In most cases, cracks found in cellular decks are less than 1/4" in size. Sealing of concrete shrinkage cracks should never be considered. Although the principle of sealing roof deck shrinkage cracks with mastic is understood, the result of the practice is questionable. It has been the author's experience, even with the best efforts of a roofing contractor to seal a deck system, that water intrusion into cracks can still occur as a result of rain during the construction period.

Given the probability that water can enter into the cracks, one must consider how the water will exit the system when weather conditions improve. Water that enters a shrinkage crack will soon evaporate upon the return of improved weather conditions. However, water which finds a way into shrinkage cracks sealed with mastic will be inhibited from evaporating when weather conditions improve and will likely remain undetected and roofed over. This moisture is now trapped near the surface of the insulating fill, below the base sheet. This is the portion of the roof system most affected by the loads of daytime heating. In the presence of ample heat, the moisture is likely to transform into vapor, which can be a potential problem to the membrane system.

*Where dripping occurs and the water evaporates, a crystalline residue is left.*

## Can anything be done to minimize this surface cracking?

Curing is one of the last and perhaps the most neglected step applicators fail to perform. Proper curing promotes the hardening or hydration of freshly-cast concrete. Hydration is the chemical process that ultimately binds cement particles into hardened concrete. Prevention of the loss of water from cellular concrete systems is important not only to the loss of strength, but to increased permeability and plastic shrinkage (a reduction in drying shrinkage cracking). Curing compounds should be used in place of three-day continuous wetting of the concrete. The advantages of curing compounds are that they are easy to apply, cost-effective, and alleviate the need for continuous monitoring or application, as would be required for continuous wetting of the concrete.

Proper curing is of particular benefit where the system will receive a fully-adhered membrane. The attachment and subsequent wind uplift resistance of the membrane system are contingent on the surface of the concrete deck. Consult with a foam concentrate manufacturer for proper curing compounds.

## Should fully-adhered single ply be installed over cellular concrete?

One of the best advantages for choosing cellular concrete is its compatibility with a variety of roof membrane applications. One just happens to be fully adhered systems. Because cellular concrete has such a low moisture content, it lends itself to this type of application. Fully-adhered systems have been successfully installed over cellular concrete decks for fifteen years. Whether the assembly is over a metal deck, precast, concrete, or reroof





*Aggregate-based material with inadequate bond at slurry coat.*

substrate, the system performs.

There have been advancements made to fully-adhered systems when applied to cellular lightweight. The main change is the fleece-back membranes. The fleece is a more forgiving membrane that allows for small troweling imperfection, construction traffic, or slight dimples from a light rain during construction. It also allows vapors to dissipate throughout the sheet. Adhesives range from contact adhesives to water-based adhesives and urethane foam.

Fully-adhered systems over cellular concrete have performed quite well in Factory Mutual testing. Approval ratings over concrete substrate and roof-over construction are as high as FM 1-540; and over metal deck substrates, ratings are FM 1-195. As with all systems, common sense must be used when applying solvent-based adhesives and base sheet attachments to cellular decks. Don't apply them during fog, drizzle, or when there is dew on the roof deck.

Because of the wide variety of roof membranes, cellular foam concentrate manufacturers have no standard requirements for venting of above-deck roof covers. Most would refer the decisions on venting to the membrane manufacturer.

## **My roof deck is starting to drip and is leaving a white residue.**

Fewer than 1% of all cellular roof decks drip. At start-up, some cellular decks begin to drip at a very slow rate, typically occurring below at the deck surface where the form deck sheets lap on the steel joist. In these areas where the dripping occurs and the water evaporates away, a crystalline residue remains. In places where the drip water accumulated prior to completely evaporating away, the solution acquires an oily texture but remains water-soluble.

Any Portland cement concrete system subjected to water percolation—a process known as *lixiviation*—will produce solutions known as *lixivium*. The primary soluble constituent of a *lixivium* from a concrete system will be calcium hydroxide. Once the water vehicle of the solution has evaporated away, the calcium hydroxide will form a crystalline residue typical of that observed on the underside of the roof deck. In time, the calcium hydroxide will combine with carbon dioxide from the atmosphere, hardening the residue into calcium carbonate. The pH of the *lixivium* dripping from the deck system is likely high alkaline (pH = 11.5 +). This is within the range for which the galvanized form deck is designed to perform without corrosion. A

discoloration of the galvanized coating will occur where the lixivium is present. This is as a result of a process known as galvanic action.

On the topside of the form deck, galvanic action is an important part of the bond development between the cementitious fill and the galvanized form deck. This bonding, of course, allows the roof deck to perform as a composite system. If you are experiencing dripping in a cellular deck, the source of moisture involved in the interior dripping would have been introduced from an outside source, such as rain during construction.

Not properly removing rain or other accumulated water before the membrane was installed could be part of the problem. The only option for this moisture to vent is at the underside of the roof deck once the roof membrane is installed. Generally, this underside venting process is not problematic because the operation of the HVAC system serves as transportation to disperse, by evaporation, moisture venting to the building interior. However, disruption or intermittent operation of the building's HVAC or ventilation system can cause the moisture venting rate to exceed the rate of evaporation and accordingly, droplet formation can occur. It is important to note that construction moisture is of a finite supply, provided that the roof system is free from leaks.

Therefore, the rate of venting will decrease as the system's moisture content falls and equilibrium is achieved. Another aggravating factor, particularly in Southern locations, is vapor drive. Due to the regional climate, downward vapor pressure scenarios (vapor drive from exterior to interior) may exist year-round. This condition, combined with the aforementioned interrupted operation of the building's HVAC or ventilation system, can cause droplet formation. While it is understood that the interrupted operation of the HVAC is a matter of energy cost savings, this practice may not be practical during the building's start-up period. It may be necessary to conduct a period of proper interior environmental management while moisture equilibrium is being obtained in all of the construction materials used to create the structure.

## Are all foam concentrates the same?

Material and procedural differences exist between foam concentrate manufacturers. For example, not all cellular concrete companies produce a closed cell material. When exposed to adverse weather conditions (rain), a closed cell product will perform quite differently. Not all foam concentrates have the ability to suspend material (cement and water). Unstable foams will result in collapsed air cells. When air cells collapse, this could affect the system's performance. A loss in insulating value and uplift value could occur, as well as water intrusion.

Some manufacturer approvals require bonding agents to be applied to both sides of the EPS insulation boards and the metal deck substrate. Other FM approvals require the metal deck to be washed down with vinegar. Others require special shaped insulation boards. Application procedure differences also exist among foam manufacturers. Some require the applicator, after placement of the insulation board, to begin the 2" topping pour within four hours. Others require the insulation board to be allowed to set overnight before installing the top 2". For this application, there is not a maximum time limit in which embedded EPS

board must be covered by a topping pour of cellular concrete. EPS insulation boards should be placed in a slurry coat of fresh cellular concrete typically within thirty minutes of placement. The boards should always be placed in a staggered, "running-bond" pattern. The 2" topping should be placed on top of the insulation at such time as adequate bond has developed between the insulation and the substrate.

Expanded polystyrene board—particularly in thicknesses of two inches or more—has a tendency to float to the 2" topping surface if there is not an adequate bonding of the polystyrene board to the slurry coat. In most cases, adequate bonding develops overnight. Mined aggregates typically install the 2" topping within four hours. One of the problems with this application is that the slurry coat has not had adequate time to set.

Example: A typical crew is made up of five to seven workers. When freshly-laid insulation boards are walked on, the slurry coat bond becomes disturbed, leaving an inadequate bond. This would be like laying a concrete block in a bed of mortar and then, four hours later, lifting the block out of its slightly-set bed of mortar, then allowing the block to sit back down in the set mortar. The block is not going to perform as well as one that was left alone, allowing the mortar to properly bond to the block.

To aggravate this situation even more, some manufacturers of mined aggregate require the insulation board to have slots throughout the EPS insulation boards. The slots are provided to allow the large volume of free mix water to go downward. When this free water comes in contact with the slurry coat, the slurry coat is unintentionally washed away, leaving no bond. The board does not float but remains at the bottom of the substrate due to the weight of the mined aggregate. If the insulation board has an inadequate bond, one will experience a loss in uplift and diaphragm values.

Various manufacturers have certain specifications to accommodate their product approvals. If any questions arise, contact the manufacturer for clarification and recommendations. This article was intended to provide the reader with the insight necessary to properly understand cellular concrete systems. Ask your roof membrane manufacturers about application over cellular concrete. ■

## ABOUT THE AUTHOR

**Mark J. Bates** is vice president for Celcore Incorporated, located in Black Mountain, NC. He has 15 years experience in the cellular concrete industry and has worked in numerous aspects of the manufacturing and contracting business. Celcore is the manufacturer of a foam concentrate. Mark's company is unique in the roof deck business because it is not only a manufacturer, but has also been an on-site applicator of its own product for over 35 years.



**MARK J. BATES**