

# LIGHTWEIGHT INSULATING CELLULAR CONCRETE:

## A SEAMLESS ROOF DECK INSULATION

BY LEO A. LEGATSKI

**H**ere is a secret that has been around for many years—the use of lightweight insulating cellular concrete for roof decks in both new construction and reroofing applications. Although cellular concrete insulating roof decks have been applied for more than forty years, many in the construction industry are not aware that cellular concrete is different from expanded aggregate concrete.

Literature has been written about lightweight insulating cellular concrete roof decks detailing the characteristics, properties, application process, and appropriate uses for the material. In this article I will discuss lightweight insulating cellular concrete as the material of choice for roof decks.

### BACKGROUND

Insulating concrete roof decks come in two basic types—produced with either cellular concrete (preformed foam) or with expanded aggregate concrete (perlite or vermiculite). Although portland cement and water are common to both of these insulating concretes, there are significant differences in handling and final product characteristics.

Cellular concrete is produced by blending a pre-

formed foam of a thick, rich consistency (similar to shaving cream in appearance) into a cement/water slurry. The water/cement ratio of cellular concrete (0.50 to 0.60) is similar to that of regular concrete. This ratio may also be expressed as 5 to 6 gallons of mix water per sack of cement.

Expanded aggregate concrete is produced from expanded minerals such as perlite or mica. When these minerals are expanded by heat, the resulting open structure has a high affinity



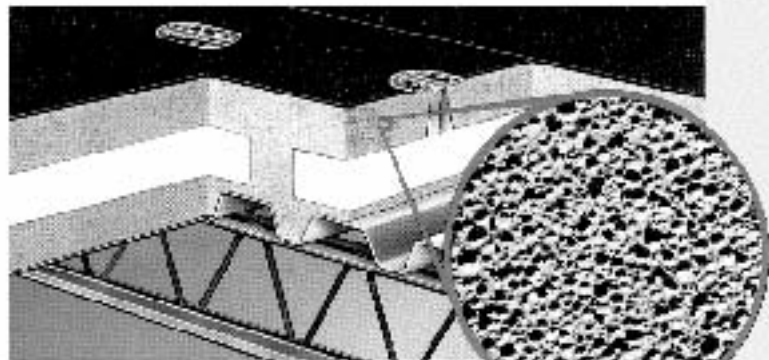
*Workers apply lightweight insulating cellular concrete.*

for water. Thus, the cement/water slurry for expanded aggregate concrete requires three to four times more mix water than the cellular concrete slurry.

Both cellular concrete and expanded aggregate concrete are lighter in weight and lower in density than regular concrete. However, the in-place properties and roof deck characteristics are different due to the mix water requirements of each material.

The designer, specification writer, and consultant must understand the differences between cellular concrete and expanded aggregate concrete. In general terms, cellular concrete is typically lighter (cast at a lower density), stronger (more cement and having a lower water/cement ratio), and contains significantly less water under normal conditions than expanded aggregate concrete. These differences may be summarized in the following table.

	<b>Cellular Concrete</b>	<b>Expanded Aggregate Concrete</b>
Mix Water/Cement Ratio	0.50 - 0.60	1.50 - 2.00
Cast Density	36 - 42 pcf	55 - 65 pcf
Air Dry Density	30 pcf +/-	45 pcf +/-
Oven Dry Density	25 - 30 pcf	25 - 30 pcf
Compressive Strength	200 psi	125 psi



*Bubble detail shows cast cellular concrete sandwiched around expanded polystyrene EPS foam insulation board.*

Most likely, the reason that designers, specification writers, consultants, and roofing manufacturers confuse these two materials is that they mentally lump them together as "insulating concrete." Much of the literature incorrectly characterizes "insulating concrete" as containing excess moisture and states that it should not be used in many roofing systems due to this high water content. Lightweight insulating cellular concrete roof decks do not have a high water content and do not contain excess moisture.

Modern cellular concrete systems today usually are a combination of cast cellular concrete sandwiched around expanded polystyrene (EPS) foam insulation board resulting in low weight and high insulating value (*see sketch*).



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## THE IDEAL INSULATION

Over the years, various people have detailed the characteristics for an ideal roof insulation. These characteristics are included in the National Roofing Contractors Association (NRCA) Roofing Manual—4th Edition. Let's review the characteristics of lightweight insulating cellular concrete roof decks in light of these criteria.

- **Compatibility with Bitumen and Other Adhesives**—It would be able to withstand the effects of being in contact with adhesives, solvents, and hot bitumen at the application temperatures required for installation of the roof membrane.

Cellular concrete is an inert material that protects the sandwiched expanded polystyrene (EPS) insulation board from adhesives, solvents, and hot bitumen with a minimum 2" thick cover.

- **Impact Resistance**—It would have strength, rigidity, and a density high enough to resist impact damage.

Cellular concrete, with a density of 30 pcf, is stronger than insulation board and resists impact damage during construction and the service life of the membrane. This difference between cellular concrete and rigid insulation board is readily apparent from just walking on these decks.

- **Fire Resistance**—It would be non-combustible and would comply with the requirements of insurance underwriters and building codes.

Cellular concrete provides a Factory Mutual Class I and UL Class A Fire Rating with over 50 systems listed in the UL Fire Resistance Directory. Furthermore, since cellular concrete fills the flutes on steel deck systems, fireproofing the underside of the steel decking is not necessary. Rigid insulation board roof decks require underside fireproofing of the steel deck for many building code classifications.

- **Moisture Resistance**—It would resist the effects of moisture vapor and free water without degradation over the life of the building.

Cellular concrete roof decks provide positive slope-to-drain that is cast-in-place during construction. As a result, water will not pond on the deck to become a source of membrane degradation. Cellular concrete with its discrete cell system does not become soft and mushy if exposed to water as does some rigid insulation board.

- **Thermal Resistance**—It would have a low thermal conductivity (k-value) so that the highest possible thermal resistance (R-value) can be achieved in the thinnest possible piece of material.

EPS insulation board is sandwiched within the cellular concrete roof deck and provides most of the insulation for the roof deck system. The cellular concrete acts as an insulation protection as well as a heat sink to moderate membrane temperatures. This reduces thermal shock to the roofing membrane that may occur with high R-value rigid insulation board systems.

- **Stable k-Value**—The k-value would remain constant and would not drift with age (i.e., the insulation would not lose thermal resistance over time).

Both cellular concrete and the protected EPS insulation board have stable k-values. Depending on the type of material, some rigid insulation board roof systems have a drifting k-value over time.

- **Attachment Capability**—Its surfaces would accommodate secure attachment. Also, its resistance to moisture absorption would not impair its physical properties and attachment capabilities.

The base sheet of mechanically-attached roofing membranes is nailed directly into the cellular concrete with the built-up or modified bitumen membranes applied in a normal fashion to this base sheet. Fully-adhered systems may be installed a few days after the cellular concrete deck is cast. These decks do not have the numerous joints that occur with rigid insulation board systems.



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- **Dimensional Stability**—It would be dimensionally stable under varying temperature and moisture conditions.

Monolithic cellular concrete and sandwiched EPS insulation board is a dimensionally stable system in the presence of varying temperature and moisture conditions. Rigid insulation board systems have joints that may open under changing environmental conditions.

- **Component Capability**—It would be formulated to be compatible with the other components of the roof assembly.

Insulating cellular concrete roof deck systems are cast-in-place such that roof deck penetrations and mechanical equipment barriers that occur on every deck can be easily accommodated. Positive slope-to-drain is created during installation along with the casting of monolithic saddles and cants that direct the water toward the drains as designed.

### WIND UPLIFT RESISTANCE

The monolithic nature of cellular concrete roof decks block air movement from inside the building during wind uplift conditions. As a result, air barriers are not needed as part of a roofing system for high wind uplift ratings.

### SPECIAL INSTALLATION REQUIREMENTS FOR CELLULAR CONCRETE ROOF DECKS

Although cellular concrete roof decks meet all the criteria of an ideal roof insulation, the installation process may have one disadvantage, in the view of some, relative to a rigid insulation board system.

Due to the fact that an insulating concrete roof deck is a cast-in-place cementitious product, it cannot be roofed the same day it is installed. As a result, the deck is exposed to the elements for several days until the roofing membrane is applied.

Under normal conditions, the roofing membrane over a cellular concrete roof deck may be installed 3-5 days after the deck is cast. If there is rain during the first few days after casting, the water typically flows to the drain. If the deck is exposed for longer periods of time, drying shrinkage cracks may appear and permit water to enter the roof deck system. Sometimes water may penetrate the deck at vertical protrusions (which have not



*Lightweight Insulating Cellular Concrete project in progress.*

been flashed) or at drains (which may not be completed).

The 3-5 day membrane installation timeframe applies to roof decks with mechanically-attached (nailed) base sheets over which a built-up or modified bitumen roofing membrane is applied and for fully-adhered, fleece-backed systems. When using fully-adhered, smooth-surfaced membranes, a test patch may be required to assure that the deck is ready to be roofed using the specified adhesive.

Cellular concrete, usually cast two to three inches thick over the EPS board, has such a low water content that most of this water is consumed by the hydration of the cement and/or dissipates from exposure to sun and wind. After a few days, the mois-



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ture content of the cellular concrete is suitable for roof membrane installation.

David Siple, in his article "Pouring Cellular Concrete Over Non-Venting Substrates (But Don't Get Caught in the Rain)," offers some very practical advice for insulating cellular concrete roof decks which may be exposed to rain.

- Simplify the roof design to reduce deck casting and roofing application times.
- Plan and coordinate the deck casting as well as the roofing membrane installation with regard to crew size, reasonable production times, and scheduling of these activities.
- Specifications should be written to include cellular concrete with a minimum 200 psi compressive strength and fiber reinforcement. Roofing membranes can be specified for faster "in-the-dry" installation if there are high probabilities of rain.
- Act quickly in case of rain. Cover the deck and utilize shop vacs if it is appropriate.

## ROOFING CONTRACTORS

Many roofing contractors recognize the advantages of lightweight insulating cellular concrete roof decks and the positive benefits these cellular concrete roof decks can have on their business. However, some contractors believe that if they lose the insulation portion of the roofing contract, they will lose their markup and profit on these projects.

From a practical standpoint, a lightweight insulating cellular

concrete roof deck system provides the contractor with the opportunity to do what he does best and most profitably—install the roofing membrane and the peripheral details that accompany these systems. Most importantly, the building will be "in the dry" sooner.

The roofing contractor can mobilize for a project while the roof deck is being cast. The insulating concrete roof deck applicator will out-produce a roofing membrane crew (greater than 100 squares per day). The time consuming cutting and fitting of rigid insulation board, in reality, reduces the daily production of membrane installation for the roofing contractor and increases the risk of days lost to poor weather.

In short, the roofing contractor's profit margin will increase due to greater and more efficient production. The roofing membrane application can begin a few days after the cellular concrete roof deck is cast. Furthermore, the roof deck will drain positively. This is not always the case with rigid insulation systems.

## SUMMATION

Lightweight insulating cellular concrete is a different product than expanded aggregate concrete even though both are used in roof deck applications. Lightweight insulating cellular concrete meets all the criteria of an ideal roof deck insulating material. Cellular concrete roof decks provide positive slope-to-drain, a solid base for the roofing membrane, and fire, seismic, and wind uplift resistance. ■

## REFERENCES

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Owner of Elastizell Corporation of America since 1971, Leo is involved with all aspects of Elastizell Cellular Concrete, including research, product development, field applications, testing, approvals, and promotion. He is a member of ACI, ASTM, RCI, and CSI.