LIGHTWEIGHT INSULATING CONCRETE SYSTEMS:

PERFORMANCE-PROVEN AND COST-EFFECTIVE

BY HUBERT T. DUDLEY

Nailing the base sheet to a lightweight insulating concrete deck.

Long Performance History

At the start of the year 2000, lightweight insulating concrete (LWIC) systems will have been in continuous use as a roofing membrane substrate for over 60 years in the United States. During this time, well over 3 billion square feet of LWIC roofing substrate have been applied over all kinds of structural decks in all types of climatic conditions and geographic regions of the country. The products continue to be specified and used by people with experience and those newly introduced to the product concept. This is because the systems have performance-proven field applications and cost-effective solutions for many building rooftop conditions.

Lightweight insulating concrete systems are composed of either aggregate or cellular concrete. The basic composition of concrete material has not changed substantially with time. However, the composite system has been improved to deal with changing market needs. Most of the system modifications were made in the 1970s. During this time, slotted metal decking became available, a special form of expanded polystyrene insulation was invented, a specialty fastener to attach the roofing base sheet was developed, and a special re-roofing system was introduced. The last of these changes will have over 20 years of proven market performance at the start of the new millennium.

Slotted metal decking allows the natural flow of water (downward by gravity and solar driving forces toward the building interior). This phenomenon speeds the rate of drying of the insulating concrete. A special "holed" form of expanded polystyrene insulation increased the insulating capacity of the systems, reduced the thickness of insulating concrete placed,

created the ability to use stair-stepped board to provide slope, and reduced the weight of the systems.

A special fastener was developed which allowed the economical use of a nailed base sheet. The nailed base sheet, in conjunction with vented edge details, eliminated high vapor pressure and roofing blisters. The fastener also allowed the systems to achieve high wind uplift approvals for membrane systems. The last modification was the introduction of a stronger insulating concrete that could be placed at a minimum of 1-inch. This reduced thickness (with the resultant weight reduction), and stair-stepped EPS application for slope, allowed a commercially viable re-roofing system. All of these changes have improved the acceptance and performance of lightweight insulating concrete systems.

Attributes Creating Continued Market Use

Product attributes have driven the continued use of these systems within the marketplace. LWIC systems are a cost-effective means of creating positive slope; are low-cost, fire-rated systems; and maintain a long history of high wind uplift performance.

All sloped insulation systems are designed as if the structural deck is tabletop flat. The important issue is not that slope can be easily designed but rather the ability to create positive slope over the real-world conditions encountered with structural substrates. The difference between a LWIC system and other systems is the ability to move from the design stage to actual rooftop conditions and still deliver the positive slope-to-drain as designed at a quoted cost. Originally, changing the thickness of insulating concrete created slope. Increasing or decreasing the LWIC thickness also easily accommodated the height variation in the structural deck. Today, slope is primarily created by placing stair-stepped thicknesses of EPS board imbedded in concrete slurry. Varying the topcoat thickness of LWIC creates the final positive slope.

Many buildings require an hourly fire rating as part of building code mandated designs. Typically, the code may require a one- to three-hour fire-rated roof system for protection of life from interior fires. LWIC systems can achieve a real cost savings of $1.00 to $1.50 per square of roof area for 1-1/2 hour or higher fire-rated steel deck construction when compared with rigid insulation systems. The cost savings occurs by eliminating the need for covering the entire deck underside with sprayed fireproofing.

Long before high wind uplift approvals for membranes were required by regulatory agencies, LWIC systems were known in coastal areas as having a performance history of resistance to high wind loads. The concrete slurry coat bonds the system to the structural substrate, helping to provide high wind load resistance. In the case of steel decks, filling the flutes with the concrete slurry eliminates air movement in the flutes. This reduces the likelihood of system delamination at this critical interface and creates a monolithic layer, eliminating the inside air pressure from being transferred upward to the membrane. Because of these factors, some LWIC systems (even with a nailed base sheet), achieve a Factory Mutual (FM) rating of Class I-165 over steel decks. A fully-adhered roofing system over structural concrete has even achieved a Class I-855 FM rating.

Improving Roofing Membrane Performance

Lightweight insulating concrete creates several benefits that extend the life of roofing membranes. One benefit is tied to the thermal properties of the concrete. LWIC has a higher specific heat than any rigid insulation material. This heat-absorptive capacity is created by the concrete mass. It reduces the rate at which the membrane temperature increases and reduces the maximum temperature the membrane experiences. These two factors reduce the daily stress undergone by the membrane. LWIC systems extend the time required to achieve maximum membrane temperature by one to three hours. LWIC systems also reduce the maximum daily membrane temperature by 15 to 25 degrees F compared to rigid insulation of the same

R-value. These less stressful conditions serve to increase membrane life.

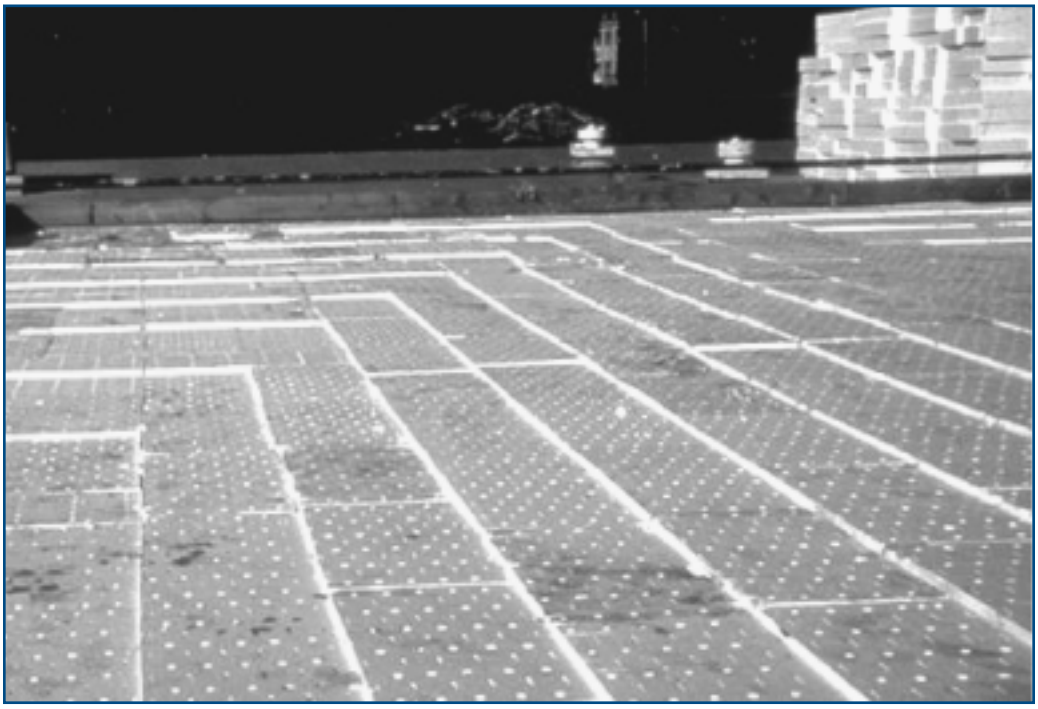
Another benefit is tied to the lower coefficient of thermal expansion. LWIC has a coefficient of thermal expansion of 10-12 x 10-6 compared to typical rigid insulation that has a coefficient of 12-18 x 10-5. This difference is a full magnitude lower for a LWIC system and creates less membrane stress for the roofing membrane installed over a LWIC roof deck.

Lastly, the roofing membrane attached to an LWIC system with mechanical fasteners also benefits from reduced stress in comparison to a rigid insulation system. A membrane fully adhered across a joint experiences stress concentrations that can create micro ruptures of the membrane and result in roof leaks. A nailed base sheet distributes the stress between fasteners by several inches versus thousandths of an inch over a joint. Applying the same load to the membrane easily demonstrates that the LWIC system will cause lower membrane stress.

Roofer-Friendly Insulation System

Roofing industry leaders continue to point to a major lack of skilled labor entering the roofing business. The younger generation does not look to the roofing industry as being attractive as a life-long vocation. Those products or application procedures that reduce the quantity of labor necessary to complete a roofing installation should be welcomed by the roofing industry in the future. Today an LWIC system provides the opportunity to the roofing applicator to reduce labor cost. Part of the labor cost reduction is associated with reduced crew size required to place rigid board insulation panels quickly enough to allow roofing to be placed the same day. An LWIC system placed by an outside contractor eliminates the need for a roofer to hire additional labor to place insulation. An LWIC system also allows increased production from the roofing crew.

Therefore, the contractor benefits by using an LWIC system by reducing the number of laborers he keeps on payroll to place the insulation, and he benefits from the fixed cost of insulation installed by another contractor. The roofer can reduce his overhead cost and increase the daily roofing area with reduced crew size. Although his gross income might be less, his profit picture will often improve from the fixed insulation cost and lower installation cost.



Stair-stepped EPS to create slope-to-drain.

2-Color
Carlisle
Pick-up from 8/99, page 5

Re-Useable, Cost-Effective Insulation

Most LWIC systems that are re-roofed these days are left in place and are repaired only where necessary. Many LWIC systems that were placed in the 1960s are being salvaged by adding a new membrane without adding the cost of new insulation when re-roofing occurs. To the building owner, this is a significant cost savings in materials. It is also a significant savings in refuse disposal cost and damage to the environment. Applying a typical rigid board insulation would cost between $ 1.20- $2.50 per square foot installed plus a $ 0.50 - $ 1.00 per square foot disposal cost. Disposal costs will only escalate with time as landfills are closed and the distance traveled to dispose of material increases. LWIC systems already reduce both of these costs since they may be re-roofable without replacement.

As previously mentioned, fire rated constructions can benefit from reduced cost by eliminating the fireproofing cost associated with a rigid board installation. Additionally, sloped applications typically provide a lower initial cost for LWIC versus rigid board insulation systems. Fastening requirements for rigid insulation on certain membranes generate these higher costs. LWIC systems have one attachment cost for all installations. In many cases, LWIC systems not only will be the lowest long-term cost for the owner but may also be the lowest initial cost.

Looking Toward the Future

LWIC systems are proven performers in the market, with a track record of over 60 years of continuous use. The system features that contribute to their long use make them an increasingly attractive roofing substrate in today's marketplace. The reduction in available labor and the continuing increase in rigid board replacement and disposal costs would indicate that LWIC will continue to be a competitive force in the market for many years to come. ■

About the Organization

The National Roof Deck Contractors Association (NRDCA) is a trade association of contractors who apply lightweight insulating concrete systems. The NRDCA is dedicated to improving the quality of application by member contractors and promoting the benefits of LWIC systems.

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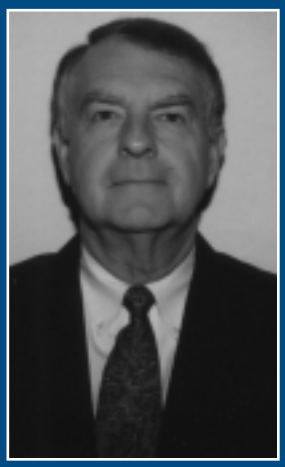

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Hubert T. Dudley, President of Constructive Consulting, has 35 years experience in heading research projects, creating products, and marketing them for use in the construction industry. Twenty years of that time have been spent developing and managing the Zonolite Roof Deck and the Siplast Roof Insulation lightweight insulating concrete systems business for W.R. Grace & Co. and Siplast, Inc. Constructive Consulting is dedicated to assisting companies in creating markets for products in the construction industry.