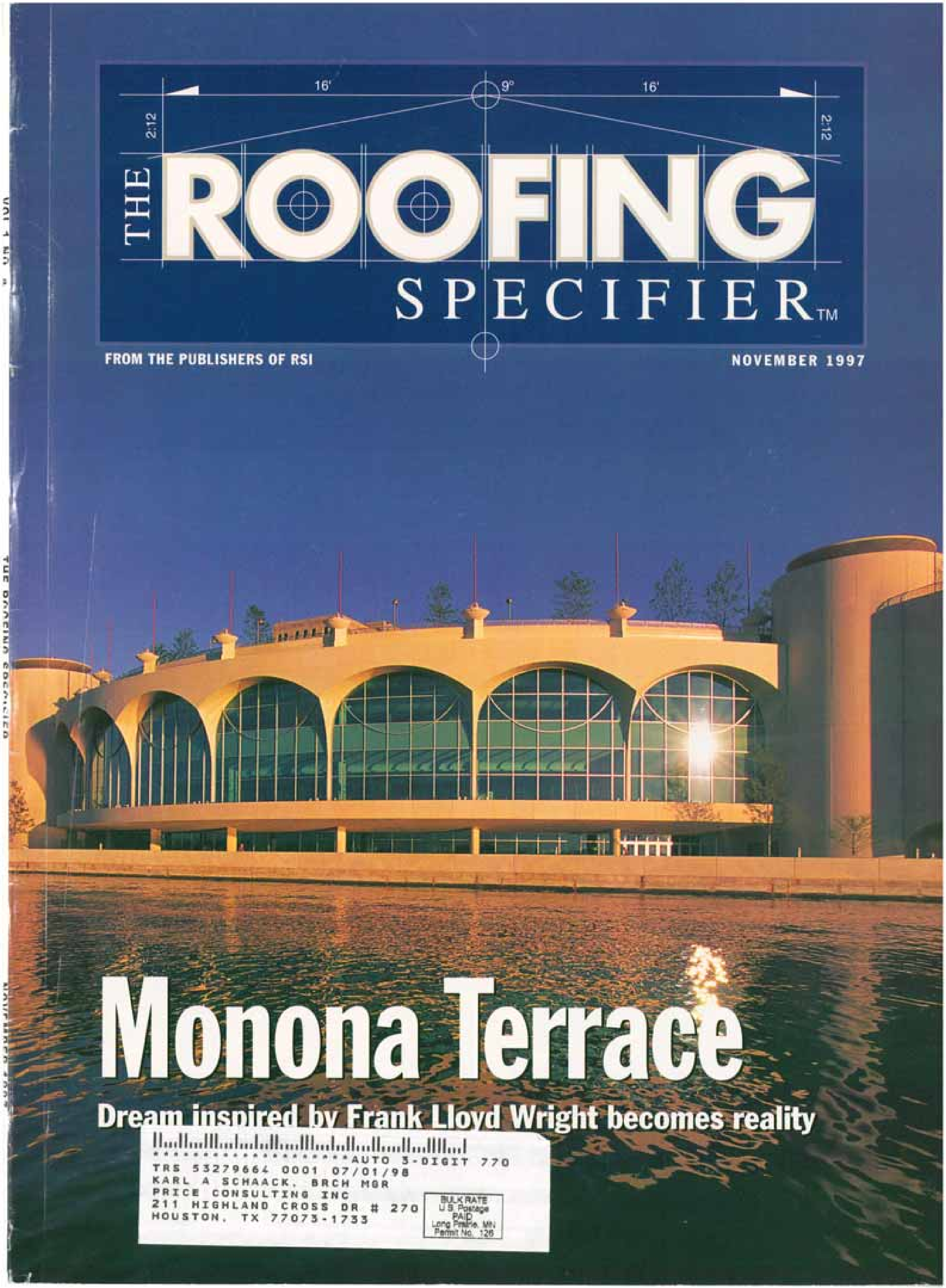

THE ROOFING SPECIFIER™

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Monona Terrace

Dream inspired by Frank Lloyd Wright becomes reality

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Testing lightweight insulating concrete

Quality control procedures are critical for lightweight concrete roof decks

***The New Orleans Museum** of Art roof features Zonolite Insulating Concrete and Paradiene 20/30 SBS modified bitumen.* (PHOTO COURTESY OF SIPLAST, IRVING, TX.)

LIGHTWEIGHT INSULATING concrete has been used successfully in the construction of roof decks since the late 1930s. This deck material is "manufactured" in the field by proper proportioning of specific components, including: Portland cement, water, a lightweight aggregate and/or an air-entraining agent. Maintaining quality control during the batching, placement and curing processes are essential in achieving the optimum performance characteristics desired.

A variety of factors can influence the finished product. These factors include, but are not limited to, the following:

- inexperienced personnel, resulting in improper proportioning or mixing of materials;
- inadequate and/or improperly functioning equipment;
- improper project and/or site conditions;
- weather.

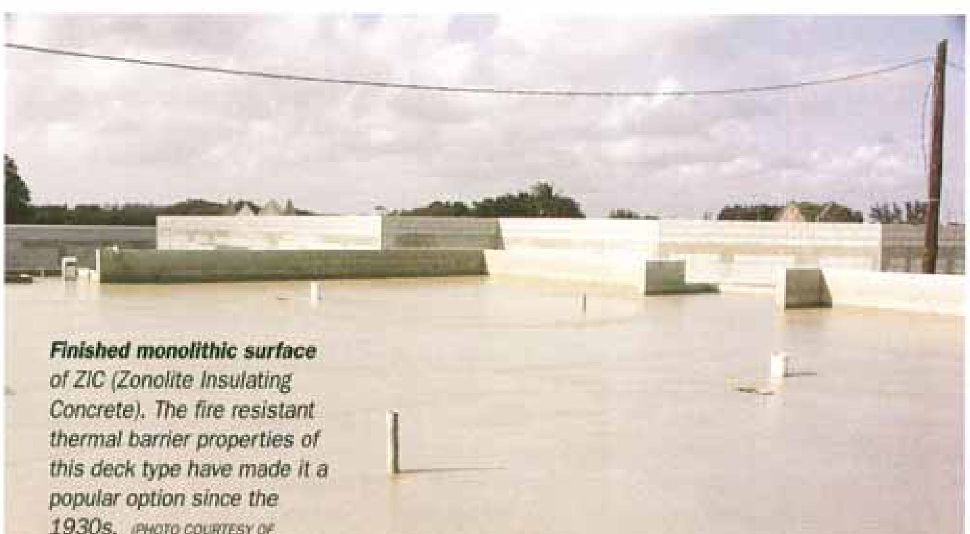
Thickness of fill is also important. When embedded polystyrene insulation is specified, the cement slurry used to adhere the insulation boards to the deck must be adequate to ensure adhesion.

The fill on top of the polystyrene should be at least two inches thick, except for a special NVS mix (one part cement to 3.5 aggregate), where the minimum thickness can be one inch.

There should also be provision for downward drying in the specification, such as with a slotted steel deck. If the fill can't dry out, the published R-value will never be achieved, and the presence of wet, alkaline material may degrade the roofing felts.

Once again, failure to maintain proper techniques and methods and lack of quality control could result in a less than desirable product for all project-related personnel (i.e. contractor, architect/designer, owner).

Fortunately, several testing procedures can be implemented during and/or after the placement of lightweight concrete in order to maintain product consistency, establish quality control methods and evaluate the lightweight insulating concrete. Some of the common testing implemented determines the following physical characteristics: wet density, fastener pull-out resistance, compressive strength, and dry density.



***Finished monolithic surface** of ZIC (Zonolite Insulating Concrete). The fire resistant thermal barrier properties of this deck type have made it a popular option since the 1930s.* (PHOTO COURTESY OF SIPLAST, IRVING, TX.)

for specification compliance

Wet density

Initial testing involves wet density. This test is performed during the initial placement of the lightweight insulating concrete. The wet density should be determined at various times during the day as the lightweight insulating concrete is being batched and placed. The wet density should be obtained at both the hopper and the point of placement.

The sample of the lightweight insulating concrete that is to be used for testing purposes should be considered representative and not be collected at the beginning or ending of the placement operation. If the batching and placement methods are terminated and restarted during the day, it is imperative that the wet density be verified after the operations are resumed.

Fastener pull-out resistance

The suitability of the newly placed lightweight insulating concrete is often verified by performing several field tests. A common rule of thumb that has been used by field personnel is, "If foot traffic does not leave impression (footprints) in the lightweight insulating concrete, then the concrete is suitable to receive the new roof."

However, there are other more scientific testing methods available to evaluate the suitability of the concrete. Fastener pull-out resistance is a relatively quick test that determines if the concrete has adequately "aged" in order to install the new roof. The fastener proposed for use in the new roof assembly should be used and tested in several random locations throughout the subject area (approximately one test per 100 squares).

The minimum pull-out resistance that is commonly required by manufacturers for the split shank fastener is 40 pounds per fastener. Care should be taken if evaluation of the new lightweight concrete is determined by only performing pull-out resistance tests on fasteners. The concerns are two-fold: 1) the concrete may not have reached the 28-day strength and, 2) galvanized steel fasteners reportedly can gain additional pull-out resistance as a bond develops between the lightweight concrete and the steel fastener as the concrete cures.

The fastener pull-out resistance testing can and should also be performed on existing lightweight insulating concrete when roof replacement is being considered. This testing can provide information regarding the quality of the deck and the appropriate values for determining fastener spacing/density.

The pull-out resistance test can be performed using a sheet metal holding clamp that could be attached to a spring (fish) type scale. The scale should have a range of 0 to 100 pounds with one-pound increments. Another pull-out tester than can be used is a hydraulic type device with a twisting crank and dial gauge. This type of apparatus is also commonly used for testing screw type fasteners.

Another easily performed test to verify the suitability or density of the cured concrete involves use of a hand-held penetrometer designed for performing field and laboratory evaluations of initial set of concrete mortars.

This testing apparatus is comprised of a hand-held cylindrical tool (seven inches long by 3/4-inch diameter) with a circular probe/-shaft with a 1/20th square inch of surface area. This piece of equipment is manufactured by ELE International and classified as a Concrete Mortar Penetrometer (see Figure 2). However, this test does not provide sufficient repeatable

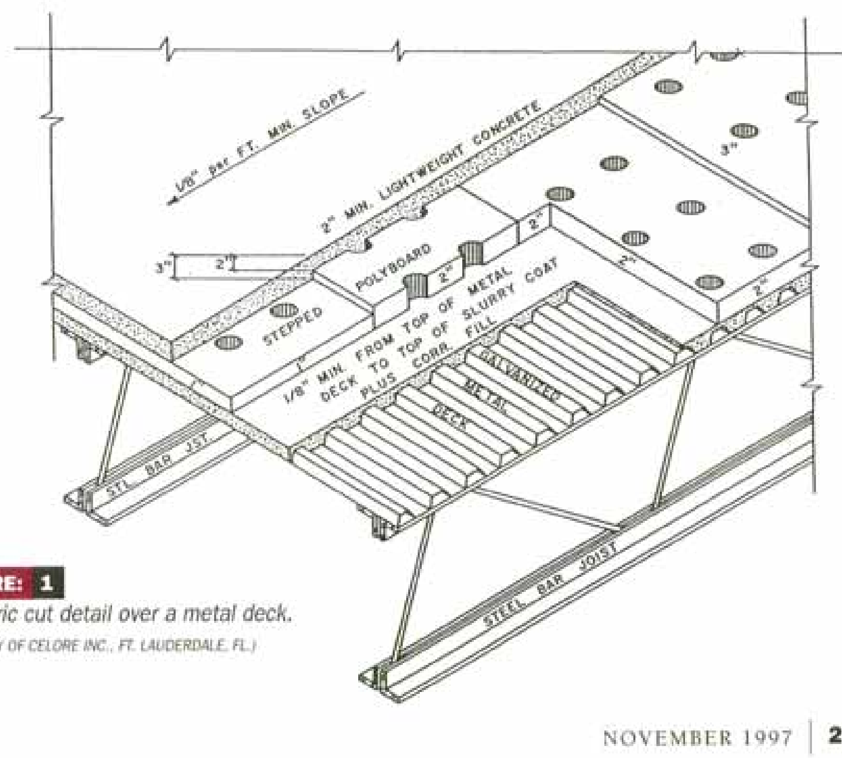


FIGURE: 1
Isometric cut detail over a metal deck.
(COURTESY OF CELORE INC., FT. LAUDERDALE, FL.)

data nor the precision to use as a single source of evaluation for lightweight insulating concrete.

Cured (existing) lightweight insulating concrete

If cylinders of the lightweight insulating concrete are not molded or physical properties of an existing lightweight insulating concrete are desired, then certain procedures are available. Testing the physical properties of existing lightweight concrete (cured concrete) can be performed in accordance with ASTM C513, Obtaining & Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength. This method covers the obtaining and preparation of in-place lightweight concrete (minimum 14 days old).

***CL-700A penetrometer** provides a relative indication of the compressive strength/density of lightweight insulating concrete. However, this test does not provide sufficient repeatable data nor the precision to use as a single source evaluation technique.* (PHOTO COURTESY OF ELE INTERNATIONAL, INC./SOILTEST PRODUCTS DIVISION, LAKE BLUFF, IL.)

In general, the procedure consists of obtaining a bulk sample of the existing (cured) lightweight insulating concrete and shaving/shaping the sample down to the desired size and number of cubes. A total of four cubes (three for compressive strength, one for density) is recommended to be obtained for the appropriate testing. Since the samples are manually produced, the actual measurements of the cube shall be achieved to determine the true size and bearing surface. The specimens shall be oven-dried (140 degrees Fahrenheit, +- 5 degrees) for three days prior to performing the respective tests.

By performing a combination of each of these tests, the specifier can obtain the assurance that the newly-placed lightweight insulating concrete will have the desired characteristics as originally intended. It will also ensure that the deck provides a suitable substrate to receive the new roof assembly and provide long term serviceability, as anticipated.

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Evaluating the compressive strength of insulating concrete

Testing of the compressive strength of newly installed lightweight concrete is particularly critical in roofing applications. It is performed in accordance with ASTM C495, Standard Test Method for Compressive Strength of Lightweight Insulating Concrete. This method covers the preparation and testing of molded cylinders (three inches diameter by six inches long) for lightweight concretes with oven dry weights not exceeding 50 pcf.

The test specimens are molded from a sample of the lightweight concrete mixture obtained from the batching equipment prior to placement. The mixture is placed in molds, stored, and specifically cured and then tested.

The ASTM procedure has specific guidelines for curing the molded cylinders, which generally involves initial moist curing process followed by an oven dried curing process. It is critical that the samples are dried prior to testing. A minimum of four cylinders should be prepared; three cylinders to be used for compressive strength tests and one cylinder to be used for dry density tests.

Several factors can affect the results of the testing of molded cylinders. These factors include the following:

1) Preparation of the specimens can have an affect on the sample.

2) The handling, storage and transportation of the molded cylinders is critical.

3) The actual cross-sectional area of the cylinder can also have an impact on the test results.

4) The accuracy of the testing machine is a critical issue.

5) The rate of loading can have an affect on the test results. The rate of loading should be maintained constant for the loading duration as outlined in the ASTM procedure. Reductions in the compressive strength have been experienced when the rate of loading was varied.