Feature

Roof Decks A to Z

Part 20: Cinder Concrete on Ribbed/Expanded Metal Lath

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This is 20th in a series of articles examining various deck types. Among the numerous considerations when selecting a roof system, the type of decking is among the most important. With the variety of decks to be encountered (both new and old), it is incumbent upon roofing experts to be the authority on these matters. This article will explore features of cinder concrete carried on ribbed and expanded metal lath.

CINDER CONCRETE IS a cast-in-place deck type (also referred to as job-cast concrete). This article concerns itself with cinder concrete placed atop ribbed and expanded metal form (also known as wire lath; **Fig. 1**). This system was used to support concrete floors and roof decks before the advent of ribbed/fluted steel form deck (**Fig. 2**). Because it is a structural configuration and installed over this unique metal form, it is not to be confused with lightweight insulating concrete (LWIC), which is typically installed over some type of form deck. It is also not to be confused with lightweight structural concrete (LWSC), which is discussed below.

As outlined in Part 7 of this series, *concrete deck* can mean any number of things, as there are numerous variations to be found.[1] The deck configuration featured in this article should not be confused with cinder concrete placed over draped fabric and steel wire mesh—a topic to be explored in a future installment. Older buildings seldom come with original drawings, so it is paramount that any deck be properly identified and scrutinized well in advance of a pending reroofing project. Moreover, the restating of some engineering properties may be helpful here to distinguish cinder concrete. Normal-weight structural concrete (NWSC) is made with natural stone or crushed gravel, complying with ASTM C33, *Standard Specification for Concrete Aggregates*,[2] that is mixed with portland cement, sand, water, and various chemical admixtures. The dry density of normal-weight concrete is typically on the order of 150 lb/ft^3 (2,402 kg/m^3), and typical compressive strengths range between 3,000 and 6,000 lb/in.^{2} (20.7 and 41.4 MPa).

Lightweight structural concrete is approximately two-thirds the density of NWSC, and it is made with aggregates such as expanded shale, clay, and slate. To create the lightweight aggregate, shale, clay, and slate are crushed, and some are heated to high temperatures, causing the small amount of water that is naturally contained within to turn to steam, causing the particles to expand in volume. The expanded particles are lighter than crushed gravel, yielding a finished density between 85 and 120 lb/ft^3 (1,361 and 1,922 kg/m^3); compressive strength values are comparable to those of NWSC. The density of cinder concrete is also in the range of 85 to 110 lb/ft^3 (1,361 to 1,761 kg/m^3), though the aggregate is considerably different from the foregoing types.[3] The loose matrix of the material, with its high void content, yields the finished appearance of a Rice Krispies Treat.

When cinder concrete was in vogue (during the 1920s through the 1940s), it was likely to have been used as the floor construction as well, and it was common that a skim coat of a portland cement–based material (slurry) was

Figure 1. *Cinder concrete is a type of cast-in-place mix, placed atop ribbed and expanded metal form (also known as wire lath). This support system was used for concrete floors before the advent of modern ribbed/fluted steel form deck.*

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installed over the poured deck. This was done to create a smoother surface for better receiving flooring and roofing materials. The closer spacing of floor support framing distinguishes it from that which would be found as roof supports (**Fig. 3**). In the case of suspended ceilings, it would be tooled and finished in a manner similar to plaster. Be aware that this arrangement (as viewed from below) is not the roof deck (**Fig. 4**).

CINDER AGGREGATES

Simply stated, cinder concrete is lightweight and very porous because of the primary aggregate, blast-furnace slag (**Fig. 5**). This stands in contrast with other aggregates that are mined (that is, from a quarry) or those dredged from a river bottom (that is, stone ballast). During the Industrial Revolution, there was an abundance of cinder available, largely considered spoils of the coal-burning process. Coarser cinders had many end uses, including railroad beds, tracks for jogging/running, and the racing surface for motorcycles and horses. One vintage motorcycle racer was known as "King of the Cinders"; several racehorses have borne some variant of the name (for example, Cinders, True Cinder, Satin Cinders, etc.). The material was also used in roadway construction, with the first slag road being built in England in 1813.[4]

The smelting of iron ore ushered in processes that resulted in the slag "byproduct." It is simply what is left over when the pure steel is separated from the impurities. The chemical makeup of slag is a hybrid mixture of silicates and oxides; it has gained wide acceptance as an admixture for many concrete applications. Screened/graded iron silicate and coal slag are now used as surfacing for built-up roofing roll goods, offering ultraviolet protection and enhancing the in-service durability of the product.

Before the term *tar-and-gravel* was coined, the moniker *slag roofing* was well recognized, and multiple contractors marketed their companies as such.[5] Also termed *goulash* construction, the mix of portland cement and slag was often so

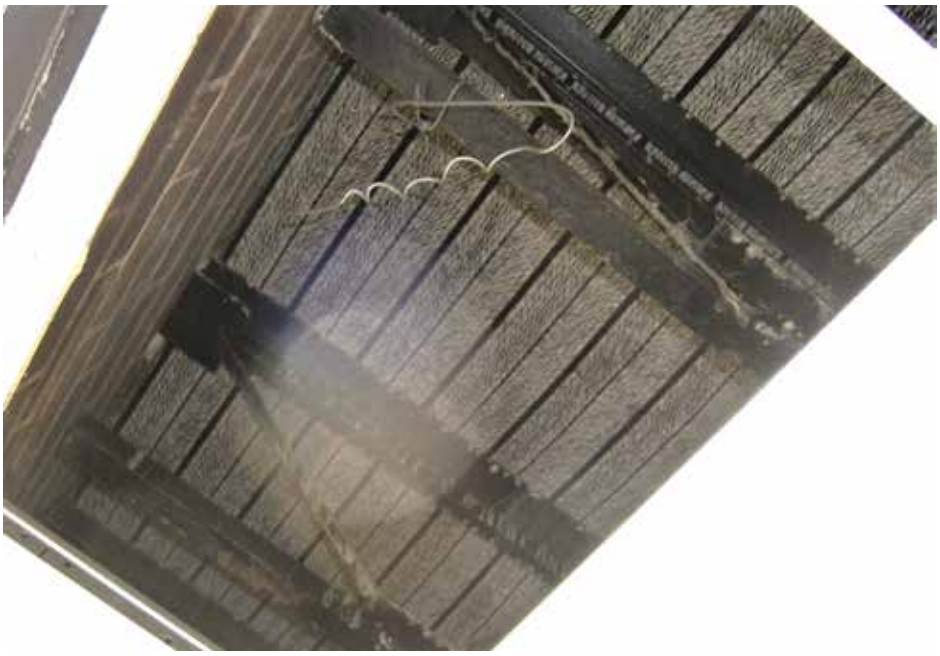

Figure 2. *Usually situated over steel framing, slight deflection between framing supports is rather commonly observed. This type of deflection likely dates to the time of construction, and it is unlikely that the same undulations would be evident topside.*

Figure 3. *When cinder concrete was in vogue, it was likely to have been used as the floor construction as well. Here the closer spacing of floor framing distinguishes it from that which would be found at the roof level.*

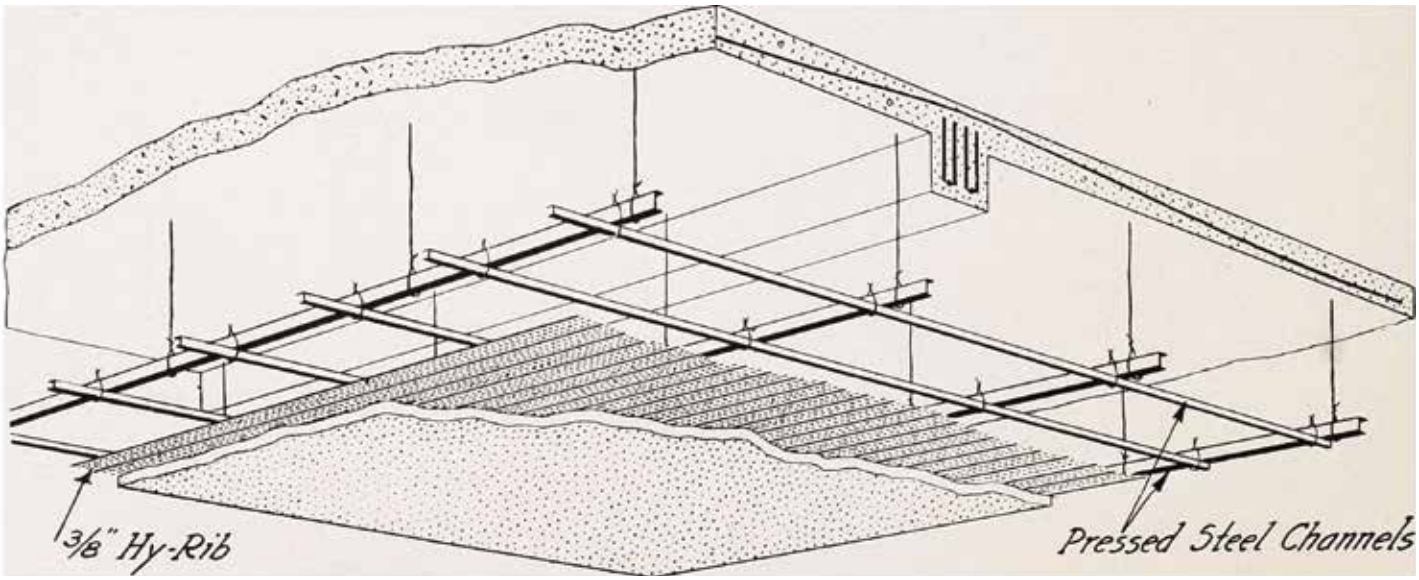

Figure 4. *Expanded metal lath is also used as part of a suspended ceiling. The exposed surface would be tooled and finished in a manner similar to ordinary plaster. Be aware that this arrangement (as viewed from within a structure) is not the roof deck underside. Courtesy of Alamy Inc.*

Figure 5. *Blast-furnace slag is what is left over when, in the smelting process, pure steel is separated from impurities. This is in contrast with other aggregates that are mined (that is, blasted from a quarry) or those dredged from a river bottom (that is, stone ballast). Courtesy of DepositPhotos.com.*

loose that water would pass through the matrix—subjecting the metal form to deterioration in the event of unchecked roof leakage. As stated earlier, the surface finish would usually be an unacceptable substrate for direct application of roofing or flooring materials, so after a period of sufficient cure, a slurry topping of concrete would ordinarily be applied to fill for the voids in such a "loose" mix.

THE PERMANENT METAL FORM

A variety of forms can be encountered for any type of job-cast concrete. Accordingly, the underside appearance of the deck can reveal how to properly identify and characterize it. Stay-in-place forming systems were economical because they avoided the cost of subsequent stripping and cleaning, as would be necessary for reusable forms.

Expanded metal lath has long been used as backing support for both vertical stucco and plaster. The quite satisfactory connection/bond of cementitious materials to lath has long been recognized. However, in a horizontal arrangement, sagging between supports was prone to develop with the flat/rolled wire lath used in vertical applications, so ribs were roll-formed parallel to the long direction of

Figure 6. *Expanded metal lath could be roll-formed into configurations similar to conventional steel decking of today; the inclusion of ribs in the profile vastly improves span capabilities.*

the product. Roll-forming also evolved into providing a shallow pocket that would be accepting of steel rebar, which vastly improved span capability (**Fig. 6**). The smooth bar shown in **Fig. 7** evidently predates the diamond pattern of modern "deformed" bars that were introduced in the 1920s.

THE COMPOSITE DECK SYSTEM

For openings or interruptions, supplementary framing is needed in locations similar to other deck types. **Figure 8** shows steel bracing for a drain opening. Usually situated over steel framing, it is rather common to observe (from below) slight deflection of the roll-formed wire lath between framing supports. This minor sagging shown likely dates to the time of construction, and it is unlikely that the same undulations would be evident topside. Following roof removal, undulations noted in the top surface could portend "creep" behavior, and further investigation would be merited.

Longer spans (that is, spacing of supports) could result in sagging between supports, so steel bar reinforcing was often added to strengthen the section.

When this type of deck was in vogue, it was common that a built-up roof was the covering, with felt plies of the built-up roof being applied directly to the deck surface with hot asphalt. Unless (as described above) a skim coat had been applied, the cinder surface would have been quite rough, and any leak water would easily pass through the matrix. "Sprinkle-mopping" would have likely been the technique of choice for bitumen application; fortunately, that dubious practice was given a decent burial some decades ago. Asphalt is certainly a plausible adhesive for insulation boards on concrete decks, but its practicality on cinder concrete may be challenged by project-specific constraints (that is, whether or not a slurry coat is present, logistical reluctance on some properties to permit a kettle, and the like).

Removal of an old mop-applied roof from a cinder deck can be arduous (with more colorful descriptors often deployed). Scarifying an old concrete surface is nice but seldom practical in reroofing and not really appropriate for cinder concrete because the rougher, courser slag surface could be damaged by such work, and the slurry topping, if present, is not intended for such a procedure. Scarifying is tedious work, and having the roof removed from an occupied building for extended time is risky.

Cinder concrete is notoriously unreliable in tension when roofing components (or features anchored below) are connected with epoxy or mechanical anchors.[6] Alternatively, modern foam adhesives (over a clean, dry surface) are well suited for roof construction over a cinder concrete deck. Because these decks are cast monolithically, pressure-equalized (that is, "valve") roof assemblies may also marry well, avoiding a host of potential setbacks from fastening, adhesion, ballast, and the like.

If a project design requires adding large openings through the cinder deck, an underside inspection is essential. Due diligence is required to avoid centering openings directly over structural steel framing elements. For instance, ductwork from new HVAC equipment on a new curb may conflict with structural framing. It may be prudent to center two edges of the openings over intersecting steel framing, to maximize the functional (load-bearing) characteristics of the existing structural framing. In theory then, the introduction of new supplemental framing members would only be required on two sides of the opening. Irrespective of the project charter or project design brief, if the work scope requires new openings or if water-damaged decking is suspected, it is recommended that a structural engineer review the conditions and provide direction for execution of the work.

Figure 7. *Longer spans (that is, greater spacing of supports) could result in sagging between supports, so bar reinforcing was added to strengthen the section. Smooth bar shown here evidently predates the diamond pattern of modern "deformed" bars, which were first used in the 1920s.*

Figure 8. *Supplementary steel framing is needed in locations similar to other deck types. Here steel bracing has been provided for a roof drain opening.*

SUMMARY REMARKS

While not limited to the period, cinder concrete roof decks were most popular during the 1920s through the 1940s. They were a robust form of construction and, if not subjected to long-term water exposure and deferred maintenance, are still in existence today. Caution should be exercised regarding any kind of demolition, building repurposing, and reroofing over a substrate of this type.

The building enclosure expert should be aware of this form of construction, as rehabilitation opportunities are sure to come about. More than the ordinary level of scrutiny may be appropriate when this type of decking is encountered. This should probably include coring and sampling of the deck, possibly load testing, lab analysis of specimens, and very close scrutiny from below to delineate any zones of metal corrosion. These efforts will be appreciated later into a project where surprises and problems often manifest.

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