ROOF DECKS A to Z

Part XV: Haydite and Nailcode

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ABSTRACT

This is the fifteenth in a series of articles examining various deck types. Among the numerous considerations when selecting a roof system, the type of substrate is one of 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 roof decks constructed from Haydite concrete with an overlay topping course of Nailcode.

SOME HISTORICAL PERSPECTIVE

While not limited to a specific era of construction, this older form of roof deck would be found mostly in pre-WWII buildings. It is best appreciated when some of its history is recognized. By the early 1900s, concrete had evolved to be recognized of great value and strength, using raw materials that were fairly abundant and cheap. Sand, cement, and aggregates (coarse and fine), correctly proportioned with water, yielded spectacular results. Concrete, in its simplest form, is heavy, becomes hard in a reasonably short period of time, and is the backbone of many buildings. But the "heavy" descriptor associated with the product resulted in limitations on overall building heights; imposing skyscrapers were unheard of at the time, but the desire to build taller buildings persisted and eventually triumphed.

On the heels of the industrial revolution, Stephen J. Hayde, the American-born son of Irish immigrants, sought to develop lightweight structural concrete that might accommodate the public's demand.[1] A brickmaker by trade, he and others engaged in production found that their kilns of uneven heat produced a widely varied product line. The rotary kiln process was originally developed in 1908 and later patented by Hayde in 1918. A typical kiln run would produce "hard-burned" bricks that exhibited favorable performance as an exterior weathering wythe (that is, hard and generally water repellent), as well as "Chicago pinks," a salmon-colored softer brick that had an affinity for water (that is, absorptive with storage capacity).[2] Finally, there was a third category of production known as "bloaters." These were bricks that had been heated too rapidly, causing them to expand by more than a third of their original size. They were simply discarded as waste.

To maximize profits, Hayde crushed the bloaters, then blended them into concrete mixtures, with the spoils no longer characterized as lost inventory. It was thought that introducing a clay-based aggregate package to concrete would result in lower density (weight). The process was improved upon, autoclaving clay (crushed bloaters) and shales, which yielded lightweight aggregates that are key components of Haydite concrete. Portions of the resultant byproduct were light enough to float. In 1918, Hayde, a patriotic soul, turned his attention and technology to building concrete ships for the war effort. Two ships were produced using his proprietary process, the *Atlantis and Selma*.[3] Testing of the concrete products used yielded a 4000-psi (28-MPa) (compressive strength) mix with a density of 106 lb/ft^3 (1700 kg/m^3). With regard to building construction, reduction in unit density from approximately 150 lb/ft^3 (2400 kg/m^3) for traditional 4000-psi concrete to only 106 lb/ft^3 with these lightweight aggregates allowed design-

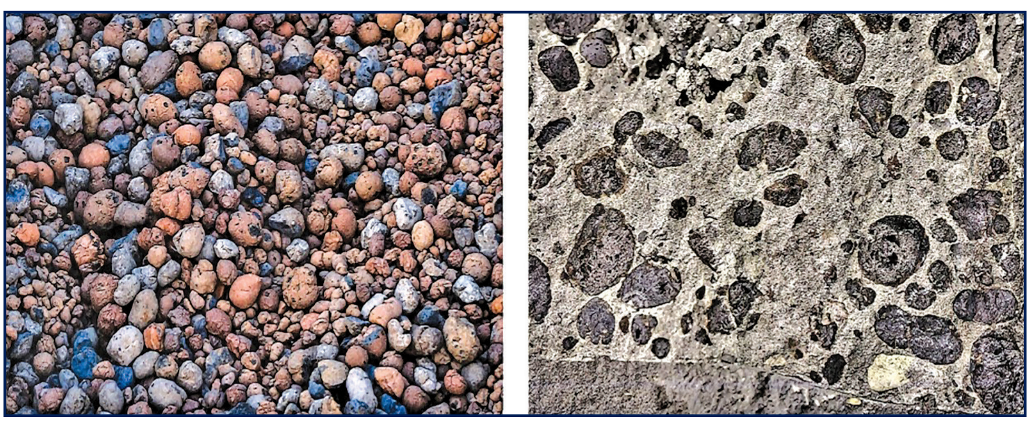

Figure 1. The expanded structure is produced by heating clay (left) or shale (right). At 90–120 lb/ft^3 (1400–1900 kg/m^3) density, Haydite concrete is considered a "lightweight structural" mixture because of the type of aggregate used.

ers to reach for greater heights. The evolution of lightweight structural concrete generated a more favorable avenue for building structures than for shipbuilding.

It can be seen that aggregates significantly affect concrete properties. Ranging from 90 to 120 lb/ft^3 (1400 to 1900 kg/m^3) density, Haydite is considered a "lightweight structural" concrete because of the aggregate used. **Figure 1** depicts the expanded structure, which is produced by heating clay or shale. Crushed slate and slag also found some use in lightweight structural mixtures. Other well-established trade names eventually came into vogue, such as Leca, Rocklite, Gravelite, and Aglite. Appropriate governing standards are:

- ASTM C33/C33M–18, *Standard Specification for Concrete Aggregates*, and
- ASTM C330/C330M-17a, *Standard Specification for Lightweight Aggregates for Structural Concrete*.

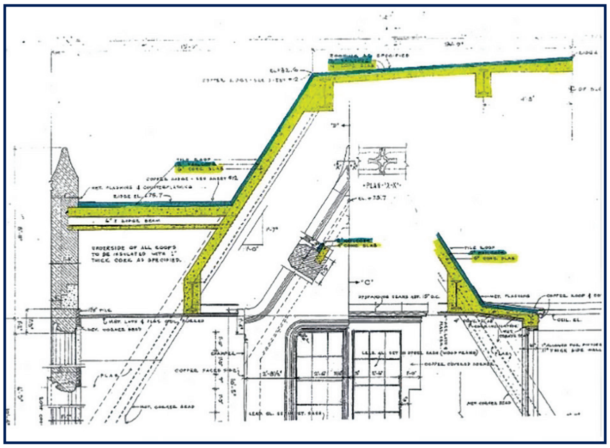

Figure 2. Section drawing of a 1930s structure where Haydite concrete (yellow) was used as the cast-in-place deck as well as over the steel framing. Nailcode topping (blue) is the "nailable" substrate for receiving the roof cover.

Figure 3. The underside of this deck shows the structural steel diaphragm (truss chords, web members, beams encased in concrete) on top of which the Haydite was cast, forming a monolithic arrangement and serving as a means of fireproofing. Residual cork material on the underside (described in original drawings as "insulation") was likely a bond-breaker for ease in stripping the forms.

Figure 2 depicts a section drawing of a 1930s structure where Haydite concrete (yellow) was used as the cast-in-place concrete deck as well as over the steel framing. Nailcode topping (blue) is the "nailable" substrate for receiving the roof cover. The Haydite concrete would still carry internal reinforcing steel in the ordinary locations for cast-in place concrete construction. The underside of the deck shown in **Fig. 3** shows the structural steel diaphragm (truss chords, web members, beams encased in concrete), forming a monolithic arrangement with the concrete deck and serving as a means of fireproofing for the steel. Cork material on the deck underside (described in original drawings as "insulation") was likely more of a bond-breaker for stripping the forms. Concrete bleed-through can be seen at regular intervals in the cork. At various rough openings (**Fig. 4** and **5**), the "speckled" shale aggregate is evident in the exposed section.

Nailcode was primarily placed as a topping course over the harder, non-nailable Haydite. Thickness of the Nailcode may vary as it could be used to introduce slope that was not present in the underlying Haydite. As viewed from above, **Fig. 6** shows the topping course extending from an internal gutter that transitioned to flat-seam copper at the apron of window dormers. Wet material was encountered at these locations, prompting remediation (asbestos abatement and localized repairs).[4]

Figure 7 depicts something of an unusual hybrid arrangement. This 1960s-era deck is

Figure 4. Note the bleed-through of concrete at regular intervals in the cork. At this subsequent rough opening, the "speckled" Haydite (shale aggregate here) is evident in the exposed section.

Figure 5. Another rough opening for a drain leader with better view of the old cork insulation (bond-breaker).

Figure 6. Nailcode topping extending from a gutter system that transitioned to flat-seam copper at the apron of window dormers. Wet material was encountered at these locations, prompting asbestos abatement and localized repairs.

Figure 7. Something of an unusual hybrid, this 1960s-era deck is lightweight concrete over a steel formboard. While containing Haydite aggregates, this concrete is not "structural" in nature. Like more modern lightweight insulating concrete, its load-carrying capacity is mostly from the metal form-deck used.

Figure 8. Notice this assembly was also fitted with reinforcing wire as would be encountered on old field-placed gypsum—and possibly some lightweight insulating concrete.

indeed lightweight concrete, but it was placed over a steel formboard. While containing Haydite aggregates, this concrete is not considered "structural" in nature. Like modern lightweight insulating concrete (LWIC), its load-carrying capacity is gained mostly from the steel form-deck. On these hybrid assemblies, reinforcing wire may be present (**Fig. 8**), as would be encountered on old poured gypsum—and possibly some LWIC as well. Aside from thorough underside examination, exploratory core sampling is particularly helpful when dealing with this type of roof deck. It is highly recommended that this material be tested for asbestos as part of due diligence (**Fig. 9**), especially regarding the Nailcode topping course; old hybrid assemblies such as these should be assumed as 'hot' and sampled and tested accordingly.

Figure 10 depicts a 100-year-old courthouse project having wood nailers embedded into the topping course. More accurately, these nailers were merely "stomped" into place while the concrete was still uncured. Considerable leveling/shimming was necessary prior to installation of new copper panels, and proper anchoring of new nailers required investigation of fastener holding capacity (that is, withdrawal resistance) (**Fig. 11**).

Figure 9. Core sample of a Nailcode topping course. It is highly recommended that this material be tested for asbestos as part of due diligence (during evaluation or design).

ASPECTS OF REROOFING

The topping course (Nailcode) does not contain the expanded aggregate and is intended as a nailable substrate for receiving the roof layers (that is, base-sheet, insulation, slate, tile, metal, etc.). It has a greater affinity for water absorption when compared to the harder, denser mixture of the Haydite. If the Nailcode is found to be in reasonably good condition, encapsulate it in-situ if possible, rather than removing (abating) it. This may be accomplished using site-mixed grout for small-scale repairs, or by adding a new skim coat of cellular concrete. Any necessary drainage improvements could be carried out during that procedure. Anticipate the potential for embedded nailers and their probable condition if the old roof was a leaker.

As outlined previously, the Nailcode was intended as the nailable layer, but some of these older placements can become very hard (some older gypsum decks have been found to have become so hard that hand-driven E-S nails

Figure 10. This 100-year-old courthouse had wood nailers embedded into the topping course, merely "stomped" into place while the mud was still green. Considerable leveling/shimming was necessary prior to installation of new copper roof panels.

were folding). It is advisable to open up and test for this condition rather than assuming it remains accepting of hand-driven/-set hybrid fasteners. Furthermore, it is advisable to rely on attachment to the structural deck, not the topping, unless testing validates that anchoring in the topping course is adequate. Following these precautions, any number of new coverings can be fitted to this deck type. Direct mopping (of hot bitumen) to the surface would necessitate a primer, and likely some moisture testing as well by one of several recognized methods. Alternatively, a base sheet could be nailed using caps or plates followed by desired layers of insulation and the membrane plies. Modern low-rise foam adhesives are also available for securing components of the new roof, although a dusty surface would diminish the good adhesion capabilities otherwise available.

This deck type, having the dual layers outlined previously, underscores the importance of conducting examination of *both the top and bottom* surfaces. Investigative coring into the topping only may suggest the deck is poured gypsum, especially since sawdust may have been used in the Nailcode mixture (wood shavings are present in most gypsum decks).[5] Selecting fasteners for a new roof based on incorrect deck identification would prove embarrassing once the work begins. When in doubt, figure it out; always deploy pull-testing to evaluate whatever fastening devices are being considered for this type of substrate (**Fig. 12**).

Figure 11. Proper anchoring of these new nailers required investigation of fastener holding capacity (withdrawal resistance).

Figure 12. When in doubt, figure it out. Always deploy pull-testing to evaluate whatever fastening devices are being considered for this type of substrate.

SUMMARY REMARKS

Although lightweight structural concrete is still quite popular for many modern applications, Haydite roof decks are far more likely to be encountered on older buildings and structures. For more than a century, heat-expanded aggregates have been used successfully in lightweight concrete masonry units, high-rise buildings, bridge decks, paving surface treatments, soil conditioner, and lightweight geotechnical fill material. The Expanded Shale, Clay and Slate Institute (ESCSI), founded in 1952, is the international trade association for producers of lightweight aggregate.[6] IIBEC

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NOTES AND REFERENCES

1. Brenner, T.W. and John Ries, *Concrete International*, August 2009, pp. 35–38.
2. The substandard weathering performance of pinks or salmons is well recognized in the brick manufacturing industry. See "Technical Notes 15 - Salvaged Brick," The Brick Industry Association.
3. Brenner, T.W. and John Ries, *Concrete International*, August 2009, pp. 35–38.
4. Author Kilpatrick recalls a university building being demolished some years ago. The due-diligence study failed to recognize and address the Nailcode (positive for asbestos), and a $2-million change order became necessary. The entire project had to be "tented" from the gutter line up, with suits and respirators deployed for the remediation.
5. Hogan, L.D., "Roof Decks, A to Z; Part 4: Poured Gypsum," *Interface*, October 2012, pp. 7–12.
6. Expanded Shale, Clay and Slate Institute (ESCSI), Chicago, IL, www.escsi.org/escs-lwa/

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Through his 36 years of uninterrupted service with Inspec, Donald Kilpatrick has been privileged to witness a wide variety of existing conditions in our built environment. His customers have come to appreciate his expertise and client-centric, hands-on approach of project management from design to construction. Kilpatrick has been a regular contributor to IIBEC Interface *and is a winner of the Horowitz Award.*