ROOF DECKS A to Z

Part 4: Poured Gypsum

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ABSTRACT

This is the fourth in a series of articles examining various deck types. Among the numerous considerations when selecting a roof system, the type of decking 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 features of poured gypsum.

In decades past, poured gypsum enjoyed a significant niche of the roof deck marketplace. Such assemblies were credited with excellent fire performance and low sound transmission, and they were quite compatible with built-up roofing, the apparent system of choice at the time. They are rarely seen in new construction of modern projects, however, and that increasing obscurity is the cause for confusion on several fronts. The author has often witnessed this type of deck being mistaken for other cementitious substrates. As poured decks go, gypsum may indeed be lighter weight than structural concrete, but it is by no means lightweight concrete, vermiculite concrete, or insulating concrete and should not be confused with these. There are several ways to distinguish gypsum decks, and positive identification should certainly be made before fasteners and coverings are selected.

For instance, there are three principal types of formboard used for gypsum decks. They are 1) compressed fiberglass, 2) compressed wood fiber, or 3) gypsum formboard (similar to drywall). These may occasionally be arranged in more than one layer. (Asbestos planks have also been used as formboards on some occasions—especially along eave overhangs—so the diligent practitioner would take notice.) Formboards are carried on a system of iron subframing girts called bulb tees, truss tees, or cold-rolled tees, which are situated across primary framing supports—usually steel (*Figure 1*).

The aggregate for gypsum is also unique: there is none. The product is really nothing more than plaster of Paris; there is no sand, no air entrainment, no vermiculite, and no coarse aggregate. Instead, wood shavings (particles) are mixed into the slurry, serving only as an extender. Slicing through a sample cut will reveal this under close examination. This is unique to gypsum and will not be found in other poured cementitious products. If sand is included in the mix, the product is a hybrid of some type and is referred to as gypsum concrete. Such material was used in floor assemblies in wood-framed construction and possibly elsewhere; it will probably contain sand as well as Portland cement. Meanwhile, the term "poured gypsum" will be reserved in this article to describe roof decks exclusively.

Strength and physical properties are also unique. Gypsum has approximately 500 psi compressive strength minimum but can range to 1,200 and beyond (depending on the mix as described above). This is in contrast with lightweight insulating concrete (LWIC; 125-250 psi) and structural concrete (2500-4000 psi and beyond). It can be scratched with a knife, but cutting or coring requires saws or drills. A similar distinction can be drawn by evaluating product density. Gypsum has 30-55 pcf dry density as opposed to LWIC (less than 50 pcf by definition—usually considerably less in practice), lightweight structural concrete (~110 pcf), and ordinary structural concrete (150 pcf). Some older gypsum decks have been found to be quite hard, sometimes bending or deforming the driven fasteners commonly used in base sheet application. Auger-type fasteners will have to be predrilled, and

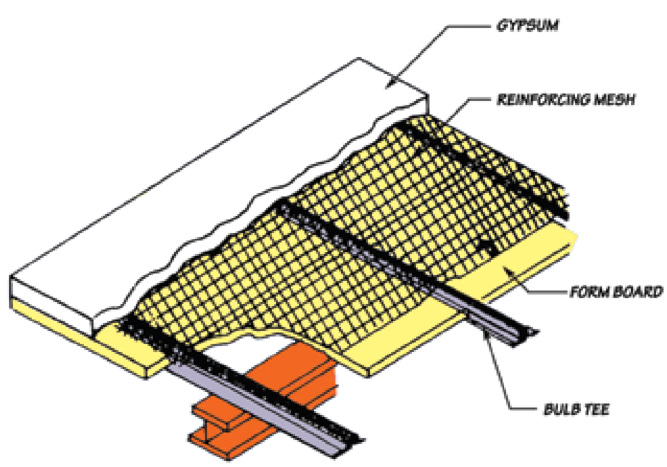

Figure 1 – Formboards are carried on iron subframing girts called bulb tees, truss tees, or cold-rolled tees, which are situated across primary framing supports (image courtesy of Ted Michelsen).

Figure 2 – Although agricultural-type chicken wire may be found, welded wire mesh is the more common reinforcement.

on-site pull testing should be implemented when using anything other than ordinary base sheet fasteners described below. Even then, pull testing is a worthwhile exercise.

Being plaster of Paris, the material sets very quickly (~15-18 minutes), liberates heat while curing (30-40 degrees higher than ambient), and increases slightly in volume (~1%).[1] Regarding fasteners, poured gypsum is classified as a nailable deck, although ordinary roofing nails are appropriate only for precast gypsum planks, which will be addressed in a later installment in this series. Specialty fasteners for low-slope roofs have been around as long as gypsum decks have been used. They are usually in the form of expanding, driven devices used for securing a base sheet (i.e., Simplex and ES Products).

Poured gypsum will almost always have embedded reinforcing of some type. Welded wire mesh (*Figure 2*) is the more common reinforcement, although agricultural-type wire resembling chicken wire (*Figure 3*) has been used on occasion. LWIC may contain chicken wire, but it is uncommon and probably unnecessary. The author has never encountered welded wire in LWIC or LWIC placed over the formboards described earlier; readers who think they have seen such construction may be seeing a hybrid configuration and should check the aggregate type and strength properties of poured slurry.

Just as with wood decks, structural cement fiber, and LWIC, ply sheets of a bituminous membrane should not be hot-mopped to the surface. Instead, a base sheet should be fastened according to wind speed parameters for the particular area. At that time, a host of roof systems can then be configured to satisfy the project requirements. Once a base sheet is installed, the surface is ready to receive any number of roof assemblies. The fastening pattern shown in *Figure 4* is one of several that can yield desired uplift resistance. Attachment in the manner shown will yield 98 fasteners per square; a stag-

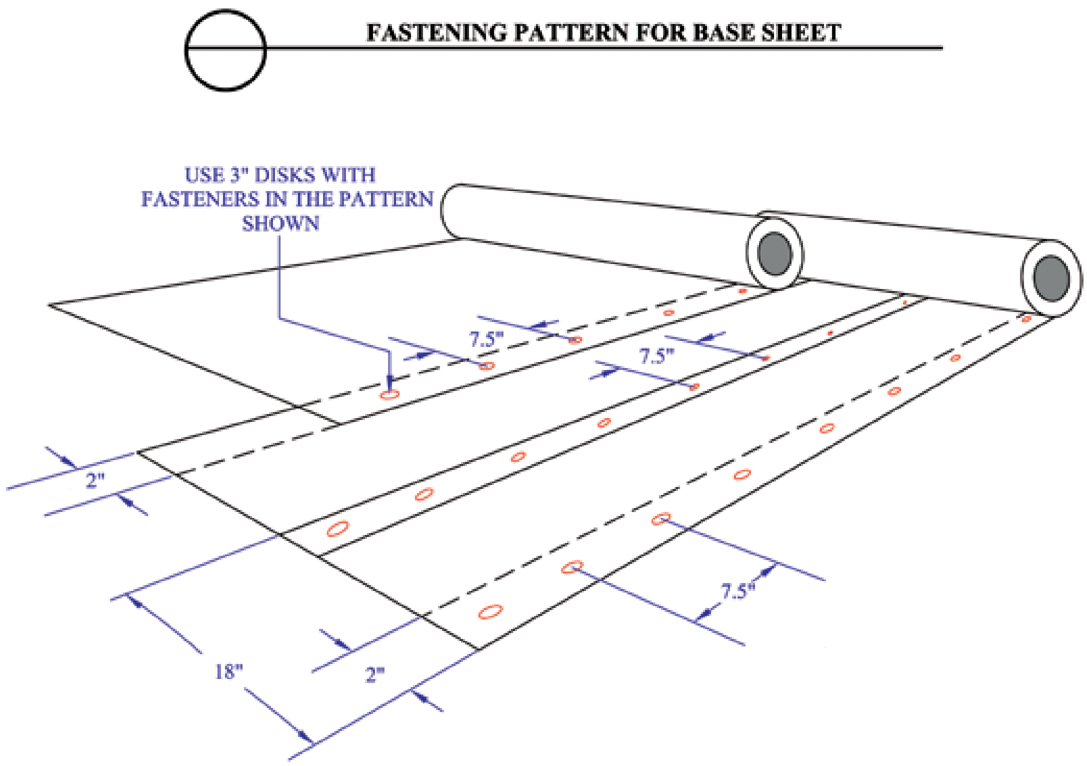

Figure 4 – The fastening pattern shown will yield 98 fasteners per square; a staggered arrangement can also be configured if desired.

gered arrangement preferred by some product vendors will yield the equivalent pattern. In zones of high wind speeds, a slightly denser pattern, together with large-diameter stress plates, should be incorporated for code compliance.

Prolonged exposure to entrapped water will compromise all properties of gypsum, including fastener withdrawal resistance. Trying to get good fasteners into wet gypsum is like trying to nail gelatin to a wall. Even specialty fasteners will not yield satisfactory results in a water-compromised deck (*Figure 5*); beyond this, drying (to the extent such procedure can be carried out on occupied buildings) will not restore strength properties of a deck that has been wet for prolonged periods.

Most of the load rating is derived by the spacing and size of subframing elements. Gypsum roof decks are a composite system whereby load-carrying capacity is the sum of the poured slurry, internal reinforcement, and some minor contribution by the formboards. When there is compromise to these components, there is corresponding reduction in loading capacity. Repairs to a gypsum deck can, of course, be made by mobilizing for replacement in kind; however, since that is often cost-prohibitive for a small setup or random spot repairs, site-mixed pourable grout (*Figure 6*) is available through vendors such as Pyrofill by U.S. Gypsum. The National Roof Deck Contractors Association (NRDCA) elaborates on this type of work with

Figure 5 – Fastening into wet gypsum is like trying to nail gelatin to a wall. Even specialty fasteners will not yield satisfactory results in a water-compromised deck.

Figure 6 – For small random repairs, site-mixed pourable grout is available through vendors such as Pyrofill by U.S. Gypsum (figure courtesy of NRDCA).

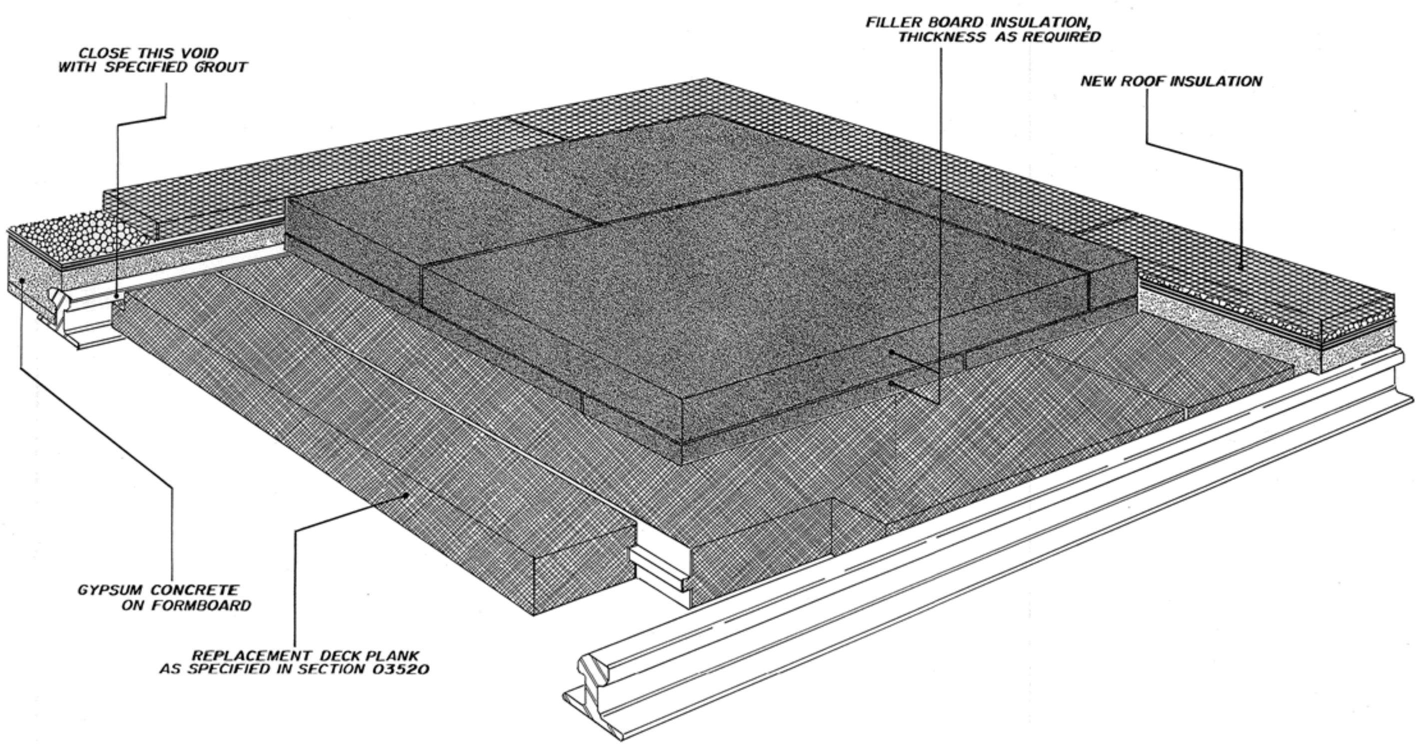

Figure 7 – Where found to be nonsalvageable, small regions can be repaired using structural cement fiber planks, provided they are tightly fitted and nested against the bulb tees.

Figure 8 – Gypsum deck needlessly damaged through reckless rooftop practices.

an excellent illustration.[2] Where found to be nonsalvageable, small regions can also be repaired using structural cement fiber planks, providing they are tightly nested against the bulb tees (see *Figure 7*).

During reroofing, caution should be exercised with demolition and installation equipment in modern use. These decks perform because of the monolithic nature of the pour, so uniform loading (such as by snow loads) is usually accommodated. But concentrated loads by wheeled equipment and stockpiled materials can damage the assembly. *Figure 8* depicts a gypsum deck needlessly damaged through reckless rooftop practices. Since most old built-up roofs were applied directly over gypsum without board insulation layers, cutting the felt plies should proceed with caution, as the roof-cutter depth must be regulated with

Figure 9 – Most old built-up roofs were applied directly over gypsum without a board insulation layer, so roof-cutter depth must be regulated with caution. (Image courtesy of Bruce Darling.)

Figure 10 – Gypsum is a mostly vintage form of decking, and many are still around. Those not suffering from deferred maintenance may be performing admirably.

accuracy (*Figure 9*). Deck construction from 50 years ago anticipated only moderate live loads such as mop tubs, hot luggers, and the like. However, modern tear-off equipment, 1,200-lb. rolls of rubber, and grouped pallets of insulation were not anticipated in the designs of that time.

Further to the notion of loading, older gypsum decks sometimes have very little slope. Even where discernible slope was provided, there are often dead flat areas between drains and ponding water. As a consequence, drainage improvements with tapered insulation (or crickets at a minimum) are often necessary, along with added insulation for energy-code compliance. These measures, as well as snowdrift considerations, necessitate review of loading capacity by a structural engineer.

SUMMARY REMARKS

Poured gypsum is mostly a vintage form of decking; many are still around, and those not suffering from deferred maintenance (*Figure 10*) may indeed be performing admirably. Several of the foregoing photos may appear unflattering, but no attempt is being made here to portray gypsum as flawed or prone to performance maladies. Indeed, the author has direct knowledge of WWII-era gypsum decks performing well to this day. Yet, in the course of a consultant's works, neglected roof decks are sure to be encountered, and gypsum is perhaps less forgiving when plagued with ongoing leakage, deferred maintenance, overloading, and the like.

REFERENCES

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2. http://www.nrdca.org/webfiles/GypsumRepairPictures.pdf.

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