

Cost-Effective Concrete Floors

Strength, durability, sound attenuation, and thermal mass make concrete the right choice for floors in residential and light-commercial buildings

By Pieter VanderWerf and
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Suddenly, whoever wants to install a short-span concrete floor deck has several good choices.

Five years ago, all concrete floor systems with spans of up to 20 feet had been adapted from commercial construction. They provided more than sufficient structural strength, but in small structures they were generally too expensive and logistically challenging. In a large commercial project using experienced crews and heavy equipment, floor systems like precast hollowcore plank and composite steel deck can be installed for as little as \$5 per square foot. In smaller applications, however, installation of bulky concrete decks is less efficient, and costs typically exceed \$10 per square foot. In contrast, wood-frame floors in small structures run about \$2.50 to \$4.50 per square foot. Concrete floors were therefore attractive only to customers willing to pay a big premium or those who had special requirements.

But now four floor systems are well suited to small buildings. All incorporate components that can be positioned by one or two workers and can be easily modified in the field without highly specialized tools or equipment. Yet these systems are engineered to provide adequate strength for floor decks with clear spans of up to around 20 feet.

The new floor options have appeared along with rapid growth in the construction of small concrete buildings. Since the early 1990s, concrete's share of single-family homes rose from about 3 percent to nearly 15 percent. The owners often chose walls of concrete because they preferred its properties to wood. Strength, durability, and sound attenuation are some of the major drivers of this growth. We now see these same benefits driving the increased use of concrete floor systems.

Concrete floor systems are new enough that their specifications will change as designs are improved and as crews invent new installation techniques. Currently, costs are difficult to discern, with crews reporting widely varying installation costs for the same system. Much of this appears to be a result of differences in crew experience, implying that the eventual cost may tend to settle toward the lower end of the range.



Life-Form Technologies

Elevated concrete floors for residential construction complement the increasing use of concrete walls.

Corrugated steel deck

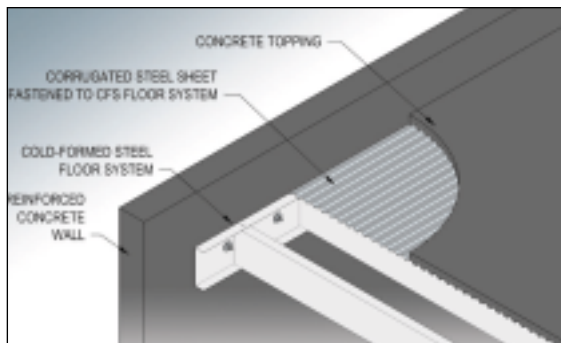
One of the simplest ways to build a concrete floor is by replacing wooden floor sheathing with shallow, corrugated steel deck and topping it with concrete. This system can be supported by a conventional light-gauge steel floor frame, or it can go over wood frame. In either case, the framing has to be designed to bear the additional weight of the steel-and-concrete.

Most steel deck manufacturers produce sheets with $\frac{9}{16}$ -inch-high corrugations designed to span short distances. The sheet is screwed to joists spaced up to 2 feet on center with the resulting deck able to support workers and a permanent layer of concrete. The topping may be as thin as 1.5 inches, and reinforcement is optional because it serves only to control cracking. Utilities and wallboard for the ceiling below are installed the same as in typical wood-frame buildings.

Few of these floors have been constructed in very small buildings, so cost data is scarce, but in principle this should be one of the least expensive concrete floors. The steel decking sells for 20¢ to 25¢ per square foot, and the quantity of concrete required is small. The light components, simple assembly steps, and lack of required bracing suggest low labor costs, although the need to build stronger framing will add to the cost.

Light steel joist composite deck

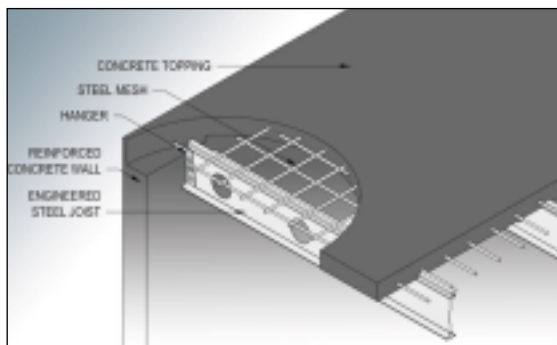
With the steel joist composite deck



A light-gauge steel floor frame supports concrete over a corrugated steel deck.

systems, the crew sets special cold-formed steel joists and pours a layer of concrete on top. A deformed flange along the top of the joists is embedded into the concrete, providing a composite steel-concrete structure that reduces the amount of other reinforcement necessary.

Architectural/Residential Technologies (ART) of Batavia, Ohio, mar-



Light steel joists form a composite with the concrete floor.

kets a version of this system called Speedfloor that it imports from the manufacturer in New Zealand. Representatives of the Hambro division of the Canam Manac Group, a construction engineering and products company based in Canada, claim to have under development a similar system that may be released soon.

Crews cut the Speedfloor joists to length and bolt heavy “hangers” to the ends. The hangers rest on the concrete walls to support the joists. Workers space the joists slightly more than 4 feet on center; then, through small holes in the joist web, they insert “roll bars” that span crosswise between the joists. Next they set 4x8-foot sheets of plywood between the joists, supported by the roll bars. Finally, they lay mesh over the flanges, position it above the plywood forms, and cast concrete on top. After the concrete is set and cured, the

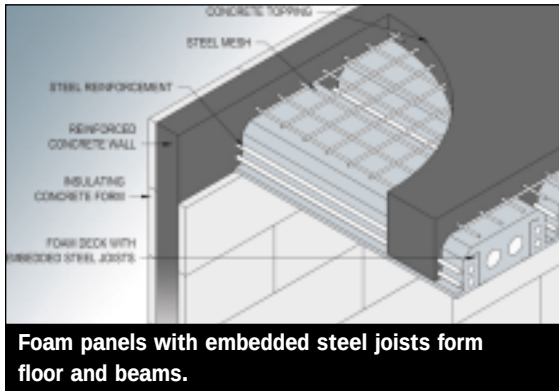
roll bars are removed, and the plywood sheathing drops out. There are also larger holes in the joist webs that allow utilities to go through the framing as well as parallel to it. To attach drywall below, crews first fasten strapping to the joists.

Much of the attraction of Speedfloor is its efficient use of labor and materials. The joists are light enough for one or two people to set, and the only added reinforcement is the mesh. The joists and plywood are easy to cut, the plywood can be reused, and there is no intermediate bracing required during construction. The investment in roll bars and the need to strap below are minuses. U.S. contractors who have installed the system report a total installed cost of \$6 to \$8 per square foot.

Foam form deck

Foam form decks use materials similar to those in insulating concrete forms (ICFs) for walls. Currently most foam decks are used with ICF construction, but the systems have been used in Europe for more than 2 decades on various structural frames. They have a unique characteristic: they simultaneously form the supporting beams and the deck.

In the late 1990s, Plastedil of Switzerland formed Insul-Deck to manufacture its foam-and-steel floor forming system. A similar product called Lite-Deck is sold by Lite-Form Technologies. Although the Insul-Deck and Lite-Deck systems have different dimensions, both consist of thick foam panels that serve as a concrete floor form. Inside the foam are light-gauge steel “joists” running the length of the panel. The top of the foam is corrugated, with beam pockets that are 6 inches deep and 4 inches wide, spaced 1 foot on center. The suppliers offer deeper versions of the product for floors of longer spans.



Foam panels with embedded steel joists form floor and beams.

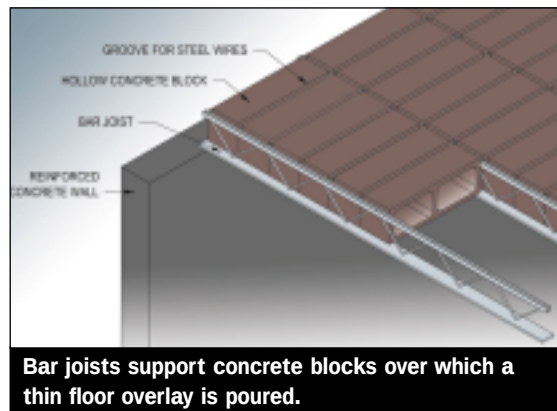
The crew sets the forms, bracing them underneath about every 6 feet. Workers can walk on top but not in the beam pockets. Rebar goes on chairs in the pockets, and mesh goes on chairs on top. Concrete is cast and finished to a depth of about 3 to 4 inches over the top of the foam. After the concrete sets and cures, the bracing is removed.

Crews make space for fixtures and utility lines by cutting into the foam from below. Insul-Deck panels have hollow cores that may reduce the cutting needed. Running utilities perpendicular to the concrete beams is, however, much more difficult. Drywall attaches directly to the joists underneath.

The panels are light and easy to cut. New crews that are not set up to do a lot of these floors report installed costs of \$10 to \$15 per square foot. Experienced, higher-volume users claim that they can get well below \$10. Currently, contractors pay \$3 to \$4 per square foot for the foam panels.

Block and joist deck

With a system called Block Joist, workers set concrete blocks on top of welded steel bar joists to create a composite floor. They cast grout between the blocks and onto the joists to lock everything into place. They can vary the properties of the floor by using different blocks, joist spacing, reinforcement, and concrete toppings.



Bar joists support concrete blocks over which a thin floor overlay is poured.

Similar floor systems have been sold for decades, but inventor Pat Ellison of Virginia set out to make them more practical. The result was Block Joist, which now has licensed producers in several Mid-Atlantic states.

The joists are 7 inches deep. The bottom chord of each is set on top of the concrete wall. The joists are spaced at 16 or 24 inches on center, depending on which blocks are used. The blocks go between the joists, with the ends resting on the wider bottom flanges. Standard installation calls for a special block with a groove along the top edge. This creates a continuous recessed joint between the blocks that runs perpendicular to the joists. The crew sets a reinforcing wire into these grooves and tops the entire floor with a thin grout. The grout runs down into these joints and encases the wires in the joints running side to side. The grout is also spread thinly on top of the blocks to create a smooth floor surface.

Enterprising users have developed modifications to this system. Some use ordinary concrete blocks without the special groove and with no wires. While this method has some strength limitations, it saves materials and time.

Utilities can be run within the block cores, which line up. Drywall for ceil-

ings can attach to strapping fastened to the underside of the joists.

When the floor deck is at ground level, all pieces can be carried by hand. In these circumstances, experienced crews report that the cost of labor and material for a floor with 24-inch spacing of joists is around \$7 per square foot. For an elevated deck with 16-inch blocks and a heavy topping the cost can rise to \$10 to \$15.

These four floor systems provide a range of properties to suit almost every purse and purpose. They are more expensive than a traditional wood-frame floor, but so are concrete walls more costly than wood-frame walls, and yet they are gaining share rapidly because they provide greater strength, consistency of materials, durability, sound attenuation, and thermal mass. Now concrete floors are becoming popular for the same reasons. ■

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For more information on the systems described in this article, circle the appropriate number on the reader service card, or contact the companies directly.

■ Corrugated steel deck: A list of manufacturers is available from the Steel Deck Institute at www.sdi.org.

■ Architectural/Residential Technologies (Speedfloor), 877-278-8802, www.arit.com, or **circle 7**

■ Insul-Deck is available through the following ICF manufacturers: American Polysteel, 800-977-3676, www.polysteel.com, or **circle 8**; Arxx Building Products, 800-293-3210, www.arxxbuild.com, or **circle 9**; Quad-Lock Building Systems, 888-711-5625, www.quadlock.com, or **circle 10**; Reward Wall Systems, 800-468-6344, www.rewardwalls.com, or **circle 11**.

■ Lite-Form Technologies (Lite-Deck), 800-551-3313, www.liteform.com, or **circle 12**

■ Block Joist Company, 804-285-1250, www.blockjoist.com, or **circle 13**