Antiquated Structural Systems Series

Part 5

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This article is the fifth in a series that is intended to provide a resource of information to structural engineers for projects that involve the repair, restoration or adaptive reuse of older buildings for which no drawings exist.

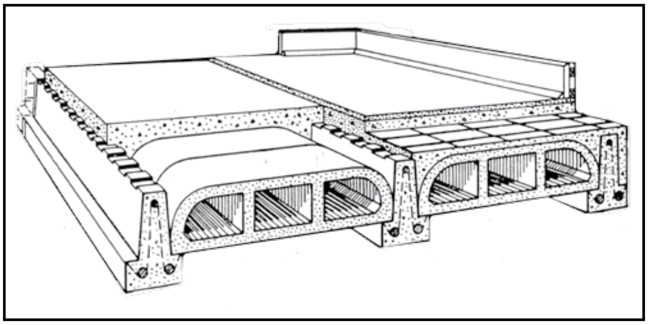

Figure 1: F&A System.

The purpose of this series is to compile and disseminate a resource of information to enable structural engineers to share their knowledge of existing structural systems that may no longer be in use, but are capable of being adapted or reanalyzed for safe reuse in the marketplace of today and the future.

Precast Concrete Framing Systems

As discussed in the last article in this series, many contractors prefabricated modular clay tile and masonry units off-site into beams and slabs that could be delivered to the job site. This method of construction ultimately progressed to solid precast concrete units, which is the topic of this article.

In the 1950s, one of the most prevalent precast concrete system in general use was the F&A System. This system (see *Figure 1*) used conventionally reinforced precast concrete inverted T-joists spaced at 28 inches on center, which supported concrete block filler slabs. The entire assembly then received a 2-inch, cast-in-place concrete topping, which acted compositely with the precast joists. Prior to the F&A System, Peter Rutten developed and patented a similar system in the 1930s (see *Figure 2*).

The F&A precast joists were available in depths of 6, 8, 10 and 12 inches, and were capable of spanning anywhere from 6 feet to 36 feet for load capacities from 30 to 900 pounds per square foot, depending on the span, depth of joist and reinforcement. The ends of the precast joists could be cast integral with a site cast concrete beam, or bear directly on either precast concrete girders or steel beams. The F&A System included filler blocks that could be either placed flush with the bottom of the joist or recessed at the same level as the bearing ledge of the joist.

Similar precast concrete systems that were in use during the same approximate time period included Tee joists and Keystone joists. Tee joists (see *Figure 3*) came in depths of 16 and 20 inches and were typically prestressed. Keystone joists (see *Figure 4*) were available in 8- and 12-inch depths and could

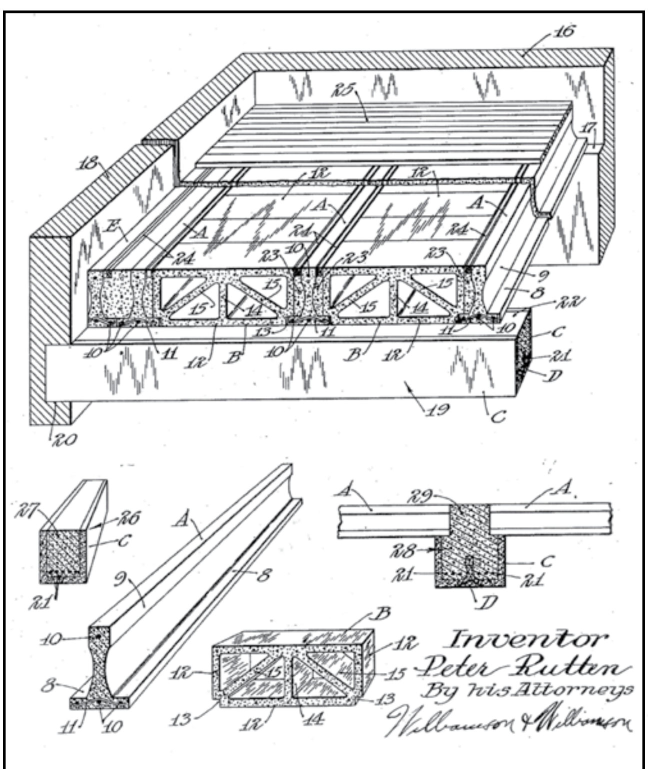

Figure 2: Rutten System.

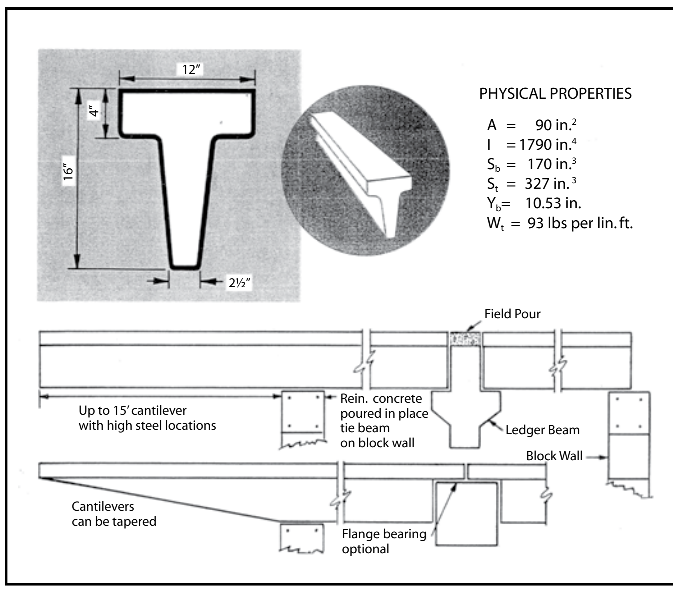

Figure 3: Tee Joist.

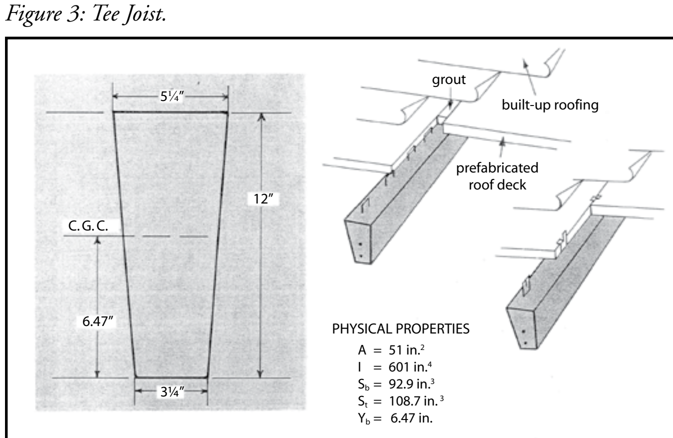

Figure 4: Keystone Joist.

be either conventionally reinforced or prestressed. Tee joists ultimately evolved into Single Tees, Quad Tees and the Double Tee member that is still in common use today.

Channel Slabs were another prevalent precast concrete member in the 1950s. These were typically used for roof construction between supporting precast beams or steel members. he slabs were typically 24 inches wide and 1 inch thick, with 3½-inch-deep by 2-inch-wide, downturned edge "flanges". This product was capable of spanning up to 9 feet and supporting up to 60 pounds per square foot of superimposed load.

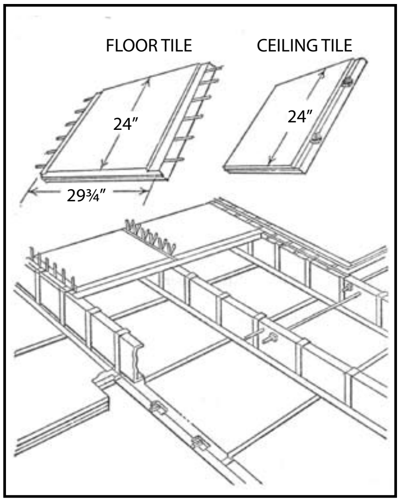

Figure 5: Gypsteel Floor & Ceiling Slab.

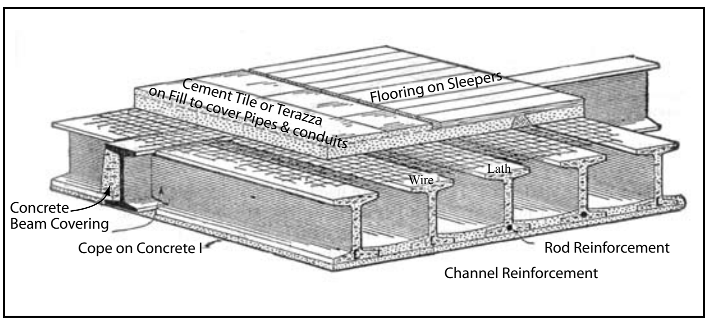

Figure 6: Waite's I Beam.

Examples of other proprietary precast systems that are no longer in use include:

Gypsteel Floor and Ceiling Slabs (Figure 5): The floor slabs of this system consisted of 24-inch-wide, 2½-inch-thick molded precast gypsum, reinforced with cold drawn wires that projected from the coped or rabbeted bearing ends of the panels. The wires were twisted together with the adjacent panel end and the slot was then filled with grout for a smooth top finish. These slabs were premanufactured to span both 24 inches and 30 inches between steel support framing members. Ceiling slabs were 24-inch-wide, 2-inch-think molded precast gypsum, reinforced

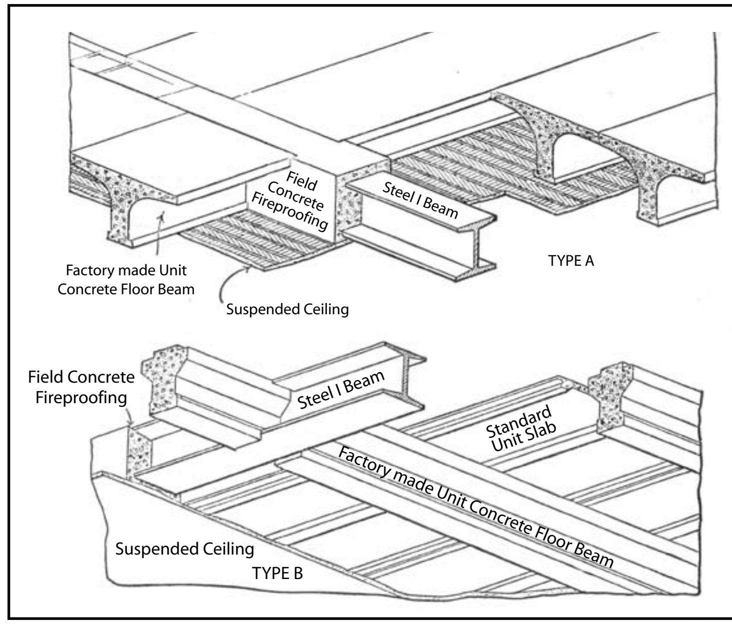

Figure 7a & 7b: Watson Floor System.

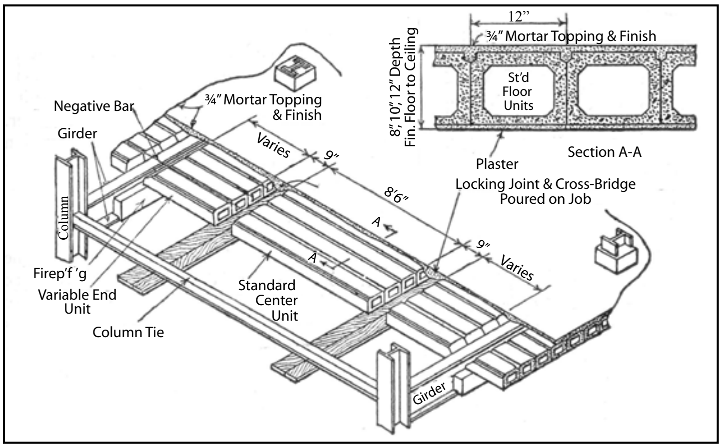

Figure 8: Miller System.

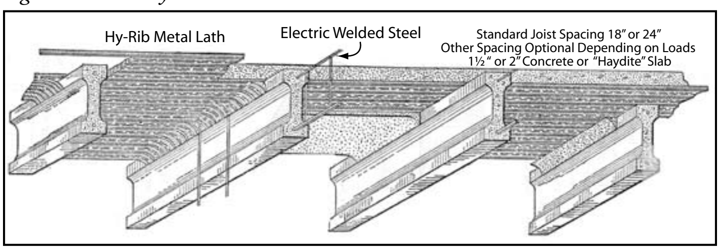

Figure 9: Lith-I-Bar System.

with flat steel bars that projected from the ends of the panels to act in conjunction with hangers suspended from the top flange of the supporting steel framing. The Gypsteel system was manufactured in New Jersey and used extensively in New York City.

Waite's Concrete I Beams (Figure 6): This system was used in a number of buildings constructed by The Standard Concrete Steel Company of New York City. The floor framing system consisted of precast concrete I-beams spaced at approximately 18 inches on center of either 10-inch or 12-inch depth, which were supported from the bottom flange of steel beams that were spaced 5 to 7 feet apart. A field-cast concrete topping was then placed on top of the I-beams, while the spaces between the lower flanges were infilled, as well, to provide a flat ceiling surface.

Watson Reinforced Concrete Floor System (Figures 7a and 7b): This type of precast construction was installed by the Unit Construction Company of St. Louis and included two types of framing. The first configuration was intended for long spans and heavy loads, and involved the use of precast T-sections placed side by side. The T-sections were supported by steel beams that were encased in concrete. For shorter spans (less than 20 feet) and loads of 200 pounds per square foot or less, precast beams spaced at 5 feet on center were used to support precast channel slabs. The precast beams were in turn supported by steel beams encased in concrete.

Miller Precast System (Figure 8): This system was devised by the Precast Floors Corporation of New York in 1929. The precast units were shipped in three separate segments, which were aligned and supported on temporary shoring at the job site. Projecting reinforcement at the interior ends of the segments was embedded in a dry mix concrete, which was used to fill in the 9- to 10½-inch-long gaps between the segments. The center segment was produced in a standard fixed length, while the end segments were produced in varying lengths to allow for adjustment to accommodate different span lengths. Negative moment reinforcement was then embedded in a field-cast topping for continuity across the supporting steel beams. The voided, 12-inch-wide, box-shaped units were produced in 6-, 8- and 10-inch depths.

Lith-I-Bar System (Figure 9): This system was developed in Michigan and involved a dry-mix, lightweight concrete that was placed in an I-shaped cross-section mold and compacted with cast-iron rollers. The

units were typically spaced at 18 or 24 inches on center with a 2-inch field topping cast on either removable or stay-in-place metal lath formwork for composite action with the members.

Porete Floor System (Figure 10): This system was manufactured in New Jersey and consisted of precast hollow formed units of 4 to 6 feet in length. This system was similar to the Miller system in that units were aligned and supported on temporary shoring at the job site. The gap between the abutting aligned units and the continuous pocket along the sides of each unit, in which field-positioned bottom reinforcement was first placed, were then filled in with a mortar/grout. All of the units were closed at each end to prevent the mortar/grout from flowing into the hollow voids of the precast member. These units were typically supported by steel beams over which top reinforcement was positioned in the continuous member pockets to provide continuity of the floor slab system. This precast system was capable of spans from 10 to 25 feet.

Tee Stone System (Figure 11): This precast member could be used as a floor beam, roof beam or wall panel and was originally manufactured in New York. The T-section was 8 inches deep, with a 16-inch-wide flange and a 1-inch-wide stem, and was manufactured in standard lengths of 8 and 16 feet. For floor construction, the T could be installed in either a flange up or flange down position. The units were placed in the field with a 1-inch gap between the edges of the flanges, which was filled with grout. The flange mesh reinforcement extended into these continuous gaps to produce a monolithic slab.

Pyrobar Precast Roof System (Figure 12): This cast gypsum system was manufactured for use as a roof slab and was available in both 3-inch-deep solid and 4-inch-deep hollow-core sections for short-span applications, as well as 5- and 6-inch hollow-core sections for long-span applications. The short-span sections were made in 12-inch widths and 30-inch lengths. The long-span sections were made in 18-inch widths and lengths from 4 feet to 6½ feet. The short-span members were typically supported by steel bulb tees, while the long-span members were supported by underslung steel wide flange and channel beams.

All of the above precast systems were designed based on the basic reinforced concrete beam analysis theories of their era. Load tables were also commonly developed and published by most of the manufacturers. The problem with all of the above systems when one encounters them in a building today is that, in the absence of existing drawings, it is difficult to determine the internal reinforcement and, consequently, the load-carrying capacity of the system. However, it is hoped that this article, by identifying the many different types of products that were in use at one time or other, will assist readers in their research of an antiquated or archaic system when it is encountered in an existing structure.▪

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Future installments of the archaic structural systems series will cover post-tensioning systems; structural steel stub-girder; open web steel joist and cast iron construction. If there are other topics along these lines that you would like to see addressed, please send your suggestions and any relevant information that you have to the author.

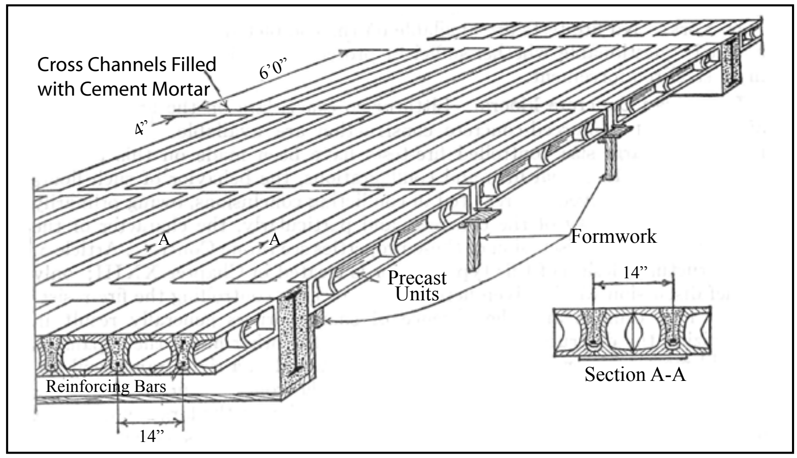

Figure 10: Porete Floor System.

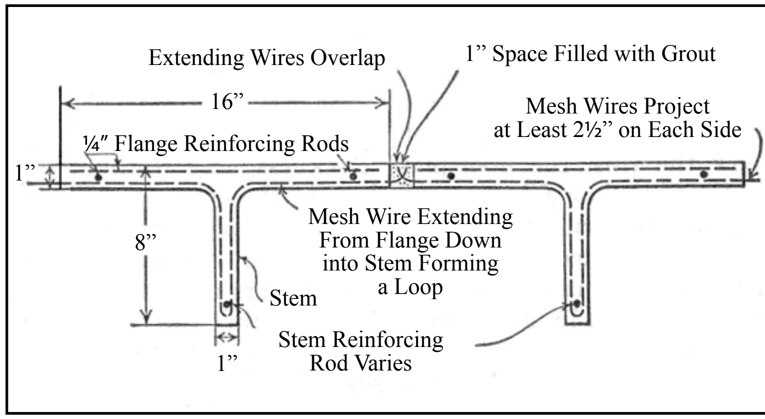

Figure 11: Tee Stone System.

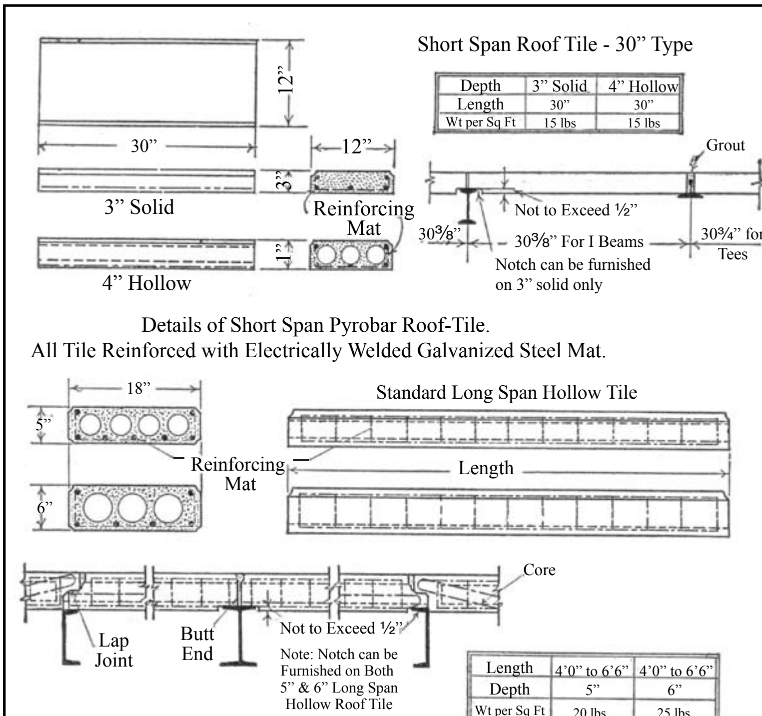

Figure 12: Pyrobar Roof System.

References

Kidder, Frank E. and Harry Parker, Architects' and Builders' Handbook, 18th Edition, John Wiley and Sons, 1956

Specification and Load Table Archives, Nitterhouse Concrete Products, Inc., Chambersburg, PA