Let's Be Plank...

BY TODD ALWOOD

Plank experts offer a few things for the structural engineer and fabricator to keep in mind when designing projects involving plank.

THERE ARE PLENTY OF GENERAL DISCUSSIONS OUT THERE ON CONCRETE PLANK AND ITS ADVANTAGES—LOWER FLOOR-TO-FLOOR HEIGHTS, FAST ERECTION, ETC. But what about the specifics?

I chatted with Phillip Iverson, P.E., Director of Business Development for Spancrete of Illinois, Inc., about plank issues that every structural engineer and fabricator (and detailer and general contractor!) should keep in mind when they begin their next plank job. Here are the highlights.

Know Your Plank

There are three general types of plank, based on their method of manufacture. Each type of plank can be used in a wide variety of projects.

Wet-cast plank offers a lot of design flexibility. The plank is wet-cast within a form, and collapsible tubes are placed within the plank to provide regularly spaced cores. This product can accommodate top and bottom embed plates, special block-outs, and specific forming requirements for complicated layouts during the casting process.

Slip-form casting is also very flexible. The plank is made of a very dry concrete, which has almost zero slump. The concrete is placed into a hopper and mechanically vibrated onto curing beds. Within the hopper are tubes that form the cores inside the plank as the slip-former moves down the bed; they are pulled out during the forming process by the machine, thus permanently forming the cores within the plank. Bottom embed plates are placed during casting, but top plates and block-outs are installed after casting before the concreted has cured.

Extruded plank is produced from an extremely dry concrete mixture. The concrete is squeezed though the machine using a hydraulic and auger-driven system. The force of the extrusion process propels the machine down the curing bed. With this method, embed plates and block-outs are added by hand after the extrusion process but before the plank has completely cured.

Plan for Bracing

When diaphragm loads are to be transferred or plank connections are needed to brace a beam, then those loads should be noted on the construction documents. Iverson recommends that the design professional note the function of the connection and specify a resistance, since he has observed many professionals note an arbitrary spacing, which is costly and overly conservative. For hollow-core plank, load-carrying connections are typically bottom embed plates that are welded to the supporting steel after erection.

Both service and erection loads need to be considered in the design of any structure, and Iverson notes that the majority of the time, the W-section supporting the plank can be stiff enough to support the unbalanced erection loads. Of course, the structural engineer of record or the erection engineer (usually hired by the fabricator) are required to check and confirm this before erection. If the beam is not stiff enough, then embedded plates could be used to attach the plank to the top flange and brace the beam during erection. Otherwise, alternate bracing would need to be considered.

Consider Connections

When it comes to moment connections and plank bearing, plank producers cut the plank around columns, diagonal gusset-plates for braced frames, and anything else that might interfere with plank bearing. This also includes top-plate moment connections. When the precaster has to cut around the column and moment connections, the cut-out can become extremely large and present several difficulties, such as limited bearing for the plank and the potential need for expensive "drop-in" pieces to be formed. Plank producers usually recommend avoiding steel-framed connections that affect the top flange of a beam, and they recommend using alternate moment connections when possible. Iverson recalled a five-level building where the owner was able to save more than $50,000 in time and effort when the design team selected moment connections to simplify plank bearing details.

Stay on the Level

"Do we need a topping?" is a common question with plank. It's an important consideration, because topping can lead to heavier structural loads, higher costs, more construction time in the field, etc. Several plank producers offer "carpet-ready" plank that can be erected to form a smooth surface, ready for carpet and pad installation.

But the fact is that the plank producer is usually unknown until after the bid has been accepted, and there is always the possibility that the carpet-ready requirement will be overlooked. It's a good idea to include a leveling compound in the initial schematic estimate to ensure a smooth finish. There are several leveling materials available, and this is a common practice for bringing concrete slabs into the required tolerances—and it usually adds less than

Six Plank Tips for Fabricators

The potential for steel using hybrid structures—i.e., precast hollow-core and structural steel framing—is considerable, especially in the multi-story residential market where steel framing has not had a large presence.

Structural and miscellaneous fabricators are accustomed to dealing with collateral materials such as joists, joist girders, metal deck, roofing, wood, concrete, masonry, or drywall; precast hollow-core is simply another product. With any project, we must define the scope of work, identify the risks, and specify the responsible party for various aspects of the project. What is new to this equation is that precast hollow-core is a much more significant portion of the structural framing system and therefore presents some potential pitfalls.

Due to the magnitude of the product cost, the age-old question remains: Who is going to buy and therefore be responsible for detailing, fabrication, delivery, and installation of the product? Historically, general contractors have been reluctant to pay the necessary mark-up on this magnitude of work, and insist on buying direct. The coordination of the plank with the steel is critical to the project's success and must be in the hands of a competent manager or the project is doomed to failure. In my opinion, the fabricator is in the best position to assume this responsibility (checking shop drawings, establishing sequences, coordinating deliveries, and overseeing erection) and must be compensated for that responsibility and risk. The project site and nature of the framing system will determine whether steel and precast is erected by a single company or by two specialty firms.

Here are six suggestions to help highlight and streamline the construction process for this system:

Educate. Contact the Precast Concrete Institute to obtain manuals for design, detailing, production, and erection of precast hollow-core. Revisit the AISC Code of Standard Practice and compare steel issues to precast issues.

Partner up. Visit precast plants and discuss the issues with the staff and management. Perform the due diligence necessary to establish the credibility and reputation of the various firms. At the very least, coordinate your proposal in much the same way you would with a miscellaneous fabricator, erector, or supplier.

Define scope and schedule. What you are doing and what you are not doing are very important. The schedule must include all aspects of the framing system. Identify who is responsible for what.

Details. Pay attention to specifications and architectural details, and review these with your precast partners, erectors, and contractors.

Establish expectations. What are the expectations of owner, architect, engineer, and contractor? What kind of finish can be expected and achieved by the precasters on the top and bottom of the plank surface? Define tolerances for plank dimensions, openings, camber, etc.

Manage the project. Consider using the same firm to detail the steel and precast. Lines of communication must be established between the fabricator and precaster. Determine sources of information for answering questions, RFIs, etc.

Ted Hazledine is president of Benchmark Fabricated Steel, Terre Haute, Ind.

¾ in. to the floor height. If a carpet-ready plank producer is selected for the project, this estimated item can be eliminated.

Another important aspect to remember is using a high quality erector for the plank installation, since the plank producer is only one part of a "carpet-ready" floor. The erector may need to do additional labor, such as feathering out joints, etc., to provide a final product that is acceptable in the field.

Go Shallow

Steel and plank systems are already known for their effect in lowering floor-to-floor heights, but can heights be reduced even further? The answer is yes, if the top of the plank is lowered to meet the top of the structural steel. While this option can increase labor and fabrication costs for the steel and precast plank package, this can be offset by the reduction in overall elevator, façade, and mechanical costs. These trade-offs need to be analyzed early in the schematic design phase to see which direction will be the best for the project. The fabricator should be a key player in this decision.

One option is to cut out the top flange of the supporting member (roughly a 5-ft cut for a 4-ft plank) and drop/slide the planks into place (see Figure 1). This can require much time and effort on the part of the steel erector and ironworkers—plus, the top flange must be welded back into place to ensure the structural capacity of the member, which is not an easy task to perform in the field.

Figure 1. Wide notches in the beam flanges allow the plank to be dropped in and slid into place.

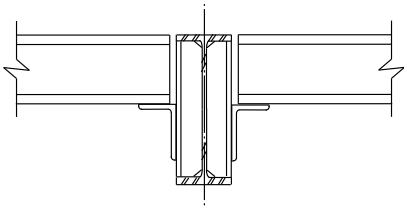

Figure 2. Adding vertical angles as stiffeners and then attaching a continuous horizontal support angle keeps the plank flush with the top flange of the beam.

Another option, which requires no cutting or dropping/sliding of plank, is to add vertical angles or stiffeners to the inside of the beam to support a continuous horizontal angle for plank bearing (see Figure 2). This simplifies erection, but the trade-off is increased shop labor. Regardless of which option is chosen, additional labor and costs will be incurred, so one must determine if added benefits of either option justify their application.

For More Information

These are just a few helpful suggestions to keep in mind on your steel plank projects. If you have more questions about plank and steel framing, contact AISC's Steel Solutions Center at 866.ASK.AISC or solutions@aisc.org. They can even provide a conceptual solution to get you going on your next steel and plank project. Learn more at **www.aisc.org/conceptual_solutions**. MSC

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letters

Dead On, but Expensive

Todd Alwood's September 2007 MSC article "Let's Be Plank..." (p. 39) is a long-needed dissertation on the detailed intricacies of combining precast, prestressed hollow-core slabs (plank) with structural steel. Ted Hazeldine of Benchmark Fabricated Steel is also correct with his tips for fabricators in his sidebar on p. 40.

Alwood's descripton of plank and its pros and cons was extremely informative and accurate, and his caveat to "know your plank supplier" could not have been more on target. I am therefore dumbfounded by his suggestions to the steel industry on what can be done with steel to optimize the use of plank. The suggestions in his article are expensive and are the type of details that usually preclude the use of structural steel and plank. I was surprised that no mention was made of the Girder-Slab system, which received the 2007 Special Achievement Award from AISC. It is the first and only innovative system that combines the advantages of structural steel and flat plate concrete for high-rise residential construction, and has been used in 38 completed buildings comprising almost three million sq. ft of built residential construction.

We are tracking new projects totalling almost 12 million sq. ft, and the case studies on our web site (**www.girder-slab.com**) contain a partial listing of all the prominent and innovative structural engineers that have used Girder-Slab.

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