Open Possibilities

Castellated beams in parking facility design

Castellated beams provide new possibilities in parking facility design.

By John Barnett

Architect John Capdevielle, II, Baton Rouge, La., says the tendency for those in his profession to get set in their ways is natural. Despite being in his mid-60s, he is resisting that tendency because new technology and new construction materials can bring improved performance and reduced costs to his clients. That is why he is interested in castellated beams.

Ideal for wide span, wide open bay designs, castellated beams have a greater strength-to-weight ratio than conventional wide flange steel beams and their strength can be precisely matched to loads.

Capdevielle notes that the castellated beam has been part of a structural steel approach that has been around for years, but is still not well known among architects. The profession needs to know about it, he says, because the castellated beam can be a better alternative to traditionally used concrete beams, wide-flange steel beams, and steel joists. And when designers and builders come to understand the cost and performance advantages of the castellated beam, he says, they can base a project on leveraging those unique advantages.

Beam Advantages

A major advantage is a smaller floor-to-floor profile than other beams because ductwork can be worked underneath or into the holes of the shallow beams, which are easy to line up. Another advantage is a lighter structure that results from the use of fewer members to create more open spaces, which also reduces foundation costs. The beams have the same structural integrity as wide-flange solid web beams, but can offer a more efficient use of steel. They help reduce floor bounce and are often made of recycled materials, Capdevielle says.

"The castellated beam has changed my outlook on parking garage design, because the beam is ideal for longer spans and shallower depths, it eliminates extra interior posts and columns, and it will keep the size of the garage elevation down compared to the adjacent building," Capdevielle says. He recommends thinking about all that the castellated beam approach can do, and then making the design adhere to those capabilities.

"To help lead the way, as an architect, all I need to do is to retool my thinking process," Capdevielle says.

Design Considerations

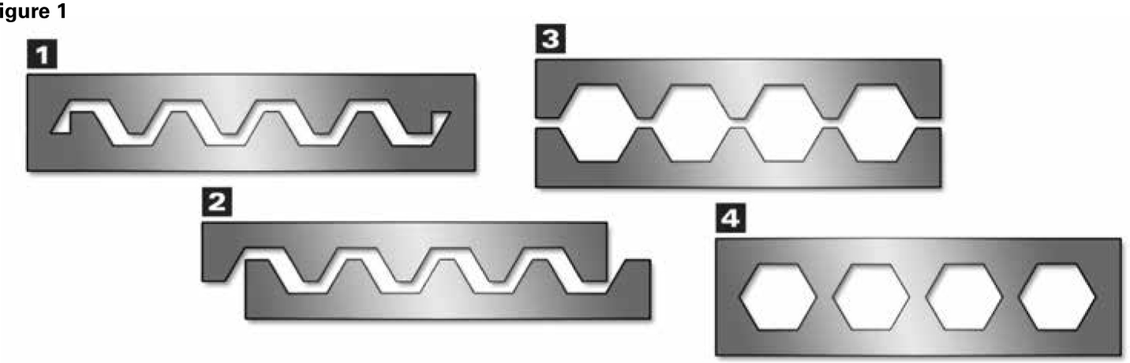
Betty M. Corkwell, PE, design engineer for castellated beam manufacturer New Millennium Building Systems, Continental, Ohio, notes that it's possible to produce a single 90-foot FreeSpan™ beam section and that even greater lengths can be achieved when necessary by using multiple spliced sections. Any required infill sections can be manually welded for special connection points.

To produce the beam, manufacturers start with an AISC standard designation beam that has a continuous web, cut a zigzag pattern along the web, shift it, and put it back together (see Figure 1). "When we do that, we increase the depth," she says. "The rule of thumb is one and a half times the root beam depth, depending on the cutting pattern we use."

Because of the unique concept behind the beam, Corkwell must use different design characteristics than she would for traditional pieces. The castellated beam behaves differently under loading stresses than a conventional beam would. According to Corkwell, the stresses are more "global" with a castellated beam. "It's just something you don't have to design for when you're designing a standard wide-flange section beam," she says, adding that she often assists engineers who are contemplating the use of castellated beams in facilities.

Her company typically produces castellated beams in 60-foot spans, and their strength is dictated by the facility where they will be in service. "In typical garage loading requirements, a beam about 30 inches deep, designed at 60 pounds per foot with composite construction, will have strength and serviceability requirements,"

Figure 1



Corkwell says. Compared with wide-flange beams, castellated beams save about one-third of the weight per foot, which translates to reduced overall mass of the structure, reduced lateral forces, and reduced foundation loads. Castellated beams also impart an open, airy look to a parking garage, thanks to the openings in the beams, Corkwell adds.

Building Advantages

Castellated beams become basic structural elements within the design of an entire building, just like a wide-flange beam. They are erected the same way and the connections are the same, Corkwell says, adding that the holes that result from the cutting might need infilling if perpendicular connections are present. "The erector doesn't see a difference," she says. "But at the back end, the owner can see the possibility of running all of their mechanical, electrical, plumbing, and ductwork through the holes."

Beams are offered in straight, camber, and combined weight options, as well as galvanized options, and are manufactured from 96 percent recycled materials.

It's important to ensure that manufacturers have quality controls in place to ensure structural integrity is paramount, Corkwell says. "When we discussed getting into this fabrication process, one of the first things we did was to become an AISC-certified fabricator. AISC is very diligent about monitoring fabrication processes. We make sure that we keep all of the paperwork that's required on a particular project and maintain our equipment in a certain way. We make sure that everything is up to AISC standards when it comes to our production."

In Service

It is estimated that incorporating castellated beams into a parking garage can reduce the cost of construction by up to 10 percent compared with concrete construction. Cost is obviously important, but design flexibility for a parking facility is another major benefit of castellated beams.

The fact that mechanical, electrical, and plumbing (MEPS) can be fed through the holes of castellated beams results in greater head height. Head height is sacrificed in concrete construction because sprinkler piping must be run under the bottom ledge of the concrete for drainage. Additionally, the concrete must be raised to allow cars to pass under. Because MEPS can be fed through the holes in castellated steel beams, floor-to-floor heights can be designed closer together while offering the same head height found with alternative methods. Additionally, the need for dropped interior beams is eliminated.

Improved lighting is another major benefit of using castellated beams. MEPs aren't the only thing passing through the holes in the beams—natural light also passes through. The amount of necessary artificial light is reduced and dark spots can be eliminated.

Parking facilities that use castellated beams are very cost-efficient. Particularly when the galvanized option is chosen, they require little maintenance throughout their service life. Long spans are possible without the need for bracing, and built-in connections make them easier and quicker to erect. When maintenance is needed, contractors have open access to the ceiling, making their jobs easier. Lighter weight means easier handling onsite. This results in a reduced need for onsite labor, not to mention lower construction costs.

"It's faster erection, it's safer, and with galvanized steel, the life expectancy is improved," says Joe Buntyn, New Millennium's eastern U.S. sales manager. "Your columns with steel are smaller, your footings are smaller, and it's still easier to expand. You can go up with steel more easily than with concrete."

A castellated beam starts out as a hot rolled beam cut lengthwise using computer controlled plasma arc torches, often in a half-circle or half-hexagonal pattern. The split halves are then offset and welded back together to form a beam that is about 50 percent deeper and up to 40 percent stronger than conventional beams.

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