A Path to Safer Balconies

These tricky cantilevered structures demand careful framing and waterproofing details

by Charles Bickford

On June 15, 2015, a group of 13 students in Berkeley, Calif., fell five stories when the balcony they were standing on suddenly collapsed. Six were killed, seven were critically injured, and the incident became the latest example of the often-fatal consequences of poor building practices. The 4-foot-5-inch by 8-foot-10-inch balcony wasn't overloaded; it was designed to support combined live and dead loads of more than 100 lb. per square foot (the code requirement at the time it was built). Subsequent investigations revealed a number of problems, however, including a leaky walking surface and a non-ventilated deck soffit that trapped water inside the deck frame, causing the engineered (but not pressure-treated) wood framing to rot.

It's a sobering lesson for any builder who thinks a balcony is basically a cantilevered deck. Unlike a deck, which is supported by a ledger and a system of posts, beams, and footings, a balcony's sole support derives from joists or beams that cantilever from the exterior wall. Its stability and longevity rely on the strength of the cantilever and a careful detailing of the exterior to protect the house and deck framing from water damage.

Code Problem

As building-code educator Glenn Mathewson notes, codes specify require-

PHOTO: COURTESY LENNY GILLIS

ments for balcony framing and railings, but they don't address the precise and often unique combinations of potential problems that balconies pose. "For example, when a balcony is designed to be waterproof and the joists are enclosed by a soffit below," he explains, "it is considered by code to be a roof assembly, and because roofs are not meant to leak, there is no code requirement to use pressure-treated lumber."

According to city officials who investigated the Berkeley tragedy, that was one of the factors that led to the collapse. Plans for the balcony called for a 2-inch concrete topping slab over waterproofing and a double layer of OSB sheathing supported by cantilevered 1 3/4-inch by 11 7/8-inch LVL joists, which were untreated. Investigators say that when the Library Gardens apartment complex was built in 2006, the balcony design met all of the requirements of the California Building Code. Of particular note, the balcony joists didn't have to be made of a "durable or preservative-treated material," because they were separated from the walking surface by an impervious moisture barrier (an exemption that has since been removed from the current Berkeley Housing Code).

Engineered Connection

Most balcony designs originate with architects or engineers, and one of their rules of thumb for cantilevered balcony joists is that the exterior length of the joist must be supported by a double length inside the building envelope. This 2:1 backspan to cantilever ratio is incorporated in Table R502.3.3(2) in the 2015 IRC, which specifies joist sizing based on the desired cantilever span, ground snow loads, and joist spacing. Following this prescriptive path, 12-foot-long 2x10s spaced 16 inches on-center would be needed to frame a 48-inch-wide balcony built in an area with 50-psf ground snow loads. Not addressed by the code are connection, insulation, and flashing details.

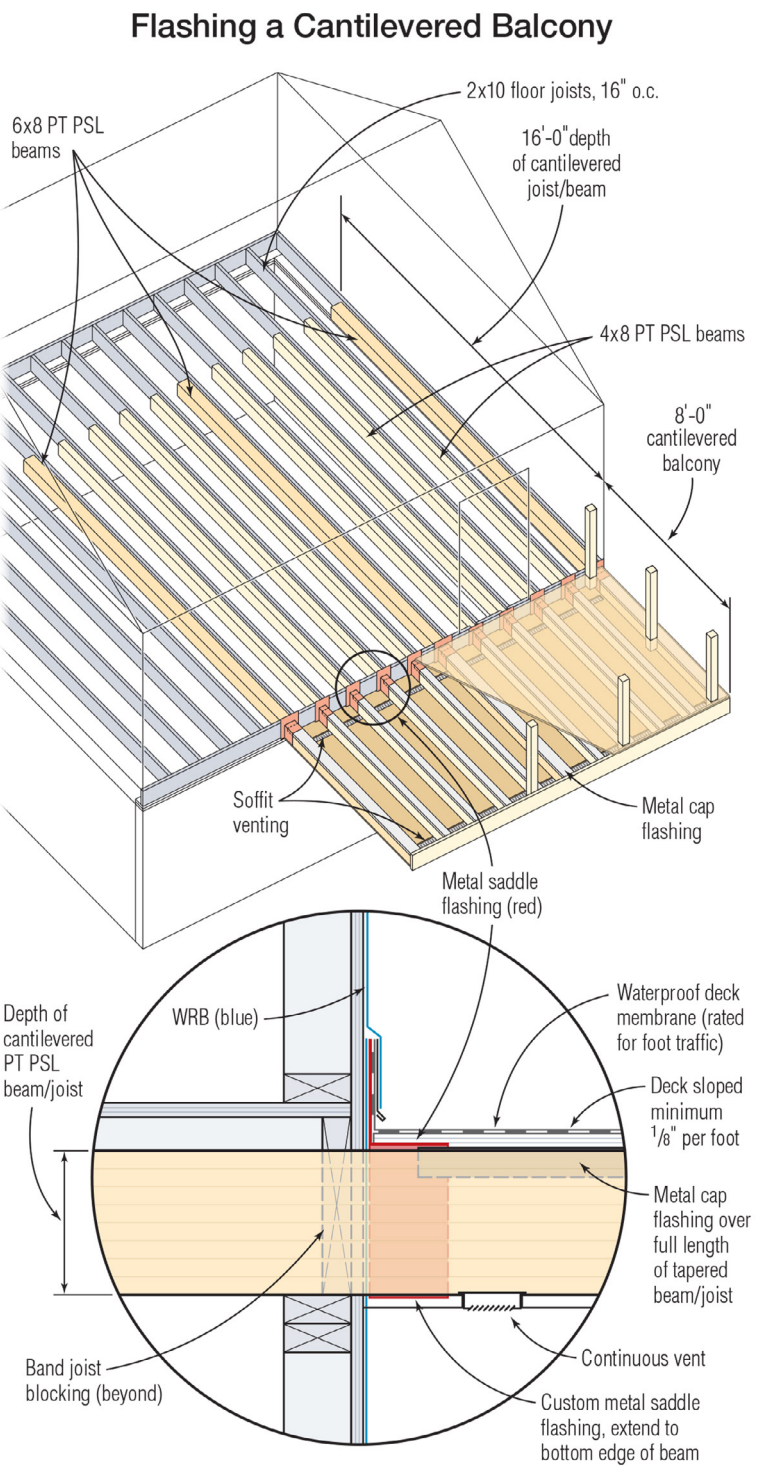

ILLUSTRATION: TIM HEALEY

Figure 1. Careful flashing is a critical component in any balcony design. Here each beam is protected with metal saddle and cap flashing, which in turn is integrated with the WRB on the wall and the floor's waterproofing membrane. Continuous soffit vents underneath allow air to flow through the assembly, essential if the balcony is enclosed.

Figure 2. Structural steel can be used to frame wider balconies, though steel often requires specialized or unfamiliar techniques and can be more expensive than wood framing.

Figure 3. On this project, four MC-10-22 steel beams were bolted to the interior joists on 8-foot centers.

Figure 4. Pressure-treated 2x12s were used for the perimeter and infill joists, as well as for the ledger bolted to the house's rim joist. Adjacent joists and the rim beam were bolted to the steel.

Figure 5. Unlike a deck's 36-inch minimum railing height, a balcony's railing is required by code to be a minimum of 42 inches high.

To achieve wider balconies, Patrick Jean-Phillip Burger, a licensed architect, builder, and building inspector, in Hayward, Calif., suggests incorporating 6x8 beams of PT Douglas fir or Wolmanized Parallel-Strand Lumber (PSL) at the perimeter and mid-span of the design. Burger says using the wider beams along with 4x8 PT joists 16 inches on-center and sistered to the interior floor system allows for an 8-foot-wide balcony. To prevent water damage to the framing, he emphasizes careful flashing at the beam-wall intersection, and if the framing is enclosed, he makes sure that the assembly is well ventilated (**Figure 1**).

Flashing and drainage. In multifamily construction, balconies are often stacked vertically and built with an enclosed waterproof deck so that the upper balconies shelter the balconies on the floors beneath them. The joist bays are typically enclosed with an exterior grade of plywood that's painted or covered with stucco to act as a finished ceiling for the balcony beneath. The problem with this type of assembly is that if the walking surface leaks, there's no way for the framing to dry out.

In the Berkeley collapse, this proved to be a critical flaw. Reports indicate that although the balcony joists were covered with a waterproof membrane, the builders apparently neglected to include the necessary drainage board above the backerboard, which made the joists

PHOTOS: COURTESY LENNY GILLIS

vulnerable to water that seeped through perforations in the membrane caused by fasteners. Making matters worse, the concrete walking surface was apparently not sloped away from the building as specified, which allowed water to collect and find its way through the concrete and the backerboard to the joists. Had the balcony deck not been enclosed, or had there been ventilation, it's possible that the framing would not have rotted. And had there been a way to inspect the framing, the problem may have been discovered prior to the fatal accident.

"The failure to adequately ventilate an enclosed deck can create a breeding ground for fungal growth," says Burger. So he recommends a belt-and-suspenders approach, which is to install continuous strip vents to ventilate each of the framed cavities, as shown in Figure 1.

On residential balconies that aren't enclosed, simply installing gapped water-resistant decking boards is an effective way to shed water, as long as the structure is adequately detailed and flashed at the exterior wall. The framing should also be sloped away from the house to maintain proper drainage. This can be done by adding tapered rips to the tops of the joists to create a ¼-inch-per-foot slope. An alternative sloping technique used by some builders is to start with wider stock and rip tapers along the length of the joists.

Steel Strengthens the Framing

Cantilevered wood framing can be reinforced with steel, an approach used by Lenny Gillis, of Colony Home Improvements, while building a cantilevered balcony as part of an extensive remodel in Wellesley, Mass. While the project's architect had initially specified pressure-treated 2x12s as the cantilever support, Gillis thought that was a bad idea. "The 2x12s were supposed to be sistered to the interior engineered I-joists, but in my experience, PT tends to twist when it's used inside a structure," Gillis explains. "In addition, we couldn't get the lengths we needed to satisfy the required amount of cantilever."

Figure 6. This lightweight, prefabricated aluminum balcony is designed with integral diagonal support rods that connect to brackets that are through-bolted to the house framing.

PHOTO: AMERICAN STRUCTURE AND DESIGN

At the time of the build (2009), pressure-treated LVLs were hard to find, so he decided to use steel C-channel beams. After packing out the webs of the 14-inch-deep I-joists, he and his crew bolted four MC-10-22 steel beams to the interior joists (**Figures 2, 3, 4, 5**). Cantilevered at the 2:1 ratio specified by his engineer, the beams were installed on 8-foot centers. They then ran pressure-treated 2x12s as perimeter and infill joists from a ledger bolted to the house's rim joist. Adjacent joists and the rim beam were bolted to the steel. As to the cost, Gillis says, "I can see the cost-saving advantages of using PT LVLs, but they would fail long before the MC10s would fail."

Innovative Solutions

To prevent moisture problems, some companies offer prefabricated aluminum balconies and balcony components. American Structures' innovative system (americanstructures.com) also incorporates a pair of support or sag rods that run between the deck's outer rim and the structure wall just above the railing (**Figure 6**). The rods and a sub-fascia ledger can be lag- or through-bolted into the interior framing. Though each balcony is engineered, all designs are based on standardized frame components that are bolted together on site, and include aluminum decking and railing posts. Owner Mark Weissenbuhler says that one advantage to this system is its ledger, which isn't continuous but is made up of individual brackets. "The ledger actually sits ½ inch off the building wall

to allow the water to flow freely behind our balcony."

Another company that offers prefabricated aluminum balconies is Wahoo Decks (wahoodecks.com). While its Wahoo Complete pre-fab balconies are designed for multifamily construction, residential builders may want to look into the company's Dry Joist EZ product. This is a component system of extruded interlocking aluminum joists that can span between 6 and 8 feet, making them well-suited for use with an engineered cantilevered frame (**Figures 7, 8, 9**). As a bonus, Dry Joist EZ framing is compatible with Wahoo's waterproof aluminum decking system to create a finished ceiling below the deck.

Citing the custom nature of their businesses, neither company would quote a precise square-foot cost, but stressed that the savings in reduced installation times compensated for the higher material costs. With both of these products, the buyer is responsible for engineering the framing and for providing adequate flashing details.

Build as if You Own It

Glenn Mathewson thinks cantilevered balconies are a bad idea. Unlike other structural details in a house, there's no redundancy in the balcony's resistance to gravity—when it's bad, it fails and fails disastrously.

But balconies are also a desirable architectural feature for some homes and almost a requirement for many multifamily projects. So the idea is not to shy away from something that's tricky to build. "It's up to the architect or engineer to design a structure that won't fail," says Mathewson. But it's up to you to build it with careful engineering and conscientious detailing, and always with the realization that your clients' lives rest squarely in your hands. ❖

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Figure 7. Instead of a system of cantilevered joists connected to the interior floor framing, these balconies are framed with pairs of cantilevered LVL beams.

Figure 8. Wahoo Deck's Dry Joist EZ is a 2-inch-high aluminum joist with an interlocking design that makes it waterproof. The system can span up to 8 feet, depending on floor loads.

Figure 9. Any standard decking can be attached to the aluminum joists; any water that makes its way into the deck's interior drains to the outer edge.

PHOTOS: WAHOO DECKS