Lateral Bracing Alternatives

Anchoring decks to the foundation rather than to the interior framing simplifies a finicky detail

by Jim Finlay
The 2009 IRC, which is the building code in my area, requires that a deck connected to and supported by its primary structure be “designed for vertical and lateral loads as applicable” (2009 IRC, R502.2.2).

The IRC’s vertical load requirement is clear: 50 pounds (40 live plus 10 dead) per square foot. Using a deck’s dimensions, you can easily calculate its vertical load on the connection between the deck ledger and the house band, and then refer to the code to find connection details and attachment configurations.

However, the IRC’s lateral load provision—intended to prevent a deck from being pulled away from its supporting structure—is anything but clear, as most deck builders know.

Instead of quantifying general lateral load requirements, the code offers a single solution with a specific design capacity: You are “permitted” to install the mechanism drawn in IRC Figure 502.2.2.3—two Simpson Strong-Tie DTT2s (strongtie.com) connected by a threaded rod, with one fastened to a deck joist and the other to a house joist (Figure 1). Two of these mechanisms, each resisting 1,500 pounds, must be installed, regardless of the deck’s size or shape.

Note that the IRC does not require this detail, nor does it set a lateral load requirement of 1,500 pounds. That load is merely what the allowed “hold-down device” should resist.

Unfortunately, installing this device poses numerous difficulties, especially after a house is built. Not only is it labor-intensive, it’s arguably unnecessary for many decks (see Bad Solution to a Non-Existent Problem, page 40). In fact, lateral load requirements are slated for revision in upcoming versions of the IRC (see Structure, page 16).

More Than One Option

If you dislike the lateral-load anchor currently permitted by the IRC, what are your options? The code allows alternatives, but offers none. In this article, I’ll describe a few solutions for resisting lateral loads that my deck-building company has successfully employed on our projects.

In my area, and probably in yours too, enforcement of the lateral brace provision is inconsistent. Of the 21 towns where I build decks, only one requires the code-specified bracket or an engineer-stamped solution. Four of the towns want “something reasonable,” and the rest ignore the provision altogether. So I’ve organized my alternative solutions into two categories: “engineered solutions,” which have been formally tested or stamped by an engineer; and non-engineered “informal solutions,” which are versatile details we’ve been able to use when the inspector doesn’t require

Figure 1. The lateral-load anchor “permitted” by the current IRC requires access to the interior house framing. In an existing house, it’s impossible to verify that the subfloor attachment meets requirements without removing finished flooring.
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Engineered Solutions

Diagonal foundation brace. The first alternative lateral-load anchor for a deck I ever designed consisted of a double 2x10 diagonal brace anchored to the deck framing with ½-inch through-bolts and to the foundation wall with a beefy 6-inch by 4-inch long L-bracket fabricated from ½-inch steel (Figure 2). My engineer approved it—and I expect yours would too. It’s well-suited to larger decks. Unlike the code-approved solution, this anchor can be installed without accessing the building’s interior. Not only that, it allows the deck to be installed 6 or 7 inches below the elevation of the house floor, a common detail in wet or snowy climates.

Materials for one diagonal brace cost about $72 (since two are needed, total cost is $144). Installation labor is roughly one hour per brace, depending on the age and density of the concrete foundation. Once installed, each brace will resist 1,500 pounds of lateral force, just like the “permitted” hold-down device.

L-bracket. To further simplify anchor installation, I’ve also designed an L-bracket that doesn’t require the diagonal 2-by brace (Figure 3). My local steel fabricator cuts 3-inch by 18-inch strips from standard ¼-inch thick steel plate, with each leg measuring 3 inches by 9 inches. The brackets are hot-dipped galvanized for corrosion protection, and when installed, are isolated from treated framing with self-adhering flashing.
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To connect a bracket to a doubled joist, I use six 4 1/2-inch HeadLOK (fastenmaster.com) screws (Figure 4). The screw manufacturer has formally tested this configuration in shear, parallel to the grain of wet #2 pressure-treated SYP, for a double 2x8 joist. In testing, the connection exceeded 1,500 pounds in shear, even after factoring in a 3x safety margin. Though the brackets are galvanized, we isolate them from treated joists with a piece of Bituthene or Vycor (graceresidential.com) or a similar self-adhering membrane.

There are several options for bolting the bracket to the concrete. For example, a galvanized 1/2-inch-diameter by 4 1/4-inch-long Red Head Trubolt wedge-type expansion anchor bolt (itwredhead.com) embedded 3 3/8 inches into concrete can safely resist more than 1,900 pounds of withdrawal force, or more than 2,900 pounds in shear. Other concrete fastening options include sleeve anchors (available in stainless steel), strike anchors (available in yellow-dichromate-plated steel only), and epoxy-bolt systems.

The size of the anchor depends on the density of the concrete. Since that is virtually impossible to test, I generally assume (in the absence of visual deterioration) that foundation concrete has a compressive strength of 2,500 psi, the weakest allowed by code (2009 IRC, Table R402.2).

It’s also critical not to install the anchor bolts any closer to the edge of the concrete than the manufacturer recommends. When the upper hole of the L-bracket would be too close to the top edge of a foundation (within 3 3/4 inches for 1/2-inch-diameter Red Head Trubolts, for example), I use a 2x4 PT spacer to lower the bracket, and I upgrade the joist-attachment screws to 6-inch HeadLOKs (Figure 5).

Materials for this anchor cost about $41, including the $20 bracket and the second joist. Installation usually takes less than 30 minutes. As a bonus, this L-bracket provides vertical support in addition to lateral strength.
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Note that the diagonal-brace and L-bracket details connect to poured concrete foundations, which are common in my area. Hollow concrete-block foundations, however, pose a challenge, because their thin walls offer considerably less withdrawal strength. For instance, Simpson Strong-Tie’s ETSP plastic screen tubes provide only 300 pounds of withdrawal strength and require 8-inch spacing. I suppose that threaded rods could be used as through-bolts, with a 2x6 PT block mounted inside as a big “washer,” but that, of course, would require access to the inside of the house.

Side strap. When the deck is aligned with the edge of a house, significant lateral loads can be resisted with a simple strap that connects the deck’s outside joist to the house frame (Figure 6). We’ve used Simpson’s 1 1/4-inch by 30-inch MSTA30 straps nailed to the deck and to the second story of a house, a solution that has been stamped by my engineer.

To ensure that the strap is fastened to solid house framing, some siding and sheathing has to be temporarily removed during installation. But once installed with 11 hanger nails in the house frame and another 11 in the deck’s double joist, this connection resists more than 1,800 pounds of tension in SPF framing, according to the manufacturer’s specifications (Figure 7).

The cost of materials for this solution is modest, just a few dollars for the strap and nails. Of course on existing construction, labor can run two hours or more, depending on the house siding.

Figure 6. When the deck framing is aligned with the house framing, a simple metal strap can provide sufficient strength to meet lateral load requirements. On existing construction, the siding and sheathing must be temporarily removed to gain access to the framing.

Figure 7. When installed as shown above, Simpson’s MSTA30 strap ties offer 1,820 pounds of allowable tension loads in SPF framing, more than enough to meet the IRC’s 1,500-pound lateral load requirement for permitted devices.
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Informal Solutions
Because my engineer is known for being very conservative, some of the building inspectors we work with will accept scaled-down and unstamped versions of his engineered brackets and braces.

Simple diagonal brace. In the "lite" version of our diagonal foundation brace (Figure 8), we’ve substituted joist hangers or pairs of 16-gauge angle brackets for the more robust—and more expensive—3/8-inch and 1/4-inch steel L-brackets used in our stamped designs. This detail can be built with either a single or a double 2x8 diagonal brace, which is through-bolted to a doubled deck joist and anchored to the concrete foundation as shown (Figure 9). Materials cost about $32 for each brace, and it takes about 45 minutes to install one of them.

While we’ve had two or three inspectors accept this brace as "reasonable" without asking to see any engineering data, the weak link in the design is the metal hardware. We typically use Simpson LUS28-2 double-joist hangers—which have a 1,315-pound allowable load capacity—or Simpson L70 angle brackets, which have a load capacity of 445 pounds each (for a total capacity of 890 pounds for a pair of brackets) in treated lumber, though the load capacity may need to be reduced since the brace is configured diagonally. If a lateral load requirement of, say, 750 pounds is added to future versions of the building code, this alternative configuration using off-the-shelf hardware would probably meet that lower standard.

House-frame bracket. On older homes with fieldstone foundations, lateral braces can’t be fastened to the foundation. But on a recent project—a classic New England house with solid 4x6 sills—the inspector suggested I anchor our custom L-bracket lateral braces to the sill.

I rotated the brackets so that they were oriented horizontally instead of vertically, and drilled another hole through...
each bracket for a third through-bolt (Figure 10). After flash-
ing the brackets with Vycor, I fastened each one to doubled
2x10 PT joists with three 1⁄2-inch-diameter galvanized-steel
through-bolts. The brackets are anchored through the deck
ledger and house sheathing into the sill with six 6-inch Head-
LOK screws per bracket.

Is this anchor strong enough? According to my calcula-
tions, each of the three through-bolts holding my bracket to
the double joist will resist 620 pounds of shear—more than
1,800 pounds total. According to the screw manufactur-
er’s ESR (Evaluation Services Report 1078), the withdrawal
strength of a HeadLOK screw embedded 2 inches into a hem-
fit sill is 360 pounds; therefore, six such screws should resist
2,160 pounds of withdrawal (6 x 360 = 2,160).

Including the bracket and the second joist, materials for this
detail cost about $48. Installation takes about 30 minutes.

Faster and Cheaper

Both the engineered and “informal” devices I’ve described in
this article have several major advantages over the lateral brace
“permitted” by the IRC. Installation is easier and less expen-
sive, since my details require no access to the interior flooring,
basement ceiling, or floor joists. And they allow us to set our
decks 6 or 7 inches below the interior house floor, a practical
detail that helps keep rain and snow outside.

Are all my lateral anchors as strong as the code-permitted
solution, which depends on special hardware, extends deep into
the house, and attaches to the floor framing? Some of them
are and some of them aren’t, but I’m not too worried that my
decks would experience an arbitrary 1,500-pound lateral force
on the ledger that would pull the rim joist or sill away from the
framing, through the house sheathing, and onto the ground. ❖

Jim Finlay is the construction manager and owner of Archadeck of
Suburban Boston, a member of the Archadeck franchise system.

Bad Solution to a Non-Existent Problem?
The reason I developed the alternative lateral braces
described in this article is that installing the code-per-
mitted device is disruptive and complex, especially when
house joists are perpendicular to deck joists. Because it
requires the house subfloor to be attached to the joists
with nails 6 inches on-center (rather than the standard
12 inches on-center), the finished floor would have to be
removed in order to verify that or remediate it. But the big-
gest problem for me is that the deck has to be level with
the house floor in order to install the device, a bad practice
where rain and snow is common.

Often overlooked in discussions about lateral loads is
that the lag bolts and ledger screws used to transfer a
deck’s vertical load to the house also resist withdrawal
forces: 582 pounds for each 1 1⁄2-inch-diameter lag bolt,
and 420 pounds for each LedgerLOK screw embed-
ded 2 inches into an SPF house-framing member. This
means that a 16-foot-wide deck with two ledger screws
per 16-inch joist bay would have more than 10,000
pounds of lateral resistance.

One explanation I’ve heard for the lateral-load connec-
tion requirement is that it prevents a deck from pulling
the band joist or sill away from the house under a severe
lateral load. But I’ve never heard of this actually occur-
ing, except when the deck ledger has been fastened to
an overhanging cantilever. And in those cases, the issue
is vertical rather than lateral loads.

Recent testing at Washington State University confirms
this. There, people moving in unison on a sample deck
were able to create a maximum total lateral load of only
1,750 pounds—875 pounds at each end of the deck. Even
under artificially-created lateral loads of 7,000 pounds, the
joists split and failed massively but the lag screws at the
ledger held firm—without any lateral braces. There was
no observed damage to the house frame (see the online
series Lateral Loads on Decks by Don Bender et al., origi-
nally published in Wood Design Focus (Summer 2013)
and reprinted with permission at deckmagazine.com/
structure/measuring-lateral-loads-on-decks_o.aspx).

This testing suggests that real-world lateral loads are
relatively small, and shows that even artificially created
loads that are four times real-world scenarios are eas-
ily handled by standard deck attachments that follow IRC
connection requirements. Hopefully, common sense and
recent tests of actual lateral loads on decks will result in
a modification of future building code requirements—and
perhaps even eliminate the “permitted” device drawing.