Critical Deck

A look at the forces at work on a deck and the

BY JUSTIN FINK

Ten or 15 years ago, the most advanced pieces of hardware you'd find on a typical deck would be bolts and joist hangers. But for the last several years—due in part to increased public awareness surrounding catastrophic deck failures, as well as complaints about the woefully inadequate treatment of decks in code books—decks have been a hot topic among code officials and builders. As the 2015 version of the IRC is adopted, decks will be subject to code provisions that are more explicit and comprehensive than ever before.

Many of the most critical connections rely on metal hardware. Curious about the purpose and function of all this hardware, we invited Simpson Strong-Tie's David Finkenbinder, an engineer and product designer of deck connectors, to spend a few days on a job site as we documented the building of a typical ledger-attached raised deck.

During the build, we peppered David with questions about the forces at work on a deck, how the hardware was designed to counteract those forces, and which details builders often get wrong. Here are some of the lessons we learned, which include some information not typically accessible to builders in the field.

Justin Fink is Project House editor. David Finkenbinder contributed to this article. Photos by the author, except where noted.

ULTIMATE DECK BUILD
Join Simpson Strong-Tie's David Finkenbinder for a video walk-through of this year's deck build, where we focus on the forces at work and the installation of connectors. Visit FineHomebuilding.com/extras.

Connections

hardware designed to keep things in check

Joist hanger

Post cap

Post base

Stringer hanger

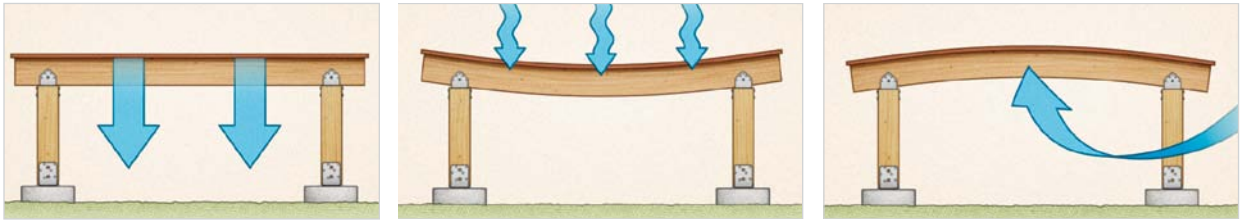
Hurricane tie

Tension tie

FORCES AT WORK

If decks only had to resist gravity, engineers would have it much easier. In reality, a deck not only has to support and transfer its own weight, but it must also support its occupants, the forces of their movements, and the forces of nature. To protect decks from failure and occupants from injury, building codes require reinforcements, including hardware and metal connectors. Some pieces of hardware are continuously at work, and others are there only to provide insurance against failure during periods of high stress.

Elevation view

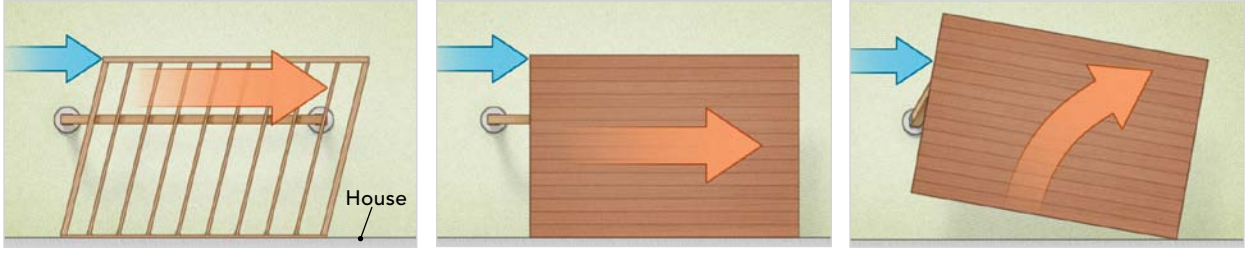


Gravity loads Gravity loads act vertically. They are transferred from the deck into the house framing via the ledger, and down to the ground via the beam, posts, and footings. A deck's dead load is the total weight of the deck and its individual materials, including beams, joists, decking, and railings (typically calculated at 10 lb. per sq. ft.). Live load is everything added on top of the deck, such as the weight and movement of people (typically 40 lb. per sq. ft.), and the weight of stationary items such as furniture and grills. Although not technically a gravity force, occasional uplift from strong gusts of wind or steady uplift created by overhanging framing are also best included in this category.

PRIMARY PROTECTION Ledger fasteners • joist hangers • post bases • stringer hangers • hurricane ties

Lateral loads Direct-bearing connections exist where wood is resting directly on top of wood, or where those pieces are separated only by a metal plate. In these cases, the hardware is there to ensure that the pieces of wood stay connected when subjected to horizontal forces. Such forces may include wind, earthquakes, and human activity on the deck. The codes that protect a deck against lateral loads are based on ongoing research but are essentially judgment calls based on what engineers consider safe tolerances.

Plan view



Racking In seismic events, the ground moves, and everything above tries to move with it. The same thing happens when people dance, or run and then quickly stop. Their momentum is transferred from their feet down into the deck. A deck isn't perfectly stiff, so these racking forces make it flex.

PRIMARY PROTECTION Decking (if through-fastened) • angled post braces (or posts set into concrete footings)

Sliding When hit by strong winds, a deck wants to slide, just like a box being pushed to the side. The risk here is either that the unified box of framing components will shift off the beam, or that the posts will shift off the footings.

PRIMARY PROTECTION Ledger fasteners • joist hangers • post bases • post caps • hurricane ties

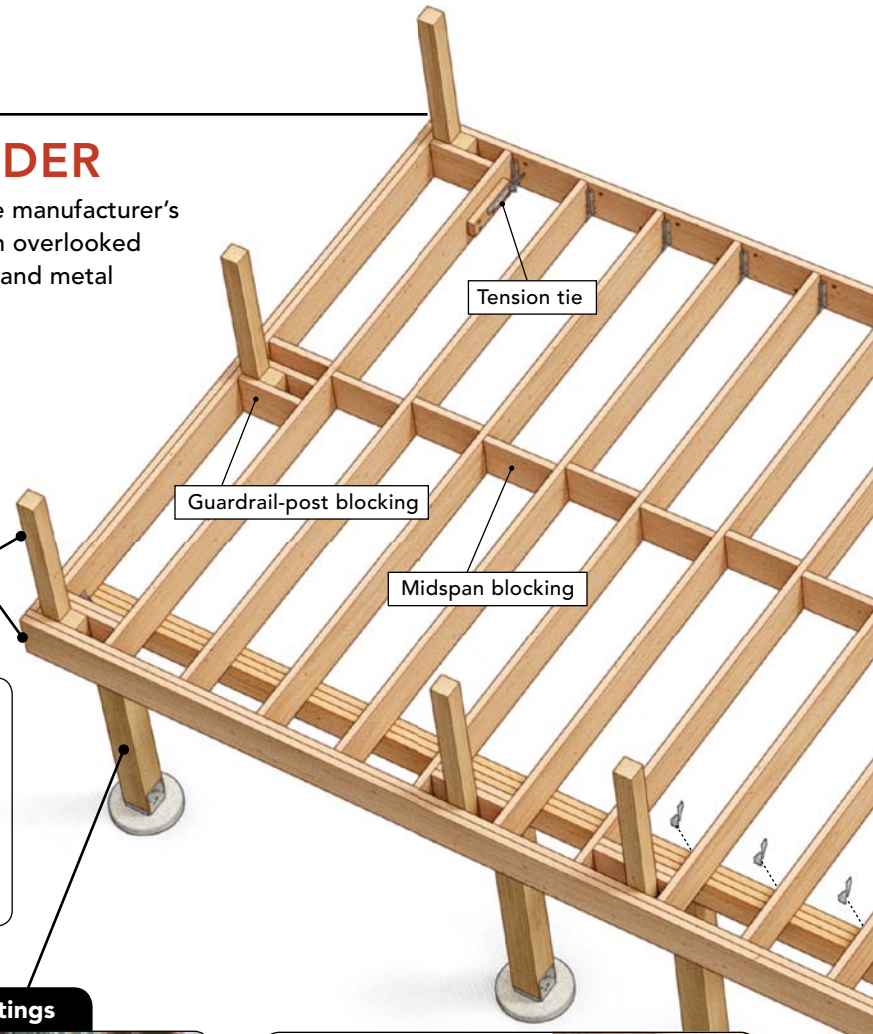
Pulling away If the deck can't rack, it will try to slide. If it can't slide, it will try to break free in a sort of lateral tipping motion. This creates large compression forces at one end of the ledger and a lot of tension at the other. Because joist hangers and ledger fasteners are not designed to resist this force, a separate connector is needed.

PRIMARY PROTECTION Tension ties

Product photos: Dan Thornton.
Drawings: Christopher Mills.

KNOWLEDGE FOR THE BUILDER

Although no substitute for specific code requirements or the manufacturer's installation instructions, here are some helpful insights, often overlooked caveats, and general advice for properly installing hardware and metal connectors on a typical deck.



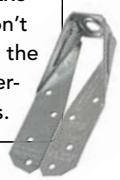
Rim and guardrails

Technically, you can attach guardrail posts however you like, as long as you can prove that the attachment will allow them to withstand 200 lb. of concentrated live load applied anywhere along the top. Tension ties and blocking are the most common solutions, however.

Working together with midspan blocking, a deck's rim keeps the joists from rolling over. To do its job, the rim must be fastened to the joists with 3-in.-long #10 wood screws, or 10d 3-in. threaded nails. If a double rim is used, these fasteners should be installed before the second layer is applied.

Guardrail posts attached to a rim are only as strong as the rim's attachment to the joist ends. Posts in these locations should be tied to joists with blocking or tension ties, too.

If guardrail posts are being reinforced with tension ties approved for that application (such as Simpson's DTT2, right), the joists must be 2x8 or larger. Smaller joists don't provide enough depth for the fasteners to resist the leverage applied to the railings.



Beam, posts, and footings

Clearance from the post base to the edge of the footing varies by the type of connector and anchor. Generally, the shallower the anchor embedment, the closer to the edge of the footing you can get. Keep in mind that minimum edge distances are a separate issue from sizing a footing to carry deck loads, and honest calculations for these two criteria usually result in a need for larger footings than are commonly used.

Post caps, regardless of type or thickness, are not designed to provide sway resistance. If you need to resist racking forces in a tall deck, the posts must be stiffened with angled wood bracing between post and beam or by sinking the posts into the footings.

Even when installing beams so that they bear directly on posts, you can't rely on toenails for this connection.

FOUR GENERAL REQUIREMENTS

Before diving into the details of each metal connector, learn these golden rules for deck hardware.

1. The right connector. Connectors are designed and tested for specific applications. There are no tested values to support their use—either in their original form or an altered form—for reinforcing other connections.

2. The right finish. The mistake inspectors see most frequently is the use of metal connectors with one type of weather resistance (galvanization or stainless steel) and fasteners with another type.

3. The right fasteners. In many cases, using hardware screws rather than nails is allowed. These screws are specifically designed with a ductile (softer) core, which allows them to bend under load rather than snap. You can't use deck screws or other general-construction screws.

Ledger, joists, and stringers

Overdriving ledger screws reduces their holding strength. They should be driven only until the back of the washer head contacts the face of the wood.

Joists must be cut to sit within ⅛ in. of the ledger, and to satisfy code, must maintain at least 1½ in. of full bearing contact with the seat of the hanger.

Hangers must match the joist they support. Hangers that are undersize place all of the forces into the bottom of the ledger, which can split off.

Much of a joist hanger's capacity relies on the 45° fasteners, which must be 3 in. long to pass through the joists and into the ledger.

Deck frames must be tied back through the ledger and into the house framing, usually using tension ties. Depending on the type, you need at least two, but sometimes four, of these connectors.

Only inverted flange hangers are tested for use at ledger ends. Never bend or cut a standard hanger for this spot.

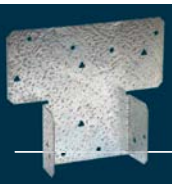
Toenails are a fast way to attach the joists to the beam but aren't a long-term solution for preventing movement. Hurricane ties are a more durable way to reinforce the connection between the joists and beam.

Stringer hangers have minimum bearing requirements. If the first step is below the deck surface, then a wider header or dropped header will be needed.

Midspan support is required for notched stringers that span more than 6 ft. (measured horizontally). Distances longer than that require midspan support posts that land on a minimum 6-in.-thick footing.

You don't need joist hangers at the rim opposite the ledger unless it's also acting as a flush carrying beam.

4. The right fastening pattern. Achieving the designed strength of a metal connector means using the proper number of fasteners. The punched holes in each connector—the only places where fasteners should be driven—are shaped by the manufacturer to match fastening guidelines (see key, right).



	Always fill	For ease of nailing in tight locations (e.g., skewed joist hangers)	To temporarily fasten a connector to ease installation	Fill to achieve maximum strength
Simpson Strong-Tie	●	●	◆	▼
USP Structural Connectors	●	●	N/A	◆