Decking Fasteners and the Jobs They Do

by Glenn Mathewson

Have you ever considered the forces that decking fasteners must resist? Seasonal expansion and contraction of wood obviously act on fasteners — evidenced by the pushed-out nails on so many older decks. Less obviously, perhaps, inconsistent joist depth, varying crowns on the joists, and deflection caused by people moving around on the deck all contribute to forces that pull upward on the fasteners. On the horizontal plane, fasteners help to share loads between adjacent joists and resist racking forces from wind, seismic, and human loads. All these forces and how to resist them should be considered when choosing and installing any fastener system.

Stereotyping the Styles

For ease of comparison, I've created five basic categories of fastening systems. This is not to imply that individual brands don't have unique features and performance, but simply that their applications are similar.

Face-fastened. In this time-tested method, the fastener runs directly through the decking to the joists below.

Toenailed (blind-nailed). The decking is fastened at the corner or side using angled fasteners. This method can be used with screws or nails, though there are systems on the market with specific installation requirements.

Friction clip. This type of clip is installed between grooved deck boards and fastened directly to the joist, but without any fasteners actually penetrating the decking.

Pinned clip. Similar to friction clips, but with integral pins that do penetrate the decking, these clips may be installed in non-grooved boards.

Track or below-clip. These systems — either individual clips for each fastener, or long metal tracks that accommodate multiple fasteners and deck boards — use two fasteners, one from clip or track to joist and the other from clip or track to decking. There is no single fastener holding the decking directly to the joist.

Vertically Secure the Decking to the Joist

The most intuitive and obvious function of a decking fastener is to hold the decking to the joist. When we consider vertical restraint alone (I'll address horizontal forces later), there are multiple sources of loading. The ones affecting fasteners are created by upward forces; resisting downward forces is a job for the joists, not for the fasteners.

Natural imperfections of lumber, like crowns in joists (the curvature of the joist along its length), introduce upward forces that fasteners must resist. Some joists crown in both directions, like an S, and others are perfectly straight. Even though pros "crown" the joists — which means to install them uniformly with their arcs bowing upward to provide as flat a surface as possible — some crowns may increase, straighten, or reverse after installation. The only consistency is inconsistency.

One force working against this inevitable irregularity is the rigidity of the decking. Once installed, rigid decking is able to slightly pull and push the uneven joists; the boards work together as a system to flatten the deck surface. The less rigid the decking is, the more it tends to bend across uneven joists, becoming a visible wave at eye level. The span rating of the decking is a good indicator of its rigidity; when installed on 16-inch joist spacing, decking rated for a 24-inch span will create a flatter deck than decking that's rated for a 16-inch span.

It's also important that the deck boards be restrained vertically. Without a strong connection that uses a fastener with good withdrawal resistance, even less-rigid decking will simply lift off a joist that's lower than its neighbors.

Another function of decking and fasteners is uniting the joists so they act as an assembly, not as individual members. Design loads for joists are based on this concept; never will a single joist carry a load all by itself. For example, even if I were to stand directly over one joist, the decking would transfer some of my load to the adjacent joists. Thus, floor joists act as a system and share the load.

Decking and fasteners act as an assembly in one more way (**Figure 1, next page**). Consider that I'm standing on that one joist again. The placement of my feet might be on only four deck boards, two under each foot, but the weight of my body is directed to the adjacent joists below and causes a deflection. This deflection pulls down on the adjacent decking through the decking fasteners. In this way, the deck boards work together with the fasteners to resist localized forces.

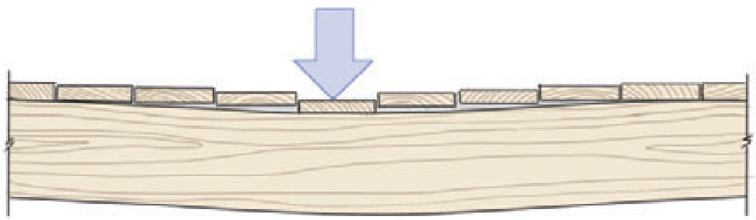

Figure 1. If deck boards were not fastened, deflection of a joist from a concentrated load above would leave a gap below adjacent decking. Decking fasteners not only hold decking down, they pull it down every time the deck is loaded. No matter what board you stand on, they're all feeling the load.

What's Your Vertical Resistance?

The different types of fasteners have varying abilities to resist these vertical forces.

Face-fastened. There's a reason most pros don't face-nail decking anymore, opting instead for screws. Nails have little resistance to withdrawal, and too quickly will begin to fail when used for vertical restraint. While spiral or ring shanks help, screws still offer better withdrawal resistance.

Toenailed. Toenails are relatively more capable than face-nails of resisting the forces from flattening crowned joists, but toenailing across the corners can split or crack the decking material if it's forced to resist too much deflection. For this fastening method, I recommend that the joists span no more than 75 percent of the maximum allowable, or that blocking be installed mid-span to resist deflection.

Various clips. When using clip or track systems, keep in mind the previously described conditions that pull the decking from the joist or the joist from the decking. Consider the design of the fastening system and what it's made of. Are the fasteners plastic or metal? Do they seem easily deformed or broken?

You've also got to consider the decking — how the fastener grabs it and how strong the decking itself is. With slot or biscuit systems, the fastener grabs only the bottom portion of the decking, not all of it from the top, as a face-screw would. And fastening systems based on screws driven into the decking from below rely on the decking to resist withdrawal of the screws; softer decking won't handle that as well. If you have any doubts about the performance of the fastening system, limit the deflection with blocking as suggested previously.

Horizontally Secure the Decking

Having addressed the vertical dimension, we're left with the forces along the two horizontal axes (north-south, east-west).

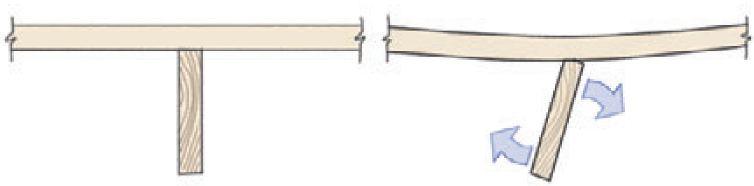

Figure 2. The decking fastener restrains the upper edge of the joist from twisting while under load. The deflection that still occurs is largely due to the bottom edge of the joist being unrestrained.

The most obvious force is the one exerted by people walking on the deck. We don't want boards sliding under our feet. This force is not a big deal to resist, and every fastening system I've seen is able to withstand it. The more significant forces are those applied to the decking by rotation of the joists and by drift movement of the deck frame.

First I'll address the tendency for a joist to rotate while under load. Think about the last time you walked the joists while framing a deck — without decking tying the joists together, every step twisted the joist you were walking on to its side. A joist is most rigid when held in the vertical position (**Figure 2**). The more a loaded joist is allowed to rotate or twist, the more it will deflect downward. The decking resists this rotation, at least on the top edge of the joist. The twisting loads get transferred to the decking through the fasteners, which keep the top of the joists from moving, thereby minimizing deflection from twisting.

While the decking keeps the top of the joists from rotating, the bottoms are still free to move, at least in the center of the deck where they aren't secured to the ledger or a beam. This is where the mid-span blocking that was suggested previously can play an important role. Full-depth blocking does wonders for resisting joist rotation, and thus limits its deflection, regardless of the decking fasteners used (**Figure 3**).

Another and possibly more significant issue is the ability of a decking fastener to resist horizontal movement from lateral loads. Here we aren't worried about hold-down anchors and ledgers. There are two dynamics to lateral loads, displacement and deformation, the latter of which is discussed here. Decking and its fasteners won't keep lateral forces from moving a deck as a whole away from the house (displacement), but they can be used to provide resistance to lateral forces causing deformation (sway), such as are caused by people moving around on a deck.

Installing decking at an angle to the joists creates triangles between the joists, ledger, and rim. Triangles are useful for creating rigid structures; where a square can be deformed (into a parallelogram), a triangle cannot, as long as each corner is held strong and the sides don't lengthen or shorten (**Figure 4**). The lengths of the decking, joists, and ledger — the sides of the triangles — aren't going to change. The connections at the triangles' corners are the weakest link, and those connections depend on how the decking is fastened to the joist. For angled decking to function as a bracing method, the decking fastener must resist significant horizontal forces, perhaps more than some can handle.

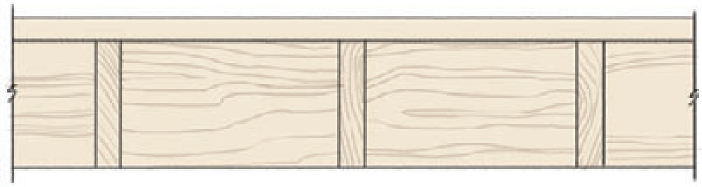

Figure 3. Installation of a row of blocking at the midspan of the joists restrains both the top and the bottom edge of the joist from rotating. Even half blocks that are held to the bottom of the joists do an excellent job of resisting deflection, as the top edge is restrained by the decking fasteners.

When decking is installed perpendicular to the joists, or if you doubt your fasteners' ability to resist these forces, other bracing methods are called for. These could be angled braces between the posts and the outer beam, or members fastened at an angle across the bottom of the joists.

Angled decking can clearly resist deformation of a deck, but I've never seen it quantified by engineering. The International Code Council Evaluation Service is prepared to analyze a proprietary concealed fastening system's ability to do this job under Acceptance Criteria #33, but currently no product carries an ES report for that purpose. Report or not, there's no reason not to carefully consider each fastening system you use to be sure it can do the job necessary or that other features are in place to lend a hand.

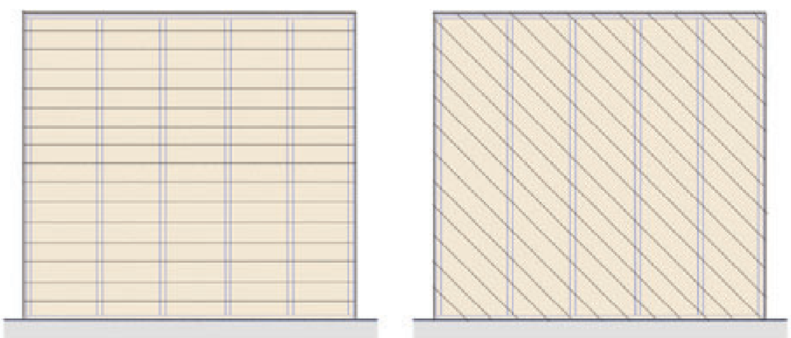

Figure 4. Perpendicular decking (left) creates squares and provides little resistance to sway. Angled decking (right) creates structural triangles throughout the decking surface, and with sufficient fastening, can act as a lateral brace.

What's Your Horizontal Resistance?

Fasteners that are better at resisting vertical forces are not necessarily better at resisting horizontal forces.

Face-fastened. Here's where nails and screws flip-flop. While a screw provides greater withdrawal resistance (vertical force), a nail provides greater shear resistance (horizontal force perpendicular to the shank). The horizontal forces between the decking and the joists are not substantial enough to shear a decking screw, however, even with angled decking installed for bracing. The greater withdrawal strength of screws over nails is so much more significant than the reduced horizontal restraint that it's an acceptable tradeoff.

Toenailed. In resisting the horizontal forces on the fastener itself, toenailed connections aren't much different from face-fastened ones. The forces that are different are the internal forces in the decking. The closer a fastener is to the edge of a board, the less internal resistance the member has to separating at the grain. Just as vertical loads can split the edge of a toenailed member, so could the horizontal forces, but in the real world the horizontal forces aren't significant enough to overcome the combined restraint of hundreds of decking-to-joist connections.

Friction clips. Because they don't have any fasteners penetrating the decking, friction clips are the weakest fastening system for resisting lateral forces. Here, the movement of the decking is resisted only by friction, something that doesn't get engineering credit for resisting loads in any application. This friction likely resists the movement of decking caused by people walking, or the rotation of joists under load, though not quantifiably. However, especially after the wood has dried and the fasteners have loosened, the clips cannot be considered sufficient for resisting movement caused by lateral deformation of the frame; specifically, the connections at the triangle points. When deck fastening systems relying only on friction are used, other means of lateral restraint against deformation must be provided.

What the Code Says

Nothing discussed above will be found in the IRC. A specific means of fastening decking to joists on an exterior deck is not provided, thus each building official must approve every application as an "alternative." As always, uncertainty or ambiguity in the code should be discussed with the local building department. ❖

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