Box vs. Common Nails

by Frank Woeste, P.E.

A contractor recently told me about a case involving a building with a leaky roof. In the attempt to figure out why the roof was leaking, it was discovered that the "plans" called for eight nails at a certain connection, but that the contractor had installed only six. The contractor had to fix the problem, at great expense. The lack of two nails per connection became a big issue. By the time the builder paid his legal expenses, he figured the extra five pounds of nails cost him over $1,000 per pound!

While something like that may never have happened to you, improper or inadequate nailing can be a serious matter in wood construction. Perhaps one of the most common problems I see is the substitution of box nails for common nails, with no allowance for their difference in strength.

Skinny Commons

In simple terms, a box nail can be thought of as a skinny common nail. A 16-penny common nail and a 16-penny box nail are both 3 1/2 inches long, but a common 16-penny nail has a diameter of 0.162 inch, while the 16-penny box nail is 0.135 inch in diameter. The question is, so what?

Nails are rated for "lateral capacity" and "withdrawal capacity." Both ratings are based on nail diameter and the density of the lumber being used. The lateral and the withdrawal strength are greatly affected by the nail's diameter (see Table A). For this reason, you can't just make a one-to-one substitution of common nails specified in a plan with the same number of box nails. Engineers and architects routinely specify common nails, and their designs are based on rated capacities of commons. But since box nails are popular with many carpenters and are widely available in builder supply stores, I've offered a formula (based on Spruce-Pine-Fir lumber) for making a safe conversion from common to box nails (Table B, page 68).

An Example

Frequently, home builders encounter a specification for attaching a "strongback" to a metal-plate-connected floor truss. The specification might read, "Attach strongback at bottom of vertical web next to centerline of truss with minimum 3-10d common nails." Assuming the contractor wants to use box nails instead, the rule-of-thumb calculation using Table B would be

1.22 x 3= 3.66, or 4

So instead of three 10-penny common nails, you would use four 10-penny box nails. Always round up.

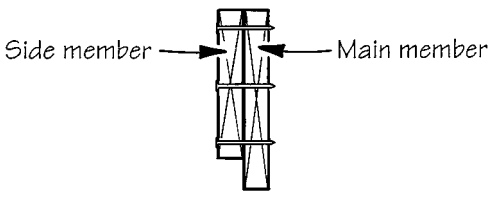
Check With the Designer

For the comparison presented in

A. Lateral Strength of Common vs. Box Nails (in Spruce-Pine-Fir)*

Penny Wgt.	8d		10d		12d		16d		20d	
Nail Type	Common	Box	Common	Box	Common	Box	Common	Box	Common	Box
Diameter (in.)	0.131	0.113	0.148	0.128	0.148	0.128	0.162	0.135	0.192	0.148
Lateral Rating (lb.)	70	57	83	68	83	68	120	88	144	100
Side Member Thickness (in.)	3/4	3/4	3/4	3/4	3/4	3/4	1 1/2	1 1/2	1 1/2	1 1/2

*Nail penetration of at least 12 diameters in the main member is assumed. Based on *National Design Specification for Wood Construction* (1997).



B. Conversion Ratio for Common to Box Nails (Lateral Capacity)*

To convert required number of common nails of a given size to box nails, multiply by the appropriate ratio and round up.

Penny Wgt.	8d	10d	12d	16d	20d
Ratio	1.23	1.22	1.22	1.36	1.44

*Based on values in Table A. S-P-F lumber assumed.

C. Lateral Strength of Gun Nails*

Length (in.)	3	3 1/4	3 1/2	3 1/2
Diameter (in.)	0.131	0.131	0.131	0.161
Lateral Rating (lb.)	64	64	64	88

*Based on *NER-272*. S-P-F lumber assumed.

Table A (which applies only to Spruce-Pine-Fir framing lumber), the common nail typically has a rated lateral capacity 22% to 44% higher than that of a box nail of the same penny weight. Note that the ratios presented in Table B will vary depending upon species of the lumber used and the thickness of the wood members being joined. The multipliers in Table B are good approximations for other species besides Spruce-Pine-Fir. If your plans specify an architect or engineer of record, always contact this design professional for an equivalent nailing schedule.

Pneumatic Nails

Pneumatically driven nails are yet another complication for the diligent contractor. For the most part, gun nails of the same length as common nails have a smaller diameter (Table C), although many nail gun manufacturers are now making a full-size 16-penny nail (0.161 inch diameter). The manufacturers will provide technical data that state the lateral capacity of their various nails. Some manufacturers will also provide a free copy of the code report, *NER-272*, that serves as the minimum guideline for the pneumatic fastener industry. Before substituting a pneumatic nail for a common nail in a critical connection, always check with the building designer.

***Frank Woeste, P.E.,** is Professor of Wood Construction and Engineering at Virginia Tech University in Blacksburg.*