Reducing Heat Loss From Steel Studs

by Bruce Sullivan

Steel framing has several advantages for home builders. Steel is lightweight, easy to install, and cost-competitive; it has a uniform structure, dimensional stability, and it is resistant to fire and decay. But steel has one major drawback — some would call it a fatal flaw: poor thermal performance.

Some builders try to compensate for steel's thermal problems by building thicker walls with more insulation. But wall assemblies lose heat through the framing as well as through the insulation, and steel studs conduct heat 300 to 400 times faster than wood. The picture is far from complete, but current information shows that steel framing has a large negative effect on a home's energy performance.

How Much Heat Loss?

"Metal studs significantly reduce the overall thermal performance of a wall system," says Merle McBride, a Ph.D. research associate with Owens-Corning, a large insulation manufacturer. "The only question is the degree of thermal degradation." That degree of degradation has now been quantified. McBride is the chairman of a committee that developed a table of correction factors (see "Corrected R-Values," below) that provides a simple and consistent method for calculating the thermal performance of metal-framed walls. (The factors are published in the most recent addendum to the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) Standard 90.1G — Energy Efficient Design of New Buildings.)

Hot Box Tests

The correction factors are based on several calibrated hot box tests. (A hot box is an enclosure with two temperature-controlled chambers separated by a test wall. The box is used to measure heat flow and to calculate R-values.) The tests looked at straight 2x4 wall sections, with 16- to 18-gauge, C-channel steel studs. Correction factors for 2x6 and 2x8 walls were extrapolated from the results for 2x4s. The portion of the wall area occupied by the framing, or the "framing factor," was assumed to be 12% for 2x4 walls with studs spaced 16 inches on-center, and 9% for 2x4 walls with studs spaced 24 inches on-center.

These values are fairly conservative. The framing in a typical house occupies 15% to 30% of the wall area, though you can get down to 12% by using advanced framing techniques. In addition, no tests were done on corners, or on wall-to-roof and wall-to-floor assemblies. And no allowance was made for screws and other fasteners that can increase heat loss.

A careful look at corrected R-values for steel studs shows that using thicker walls and adding insulation does not dramatically improve insulating value. For example, the effective insulating value of R-21 batts in a 2x6 steel-stud wall with the studs spaced 24 inches on-center is R-9. Increasing the studs to 2x8s and using R-25 batts only increases insulating value to R-9.6.

Foam Sheathing

The lesson here is that building thicker steel walls with more cavity insulation is a waste of money. The real solution is not to put more insulation between steel studs, but to put rigid foam sheathing on the outside of the wall. Foam sheathing improves a wall's thermal performance by breaking the thermal bridge through the steel.

Exactly how much the foam sheathing adds to the overall building R-value is the subject of ongoing research, but you can probably get close to the R-value of a wood-framed wall. ASHRAE is currently planning a series of large-scale tests on wall sections using a wide variety of materials, including steel framing. And the American Iron and Steel Institute is in the process of publishing design guidelines for the construction of steel-framed buildings. ■

Corrected R-Values for Insulation in Steel-Stud Walls

Stud Size	Stud Spacing	Cavity Insulation	Correction Factor	Effective R-Value
2x4	16" o.c.	R-11	0.50	R-5.5
		R-13	0.46	R-6.0
		R-15	0.43	R-6.4
2x4	24" o.c.	R-11	0.60	R-6.6
		R-13	0.55	R-7.2
		R-15	0.52	R-7.8
2x6	16" o.c.	R-19	0.37	R-7.1
		R-21	0.35	R-7.4
2x6	24" o.c.	R-19	0.45	R-8.6
		R-21	0.43	R-9.0
2x8	16" o.c.	R-25	0.31	R-7.8
2x8	24" o.c.	R-25	0.38	R-9.6

This chart of correction factors for steel walls shows that thermal bridging — the conduction of heat through a wall's studs — greatly reduces the insulating value of cavity insulation. A more cost-effective means of countering thermal bridging is to install a layer of rigid foam on the exterior of steel studs.

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