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IRC's Fire Risk Management Program, working with nine industry partners, conducted 14 full-scale standard tests to study the effect of various parameters on the fire resistance of load-bearing steel-stud wall assemblies. Test parameters included the spacing of steel studs; the number of stud rows (i.e., single- versus double-stud walls); the number of gypsum board layers (i.e., one versus two layers of protection); the use of cross-bracing; the replacement of one layer of gypsum board with an oriented strand board (OSB) shear membrane; the use of resilient metal channels to support the gypsum board; and the type of insulation used in the wall cavity.

Each full-scale assembly was exposed to a standard fire in a propane-fired vertical furnace until it failed in one of three ways: structural failure; exceeding a specified temperature; flame or gas penetration. In all cases, the wall assemblies failed structurally. The unexposed surface temperature at this time was below the temperature criteria for failure.

Two of the factors that most affected the fire performance were the stud spacing and the type of insulation. For stud spacing, the results indicate that steel-stud wall systems with stud spacing of 610 mm provided higher fire resistance (74 minutes) than those systems with stud spacing of 406 mm (59 minutes). This difference in fire-resistance performance is attributable to the fact that the wall assembly with wider spacing has fewer studs than the assembly with closer spacing and therefore carries a smaller load. In accordance with the test protocol, the load is based on the number of studs – fewer studs mean a smaller overall load. In the course of the fire tests for both assemblies, the load shifts to the end studs, which are less exposed to fire than the inner studs. But since the end studs must carry a greater load for the wall assembly with closer spacing, this assembly fails more quickly than the assembly with wider spacing.

As for insulation, the research results indicate that uninsulated wall assemblies provide a higher fire resistance than insulated ones. There are two reasons for this:
1. The insulation keeps the gypsum board facing the fire hot, causing it to crack and fail more quickly than in an empty cavity. Once it has failed, the insulation and studs are exposed to the heat of the fire.
2. The insulation allows the heat to build up and become trapped in the cavity, thus hastening the structural failure of the studs.

The results also showed that there is considerable variation in the effects of different types of insulation on fire resistance. Glass fibre produced a fire resistance of 56 minutes, rock fibre 59 minutes and cellulose 71 minutes. By contrast, the fire resistance of an uninsulated assembly was 77 minutes.

Sound performance results

Since sound ratings for party walls are needed in conjunction with fire resistance ratings, IRC's Acoustics Group, in a related project, studied the sound transmission

characteristics of steel-stud wall assemblies. Using wall assemblies similar to those tested for fire resistance, the acoustics researchers found that the method of framing had some effect on sound transmission. Each wall assembly tested had one row of load-bearing studs and used horizontal resilient metal channels to support the gypsum board covering on one side.

One focus of the project was the effect of shear bracing, such as might be used in earthquake-prone areas. It was found that steel framing elements, such as blocking or cross-bracing straps, had a negligible effect on sound transmission. Adding an oriented strand board layer between the studs and the attached gypsum board, however, improved the sound transmission class (STC) as a result of the increased surface weight. (The higher the STC, the greater the noise reduction.)

The single most important parameter in sound transmission control was the weight of the gypsum board surface layers. Typically, the STC improved by about 5 when the weight of the gypsum board on either side of the wall was doubled. The researchers demonstrated this improvement by both changing the number of gypsum board layers on the assembly and changing their weight.

Other ways to improve the STC include: filling the inner-stud cavities with fibrous insulation, allowing for greater spacing between the resilient channels, and using studs made of thinner steel. In fact, compared to cases with empty cavities, the STC improved by 8 to 10 when stud cavities were completely filled with insulation, although the type of insulation had only a slight influence.

Although the fire and acoustics research showed that uninsulated assemblies performed better in terms of fire resistance while insulated assemblies were superior acoustically, it also identified a wide variety of constructions that provide both satisfactory fire resistance and noise control in terms of meeting National Building Code (NBC) requirements. As well, by studying sound and fire together, some constructions that don't meet the intent of the code were also identified.

A group of industry partners are drafting a proposed addition to the Appendix to Part 9 of the NBC, which could result in many more entries for steel-stud wall assemblies in the table of fire-resistance ratings (FRR) and sound transmission class (STC) ratings for walls. These fire and sound ratings make it possible for designers and builders to assess an assembly's compliance with code requirements.

This article was adapted from two articles appearing in the June 2002 edition of IRC's quarterly newsletter, *Construction Innovation*. Questions about the fire-resistance of wall assemblies can be directed to Dr. Venkatesh Kodur at (613) 993-9729, fax (613) 954-0483, or e-mail at venkatesh.kodur@nrc.ca
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The partners for the project were as follows: Canadian Home Builders Association, Canadian Sheet Steel Building Institute, Canadian Steel Construction Council, Canadian Wood Council, Cellulose Insulation Manufacturers Association of Canada, Fortinek Canada Corporation, Gypsum Manufacturers of Canada, Owens-Corning Canada, and Roxul Inc.