

SOUND TRANSMISSION THROUGH GYPSUM BOARD WALLS - EFFECT OF SHEAR MEMBRANES AND FRAMING DETAILS

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1. INTRODUCTION

This paper focuses on trends observed in the sound transmission results from a research project that studied both sound and fire resistance of wall assemblies intended for multi-family residential buildings. The National Research Council led the consortium project, with support from CMHC, Canadian Wood Council, Forintek Canada, Gypsum Manufacturers Canada, Ontario Min. of Housing, Owens Corning, Roxul, and Can. Home Builders' Assoc.

The series of 70 wall assemblies were all load-bearing constructions with gypsum board surfaces, but they varied in other details. Approximately half had framing of 16-20 gauge steel; the others were framed with wood studs plus a shear-bracing layer to increase the racking strength of the wall. To provide a basis for assessing the range of constructions in common use, the study included typical variations of component materials, as indicated in Figure 1.

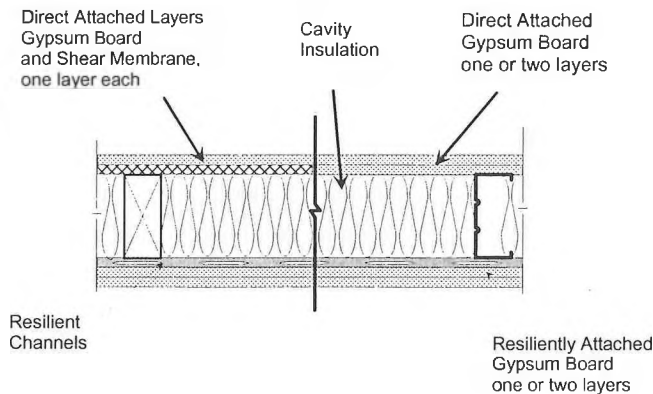


Figure 1: Horizontal cross-section through the wall assemblies.

Assemblies are identified in captions using a short hand coding for components. For surfaces, 'n' layers of Gypsum board 'xx' mm thick is denoted: **nGxx**. Corresponding codes for Oriented Strand Board and Plywood are **OSBxx** and **PLYxx** respectively. For framing members 'xx' mm deep spaced 'ss' mm apart on centre, **WSxx(ss)**, **SSxx(ss)**, and **RCxx(ss)** denote Wood Studs, Steel Studs, and Resilient metal Channels. Insulation in inter-stud cavities is denoted **GFBxx**, **MFBxx**, or **CFLxx** for Glass Fibre Batts, Rock Fibre Batts, or Cellulose Fibre 'xx' mm thick. For this key, all dimensions are rounded to the nearest mm; for example 12.7 mm gypsum board is listed as G13.

The discussion of factors controlling the sound transmission loss (TL) focuses first on factors controlling airborne

transmission, and subsequently on structure-related aspects.

2. FACTORS FOR AIRBORNE TRANSMISSION

Density of the surface layers is the single most important parameter. As shown in Figure 2, the typical improvement in transmission loss (and STC) is 4-5 dB when the number of layers of gypsum board (and hence the mass) is doubled on one side of the wall. Similar changes are observed with both wood and steel studs.

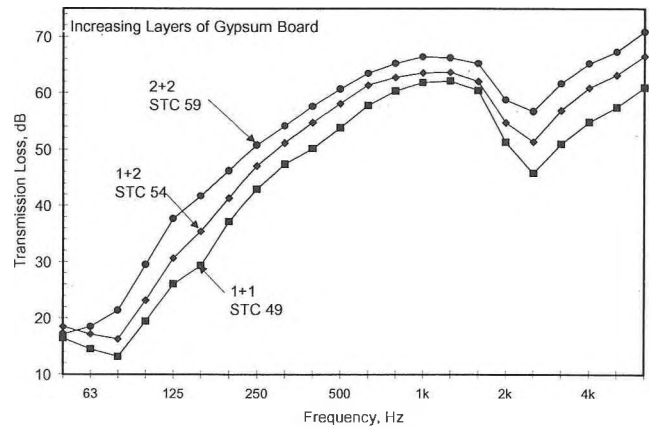


Figure 2: Adding layers of gypsum board to wall construction nG16_SS92(406)_GFB92_RC13(610)_mG16.

Adding cavity absorption improves the TL above 80 Hz, but the effect is smaller at the low frequencies that control STC for these walls. The type of insulation has a slight influence. Data in Figure 3 suggest that for frequencies above 400 Hz,

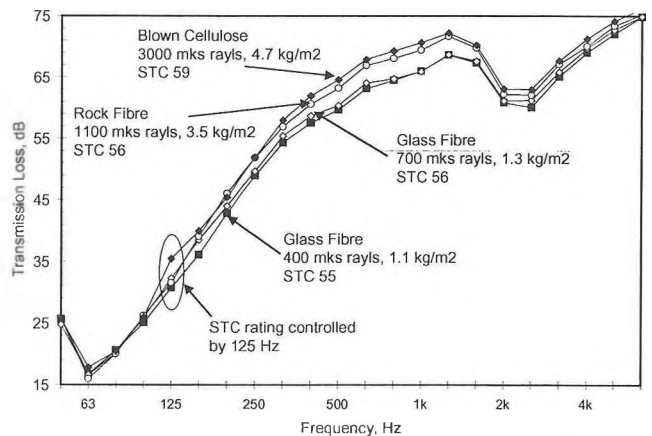


Figure 3: Varying the cavity insulation for wall constructions G16_OS13_WS89(406)_xxx89_RC13(610)_2G16.

the airflow resistance of the fibrous insulation in the cavity controls the ranking of the walls' transmission loss. The additional mass and any damping introduced by heavier fibrous materials in contact with the surfaces may also contribute. At low frequencies (where the STC tends to be determined and reproducibility is worse) the trend is much less clear. For the few cases with partly-filled cavities, the TL is lower than those shown in Figure 3, but the type of insulation seems less significant.

3. EFFECT OF STRUCTURAL ELEMENTS

Structural elements affect both structure-borne transmission and airborne transmission (via panel boundary conditions).

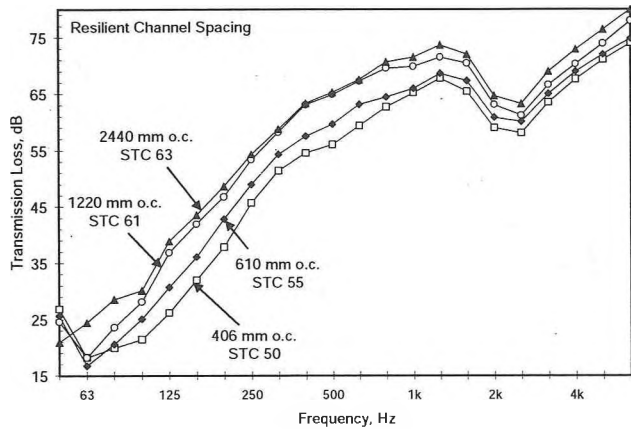


Figure 4: Changing resilient channel spacing in constructions G16_OS13_WS89(406)_GFB89_RC13(xxx)_2G16.

Resilient metal channels are used to reduce structural transmission in these walls. As shown in Figure 4, the TL rises with greater inter-channel spacing (or equivalently, with fewer channels) approaching a limit as the structural transmission becomes negligible at very large spacing.

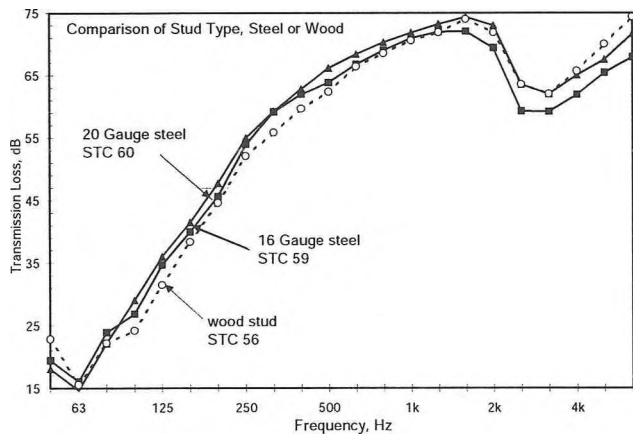


Figure 5: Effect of changing stud type, in wall constructions 2G13_stud(406)_MFB90_RC13(xxx)_2G13.

Because these steel studs are more compliant than wood studs of the same nominal depth, they give slightly greater

TL at the lower frequencies, as shown in Figure 5. Regression analysis confirms this trend in STC versus stud type. The lower TL for 16 Gauge steel framing above 1 kHz is unexplained, and may be due to a construction anomaly.

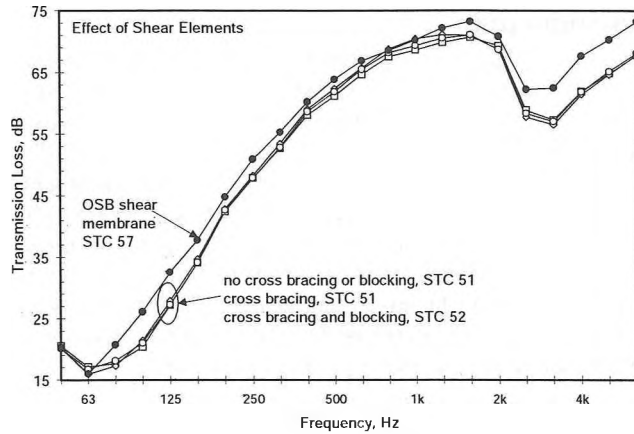


Figure 6: Adding shear bracing to 20 gauge steel-framed wall G13_SS92(406)_MFB90_RC13(404)_2G13.

A major focus of this project was the effect of shear bracing on sound transmission. Figure 6 shows that blocking and/or cross-bracing straps have little effect on TL of these steel-framed walls. Adding an OSB layer gives the highest TL, mainly due to increased surface weight.

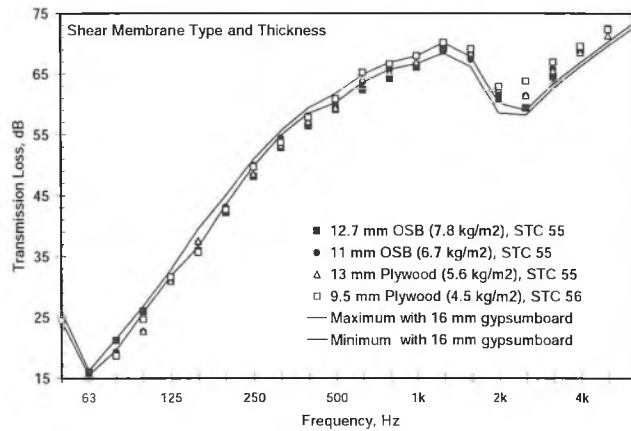


Figure 7: Replacing G16 with shear membrane in wood-framed wall G16_xx_WS89(406)_GFB89_RC13(404)_2G16.

Adding a shear membrane to a wood-framed wall also increases the TL. As shown in Figure 7, the four walls with wood-based shear membranes have quite similar TL. When the plywood or OSB layer is replaced with gypsum board (11 kg/m²), the TL changes slightly. The increase in surface weight should increase TL by ~2 dB at all frequencies, if behavior matched that in Figure 2. This expected increase is apparent below 500 Hz, but at higher frequencies specimens with the (lighter) shear membranes consistently exhibit higher TL, presumably due to typical stiffness and damping.