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GUIDE FOR FLANKING SOUND TRANSMISSION IN WOOD FRAMED CONSTRUCTION – AIRBORNE SOURCES

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Abstract

This paper reports results from continuing studies of sound transmission between adjacent units in wood-framed multi-dwelling buildings conducted at in the Flanking Transmission Facilities at IRC/NRC. The paper examines how common construction details affect structure-borne (flanking) transmission between adjacent rooms. Previous reports from our multi-year experimental study showed that the dominant flanking path between horizontally, vertically and diagonally separated rooms typically involved the exposed surface of the floor. This paper reports on the most recent study, which revealed that there are a number of other transmission paths involving the sidewalls, and ceilings, which become collectively important once the more obvious paths are addressed. Estimates of the apparent sound insulation were obtained by summing the energy transmitted directly through the separating wall or floor assembly with that for all the flanking paths involving the wall/floor/ceiling surfaces abutting the separating construction. These estimates provide the basis for a design guide [1]T to predict sound isolation in typical wood-framed row housing or apartment buildings.

1. INTRODUCTION

This paper reports results from continuing studies of sound transmission between adjacent units in wood-framed multi-dwelling buildings. First, the paper presents some recent extensions of our multi-year experimental study, which has assessed how common construction details affect structure-borne (flanking) transmission between adjacent rooms, for a broad range of wall and floor constructions. Previous reports have focused on the wall and floor surfaces connected at the wall/floor junction - especially the floor surface, which is often the dominant problem. This paper includes a number of other paths that may collectively become significant when more obvious paths are controlled.

Estimates of apparent sound isolation were obtained by summing the energy transmitted directly through the separating wall or floor assembly with that for all the flanking paths involving wall, floor, or ceiling surfaces abutting the separating assembly. These estimates provide the basis for a simplified design guide [1] to predict sound isolation in typical wood-framed row housing or apartment buildings. The Guide presents the sound insulation using

ASTM ratings; for the international audience of this conference, the performance is recast in terms of the equivalent ISO ratings, as Apparent Sound Reduction Index, R'_w.

This paper presents a subset for airborne sources and horizontal transmission, for wood-framed constructions with the wall and floor assemblies shown in Figure 1, or minor variants on them. Construction specifications and AutoCAD detail drawings are given elsewhere . References to the pertinent technical standards, and procedures to determine the appropriate sound reduction index – due to direct transmission through just the separating wall or floor assembly between two rooms, or transmission via individual flanking paths involving specific surfaces in the two rooms, or the overall transmission for sound energy via all paths – are also given in Reference [2].

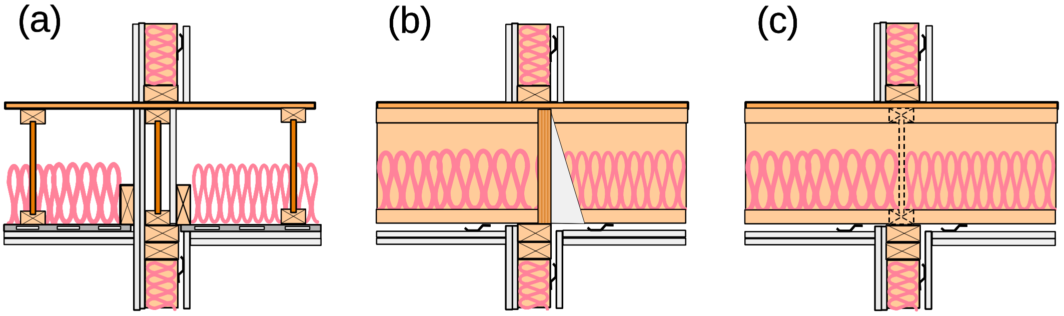


Figure 1: Construction details of the 3 wall/floor systems. Joists were oriented (a) parallel to the wall, (b) perpendicular to the wall, and (c) with joists continuous across the wall, perpendicular to it.

2. RESULTS AND DISCUSSION

As discussed in previous papers [3], sound isolation between adjacent units in a wood-framed building typically involves significant transmission via several paths. Figure 2 compares direct sound transmission through the separating wall between two side-by-side apartments vs. flanking transmission via the floor surfaces for the constructions illustrated in Figure 1.

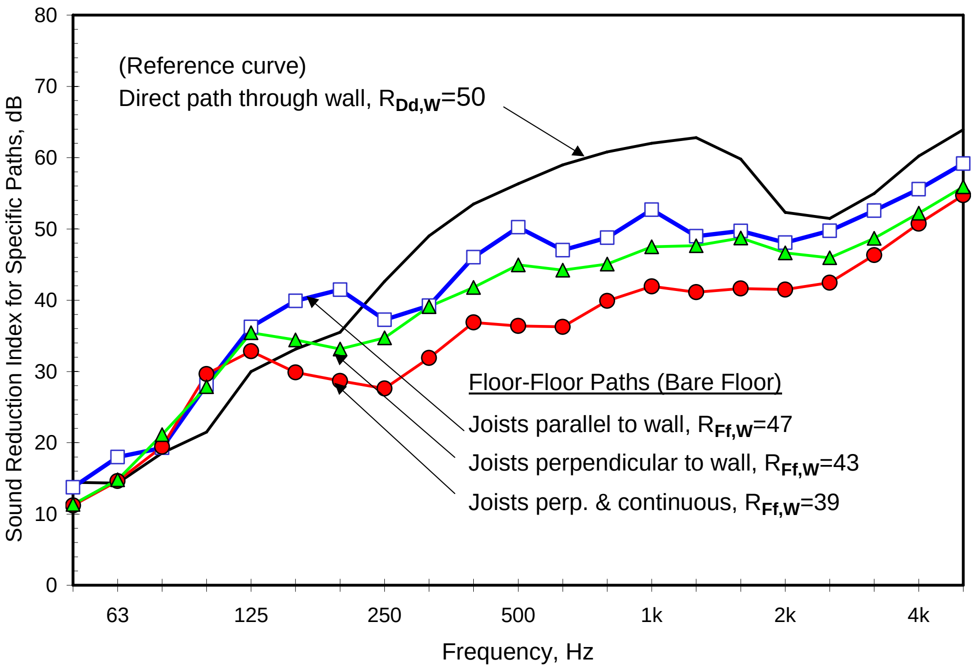


Figure 2: Path sound reduction index via specific paths with bare OSB subfloor and basic separating wall, as in Figure 1.

In the case shown in Figure 2, (with bare subfloor) most of the sound is transmitted via the floor surfaces. There are other paths – such as via the ceiling or the abutting sidewalls – but they transmit less than these dominant paths. As shown in Figure 3, adding a topping over the subfloor increases the transmission loss for this path; other toppings would provide somewhat different improvements. This increases overall apparent sound reduction, R'_w. Note, however, that when the floor-floor path is improved, other transmission paths become significant - two obvious paths of concern involve the ceiling or the abutting walls. For example, Figure 4 shows the main transmission paths between side-by-side apartment units.

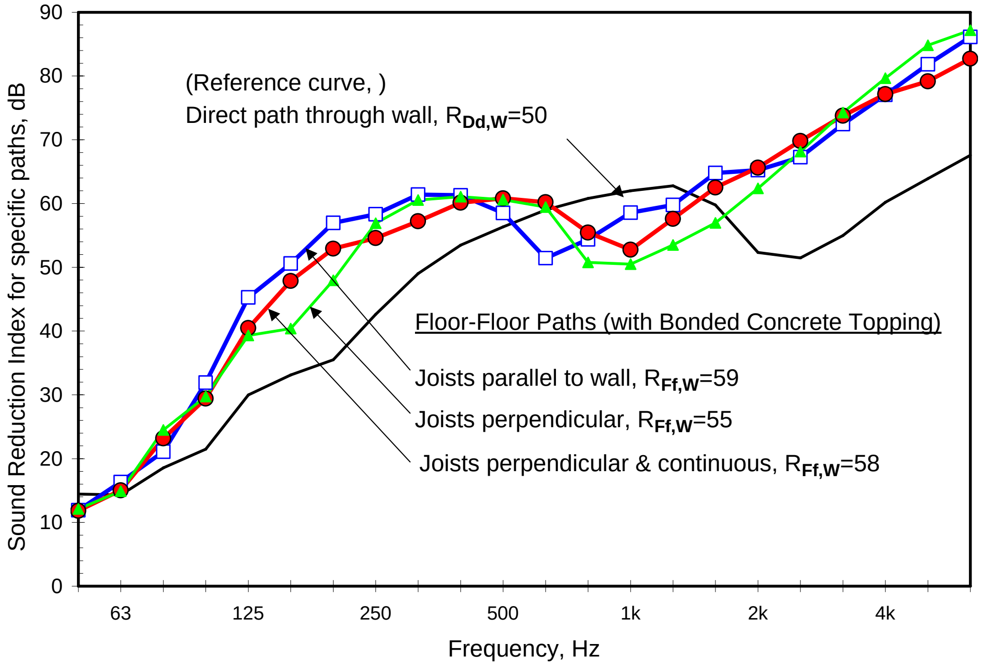


Figure 3: Path sound reduction index for specific paths with the same basic separating wall, and bonded concrete topping on the OSB subfloor.

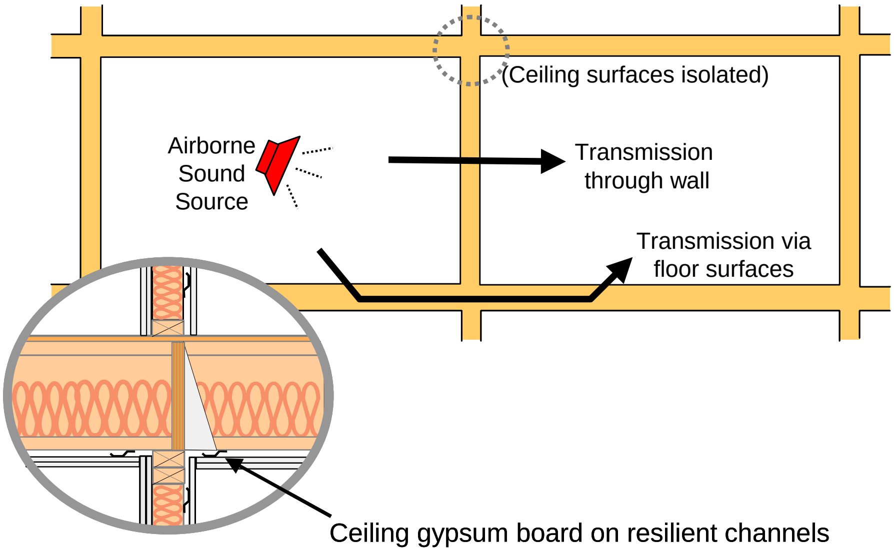


Figure 4: Typical transmission paths between adjacent 1-level apartment units. The walls parallel to the plane of this figure (side walls) also transmit sound, but resilient channels supporting gypsum board of the ceiling suppress transmission via ceiling-ceiling path.

In apartments, the gypsum board ceiling is normally mounted on resilient channels (to enhance isolation from the apartment above), which reduces flanking transmission between the side-by-side units via the ceiling-ceiling path to insignificance. Flanking via an abutting side wall transmits little sound ($R_{Ff,w}$ 61 for one wall in the case tested), but this could also limit overall performance if the separating wall and the floor were improved, and would drop to $R_{Ff,w}$ 58 if there were two such walls.

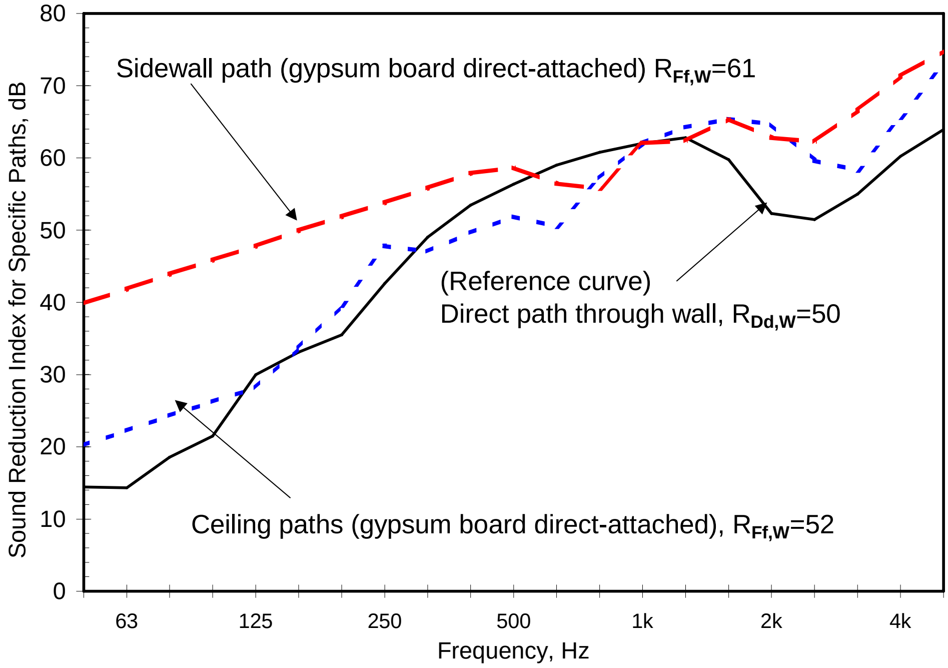


Figure 5: Sound reduction for flanking paths not involving transmission via the wall/floor junction.

But in row housing (where transmission between stories within a dwelling unit is not a concern) the ceiling would commonly be screwed directly to the bottom of the joists. Then the ceiling-ceiling flanking path also becomes significant, as indicated in Figure 6; the associated sound transmission for this ceiling-ceiling path is given in Figure 5.

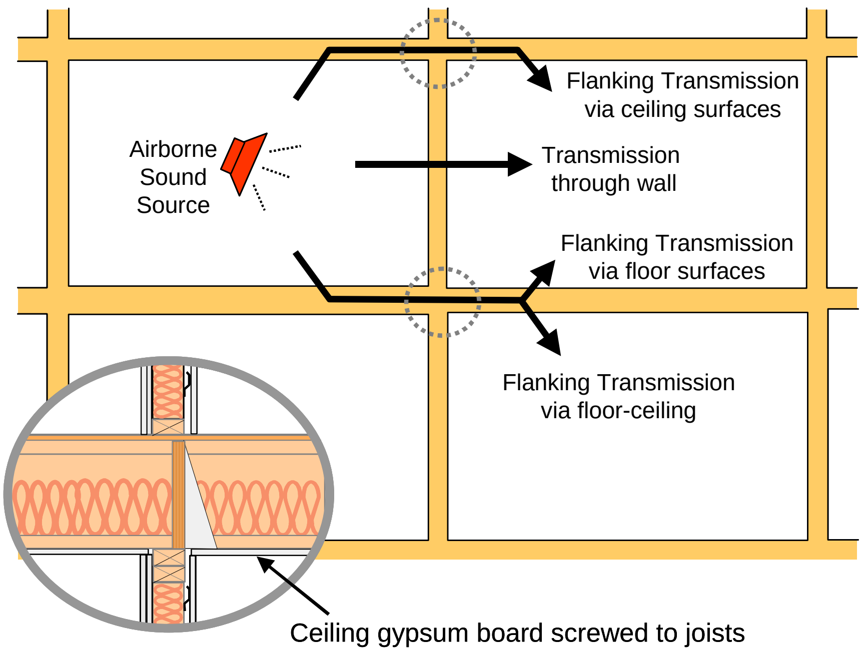


Figure 6: Typical transmission paths in multi-level row housing.

3. THE DESIGN GUIDE

Obviously, all paths should be considered for good design. In the Guide, tables present the combined effect of all paths for typical variants.

Table 1: The table gives Apparent Sound Reduction Index, R'_w for "apartment design" in the case with joists perpendicular to separating walls as shown in the drawing to the right (case b in Figure 1). R'_w in a given building will not exactly match the tabulated values, but the trends should apply.

Separating wall	Basic Wall (R_w 52)	Better Wall (R_w 57)	
Sidewall gypsum board	Direct or resilient	Direct	Resilient
Floor Surface	Apparent sound reduction, R'_w		
No topping (basic)	43	43	44
19 mm OSB stapled to subfloor	48	49	50
25 mm gypsum concrete bonded to subfloor	49	51	51
38 mm gypsum concrete + resilient mat on subfloor	51	53	54

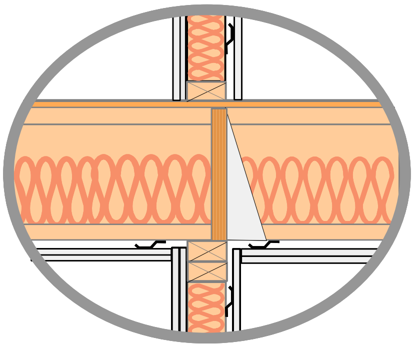
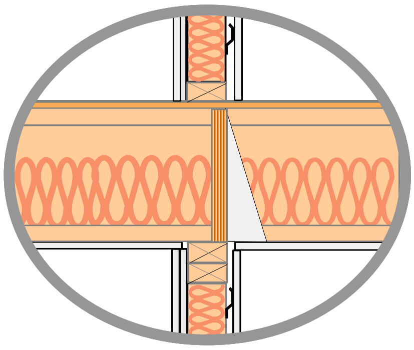


Table 2: The table gives Apparent Sound Reduction Index, R'_w for "row house design" in the case with joists perpendicular to separating walls as shown in the drawing to the right – a variant on case (b) in Figure 1. Note the R'_w values are significantly lower than corresponding values in Table 1 due to the stronger transmission via the ceiling-ceiling path.

Separating wall	Basic Wall (R_w 52)	Better Wall (R_w 57)	
Sidewall gypsum board	Direct or resilient	Direct	Resilient
Floor Surface	Apparent sound reduction, R'_w		
No topping (basic subfloor)	42	43	43
19 mm OSB stapled to subfloor	47	48	48
25 mm gypsum concrete bonded to subfloor	48	49	49
38 mm gypsum concrete + resilient mat on subfloor	49	51	51



In all cases, the overall Apparent Sound Reduction Index, R'_w is lower than the R_w for the separating wall – in some cases it is much lower. By altering design details to balance transmission via specific paths a cost-effective yet satisfactory design can be chosen.

6. SUMMARY

This paper provides a very terse overview of how experimental characterization of the direct and flanking sound transmission paths in wood-framed construction can lead to a manageable set of path transmission terms to represent the effect of specific design tradeoffs. By combining the energy transmitted via all paths it is possible to arrive at estimates of the overall apparent sound reduction, R'_w for a range of constructions.

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REFERENCES

[1] J.D. Quirt, T.R.T Nightingale, and F. King, *Guide for Sound Insulation in Wood Frame Construction*, RR-219, NRC-IRC, Canada, (2006)

[2] T.R.T. Nightingale, J.D. Quirt, F. King, R.E. Halliwell, *Flanking Transmission in Multifamily Dwellings: Phase IV*, RR-218, NRC-IRC, Canada, (2006)

[3] J.D. Quirt, T.R.T. Nightingale, R.E. Halliwell, *Estimates of flanking paths involving the wall-floor junction in wood framed construction* and included references, Proceedings of Inter-noise 2005, Rio de Janeiro, Brazil, 2005