

VERTICAL FLANKING SOUND TRANSMISSION VIA THE WALL-FLOOR JUNCTION IN WOOD FRAMED CONSTRUCTION

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1. INTRODUCTION

This paper presents factors controlling transmission of impact (footstep) sound from the floor of one room, to the room below, as indicated in Figure 1, and outlines how transmission data were used to develop a simplified design guide¹ that provides estimates of “**Apparent** Normalized Impact Sound Pressure Level” which is the combined transmission due to all direct and flanking paths.

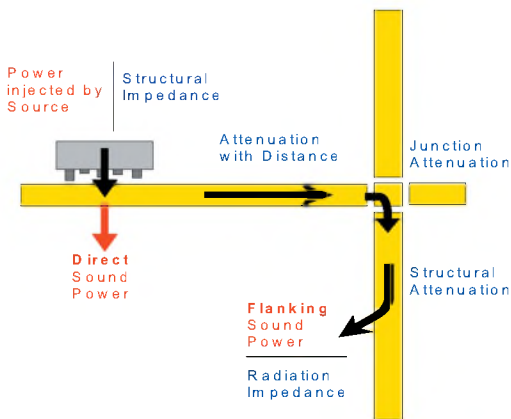


Figure 1: Transmission paths for impact sound.

The procedures to determine the “**Direct** Normalized Impact Sound Pressure Level” (due to transmission through just the floor-ceiling assembly) and the “**Flanking** Normalized Impact Sound Pressure Level” (due to flanking transmission via each wall below) are given elsewhere².

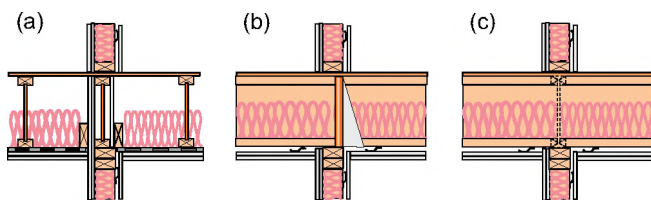


Figure 2: Construction details of the 3 wall/floor systems. Joists were oriented (a) parallel to the wall, (b) perpendicular to the wall, and (c) with joists continuous across the wall, perpendicular to it.

The basic procedure is to determine the path transmissions and then obtain estimates of the apparent sound insulation by summing the energy transmitted via the direct path through the floor-ceiling assembly and all the flanking paths involving the four wall-floor junctions. Results in this paper apply to wood-framed constructions, typical of those shown in Figure 2. Construction details are given elsewhere².

2. RESULTS & DISCUSSION

Impact sound transmission was measured in accordance with ASTM E1007, except all source positions were 2.2 m from the wall. Additional tests were made to characterize structure borne propagation across the floor. Figure 3 shows that the Flanking NISPL depends on the joist orientation relative to the wall. However, the difference between single- and double-stud wall framing was small, so an average over the wall-framing cases can be used to create an estimate of flanking for the design guide.

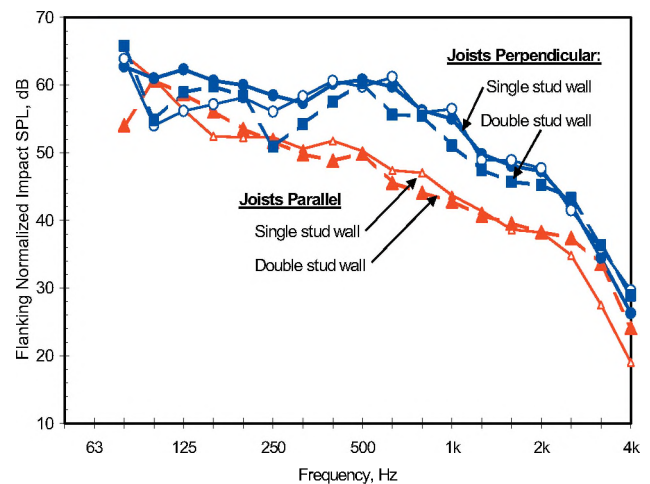


Figure 3: Flanking-NISPL for a single flanking wall with 2 layers of gypsum board, impact source 2.2 m from the wall.

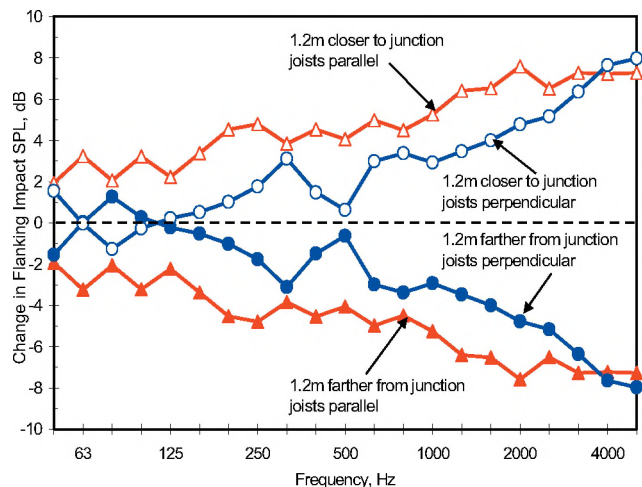


Figure 4: Change in Flanking-NISPL for one wall due to moving an impact source on the bare OSB floor surface

Flanking-NISPL for the path shown in Figure 1 increases as the source moves towards the floor-wall junction, as shown in Figure 4. The change is greater when the floor joists are parallel to the junction because attenuation across the floor is stronger in that direction.

A design estimate is obtained by considering the effect of all paths for the four walls in the room below. By evaluating a number of scenarios, it was found that different positions of the impact source on the floor above had little effect on total sound power transmitted by the combination of the four flanking paths. Figure 5 shows estimates of the Flanking-NISPL due to all four flanking walls, and compares these with direct transmission through the floor.

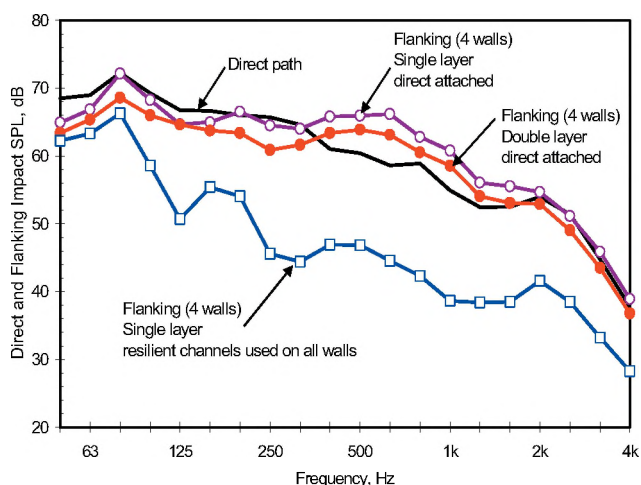


Figure 5: NISPL due to the direct path, or combined flanking paths for all four walls in the room below

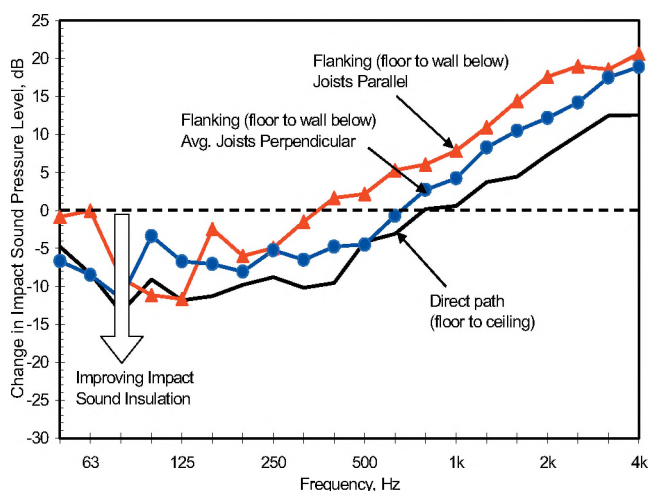


Figure 6: Effect of a 25 mm thick gypsum concrete topping bonded to the OSB subfloor

Changing the floor surface can alter impact sound transmission in two ways – changing the power injected into the floor by the impact, and changing transmission across the floor surface to the floor-wall junction. Figure 6 shows that adding a 25 mm layer of gypsum concrete reduces the

ISPL at the lower frequencies. The ISPL is significantly increased at higher frequencies because gypsum concrete is harder than OSB and more power is transferred from the tapping machine. Adding this topping also significantly changes vibration propagation across the floor surface (so in Figure 6, the change in direct transmission differs significantly from that for flanking and the flanking change is different for the two joist orientations).

In practice the gypsum concrete topping will have a floor covering that will add a compliant layer at the point of impact and there will be a significant reduction in the ISPL as shown in Figure 7. The basic vinyl flooring indicates the minimum improvement likely – carpet, or a resilient interlayer under the concrete topping could increase the attenuation for high frequencies.

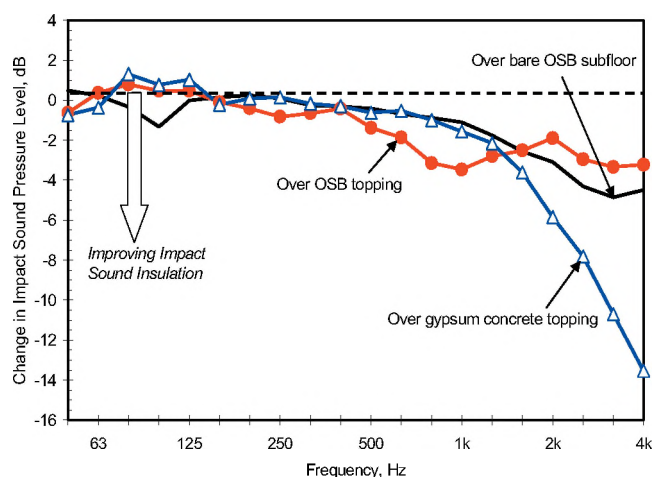


Figure 7: Change (for direct or flanking paths) due to adding vinyl floor covering over typical floor assemblies.

3. SUMMARY AND REFERENCES

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 attenuation terms to represent the effect of specific design tradeoffs. By combining the energy transmitted via all paths allowing for the various attenuation mechanisms it is possible to arrive at estimates of the Apparent-NISPL for a range of constructions. Note that the reports are available on the IRC website at <http://irc.nrc-cnrc.gc.ca/ircpubs/>.

We wish to acknowledge the contributions of Ms. Frances King in performing many of the experimental measurements and the support of the industry partners^{1,2}.

- 1 Quirt, J.D. Nightingale, T.R.T. Halliwell, R.E. Guide for Sound Insulation in Wood Frame Construction: Part 1, **RR193**, IRC, NRC Canada, March 2005.
- 2 Nightingale, T.R.T. Halliwell, R.E. Quirt, J.D., F. King, Flanking Transmission at the Wall/Floor Junction in Multifamily Dwellings, **RR168**, NRC Canada, March 2005.