Dealing with Flanking Transmission in Wood Framed Construction

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1. INTRODUCTION

The sound isolation between adjacent dwellings in multi-family buildings is often much less than would be expected from the STC rating of the nominally-separating wall or floor, due to structure-borne transmission of vibration via the junctions of wall and floor assemblies. Recent studies[1-3] have both identified key paths for this structure-borne transmission, or "flanking", and established the performance for a variety of construction modifications to control such transmission. This paper will present the trends evident from the available data, to provide guidance for practical solutions and indicate some remaining challenges for designers and consultants.

For adjacent rooms in a building, direct transmission through the separating partition, plus "flanking" (structure-borne vibration involving other surfaces of the rooms and transmitted via the junctions between these surfaces) both contribute to the transmitted sound power. Their combined effect is the Apparent Sound Transmission Loss.

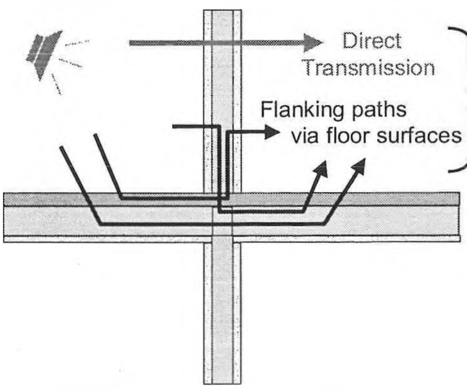

Figure 1: Sound transmission paths between adjacent rooms are shown on a conceptual sketch of the wall/floor junction.

2. RESULTS

The trends are similar for transmission of airborne and impact noise; this paper focuses on the former. Although many surfaces contribute to flanking transmission, some transmit more energy than others.

For vertical transmission (where direct transmission is through the floor/ceiling assembly) the main flanking path involves transmission via the sub-floor in the room above and wall surfaces with directly attached gypsum board in the room below. For horizontal transmission (where direct transmission is through the separating wall assembly, as shown in Figure 1) the main flanking path involves transmission via the sub-floor in each room. The range of typical flanking effects with a bare sub-floor of plywood or OSB is illustrated in Figures 2 and 3.

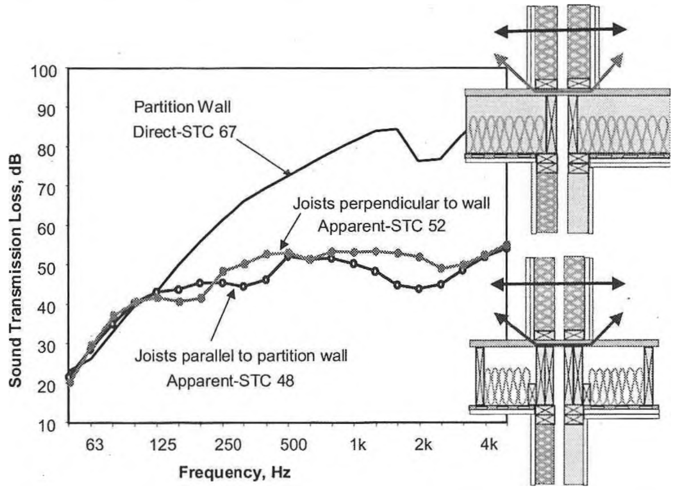

Figure 2: Apparent Sound Transmission Loss with a double wood stud wall (STC 67) and bare OSB sub-floor in the rooms.

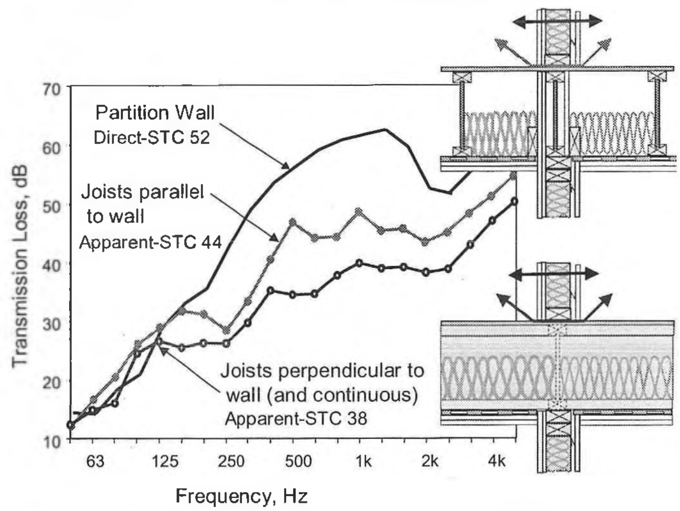

Figure 3: Apparent Sound Transmission Loss with a single wood stud wall (STC 52) and bare OSB sub-floor in both rooms, for two configurations of wood-I floor joists.

Flanking reduces the isolation between side-by-side rooms over most of the frequency range of interest, and reduces Apparent STC (which indicates what occupants will perceive) by nearly 20 dB in some cases. The flanking is primarily due to continuity of the floor joists and/or the sub-floor across the wall/floor junction[1,3].

In practice, such connections are required for 3- or 4-storey multifamily buildings, and even for row housing in areas of high seismic risk. Hence the practical problem shifts to design changes to reduce the flanking.

For horizontal transmission, most of the flanking energy is transmitted via the sub-floors; hence modifying the floor surfaces is the obvious remedy. An example with 25 mm gypsum concrete over the OSB is shown in Figure 4.

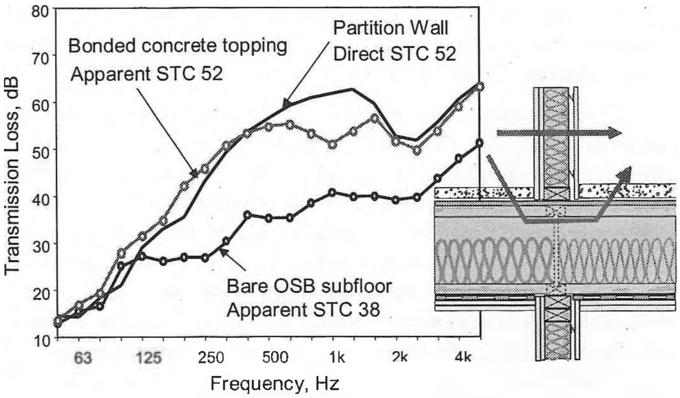

Figure 4: Apparent Sound Transmission Loss with bare sub-floor of 16 mm OSB, or with addition of a gypsum concrete topping.

Addition of the gypsum concrete topping increased the Apparent Transmission Loss at all frequencies where the flanking was significant. Except in a few bands near 1 kHz (the coincidence dip for this topping) the transmission via the floor became negligible, so the Apparent TL was limited only by direct transmission through the partition wall.

For cost-effective construction, transmission must be tested for a variety of floor toppings. To measure sound transmission via the floor-floor path, the direct transmission through the wall was blocked using a covering assembly. The results (listed in the table as "Flanking STC") were normalized to the area of the separating wall, for direct comparison with the overall Apparent STC.

Type of topping	Flanking STC*	Change
Bare 16 mm OSB sub-floor	39	
19 mm oriented strand board (OSB), stapled to OSB sub-floor	48	+9
25 mm gypsum concrete bonded to OSB sub-floor	57	+18
38 mm gypsum concrete floating on resilient foam pad over sub-floor	60	+21

* *Flanking transmission (floor-to-floor path). Joists and sub-floor continuous across wall/floor junction, and wall blocked.*

Note that somewhat different results would be expected for the same toppings when installed on different floor assemblies, especially in the case of bonded toppings, which depend significantly on joist orientation[3].

For vertical transmission (where the main flanking path is via the OSB or plywood sub-floor in the room above and wall surfaces with directly-attached gypsum board in the room below), a reduction of 1-3 in the Apparent STC could be ascribed to flanking, as shown in Figure 5. The variation could be due to specific construction details, or experimental uncertainty. In the test facility, flanking was suppressed except for one test wall; in a normal building with flanking via several walls, the Apparent STC could be reduced more.

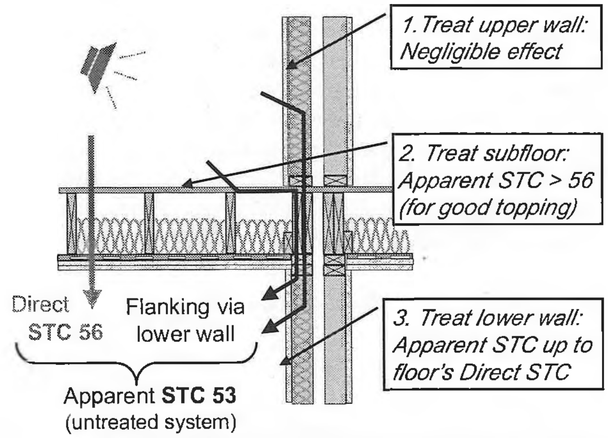

Figure 5: Flanking paths and typical effect on the Apparent STC, with one layer of directly-applied gypsum board on the flanking wall, and a sub-floor of one layer of OSB or plywood.

Because the wall-wall path transmits little flanking energy, the two effective treatments are to modify the sub-floor or the wall below. Mounting the wall's gypsum board on resilient channels increased the attenuation for this flanking path by ~10 dB, making the flanking insignificant. Adding a topping reduced transmission via the flanking path, but also improved attenuation of direct transmission through the floor/ceiling system. As toppings also suppress horizontal flanking, they may be more cost-effective.

3. CONCLUSION AND REFERENCES

A study of flanking transmission in wood frame construction has shown that for airborne excitation the floor/wall junction in multifamily buildings provides serious structural flanking. This can be controlled by systematic changes to the floor and wall assemblies.

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2. T.R.T. Nightingale, R.E. Halliwell, J.D. Quirt, "Vibration response of floors and the effectiveness of toppings to control flanking transmission", Proceedings INTERNOISE 2002
3. T.R.T Nightingale, R.E. Halliwell, J.D. Quirt, (2002) "Flanking Transmission in Multi-Family Dwellings Phase II: Effects of Continuous Structural Elements at Wall/Floor Junctions", *Research Report 103, IRC, NRC Canada*

This work was supported by a consortium that included: Canada Mortgage and Housing, Forintek Canada, Marriott International, Owens Corning, TrusJoist, and USG.