FLANKING SOUND TRANSMISSION IN WOOD-FRAMED CONSTRUCTION

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1. INTRODUCTION

This paper presents selected results from a research project to study sound and fire resistance of wall/floor junctions intended for multi-family residential buildings. A consortium - CMHC, Forintek Canada, Gypsum Manufacturers Canada, IRC/NRCC, New Home Warranty (Ontario, Alberta, B.C. & Yukon), Ontario Ministry of Housing, Owens Corning Inc., Roxul Inc., and Canadian Home Builders' Association - supported the project.

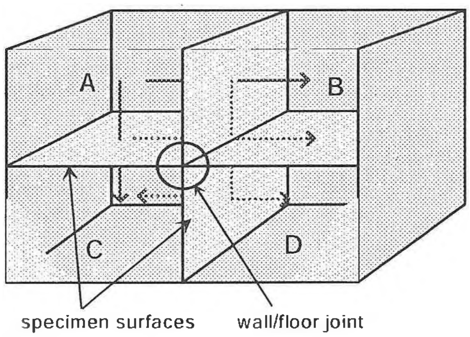


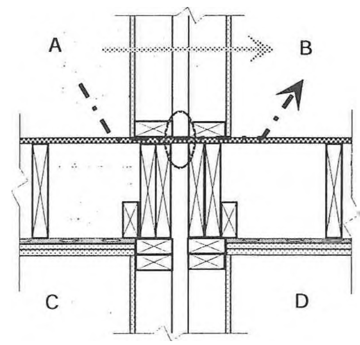
Figure 1: Special facility for the measurements. Party wall assembly and floor divide the space into 4 rooms. Structural transmission via facility surfaces is suppressed.

First, it is necessary to establish terminology. ***Direct*** sound transmission between rooms A and B is by airborne transmission through the party wall separating the two rooms. ***Flanking*** transmission involves all the other transmitted sound energy, which includes other source room surfaces such as the floor, is transmitted by structure-borne paths, and is radiated into the receiving room from various surfaces. The ***Apparent Sound Transmission Loss*** combines the sound energy transmitted directly through the partition and via all flanking paths.

This paper presents only the apparent airborne sound transmission loss between Rooms A and B. Other results - including impact sound transmission, airborne sound transmission between all pairs of rooms, acoustic intensity from various surfaces, and non-standard tests - are given in Report IRC-IR-754.

Measurements were made according to ASTM E336, except that in most cases the sound transmission includes direct transmission through the party wall separating the rooms, plus flanking transmission involving the wood joist floor system. Typical wall and floor constructions are shown in Figure 2. Two wall types were used, both with two rows of wood 2x4 studs. The basic wall has one layer of 5/8" Type-X gypsum board on each face and glass fiber batts filling the inter-stud cavities of one row of studs. The superior wall has 2 layers of 5/8" Type-X gypsum board on each face and has glass fiber batts filling cavities of both rows of studs.

Figure 2: Wall and floor specimen details for the basic wall with floor joists parallel to the party wall. For clarity, the insulation batts in the stud and joist cavities are not shown.



The floors had wood 2x10 joists, with joists parallel to the party wall (as in Fig 2), or perpendicular to the wall with each set of joists supported on one row of studs. Changing joist orientation had little effect on FSTC for this wall/floor combination. The sub-floor membrane was 5/8" oriented strand board (OSB) for most specimens. Substituting plywood caused negligible change.

2. TRANSMISSION AT FLOOR /WALL JUNCTION

The most important detail for flanking was continuity of the OSB or plywood sub-floor across the floor-wall junction. This slows fire spread (a focus of this project), but is also commonly used where seismic resistance or wind loads are of concern. This provided the main structure-borne path.

Previous papers examined the effect of changes in the floor/wall junction to reduce vibration transmission while maintaining adequate fire resistance. The continuous OSB sub-floor gives only apparent FSTC 52 even with the superior wall. Thin sheet steel (on top of the OSB sub-floor, bridging the gap) gives apparent FSTC 57, as does 1" thick gypsum board (filling the gap between the rows of studs across the junction). The best case, FSTC 66, has a gap in the OSB to eliminate the structure-borne vibration; batt or semi-rigid insulation material in the gap handles fire resistance. All these junction details resist fire spread, but some would not provide enough shear bracing for structural performance, especially where seismic loading or high winds are an issue.

This paper focuses on modifying floor systems to reduce the effect of vibration transmission via the continuous subfloor membrane across the floor-wall junction

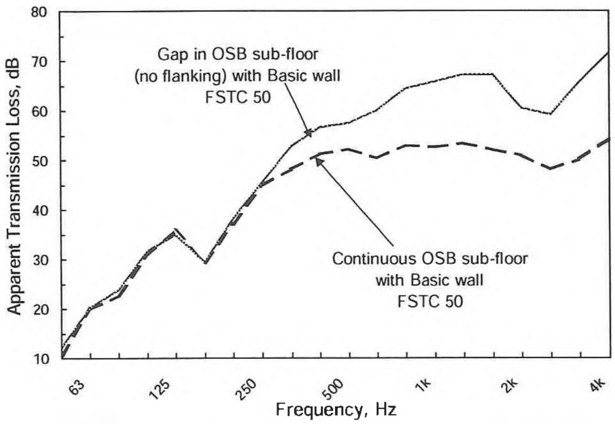


Figure 3: Effect of flanking transmission via the continuous OSB sub-floor in the case with the basic party wall.

The upper (solid) curve in Figure 3 is the apparent sound transmission loss when the flanking path across the wall is eliminated, by cutting the OSB membrane at the party wall between the two rows of studs. The dashed curve shows the lower apparent sound transmission loss when the OSB layer is continuous across the junction. Above 250 Hz, the transmission from one floor surface to the other becomes dominant, and limits the apparent TL. This onset of flanking effects above a characteristic frequency is typical of flanking effects in wood-framed construction. Below about 250 Hz, the flanking path has negligible effect. Changing to the superior wall (not shown), one observes essentially the same apparent sound transmission loss above 250Hz where the floor-floor flanking transmission dominates, because the floor systems are identical. At lower frequencies where direct transmission through the party wall is dominant, the apparent TL increases by about 10 dB with the superior wall, but apparent FSTC increases only from 50 to 52.

3. THE FLOOR/FLOOR PATH

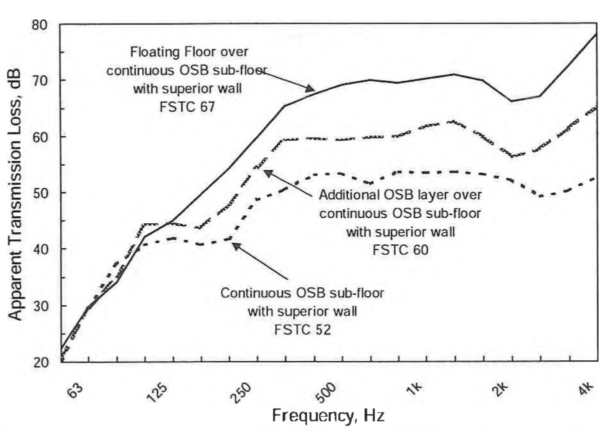


Figure 4: Apparent TL with the superior party wall and various treatments over a continuous OSB sub-floor.

A large improvement can be introduced by treatments over the sub-floor surface, as shown in Figure 4. Improving the sub-floor, by adding a second layer of 16mm OSB stapled on top of the sub-floor within each room (but not across the wall junction) increased apparent FSTC from 52 to 60. This both increases the mass/unit area of the exposed surface (reducing radiation) and introduces an impedance change at the junction (reducing vibration transmission). When an engineered floating floor system (18mm wood chipboard supported on 40mm rock wool material) was added over the continuous OSB sub-floor, FSTC increased to 67, with apparent TL limited over most of the range by direct transmission through the party wall.

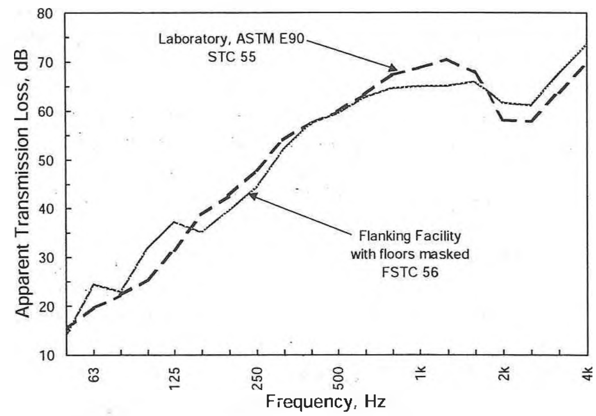


Figure 5: Comparison of laboratory and field TL for basic wall.

Preceding slides have shown that transmission via flanking paths can significantly reduce the apparent sound transmission loss. The comparison in Figure 5 emphasizes the flip side - there is little change due to different transmission through the wall itself. The result here is typical - when a wall system is built with identical materials and construction practice, the laboratory result deviates only slightly from the field performance with the flanking paths suppressed. At low frequencies, results from the flanking facility fluctuate around those from the laboratory, presumably due to modal response of the smaller rooms in the field situation. At frequencies above 2kHz (i.e. above coincidence) laboratory results are generally lower, presumably indicating lower damping. Because edge conditions and room sizes in the flanking facility are expected to resemble common field conditions, similar deviations are probable in the field.

4. SUMMARY

Overall, the key message is that the lower apparent TL observed in the field is often due to flanking. It is *apparent* sound transmission that determines the sound perceived by occupants of adjacent apartments. Flanking effects can significantly lower the apparent sound transmission loss, and cannot be effectively offset by improving the nominal separation (A-B party wall in this case). However, details to control the flanking paths can be developed, to provide a basis for effective designs and retrofit improvements.