GUIDE FOR FLANKING SOUND TRANSMISSION IN WOOD FRAMED CONSTRUCTION: ISSUES FOR IMPACT NOISE

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1. INTRODUCTION

This paper reports results from continuing studies of sound transmission between adjacent units in wood-framed multi-dwelling buildings. Previous papers[1] discussed the basis for a design guide[2] to predict sound insulation in typical wood-framed row housing or apartment buildings, for airborne noise sources. This paper addresses the rather different issues that apply for impact (footstep) noise. In both cases, the flanking transmission is governed by the same basic propagation of structure-borne vibration. However, differences between airborne and impact sources shift the importance of specific elements of the construction, and increase the significance of source location for impact sound. The paper presents a brief overview of key concerns, and how they are handled in the design guide.

Results in this paper apply to wood-framed constructions, with the wall and floor assemblies shown in Figure 1, or variants on them. Specifications and architectural drawings are given in detail elsewhere.[3]

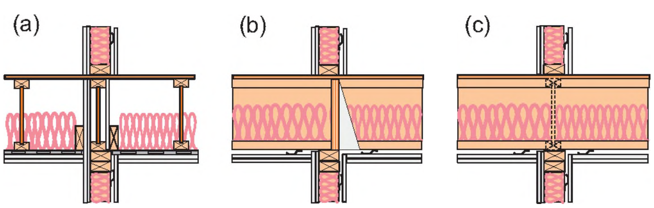

Figure 1: Construction details of the 3 wall/floor systems. Joists were oriented (a) parallel to the wall, (b) perpendicular to the wall, or (c) with joists continuous across the wall, perpendicular to it.

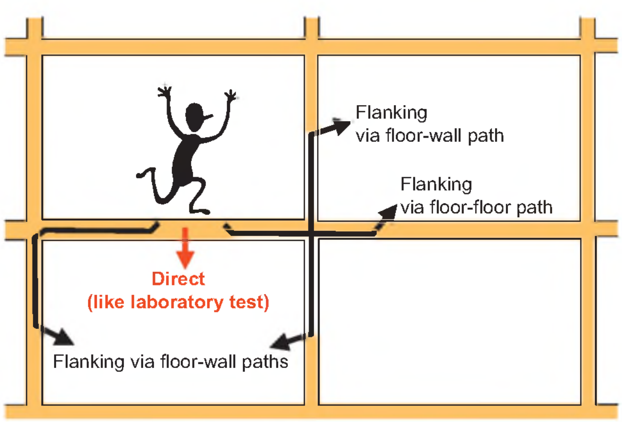

Figure 2: Typical paths for transmission of impact sound (both direct and flanking) to adjacent units below and beside.

Impact transmission to adjacent units in a wood-framed building typically involves transmission via several paths, as illustrated in Figure 2. Impact noise to the unit below combines direct transmission through the floor/ceiling assembly with flanking via 4 floor-wall paths, as discussed previously. Impact transmission to the unit beside (the focus of this paper) includes only flanking – mainly via the floor-floor path, although the floor-wall path also contributes in some cases. The term "Apparent-NISPL" (and single-number rating "Apparent-IIC") are used here to mark it as a special case ignored in ASTM standards.

2. RESULTS AND DISCUSSION

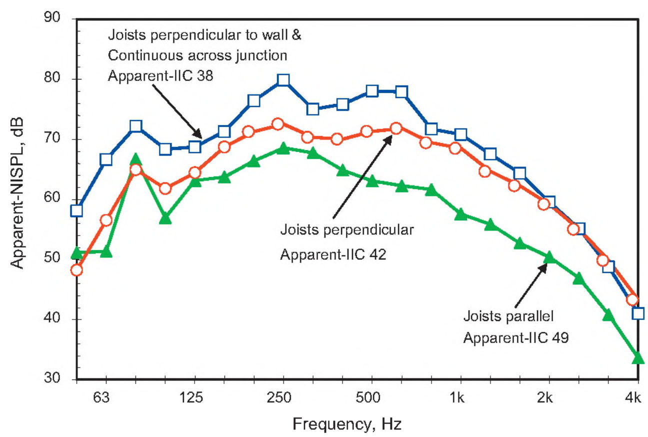

Figure 3: Impact level (Apparent-NISPL in unit beside due to flanking transmission) for the three constructions in Figure 1, with source positions ~2 m from separating wall.

As shown in Figure 3, there is strong transmission of impact sound to the adjacent unit when the floor surface is just the basic OSB panels. Most apartment dwellers experiencing such sound insulation would be seriously annoyed. As noted in previous papers, the three cases differ markedly, because the framing changes strongly affect attenuation across the floor assemblies and the floor/wall junction.

Figure 4 illustrates the change in transmitted impact sound when a topping is added over a basic OSB subfloor. In this case the topping is 25 mm thick gypsum concrete. At low frequencies the impact level is lower (better), due to the weight and stiffness of the concrete. At high frequencies the impact levels increase because the standard impact hammers inject more power into the hard concrete surface, but fortunately this effect is offset by adding compliant flooring such as vinyl or carpet over the topping (See Figure 5).

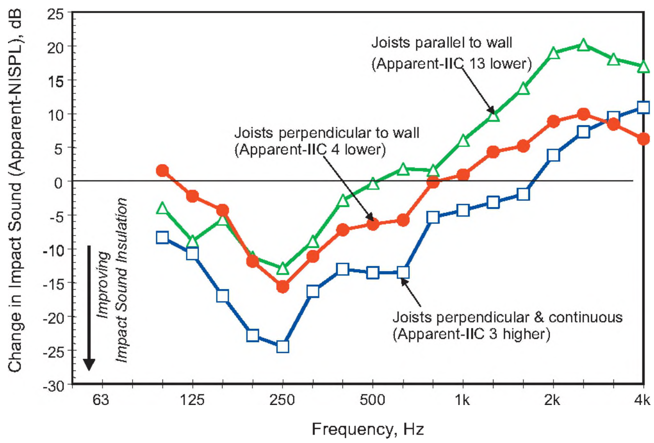

Figure 4: Change in impact level (Apparent-NISPL in unit beside due to flanking transmission) for the 3 constructions shown in Figure 1, due to 25 mm gypsum concrete applied over subfloor.

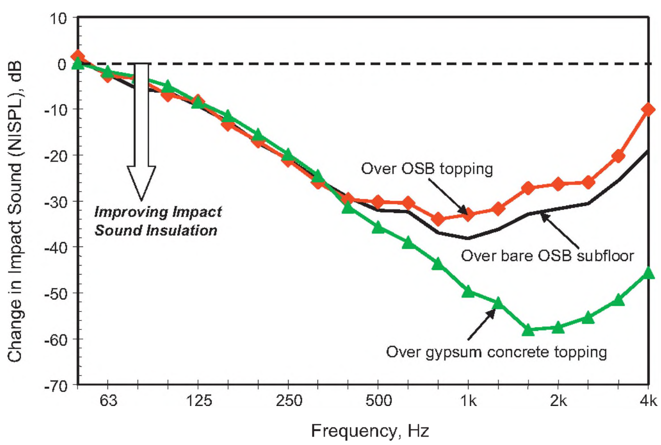

Figure 5: Change in impact level (for either flanking or direct transmission) due to carpet added on the subfloor or over topping.

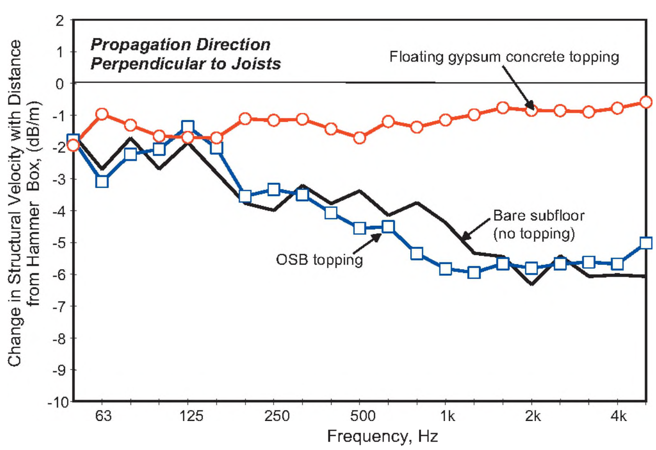

Figure 6: Attenuation of transmitted vibration (dB/metre separation of impact source from floor/wall junction..

Location of the impact source is important, because attenuation of the structure-borne vibration across the floor assembly also has a strong effect; this depends on joist orientation and on the floor topping over the basic floor. Figure 6 shows the attenuation for three treatments with one orientation of the joists; comparable curves have been determined for other toppings and propagation parallel to the joists. For transmission to the room below, this effect averages out as discussed elsewhere[1,2] but Apparent-NISPL in the room beside depends appreciably on location of the impact. To include these effects, scenarios with a range of typical source positions were evaluated. For each source position, the combined attenuation due to all the construction variables were evaluated for potentially-significant flanking paths, and the resulting Apparent-NISPL values were calculated. Fortunately just a few cases suffice to provide a basis for practical design.

Table 1: Apparent-IIC to unit beside the source of impacts when floor and wall constructions match detail (b) in Figure 1.

Flooring finish:	Bare	Vinyl	Carpet	Bare	Vinyl	Carpet
Floor Surface:	Apparent IIC (Impacts at 1-3 m)			Apparent IIC (Corridor- impact at 1 m)		
No topping (basic)	42	43	63	39	40	63
19 mm OSB stapled to subfloor	47	47	61	44	44	61
25 mm gypsum concrete bonded to subfloor	38	43	62	35	40	61
38 mm gypsum concrete + resilient mat on subfloor	46	50	68	46	49	66

In the guide, tables like Table 1 present the combined effect of all paths for typical variants of the construction elements. The table gives two sets of values – one set for impact sources 1 to 3 m from the separating wall (typical range of source positions in an adjacent room), the other for impact sources 1 m from the separating wall (typical for an adjacent corridor). Apparent-IIC in a given building will not exactly match theses values, but the trends should apply.

3. SUMMARY AND REFERENCES

This paper provides a terse overview of how experimental characterization of the direct and flanking sound transmission paths in wood-framed construction leads to a manageable set of path transmission terms to represent the effect of specific design tradeoffs. By combining the energy transmitted via all paths, estimates of the Apparent-IIC for typical constructions can be derived. Results are presented in a design g uide for many common constructions.

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1 Quirt, J.D. Nightingale, T.R.T., King, F. (2005, 2006) Canadian Acoustics, vol. 33, 68-69 and vol. 34, 88-89

2 Quirt, J.D. Nightingale, T.R.T. King, F. Guide for Sound Insulation in Wood Frame Construction, **RR219**, NRC-IRC Canada, (2006)

3 Nightingale, T.R.T. Quirt, J.D., King F., Halliwell, R.E. Flanking Transmission in Multifamily Dwellings: Phase IV, **RR218**, NRC-IRC Canada, (2006).
(Note that the reports are available on the IRC website at http://irc.nrc-cnrc.gc.ca/ircpubs/.)