CHARACTERIZING FLANKING TRANSMISSION PATHS IN THE NRC-IRC FLANKING FACILITY

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1. INTRODUCTION

This paper is the third of a series of papers that provide an overview of work conducted by NRC in the past years on flanking transmission. In the previous papers the measurement system and the new NRC-IRC Flanking Facility are described[1,2]. The ISO 10848 method for measuring flanking paths is time-consuming and not feasible for a facility of this complexity. This paper describes the methodology used in the Flanking Facility to systematically measure airborne sound transmission through the individual flanking paths for the 6 junctions of the specimen.

2. METHODOLOGY

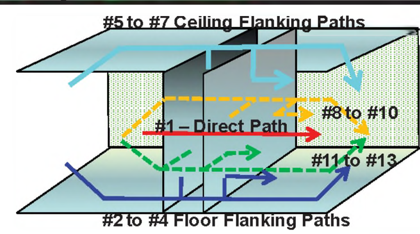
Between two adjacent rooms there is 1 direct path through the partition and a total of 12 flanking sound transmission paths (3 for each of the 4 junctions, shown in Table 1 for the horizontal side-by-side case) and even diagonal room pairs that are connected by only one junction have four flanking paths. The room arrangement in the Flanking Facility allows evaluation of 8 horizontal, 4 vertical, 8 diagonal and 8 cross diagonal room pairs. The relative importance of these paths will depend on the properties of the floor, ceiling, party wall and side walls and of the junctions. Hence, extensive research studies are carried out in the Facility to characterize the sound transmission loss (TL) of each flanking path for different specimens[3,4,5].

ISO 10848 suggests to measure all flanking paths one-by-one by shielding the surfaces of all other building elements that are not part of the considered path, but are either excited in the source room or radiate sound into the receive room. In the NRC-IRC flanking facility, 16 mm gypsum board on 90 mm glass wool is put in front of the building elements as shielding with no rigid connection to the test specimen. However, applying shielding to horizontal surfaces, the floor or ceiling, is not always feasible. In the NRC-IRC facility, some flanking paths are characterized with a slightly modified approach by extracting single path data from measurements with different shielding conditions.

For example, the paths listed in Table 2 are measured between two lower horizontal rooms of the Flanking Facility using both the ISO standard and the modified approaches as described below. The measurement results presented in Figure 1 are for the specimen that was used for the commissioning of the Facility[2].

Table 1: Direct and flanking transmission paths between two horizontal side-by-side rooms.

Path #	Direct and FlankingTransmission Paths	Airborne
#1	Party Wall–Party Wall	Direct
#2	Floor–Floor	Flanking
#3	Floor–Party Wall	Flanking
#4	Party Wall–Floor	Flanking
#5	Ceiling–Ceiling	Flanking
#6	Ceiling–Party Wall	Flanking
#7	Party Wall–Ceiling	Flanking
#8	Side Wall–Side Wall (1)	Flanking
#9	Side Wall–Party Wall (1)	Flanking
#10	Party Wall–Side Wall (1)	Flanking
#11	Side Wall–Side Wall (2)	Flanking
#12	Side Wall–Party Wall (2)	Flanking
#13	Party Wall–Side Wall (2)	Flanking



The Flanking-TL of the *ceiling-ceiling (#5)* path in Figure 1 is measured according to ISO 10848. For the measurement, only the party wall and one pair of the side walls that belongs to the specimen have to be shielded in both rooms since measures have been taken to suppress sound transmission between the rooms through the permanent shell of the Facility[1] which forms one pair of side walls and the floor of the considered rooms.

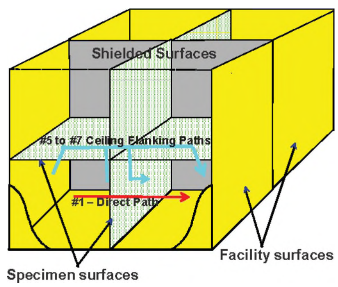
The remaining paths in Table 2 are obtained with the modified approach. The shielding is removed from the party wall in the receiving room and the TL due to the *ceiling-wall (#6)* and the *ceiling-ceiling (#5)* path is measured. The TL of the *ceiling-wall (#6)* path shown in Figure 1 is obtained by subtracting the TL of the *ceiling-ceiling (#5)* path from the measured data. Similarly, the TL due to the *wall-ceiling (#7)* path and the *ceiling-ceiling (#5)* path is obtained by moving the shielding from the party wall in the source room to the receiving room. The TL of the *wall-ceiling (#7)* (Figure 1) is obtained by subtracting the TL of the *ceiling-ceiling (#5)* path from the measured data.

Finally, all shielding is removed from the party walls and the TL due to all four paths of Table 2 is measured. Since the TLs of three of the paths are known, the remaining direct path (#1) can be extracted.

For the side wall paths listed in Table 1 (#8 to #10 or #11 to #13), they can be characterized by shielding all the party walls and changing the shielding condition of the side wall systematically. The floor flanking paths (#3 to #5) can be characterized in the upper rooms of the Facility. The flanking paths of the vertical and diagonal room pairs can also be estimated following the same methodology.

Table 2: Direct and floor-ceiling paths in the Flanking Facility.

Path #	Direct and FlankingTransmission Paths	Airborne
#1	Party Wall–Party Wall	Direct
#5	Ceiling–Ceiling	Flanking
#6	Ceiling–Party Wall	Flanking
#7	Party Wall–Ceiling	Flanking



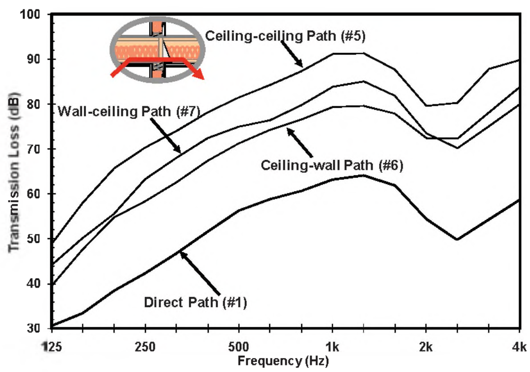


Figure 1: TL of ceiling-ceiling, wall-ceiling, ceiling-wall and direct path between two rooms separated by a party wall.

3. LIMITS OF MEASUREMENT METHOD

Although this paper shows that the applied method works fine, its limitations are discussed in this section. In Figure 2, the TL of the direct, the *ceiling-wall* and *ceiling-ceiling* path is presented for an extended frequency from 63 Hz to 4 kHz. Below 125 Hz, the TL of all three paths is very low and converges around the Apparent-TL. Hence, the applied shielding is not effective at low frequencies - most sound is transmitted directly through the shielded party wall – and the TL of all flanking paths is underestimated. Similar to the limitation of TL due to the mass-spring-mass resonance of double leaf walls (leaves are the masses and the spring is the air in the cavity), the TL of the shielded wall (now a system with 4 masses coupled by 3 springs) is limited by resonances. The shielding could be improved by increasing the mass of the applied gypsum board, which generally makes the shielding method even more impractical. Thus, previous study[6] has shown that it is reasonable to fit 'tails' with a 6 dB increase per octave band to the measured flanking TL below 315 Hz as shown in Figure 2.

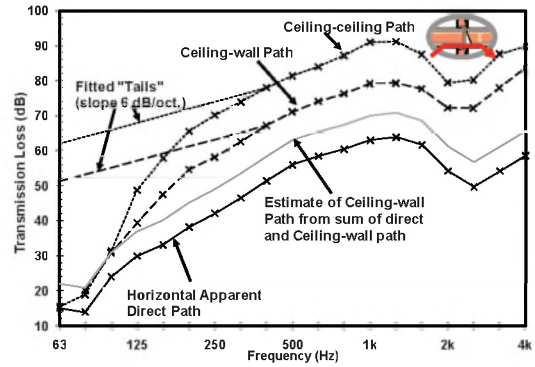


Figure 2: Shielding limits at low frequencies – flanking TL with fitted "tails"; Conservative estimate of Ceiling-wall path due to small measured differences (grey)

Another limitation that affects the extraction of flanking paths is discussed in the following. In the example in Figure 1 an ideal case is presented with rather big differences in measured TL because the flanking path with the highest TL was measured separately. But in some cases the measured differences are small, and sometimes less than the repeatability uncertainty of measurements despite the high precision measurement system[1]. In such cases, only a conservative estimate can be defined as shown below. It is assumed that in this example the TL of the direct path with smallest TL is measured separately. The difference of this TL to the apparent TL due to transmission by the direct path and by any other ceiling paths that is measured next is small. If it is less than the measurement uncertainty of 1 dB then it could certainly not be related to a change of the shielding condition. In the extraction of the path data, the difference must be assumed to be 1 dB. This gives a conservative estimate for TL of the second path that is only 7 dB greater than the TL of the direct path. In most cases this estimate grossly underestimates the flanking TL as shown by the grey line in Figure 2.

Like every measurement method, the one applied in the NRC-IRC Flanking Facility has its limitations. Hence, thorough planning of the tests and care in the data analysis is required.

REFERENCES

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