CHANGING STANDARDS FOR BUILDING ACOUSTICS REGULATION

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1 Introduction

A new approach to the control of sound transmission between adjacent units in multi-family residential buildings is among the changes in the 2015 edition of the National Building Code of Canada (NBCC). Provincial codes are expected to follow essentially the same approach. The design objective has changed from a minimum direct STC for the wall or floor/ceiling assembly separating adjacent units to a requirement for the Apparent Sound Transmission Class (ASTC) that includes both direct and flanking sound transmission. The required design procedure uses data from conventional laboratory measurements (ASTM E90) of direct transmission through wall or floor/ceiling assemblies combined with measurements of flanking transmission (conforming to ISO 10848) as inputs for a calculation procedure based on ISO Standard 15712 Part 1 (1995).

Meanwhile, ISO committee TC43/SC2 is revising the ISO calculation standard. The new ISO 12354 series of standards will use the latest version of the European EN 12354 standards thus aligning with European practice, and the ISO 15712 series will be withdrawn. This change was balloted in early 2016, and should become final by the end of this year. In the longer term this will provide better support for Canadian regulations, but in the short term this leaves the new provisions in the Canadian building code pointing to an old standard that will no longer be available to practitioners.

This paper focuses on explaining the technical intent and form of the new Building Code requirements, and how these will be supported better by the ISO 12354-1 (2016) version of the ISO calculation standard.

2 The Calculation Method

ISO 15712-1 and the new Code requirements approach predicting the sound transmission from the same basic concept – combining the sound power transmitted directly through the separating assembly with the flanking sound power transmitted via first-order flanking paths at the four edges of the separating assembly.

To discuss this, it is useful to introduce the convention used in ISO 15712-1 and the new ISO 12354-1 for labelling the transmission paths, as illustrated in Figure 1. Consider transmission from a source room at the left to the receiving room beside it. Each transmission path involves one surface in the source room (denoted by a capital letter) and one in the receive room (lower case). **D**irect transmission through the separating wall is path **Dd**. For each edge of the separating assembly there are three 1st-order flanking paths, each involving a surface in the source room and one in the receiving room, that connect at this edge: **Ff** from **f**lanking surface **F** to **f**lanking surface **f**, **Df** from **d**irect surface **D** to **f**lanking surface **f,** and **Fd** from **f**lanking surface **F** to **d**irect surface **d** in the receiving room.

Note that "**F**" and "**f**" denote **f**lanking surfaces, whereas "**D**" and "**d"** denote the surface for **d**irect transmission, i.e. - the surface of the separating assembly. Each of these labels may apply to either wall or floor/ceiling assemblies, depending on the orientation of the room pair.

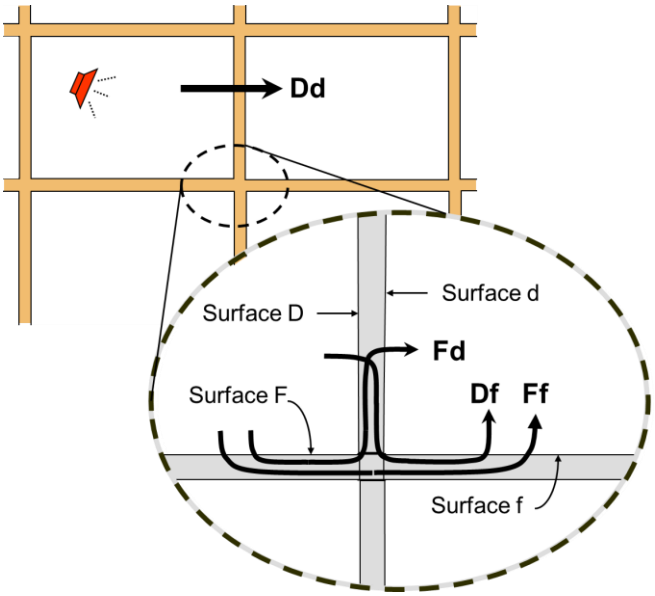

Figure 1: Labelling convention used in ISO 15712-1 (and its successor ISO 12354-1) for direct and flanking transmission paths

In Canada, the acoustic testing of building elements (walls, floors, etc.) is normally done according to ASTM E90 and the Code requirements are given in terms of STC or ASTC ratings determined from the 1/3-octave test data, following the procedure in ASTM E413. Merging this ASTM context familiar to Canada's building industry and regulators with the ISO procedures now being added to Canadian building codes, requires new terminology, so "direct transmission loss" and "flanking transmission loss" have been introduced. These provide consistency with ASTM terminology, but match the function of the direct sound reduction index and flanking sound reduction index, as defined in ISO 15712-1 and the new ISO 12354-1.

Section 4 of ISO 15712-1 (and of its successor ISO 12354-1) specifies a process to calculate apparent sound transmission by combining the sound power transmitted via the direct path and the twelve first-order flanking paths (as illustrated in Figure 1).

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Equation 14 of ISO 15712-1 is recast here in Eq. 1 with the paths labelled and grouped consistent with the naming in Fig.1, assuming rectangular room geometry and neglecting paths due to leaks, ducts, crawlspaces, etc., which should be controlled by normal good practice. The Apparent Sound Transmission Loss (ATL) between two rooms is the decibel expression of the sum of sound power due to Direct Sound Transmission Loss (TL_{Dd}) through the separating wall or floor element and the sound power due to Flanking Sound Transmission Loss contributions (TL_{Ff}, TL_{Fd}, and TL_{Df}) of the three flanking paths for every junction at the edges of the separating element:

$$ATL = -10\lg\left(10^{-0.1\cdot TL_{Dd}} + \sum_{edge=1}^{4}\left(10^{-0.1\cdot TL_{Ff}} + 10^{-0.1\cdot TL_{Fd}} + 10^{-0.1\cdot TL_{Df}}\right)\right) \quad \text{Eq. 1}$$

This summation of transmitted sound power is valid for all building systems, but the remaining challenge is to find the right expressions to calculate the sound transmission via each path for the chosen building system and situation. The design procedure proposed for the NBCC constrains these choices, depending on the type of wall and floor constructions combined to form a complete building, as follows:

- ***For heavy homogenous types of construction*** such as concrete floors or concrete block walls, the NBCC design procedure determines the flanking sound transmission loss following either the Detailed or Simplified calculation procedures of ISO 15712-1. For input data, these calculations use sound transmission loss data (for the base wall and floor assemblies and for linings) measured according to ASTM E90. Changing to the new ISO 12354-1 will not change this approach.
- ***For lightweight steel- or wood-framed assemblies***, the NBCC design procedure substitutes the use of experimental flanking data (treating flanking sound reduction index determined using ISO 10848 as Flanking Transmission Loss) for values calculated following the procedures of ISO 15712-1. Either a detailed calculation using 1/3-octave-band data in Eq. 1 or a simplified procedure using the corresponding single-number ratings is permitted.

In both cases, the calculation of system performance combines the sound power due to direct and flanking sound transmission in the same way, using Eq. 1.

3 Discussion

Because the ISO 15712-1 standard used in the noise control requirements in the 2015 NBCC was based on an old (circa 1990) version of EN12354-1, it made no reference to the newer measurement procedures of the ISO 10848 standards, which are essential for accurate characterization of the lightweight constructions used in many Canadian multifamily residential buildings. Specific provisions for calculating sound transmission in lightweight constructions were written into the NBCC requirements to get around this weakness of ISO 15712-1.

The new ISO 12354-1 standard includes references to ISO 10848 measurement procedures, clearly identifies situations where the standard procedures don't apply, and strongly recommends use of ISO 10848 data for lightweight constructions. Thus the new ISO 12354-1 standard is fully compatible with the intent of the NBCC provisions.

A second major advantage of the new ISO 12354 series is that Part 2 provides both detailed and simplified procedures for calculating transmission of impact noise in buildings of various types, including those with lightweight framed constructions. This provides a good foundation for adding impact noise control to the requirements in future editions of the NBCC.

4 Conclusion

The National Building Code and the standards referenced in the Code do not constitute a clear and readily-followed guide to the intended design approach for noise control in buildings. For additional advice, the NBCC refers users to the NRC publication RR-331, "Guide to Calculating Airborne Sound Transmission in Buildings". Edition 2 of this guide [1] was published in 2016, and further editions are expected as content is refined and approved by the industry steering committee (including extensive editorial changes to reference the new ISO 12354-1 after the change of standards is completed). Guide RR-331 presents extended descriptions of the calculation process (both simplified and detailed methods) for specific types of construction, and includes numerous benchmark examples of the calculations. It is supported by a set of other NRC reports, each for a specific type of constructions (such as concrete block walls, or wood-framed wall and floor assemblies), that include the test data needed as inputs for the calculations.

5 Remerciements/Acknowledgments

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References

[1] B. Zeitler, D. Quirt, C. Hoeller, J. Mahn, S. Schoenwald, I. Sabourin, "RR-331: Guide to Calculating Airborne Sound Transmission in Buildings, 2nd Edition, NRC Canada, 2016.