SOUND FLANKING THROUGH COMMON LOW-VOLTAGE ELECTRICAL CONDUIT IN MULTI-FAMILY RESIDENTIAL BUILDINGS

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1 Introduction

Sound flanking between suites in multi-family residential buildings is a prevalent issue in architectural acoustics and building construction that can decrease the sound insulation performance of suite-demising partitions, compromising acoustical privacy and comfort for residents. In recent times, the presence of a specific deficiency regarding the sealing of common low-voltage electrical conduit routed between residential suites has been increasing in prevalence in construction of residential buildings, resulting in otherwise appropriately designed suite-demising configurations performing poorly in situ, and in some cases, even failing to meet minimum Ontario Building Code requirements (ASTC-47 in-situ [1]) for sound insulation between dwelling spaces during site testing. This article presents test data sampled from multiple residential buildings in Ontario, highlighting the extent of this issue and its implications, along with discussion regarding proactive prevention and post-construction rectification of this issue.

2 Background

2.1 Configuration of Electrical Conduit

In multi-family residential buildings where sound flanking through low-voltage electrical conduit between dwelling units has been found to significantly degrade the sound insulation performance of the demising assembly, the configuration has involved electrical conduit embedded in and routed through the poured concrete ceiling slab of each suite to connect emergency alarms to each other. The conduit has typically been observed as flexible conduit, and in these cases, left unsealed at the junction boxes. This results in a direct path for noise to flank from one suite to another across the common ceiling slab, bypassing the suite-demising wall assembly. This leads to a significant weakness in sound insulation between suites, which has been confirmed by various in-situ sound insulation tests with multiple assembly types as presented herein.

2.2 Prevention and Rectification

The simplest method to prevent sound flanking through common conduit altogether is to design low-voltage electrical systems such that there is no common conduit routed between dwelling spaces, subject to requirements of the relevant Building Code. However, measurements have confirmed as presented herein that, when systems are designed such that there is common conduit routed between suites, rectification of the issue is feasible. The application of non-resilient caulking at both ends of the conduit, such that the opening is fully sealed (see Figure 1), has been found as sufficient to mitigate this weakness such that the sound insulation performance of typical suite-demising wall assemblies is not distinctly affected by this flanking path.

Figure 1: Unsealed Conduit Opening in Fire Alarm Junction Box (Left), and Conduit Opening after Applying Sealant (Right)

3 Measurement Results

3.1 Characteristics of Sound Flanking Through Conduit

In the cases where sound flanking through common electrical conduit has been observed, an atypical weakness primarily presenting in the mid-range 1/3-Octave frequency bands (315 to 630 Hz) is prevalent, and has been found in most cases to occur within the 400 Hz 1/3-Octave frequency band. The weakness of the assembly can also be seen in higher frequencies (1000 Hz and above) in most cases, although not as prevalent. In measured examples, this deficiency has been found to lower the measured sound insulation rating of the tested assembly by up to ten Sound Transmission Class points (STC, as defined by ASTM E-336 [2]).

It can be difficult to qualitatively detect this weakness in situ if not specifically checking for it, especially for poured concrete assemblies for which typical deficiencies tend to present within the same frequency range [3]. The weakness typically manifests audibly as a seemingly more broadband-sounding deficiency, although this can be traced to the conduit upon close inspection near the alarm speakers.

3.2 Steel Stud Walls

Steel stud suite-demising walls most typically include two sets of non-loadbearing steel studs with the cavities of both filled with insulation, separated from each other with an air gap, and clad with drywall on both suite sides, sometimes including drywall on the inside of one of the sets of studs as

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well. Other steel stud suite-demising walls can instead comprise only a single set of non-loadbearing steel studs, with the cavity filled with insulation, and clad with drywall on both sides. In either case, these walls typically perform relatively well throughout the frequency range included in the STC calculation.

Measurement results from the following assembly, as tested by HGC Engineering on two recent projects, are summarized in Figure 2:

a) One layer of 16 mm type 'X' drywall on either side of 92 mm studs spaced at 610 mm on centre, with 76 mm mineral wool insulation in the stud cavities, plus an additional furring partition on one side, including 64 mm studs spaced at 610 mm on-centre and stood off from the base partition by a varying air gap, with 65 mm batt insulation in the stud cavities, and clad with one layer of 16 mm type 'X' drywall.

There is no publicly available published test data for the above assembly; however, based on numerous in-situ sound insulation tests, this assembly is expected to achieve a rating in the low STC-50s. Figure 2 shows the results of measurements conducted on two sites where the conduit opening at the junction box was found to be unsealed, before and after the opening was sealed with caulking.

3.3 Poured Concrete Walls

Many typical suite-demising walls within multi-family residential buildings comprise minimum 200 mm thick poured concrete, with a layer of drywall laminated to both sides of the poured concrete wall. As it is typical that the drywall layers are not perfectly laminated to the concrete, deficiencies in the mid-band frequency range, typically near the 400 Hz 1/3-Octave frequency band, are common due to the resonance of the small air cavities between lamination points, making it more difficult to observe other deficiencies in the same frequency range (i.e. sound flanking through low-voltage electrical conduit).

Measurement results from the following assembly, before and after the conduit was sealed with caulking, as tested by HGC Engineering on two recent projects, are summarized in Figure 3:

b) One layer of 13 mm drywall laminated to both sides of a 250 mm thick cast-in-place concrete wall.
c) One layer of 13 mm drywall laminated to both sides of a 200 mm thick cast-in-place concrete wall.

With adequately laminated drywall and no other construction deficiencies, this assembly achieves in-situ performance ratings above ASTC-50, most typically in the range of ASTC-53 to ASTC-55. Again, the figure below shows the results of measurements conducted on two sites before and after the conduit opening was sealed with caulking.

4 Discussion

The above-presented measurement data demonstrates that, with the conduit openings at the ceiling-mounted fire alarm junction boxes sealed with resilient caulking, the assemblies achieve the expected ASTC ratings. Without the caulking

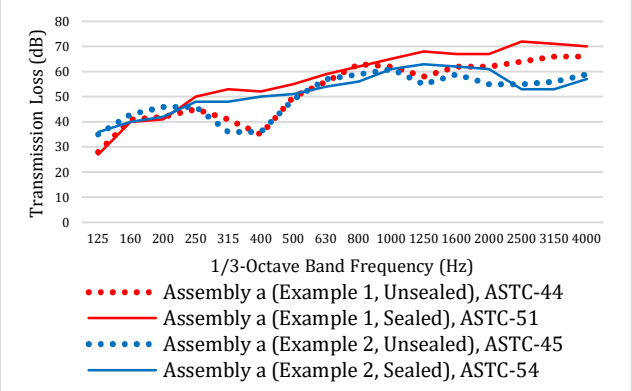

Figure 2: Steel Stud Walls Transmission Loss Results

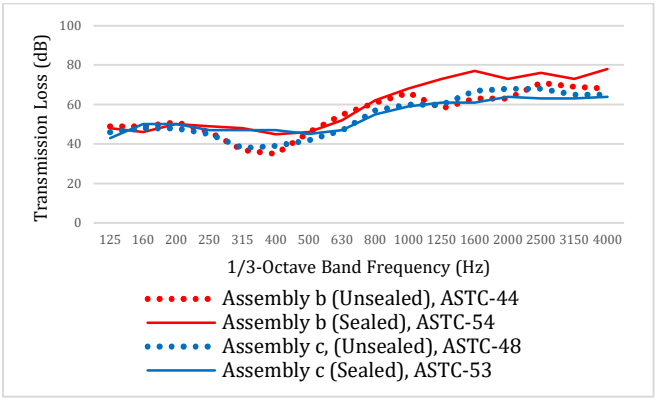

Figure 3: Poured Concrete Walls Transmission Loss Results

however, and the conduit openings left unsealed, sound flanking through this path is demonstrated to degrade the sound insulation performance of these assemblies significantly, ranging in severity from five to ten STC points across the tests presented above. The method of sealing the conduit opening with caulking (as shown on the right side of Figure 1) is not generally cost-prohibitive, and should be included in the scope of work for the relevant contractor for construction of all multi-family residences where this condition exists.

5 Conclusions

Sound flanking through common low-voltage electrical conduit has been found to significantly degrade the acoustical separation between suites in various multi-family residential buildings, with instances of this phenomenon anecdotally increasing over time. Measured data is presented herein, demonstrating performance decreases of up to ten STC points due to this deficiency, and confirming that the sealing of the conduit on both sides using caulking is sufficient to effectively mitigate this deficiency.

References

[1] Ontario Building Code, O Reg. 332/12, s.5.8.1.1

[2] ASTM E-336

[3] J. Niinivaara, A. Lorimer, and S. Edwards, Effect of Insufficient Adhesive on ASTC Performance in Concrete Partitions with Laminated Drywall. *Canadian Acoustics Association* Vol. 45 No. 3 2017.