

IMPROVING ASTC PERFORMANCE OF AS-BUILT WOOD-FRAME DOUBLE-SHEAR PANEL WALL ASSEMBLIES

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1 Introduction

As noted in the initial comparative study on this specific subject [1], acoustical engineers often encounter designs specifying multiple cavity partitions, with the expectation that they will provide equal or greater sound transmission loss performance than a single cavity partition of similar overall mass and dimension. That study confirms that this is not generally true, in particular for double-stud wood-frame and drywall demising partitions with structural shear panels on the inner faces of the studs. Using field results, it concludes that such configurations should be avoided in design where the goal is to achieve Sound Transmission Class (STC) ratings of 50 or higher. It also notes that these conditions nevertheless appear in the field with a high risk of not conforming to building code requirements [2]. Options to improve the performance of these walls were previously suggested [1], but had not been field verified. This article compares field performance of several partitions, and presents the acoustical effects of a commonly encountered shear configuration and mitigation scheme.

2 Background

2.1 Wood stud frame walls

In wood frame buildings, typically up to 6 storeys, the wood stud walls are often part of the load bearing structure, and as such, those walls require a shear panel. Commonly, this involves adding a plywood or OSB panel on one side of the studs, followed by the required layers of drywall to achieve the fire rating. For various reasons, but often for separate plate floors, a double-stud wall is used; one on each floor plate. Thus, for load bearing, shear panels for these walls are required on both stud sets. In modern building practice, the sheathed walls may be prefabricated or the framing is constructed flat on the floor with the sheathing layer on top, and then the wall is stood up in place. This results in stud cavities open on the suite side, as preferred by builders to add services and insulation prior to the drywall finish facings. This is repeated on the other side of the demising assembly. For a single floor plate, the second stud set does not include sheathing and creates a 3-leaf system (2 cavities). For separate floor plates and a shear panel on the inside of each stud set, a 4-leaf system results (3 cavities; 2 insulated cavities, and a small un-insulated cavity between).

As described in the previous study [1], the fully unsheathed assembly is given in the NBC supplementary

tables [2] as W13 (a or b), rated at STC-57, with insulation between both sets of studs and one layer of type X drywall (13 mm or 16 mm) on each side. The two-cavity assembly is not listed, however, the endnotes in the supplementary table suggest a three point degradation in the STC rating with a single inner sheathing layer, which is consistent with past experience and discussed in reference [3]. The three-cavity assembly is also noted briefly in the end notes of the supplementary table [2] where it is noted that this “may drastically reduce the STC value”, but no specific value is assigned. These are shown schematically in Figure 1.

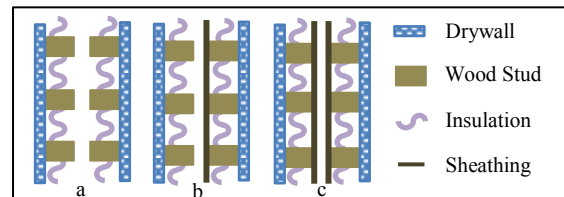


Figure 1: a) single cavity; b) double cavity; c) triple cavity.

HGC Engineering compared [1] non-shear (a) to double shear (c) field results with laboratory results for (a) and (b).

2.2 Coupling

There are two main sound transmission mechanisms between the multiple layers of the assembly: solid stud connection and airborne coupling via resonant cavity (mass, damping, and stiffness are the main factors relating to transmission within each material layer).

There is no solid connection in the non-shear double stud assembly (a), hence the high rating. In the two-cavity system, the inner layer of sheathing is solidly coupled via the stud to an outer drywall layer on the same stud. This connection is much stronger than the airborne coupling in that part of the assembly; however, this drywall-stud-sheathing assembly is still only airborne coupled to the other layer of drywall resulting in the 3-point degradation.

In the 3-cavity system, each stud assembly is dominated by solid coupling, and these two assemblies are separated by only a small (25 mm or less) un-insulated cavity with strong airborne coupling at a resonant frequency, within the STC frequency range. These assemblies are rated even lower, and with less consistency due to the close coupling.

2.3 Comparison of typical assemblies

As noted in the previous study [1], there is good agreement between the lab and field data sets. In both single and double cavities, the field performance is reduced at higher

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frequencies due to flanking, but gives similar STC ratings and curve shapes. The triple cavity is only measured in the field. As noted in the supplementary table notes [2], the double cavity rating (STC-54) is only 3 STC-points below the single cavity; however, the low-frequency degradation is responsible for the reduced STC rating, despite the boost at higher frequencies. The average triple-cavity assembly measured below the target with ASTC-49, with reduced performance throughout the frequency range but dominated by the low frequencies. The note in the NBC supplementary tables is accurate in discouraging these assemblies.

2.4 Possible mitigating assemblies

From the foregoing, these conditions should be avoided in design by locating at least one of the shear panels on the finish side of the studs. Other alternative may be considered in future, however, a recent building project included double shear panels, and the structural design could not feasibly be changed, thus, via mock-up tests, and final measurement upon substantial completion, the application of resilient channels was studied.

3 Measurement results

3.1 Mock-up

The subject site was under construction and site conditions were not ideal for mock-up; but it was intended that the trend and best estimate of performance from the addition of proposed mitigation could be established. Sound isolation of one partition, comprising double 89 mm studs separated by 25 mm with a layer of 11 mm sheathing on the inside face of each stud, 90 mm batt insulation, and 16 mm type X drywall on each finished side, fastened via resilient metal channels on both sides, was measured to be ASTC-52. A second partition was prepared with the same construction, except only one side used resilient channels. However, the room configuration gave rise to measurement contamination by excessive high-frequency airborne flanking, with a rating of only ASTC-44. Mathematically rejecting high frequency flanking suggested that this partition may achieve a rating of about ASTC-47 to 50. While this was not rigorous, even if it did achieve ASTC-50, it was only marginal at best.

A third partition with the same general construction but with 140 mm double studs and 125 mm insulation with one layer of 16 mm type X drywall on each face was also measured. Despite contamination and small rooms, the ASTC calculation gave an estimate of about ASTC-48. As this partition was to have an extra layer of drywall on each face, without resilient channels, it was further estimated to achieve a rating in excess of ASTC-50. Given the room sizes, this cannot be formally field confirmed.

3.2 Final measurements

The double-stud, double shear walls were then constructed using resilient channels on each face. Three field measurements resulted in an average rating of ASTC-53,

ranging from ASTC-49 to 55, demonstrating marginal to robust compliance with the target.

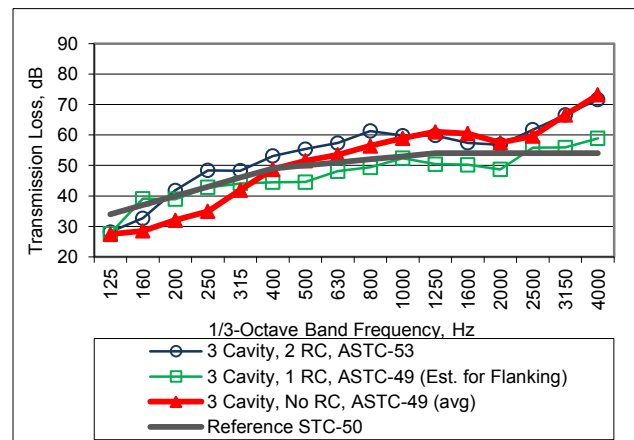


Figure 2: Mock-up apparent transmission loss results

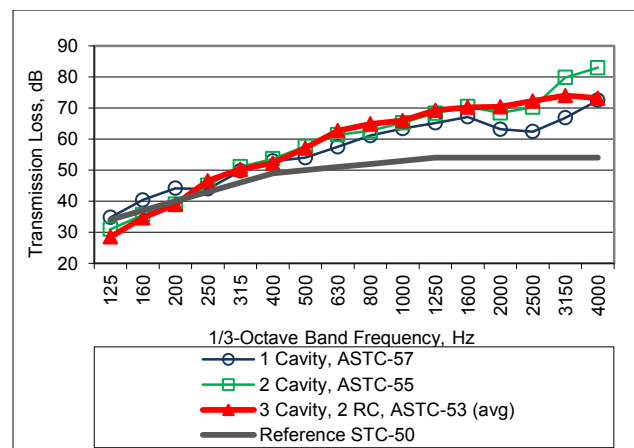


Figure 3: Final apparent transmission loss results

4 Conclusion

Field measurements have verified that the performance rating of partitions with double-stud and internal double-shear panel constructions do not reliably meet ASTC-50. Mitigation using resilient channels to fasten the finished drywall on each face have been shown to result in a four point increase resulting in generally compliant constructions. Adding a second layer of drywall to each side is tentatively expected to also achieve acceptable results, but only with deeper (140 mm) studs.

References

- [1] A. Lorimer and J. Tinianov, STC Ratings of Drywall Partitions With and Without Structural Sheathing, *Acoustics Week Proceedings*, 2015.
- [2] National Research Council Canada. National Building Code of Canada, Volume 2. 2010.
- [3] W. Gastmeier and M. Wu, Field Sound Transmission of Demising Walls and Floor / Ceiling Assemblies. *Internoise 92 Proceedings* Volume 2. 1992.