FACTORS AFFECTING THE ASTC PERFORMANCE OF DOUBLE WOOD STUD SHEAR WALLS IN MID-RISE RESIDENTIAL CONSTRUCTION

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1 Introduction

Mid-rise wood-framed multi-unit residential buildings are becoming a common building form. Demising walls between adjacent dwellings are typically constructed of double stud wall assemblies. Structural (shear) requirements often require the addition of structural sheathing on the inner face of the studs. There is limited laboratory test data to establish Sound Transmission Class (STC) ratings for these walls; however, it is well understood that the sheathing layers on the inner face of the studs can reduce the STC ratings of the walls.

This paper presents the results of numerous Apparent Sound Transmission Class (ASTC) field tests done on double stud wall assemblies in mid-rise buildings. The test results provide an indication of the degree to which interior structural sheathing lowers the ASTC ratings of these walls. The test results also suggest that increasing the number of gypsum board layers in these walls can provide adequate ASTC ratings. These findings point to the need for a program of laboratory STC tests to establish STC ratings for these wall types.

2 Background

2.1 Double Wood Stud Demising Walls

A common suite demising wall assembly in wood framed construction is:

- Two rows of 89 mm wood studs spaced 400 mm o.c. on separate 89 mm plates set 25 mm apart
- 89 mm batt insulation on both sides
- 1 layer 16 mm Type X gypsum board on both sides

The National Building Code of Canada (NBC) provides a rating of STC 57 for this wall type based on laboratory testing [1].

In mid-rise construction the above assembly is often modified to use 140 mm rather than 89 mm wood studs. This increased stud depth is expected to increase the STC rating of the assembly; however, there is little laboratory test data for this assembly with 140 mm studs.

Structural sheathing, typically oriented strand board (OSB), is also often added to these walls to provide shear stiffness. Standard practice has the sheathing added on the inner face of the studs to allow insulation, electrical services, etc., to be installed in the stud cavities after the structural elements have been constructed. Figure 1 shows a typical double stud demising wall configuration with and without sheathing added

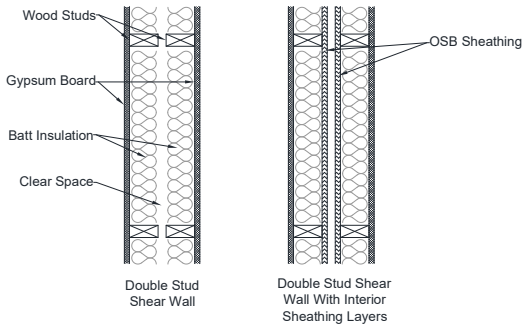

Figure 1: Typical double stud demising wall (left) and double stud demising wall with added OSB sheathing (right)

There is little laboratory test data for these walls with structural sheathing. The NBC does note that a single layer of sheathing, on the inner face of the studs, is expected to reduce the STC rating by 3 points [1]. If sheathing is added to the inner face of both rows of studs, the NBC notes that this may "drastically" reduce the STC rating; however, the NBC does not provide an STC rating [1].

The reduction in the STC rating is due to changes to the wall cavity that result from adding the sheathing. A single layer of sheathing divides the wall cavity into two shallower cavities. Two layers of sheathing divides the wall cavity into three cavities with the middle cavity having a mass-air-mass resonant frequency effect that lowers the STC rating.

2.2 Building Code Requirements

The NBC and provincial building codes that follow the NBC provide several methods to show compliance with the requirements for acoustical separation between residential dwelling units. To demonstrate compliance using a field (ASTC) test, a suite-to-suite demising partition must achieve an ASTC rating of ASTC 47 or higher.

3 Method

Valcoustics Canada Ltd. has done field tests (ASTC) on numerous double stud demising wall assemblies in mid-rise (4 to 6 storey) wood framed multi-residential buildings. ASTC testing was done in accordance with ASTM standard E336 Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.

Test results from four buildings that use similar construction have been selected for presentation here. The tested assemblies all used 16 mm Type X gypsum wall board (GWB), two rows of 140 mm wood studs spaced at 400 mm on centre (o.c.) on separate plates, and batt insulation in both stud cavities. The structural sheathing, where used, was OSB panels applied to the inner face of the studs as shown

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Table 1: Tested Assemblies

Material	Assembly			
	A	B	C	D
GWB	1 layer	1 layer	2 layers	2 layers
Wood Studs	140 mm	140 mm	140 mm	140 mm
Batt Insulation	140 mm	140 mm	140 mm	140 mm
OSB Sheathing	None	16 mm	16 mm	19 mm
Clear Space	25 mm	25 mm	25 mm	25 mm
OSB Sheathing	None	16 mm	16 mm	19 mm
Batt Insulation	140 mm	140 mm	140 mm	140 mm
Wood Studs	140 mm	140 mm	140 mm	140 mm
GWB	1 layer	1 layer	2 layers	2 layers

in Fig. 1. Details of the tested assemblies are shown in Table 1.

Assembly A is a typical double stud wall without structural sheathing. Assembly B is the same as A but with the addition of structural sheathing on the inner face of both rows of studs. Assembly C is the same as B but with one additional layer of GWB on the outside of each side of the wall. Assembly D is similar to C but used thicker sheathing.

4 Results

The range of results of the ASTC testing is shown in Table 2 as well as the number of tests completed for each assembly type. Each test was done in a unique pair of adjacent dwelling units.

Figure 2 shows the transmission loss curve for one example of each assembly type.

Table 2: ASTC Test Results

Assembly	Number of Tests	Range of ASTC
A	3	55-57
B	6	43-46
C	1	50
D	2	51-52

5 Discussion

The ASTC test results for Assembly A show compliance with the minimum ASTC 47 requirement of the NBC. The test results for the same assembly with added structural sheathing on the inside of both studs (Assembly B) are below ASTC 47 and significantly lower than Assembly A. Figure 2 shows that Assembly B has lower transmission loss, compared to Assembly A, in low frequency bands (particularly from 125 Hz to 250 Hz). It is expected that the lower performance in these bands is due to the resonance in the cavity between the two layers of structural sheathing.

The ASTC test results for the assemblies with structural sheathing on the inside of both studs and an additional layer of GWB on the outside of the studs (Assemblies C and D) comply with the minimum ASTC 47 requirement of the NBC but are still lower than the results for Assembly A. Figure 2 shows that the low-frequency transmission loss for these assemblies is better than Assembly B, but still lower

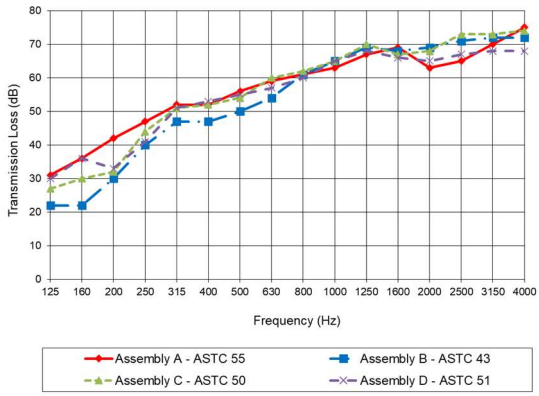

Figure 2: Transmission loss comparison for one example of each assembly type

than Assembly A. It is expected that the somewhat improved low-frequency results are due to the additional mass on the outside of the studs

Field ASTC testing has numerous limitations including the effects of structural flanking, quality of the installation, and differences in adjacent structures between different buildings. Further, the influence of variables such as stud size, stud spacing, insulation depth, air space depth, and sheathing material and thickness could not be examined as testing is limited to as-built assemblies.

Laboratory testing of these wall assemblies has largely been limited to tests sponsored by manufacturers of resilient dry-wall clips to assess the effectiveness of their proprietary products in this application.

The building industry would benefit from a basic laboratory STC study to establish STC ratings for double wood stud demising walls that include structural sheathing on the inside of the studs. The influence of stud size, stud spacing, air space depth, GWB type, number of layers of GWB, insulation depth, and sheathing material and thickness should be examined. It would also be beneficial to examine if the performance of these walls can be improved using typical construction materials such as resilient metal channels or the use of batt insulation in the cavity between the sheathing layers.

6 Conclusion

The ASTC test results presented here indicate that the addition of structural sheathing on the inside of the studs in double wood stud wall assemblies significantly reduces the ASTC rating, due primarily to lower transmission loss in the low frequency bands. The addition of extra layers of GWB appears to compensate, to some degree, for the reduced performance due to the sheathing. Further independent laboratory testing is needed to confirm STC ratings for double wood stud demising walls that include structural sheathing on the inside of the studs.

References

[1] National Research Council of Canada. National Building Code of Canada, 2015.