DEGRADATION OF WOOD STUD WALL SOUND ISOLATION BY ELECTRICAL BOXES

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This paper presents a brief summary of a recent study that examined how sound isolation of wood stud walls was degraded due to penetrations formed by electrical outlet boxes. The walls included double wood stud, staggered stud, and single stud constructions. For this brief summary paper, we restrict ourselves to results for double wood stud walls and only STC ratings are reported. This summary further focuses on the main factors affecting the sound isolation: box location, box type, cavity absorption and baffle^. Other factors, such as modification of the electrical boxes and the effect of outlets in other types of walls will be presented in a subsequent report.

Test Specimens and Test Method

The basic walls (i.e. without penetrations) provided a sound isolation greater than STC 50, and also have a one-hour fire resistance rating. The electrical boxes were positioned with the bottom of each box approximately 300 mm from the bottom of the wall. Outlets were wired to simulate normal field installation. The sound isolation tests were conducted in accordance with the requirements of ASTM E90-1990 and the single number STC rating was obtained using ASTM E413.

There are several electrical box locations depending on the framing of the wall. The wall details, the box locations, and the nomenclature to identify box locations are given in Figures 1(a) through 1(c).

Test Procedure

For each type of framing, a "base case" wall specimen was constructed with no penetrations and the measured sound isolation was compared to previously tested walls of nominally identical construction. Good agreement was obtained in all cases. Then the gypsum board was removed and saved for later re-installation.

The electrical outlet boxes and associated wiring were installed in accordance with the Canadian Electrical Code. Holes were cut in the gypsum board to accommodate the electrical boxes, and the gypsum board was re-installed. The openings in the gypsum board for each outlet were masked with heavy covers, and the sound transmission was re-tested. In all cases, the difference between the result with all outlets masked and that with no penetrations was less than the known repeatability associated with removing and replacing a layer or layers of gypsum board.

Electrical outlets and normal cover plates were then installed and tested for each outlet configuration in turn, with the other outlet positions masked.

When comparing the measured sound isolation performance of two assemblies expressend in terms of STC, it is important to realize that due to errors in repeatability and the round-off of the individual TL data in calculating the STC rating, a difference of one STC point should not be considered significant. A difference of two is probably significant, while three or more is a clear indication of different sound isolation performance.

Effect of Box Type

Two types of boxes were investigated: standard metal boxes and plastic air-barrier boxes. The two are fundamentally different by design. The plastic air-barrier box has few penetrations and those that exist (for electrical cables) have a closed-cell foam gasket. The plastic box also has a flange and gasket designed to form an airtight seal with the back face of the gypsum board.

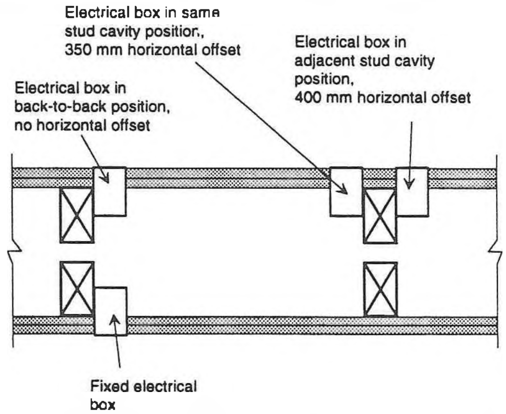

Figure 1(a): Positions of the electrical boxes in the double stud wall having double wood studs 400 mm o.c., separate head and sole plates separated by 25 mm, two layers 12.7 mm regular gypsum board on either side.

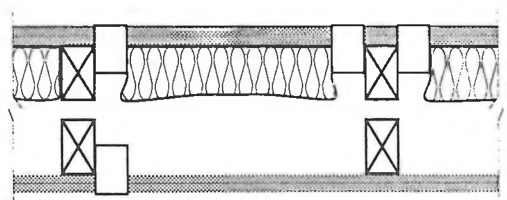

Figure 1(b): This construction was the same as in Figure 1(a), but with 90 mm glass fibre batt displaced around the electrical boxes in the stud cavity.

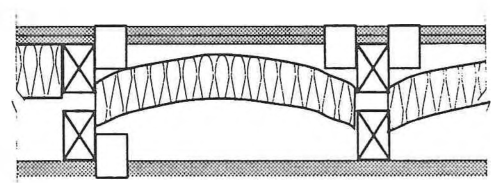

Figure 1(c): This construction was the same as in Figure 1(b), but with 90 mm glass fibre batts installed against the studs and covering the backs of the outlet boxes

Table 1 shows the measured sound isolation for a double wood stud wall as a function of the two box types for the two extreme locations. The plastic air-barrier provided consistently better sound isolation than the untreated metal boxes, especially in the back-to-back configuration. The results indicate that if the boxes are airtight then there is negligible sound transmission through the boxes, and placement is not critical. Similar performance was obtained when the standard metal boxes were treated to make them air tight, (as will be presented in a subsequent detailed report).

COMPARISON OF BOX TYPE		Electrical Box Location	
Box Type	Base Case	Back to Back No offset	Adjacent Cavity 400 mm offset
Metal	55	51	53
Plastic	55	55	55

Table 1: Measured Sound Transmission Class (STC) for standard metal boxes and plastic air-barrier boxes in a double wood stud wall without cavity absorption. See Figure 1(a).

Box Placement and Cavity Absorption

Table 2 shows the change in sound isolation relative to the base case for various locations of the untreated metal boxes. From the table it is immediately obvious that the effect of electrical boxes on the sound isolation of a party wall can be large — degradations of up to 6 STC points were experienced for poorly located boxes.

The reduction in the sound isolation depends on several factors: the separation (horizontal offset) of the electrical boxes and the location of absorptive material.

METAL ELECTRICAL BOXES		Electrical Box Location		
Cavity Absorption	Base Case	Back to Back (no offset)	Same Cavity (offset 350 mm)	Adjacent Cavity (offset 400 mm)
None	STC 55	- 4	- 6	- 2
90 mm displaced	STC 61	- 6	-1	- 0
90 mm	STC 62	- 1	- 1	- 1

Table 2: Wall sound isolation (expressed as STC or change in STC relative to the base case) for walls with untreated metal boxes at various locations.

The greatest reduction of the STC occurred when there was a short unimpeded path between boxes — that is, the sound did not have to travel through the cavity absorption or through the narrow gap between studs into the next cavity. However, when the sound must travel through the absorption (i.e., all other absorption cases), the impact of box location is greatly reduced.

Very little reduction of the STC was evident for walls that have the electrical box in the adjacent stud cavity position (at least 400 mm from the fixed box) when there was absorption in the cavity. The combination of absorptive material and a horizontal offset greater than the stud separation ensures the outlets have minimal effect. The trend of increased sound isolation with increased separation may not hold true if there is no cavity absorption and standing waves can form in the cavity.

Table 2 shows the change in sound isolation for the double stud wall with cavity absorption installed in two ways: displaced around the side of the box (Figure 1(b)) or placed completely over the back of the box (Figure 1(c)). The table shows that for boxes located in back-to-back positions, having the layer of insulation between them greatly reduces the impact on the STC.

Cavity absorption reduces the effect that poorly placed electrical boxes have on the sound isolation of a party wall especially if the absorption is placed so it covers the backs of the boxes.

Gypsum Board Baffle

Often 'better building practice guides' recommend the use of gypsum board baffles to improve both the fire and sound resistance of wall assemblies having penetrations. Figure 2 shows a possible installation. In the specimen tested the gypsum board baffle extended from the sole plate to a height 300 mm above the box.

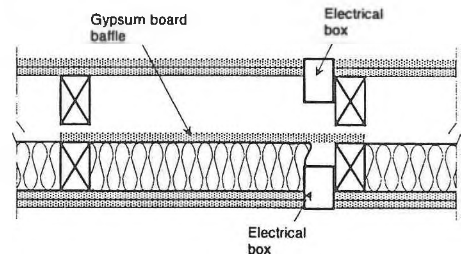

Figure 2: Sketch of a baffle for a double stud wall. Note that the structural isolation between the two faces is preserved.

Table 3 shows that the acoustical effectiveness of the baffle depends on the the presence of cavity absorption. This is to be expected since the cavity absorption controlls the reverberant field in the cavity and a baffle will only be effective if the reverberant energy is much less than that travelling directly between the two outlets. Consequently, reducing the direct component with the use of a baffle will only provide marginal improvement without absorption.

METAL ELECTRICAL BOXES		Back-to-Back Box Location	
Cavity Absorption	Base Case	No Treatment	Baffle
None	55	51	52
90 mm displaced	61	55	62

Table 3: Wall sound isolation (expressed as STC) with and without the gypsum board baffle shown in Figure 2.

Conclusions

Well-sealed electrical boxes offer better sound isolation performance than standard metal boxes. Where possible, electrical boxes should be suitably offset, preferably by at least 400 mm. Cavity absorption can be very effectively used to reduce any impact, especially if the absorption is placed so that it covers the backs of the boxes.