FLANKING TRANSMISSION CAUSED BY FIRE STOPS IN WOOD FRAME CONSTRUCTIONS

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Introduction

In multi-family dwellings, the nominal party wall or floor between units is both fire and sound rated. At the joint between two fire rated assemblies, there must exist a fire stop to control smoke and flame spread in the event of a fire. Typically, the fire stop provides a physical connection between building elements thereby causing a flanking path. The degradation of the net sound isolation of a double leaf construction is examined for two types of fire stop materials listed in the National Building Code of Canada (NBCC). In this paper, fire stops formed from continued room surfaces are examined. A section through the specimen without any fire stopping is shown in Figure 1.

Measured Results

Figure 2, a plan section through the party and end walls, shows the installed fire stop; both layers of the 13 mm gypsum board were run across the end of the party wall separating rooms A and B. This represents an acceptable fire stop construction as gypsum board having a thickness of greater than 12 mm satisfies the NBCC criterion[1].

Figure 3 shows the measured net sound isolation for the assembly with and without the fire stop at the end of the party wall. The presence of the fire stop between rooms A and B has degraded the net sound isolation by 9 STC points. The outstanding sound isolation of STC 63 has been reduced to STC 54. Other room pairs were not impacted.

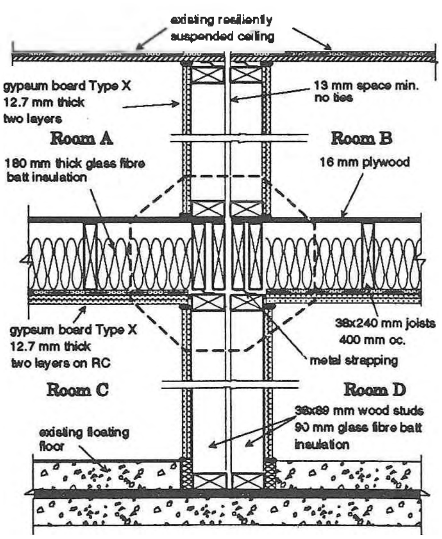

Figure 1: Section through the specimen without any fire stopping.

Figure 4 shows the measured transmission loss data between rooms A and B (ASTM E336) for the construction with and without the fire stop at the end of the partition wall. From the figure it is clearly evident that the presence of the fire stop has degraded the sound isolation over the frequency range 500 to 4000 Hz. However, the sound isolation for frequencies greater than 2000 Hz was severely degraded; by 10 dB or more.

The second fire stop to be examined is at the base of the party wall separating Rooms A and B. Figure 5 shows the fire stop formed by running the 16 mm thick plywood floor decking under the partition wall. Figure 6 shows the measured net sound isolation between the various room pairs expressed in terms of STC. From the figure it can be seen that the sound isolation between rooms A and B was severely degraded by the fire stop. The system, with the fire stop, achieved an STC 45, a
degradation of 17 STC points. As installed, it would fail to meet the NBCC criterion of STC 50. Rooms on the diagonals were also effected but to a much lesser extent. From Figure 4, it can be seen that the flanking path caused by the fire stop was the dominant transmission path for the frequency range 160-4000 Hz. The affected range of

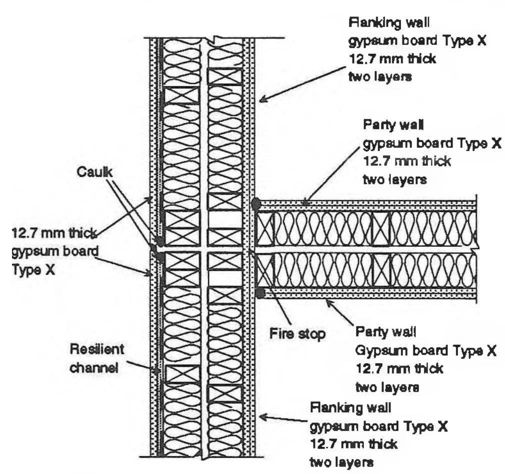

Figure 2: Plan section through the party and end walls showing the fire stops.

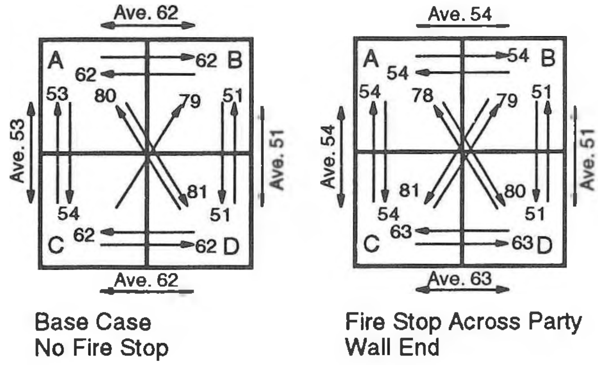

Figure 3: Measured net sound isolation(STC) for room pairs with and with out the fire stop across the end of the party wall.

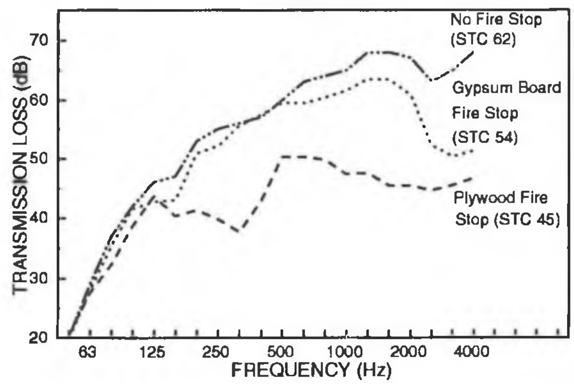

Figure 4: Measured net transmission loss (ASTM E336) between rooms A and B for the three cases.

frequencies represents nearly all of the building acoustics range which makes the impact so severe.

Discussion

The two fire stops considered – which are not typical of all fire stops – were constructed by continuing a room surface across or under the partition. This provided a very efficient flanking path for vibratory energy to propagate from one room to the other without having to pass through the partition wall. The magnitude of this flanking transmission and hence the degradation of the net sound isolation is a function of three factors. They are:

- Ability of the surface to accept airborne acoustic energy in the source room and convert it to vibration energy;
- Effectiveness of the continued surface (i.e. fire stop) for transmitting the vibration energy;
- Ability of the receiving room surface to convert the vibratory energy to airborne acoustic energy.

The effectiveness of the continued surface to transmit the vibratory energy through the joint at the two walls is discussed in the companion paper[2].

The ability of the source surface to accept and the receive surface to radiate sound energy is directly related to the radiation efficiency of the surface. The radiation

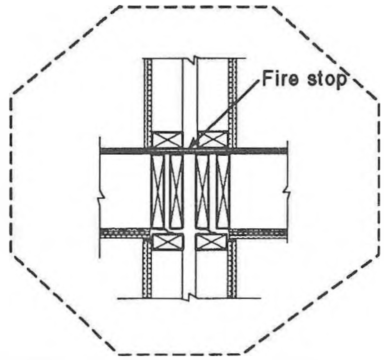

Figure 5: Section through the specimen showing the fire stop under the party wall separating rooms A and B.

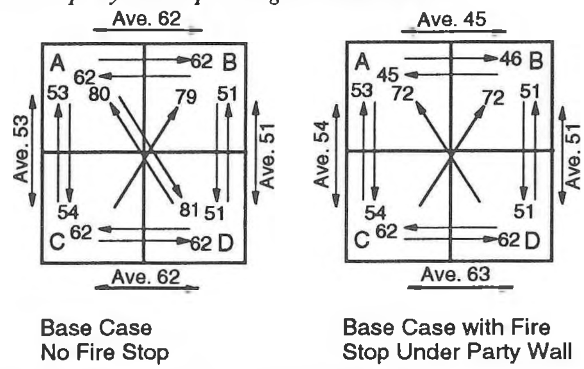

Figure 6: Measured net sound isilation (STC) for room pairs with and without the fire stop under the party wall.

efficiency of a surface is a maximum at the critical frequency and is only slightly less for frequencies above the critical frequency Thus, for a system having a joint whose transmission characteristics are reasonably independent of frequency, it is the radiation efficiency of the flanking surface that defines the frequency at which the flanking transmission will be the greatest. This was shown in Figure 4 where the frequency at which severe degradation begins (~2000 Hz) is very close to the critical frequency for the double layer of the 13 mm gypsum board (~2500 Hz) that forms the fire stop and the continued room surfaces. With the floor decking under the party wall, the wide range of affected frequencies may be explained by viewing the floor as having two distinctly different stiffnesses. The floor stiffness in the direction perpendicular to the joists will be similar to that of the plywood, while in the direction parallel to the joists the apparent stiffness will be very much higher. This causes there to be two critical frequencies – one for each of the orthogonal directions.

Fire stops formed by continuing a room surface across or under the nominally separating element should be avoided as they form flanking paths.

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[1]National Building Code of Canada, Fire Stopping 9.10.15.

[2]Nightingale,T.R.T, Craik,R.J.M., Numerical Modelling of Wood Frame Joints Having Fire Stops, Canadian Acoustics Proceedings 1994.