COMPLYING WITH HIGH SOUND ISOLATION REQUIREMENTS IN ACOUSTICS STANDARDS WHEN A SUSPENDED CEILING EXTENDS CONTINUOUSLY OVER PARTIAL-HEIGHT INTERIOR PARTITIONS

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1 Introduction

In some buildings, sound isolation between rooms is important. For example, conversations between employees and their human resource professionals are meant to be private. Even when speech privacy is not a concern, sound transmitting between rooms can be annoying or distracting and can inhibit productivity, concentration or relaxation.

Acoustics requirements in building standards, guidelines and rating systems list sound transmission class (STC) most frequently as the sound isolation performance metric. STC requirements generally range between 40-50, with STC 45 being the most common[1]. Interior partitions are required to be full height from structural floor slab to structural floor slab with any penetrations sealed airtight.

Despite these requirements, some building designs have partitions that instead stop at the height of a suspended, acoustic ceiling, leaving an open plenum above. This may be due to the desired cost savings or a requirement to use premanufactured, demountable wall systems that can be relocated as space requirements change. The resulting open plenum above the ceiling creates a noise flanking path over the lower wall, resulting in noncompliance with the sound isolation requirements and occupant expectations.

This research studied how to achieve the required sound isolation ratings with plenum barriers above the partial-height partitions when the ceiling grid runs continuously over the tops of the partitions.

2 Method

A series of sound isolation tests was performed on a suspended, modular, acoustic ceiling system with and without various lightweight plenum barriers under laboratory conditions in a dual-room chamber. For the baseline test, the specimen comprised a metal suspension grid filled with ceiling panels, but no plenum barrier above the demising wall. Subsequent tests added various lightweight plenum barriers. In all cases, the ceiling grid ran continuously (uninterrupted) over the top of the laboratory's central demising wall.

2.1 Test facility and procedure

The tests were performed at NGC Testing Services in Buffalo, New York, in November and December 2016 by a Senior Test Engineer. The laboratory is accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) (Laboratory Code 200291-0). Tests were performed according to ASTM E 1414 and E 413.

2.2 Ceiling system, components and installation

The ceiling panels were white, stone wool, measuring 1220 mm (48 inches) (nominal) in length by 610 mm (24 inches) (nominal) in width by 16 mm (5/8 inch) thick with square, lay-in edges. Their weight was 1.27 kg/m2 (0.26 psf). They have a noise reduction coefficient (NRC) per ASTM C 423 of NRC 0.75 and a ceiling attenuation class rating (CAC) of CAC_{panel} 23 per ASTM E1414 and E413. The suspension system was a standard 24 mm (15/16 inch) wide, 38 mm (1-1/2 inches) high, steel, tee-bar suspension grid. The grid was installed in an uninterrupted manner, meaning the grid ran continuously over the central demising wall. For the baseline test, the ceiling panels ran continuously over the central demising wall.

2.3 Plenum barrier, components and installation

Prior phases of the research program determined that using lightweight, stone wool, insulation plenum barriers in combination with stone wool acoustic ceilings could achieve high CAC_{system} ratings[2]. However, those tests were conducted with an interrupted grid configuration where the demising wall extended slightly above the ceiling, breaking the ceiling grid in two separate areas. The goal for this phase of the research was to test if stone wool plenum barriers could achieve similarly high sound isolation ratings if the grid instead ran continuously over the wall.

The material used for the plenum barriers was stone wool insulation with the following properties: thickness 38 mm (1-1/2 inches), density 128 kg/m3 (8.0 pcf), and surface weight 7.32 kg/m2 (1.5 psf). The plenum barrier boards had a fiber-reinforced, foil, facing on one side. Both single- and double-layer plenum barriers were tested. When the double-layer plenum barriers were tested, the foil was oriented towards the open ceiling plenum, not into the 41mm (1-5/8 inches) interstitial airspace between the two layers.

The plenum barriers were mechanically fastened along the top edge using common, self-tapping, sheet metal screws with insulation washers into a common 41 mm (1-5/8 inches) wide metal channel that was attached to the test chamber overhead slab. Screws were spaced approximately 305 mm (12 inches) to 457 mm (18 inches) on center.

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Typically each 610 mm (24 inch) panel had two screws along the top. The bottoms of the plenum barriers were only friction-fitted against the top track of the demising wall and the grid. They were not mechanically fastened, glued or caulked.

Each panel was abutted to the adjacent panels along the sides with no overlap. The vertical seams between adjacent panels were taped using 50 mm (2 inch) wide metal tape for sealing butt-joints. When the double-layer plenum barrier was tested, the 610 mm (24 inch) wide panels were staggered 305 mm (12 inches) so that the seams were not aligned. This required a small cut along the bottom of one layer of the plenum barrier boards so that they could slide down over the grid bulb and allow the bottom of the plenum barrier board to sit on the top track of the demising wall. No caulk or sealant was used. Small gaps around and in between some of the plenum barrier panels were visible. Most gaps were closed during installation due to the pliability of the stone wool. The panels were cut slightly oversized and then compressed vertically and laterally during installation, which helped prevent gaps.

The ceiling panels were installed last. They did not extend under the plenum barriers. This is an important factor in achieving the high sound isolation ratings.

3 Results

The effect of installing the single- and double-layer stone wool plenum barriers with a continuous grid configuration on normalized transmission loss ($D_{n,c}$) and CAC_{system} values are shown in Figure 1 relative to the baseline test of the ceiling alone without any plenum barrier.

4 Discussion

The Optimized Acoustics Research Program is an ongoing, multi-year, multi-organization investigation into cost-effective means of designing and constructing interior architecture that complies with the acoustic requirements in industry standards, guidelines and building rating systems. It began in 2014, and progress updates of the findings have been presented at and published in the proceedings of InterNoise 2015, NoiseCon 2016, NoiseCon 2017 and Acoustics Week Canada 2015 and 2016 as well as published in various industry magazines and journals such as Sound & Vibration, Canadian Acoustics and Construction Canada. To learn more about the findings of other research phases or more details about this phase of the research, refer to one of the whitepapers or articles in the above listed sources or go to www.OptimizedAcoustics.com.

Other findings of this phase of the research include the importance of the foil facing on the plenum barrier board. When removed, the CAC_{system} rating decreased seven points for a single-layer plenum barrier and ten points for a double-layer plenum barrier. Conversely, whether or not the vertical seams between abutted plenum barrier boards were taped did not affect the CAC rating of the system.

5 Conclusion

Historically, it has been believed that installing an acoustic ceiling continuously above partial-height interior partitions leads automatically to poor acoustic performance and noncompliance with user expectations and standards. The findings shown in Figure 1 demonstrate that it is possible to achieve high levels of sound isolation, CAC_{system} 40-52, between rooms by using common, stone wool, acoustic ceilings combined with plenum barriers, even when the suspended, modular, ceiling grid runs continuously above the partial-height interior partitions. The design approach and installation method defined in this research can lead to compliance with the acoustic standards, guidelines and building rating systems that require STC 40, 45 and 50 levels of isolation. These findings can be used by designers and building owners to optimize acoustic performance when a continuous ceiling is desired but full height walls are not.

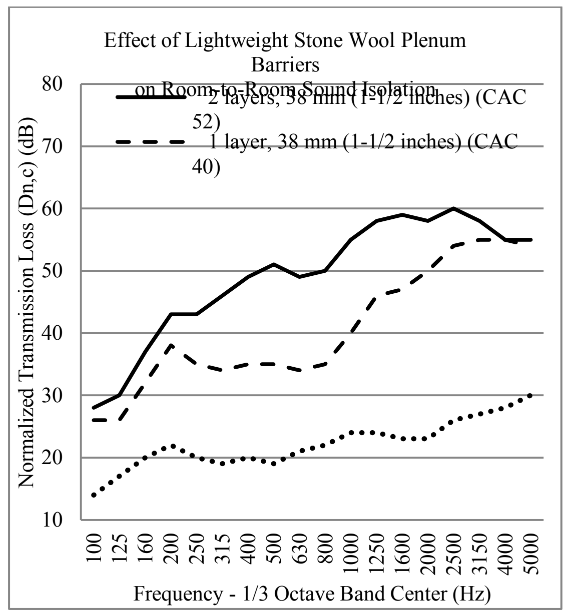

Figure 1: The effects of using lightweight, stone wool, plenum barriers on room-to-room sound isolation when the interior partitions stop at the underside of a continuous, suspended, acoustic ceiling.

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References

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