A Reference Specimen for Air Flow Resistance Measurements.

Wing T. Chu
Acoustics Laboratory, Institute For Research in Construction
National Research Council of Canada, Ottawa, Ontario, K1A 0R6.

1. Introduction

For quality assurance purposes, it is necessary to design and fabricate a reference specimen for periodic checking of the entire measurement system. Presumably properties of the reference specimen should remain stable for at least a number of years. Two different types of materials are currently being tested and monitored at the Acoustics Laboratory of IRC/NRC. This report covers some of the preliminary results gathered up to the present.

2. Measurement System

Figure 1 shows a schematic drawing of the apparatus used for the test according to the ASTM C522 standard[1]. It consists of a 15.24 x 15.24 x 15.24 cm plexi-glass pressure equalization chamber and a specimen holder of the same cross-section locked onto it with latches on four sides. The joint is sealed by an "o" ring and high vacuum grease. For this particular test, the reference specimen formed an integral part of the sample holder.

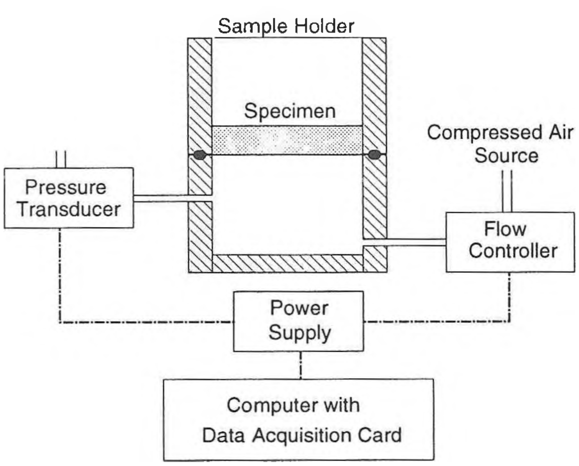

Fig. 1 Schematic diagram of airflow apparatus.

The air flow is provided by the building's compressed air line. A pressure regulator maintains an overpressure at the "upstream" side of the system. The downstream side from the specimen is vented to atmospheric pressure. The air flow is controlled by an MKS flow controller (1259B). The constant pressure drop across the specimen is measured with an MKS 223B differential pressure transducer. An MKS 246 power supply/readout package is used to power both the flow controller and the pressure transducer.

The outputs from the MKS 246 are sampled by the A/D converter of a data acquisition card (DAC) installed in a personal computer (PC). The MKS flow controller receives commands from the PC through the I/O ports of the DAC. Using different volume flow rates through the specimen and measuring the corresponding pressure drops, the airflow resistance can be deduced if laminar flow is maintained[1].

The test is automated using computer software developed in-house.

3. Description of Specimens

Potential reference specimens using two different types of material were tested. The first specimen consists of small glass beads designated as A090 'Highway Beads' by Potter Industries. The diameter of these beads is approximately 1 mm. 924.6 grams of them were packed between two 100 mesh (100 wires per inch) screens exactly 25.4 mm apart. The screens were held in place by two heavy wire-grid supports. The specimen was built into the sample holder as shown in Fig. 2. Two samples having the same weights were tested using two similar sample holders.

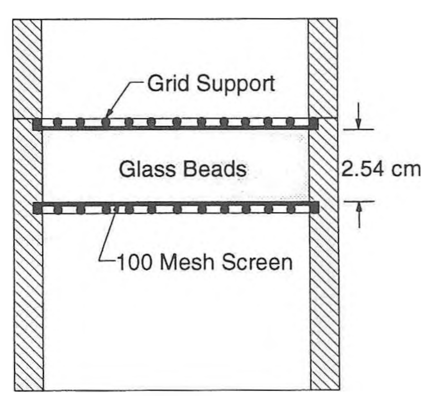

Fig. 2 Schematic diagram of sample holder with the glass-beads specimen.

The second specimen is a 3 mm thick sintered aluminum. Two samples were tested using the same sample holder.

4. Results and discussions

Figure 3 shows the pressure drops across the specimens as a function of the volume velocity of airflow through the specimen. Linear relationships are obtained for both specimens indicating that they passed the first requirement of a reference specimen.

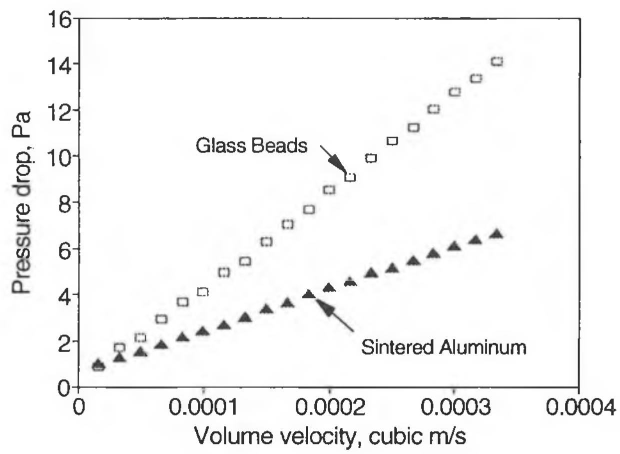

Fig. 3 Pressure drop vs. volume velocity plots for the two specimens.

Further tests showed that it is necessary to pack the glass-beads specimen properly. This was done by shaking the specimen on a shaker table. The following table shows the airflow resistivity of the glass-beads specimen at different stages of packing. There was a 11% change in the airflow resistivity between loosely filled and properly packed conditions.

Condition	Airflow Resistivity (mks rayl/m)
Loosely filled	32757
After tapping	34766
After shaking	36461
8 days later	36213

For each specimen, the same test was repeated ten times over a period of several days without any rearrangement of the sample and equipment. These tests were carried out in an ordinary room without any environmental control. Averages and normalized standard deviations were computed and they are shown in the following table.

Specimen	Average Airflow Resistivity (mks rayl/m)	Normalized Standard Deviation
Glass Beads #1	39144	0.010
Glass Beads #2	36425	0.010
Sintered Aluminum #2	123664	0.005
Sintered Aluminum #3	140502	0.007

The low values of the normalized standard deviation indicate that the specimens are not sensitive to environmental changes and that they have good short term stability. However, both types of specimens lack good homogeneity. There was a 7 % change in the average airflow resistivities of the glass-bead samples and a 12% change for the sintered aluminum samples. For the glass-beads samples, a portion of the change could be due to the non-uniformity of the 100 mesh screens which form part of the sample. Additional tests are required to confirm this assertion.

5. Conclusions

Preliminary tests show that both the glass beads and the sintered aluminum specimens have fairly good short term stability. However, the glass-beads specimen required proper packing. This could be done with a shaker table. Their long term behavior is currently being monitored. Because of the lack of homogeneity, these specimens might not be suitable for round robin tests between laboratories

6. References

1. 'Standard Test Method for Airflow Resistance of Acoustical Materials', ASTM C 522 - 87 (Reapproved 1993).