

IN2000/817

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ABSTRACT

A new opportunity to protect buildings located near motorways or high traffic roads is constituted by High Sound Insulation Ventilating Windows (HSIVW). These windows show good insulation performances and, meanwhile, allow airflow through the window itself.

In a previous work, acoustic and airflow performances of the windows have been measured; in the present paper the research is carried on by putting a filter in the aerator of the windows; the filter is necessary to make the inlet airflow cleaner.

Acoustic (single number sound reduction index R_w) and airflow (air flow through the aerator g) performances are again measured with regard to four different filters, including one with active carbon.

Experimental investigation shows that the windows equipped with filters still present high sound insulation, with good airflow properties. The airflow reduction due to the filters, in fact, varies from 10 to 40%, but is still high enough for the ventilation and cooling of the building.

INTRODUCTION

High Sound Insulation Ventilating Windows (HSIVW) represent a recent opportunity to protect urban buildings, especially those close to motorways or high traffic roads, against noise pollution.

HSIVW, in fact, show good insulation performances and mean while allow airflow through the window itself; such a performances matches summer indoor refreshment needs with respect to the characteristics of Mediterranean climate.

In a previous work [1], twelve different samples of HSIVW have been tested to compare acoustic performances with airflow ones; in particular sound reduction index (R) and single number sound reduction index (R_w) have been determined according to ISO 140/3/95 [2], while airflow rates have been evaluated thanks to an original experimental facility [3].

The research was carried out by measuring the influence of different filtering systems, inserted in the aerator of the window, on the acoustic and airflow performances of the window itself. To this aim, the aerator has been modified to allow insertion of the filters (fig. 1).

The filter in the aerator is necessary if inlet air is of bad quality; this situation is frequent especially if the window is located in an urban area or close to a motorway.

EXPERIMENTAL FACILITIES

The shape and the volume of the UNIPG Lab test room are in agreement with the constraints of ISO 140/1 [2]. The window under testing has been installed on a filler wall which divides the emitting and the receiving room. Test room map and filler wall sections are sketched in Fig.2. R_w measurements have been performed according to ISO 140/3 procedure by means of 2-channel real time FFT sound analyzer equipped with an automatic software for R_w calculation [2]. The sound source employed to excite the emitting room is a Twelve Loudspeakers Omnidirectional Source (TLOS) home-made at the UNIPG Lab. Source supply signal is white noise. As shown in Fig.3, determination of air flow rate versus pressure difference (ΔP) is attained as follows: a power fan produces a ΔP between emitting and receiving room; ΔP may be set by means of an adjustable fan valve; an anemometer is installed on the receiving room outlet duct to measure the air flow rate; a differential manometer picks up ΔP between the rooms [3]. During the air flow measurement, the rooms are pneumatically insulated from the external environment.

TESTED SAMPLES

Measurements have been carried out with reference to a window with simple frame, sandwich glass thickness of 12-12-9 mm, gas Argon inside the sandwich glass.

Airflow measurements have been made with both a natural convection aerator (model Renson 43NM), and with a forced ventilated one (mode Renson 40V).

As far as filters, four different kind of systems have been considered,

- filter 1, model P150 Luwa Filters, thickness 10 mm, weight: 120 g/m², ponderal average efficiency: 86%; airflow per m²: 5400 m³/h;
- filter 2, model P200 CL Luwa Filters, thickness 20 mm, weight: 200 g/m², ponderal average efficiency: 93%; airflow per m²: 5400 m³/h;
- filter 3, black sponge cloth filter, Luwa Filters, thickness 20 mm, weight: 1800 g/m²;
- filter 4, model 620 TF, Luwa Filters, thickness 20 mm, weight: 600 g/m², average ponderal efficiency: 98%; airflow per m²: 5400 m³/h;

MEASUREMENTS RESULTS

R_w measurements results are reported in fig. 4 and in table 1 and 2; the condition of the aerator with no filter is compared to the ones with the four different filters. As can be seen, the introduction of all different filters reduces the value of R_w of 2 dB, thus improving sound insulation of the window.

Frequency (Hz)	Aerator Renson 40 V with fan					Aerator Renson 43 NM without fan				
	Without filter	Filter 1	Filter 2	Filter 3	Filter 4	Without filter	Filter 1	Filter 2	Filter 3	Filter 4
100	14,0	13,2	13,1	13,4	12,9	18,1	16,7	17,1	16,5	18,1
125	18,2	15,5	16,1	15,6	15,9	21,8	21,9	22,3	22,4	21,8
160	13,4	12,2	12,0	12,6	13,3	21,0	20,6	21,5	21,0	21,0
200	17,5	16,5	16,9	17,0	17,7	27,2	26,2	27,3	27,3	27,2
250	19,3	19,5	19,1	19,9	20,2	26,8	26,5	27,2	27,3	26,8
315	25,3	25,1	24,5	24,7	25,0	31,1	31,4	31,6	31,7	31,1
400	24,7	23,6	23,9	23,3	24,2	29,7	29,1	29,0	29,2	29,7
500	25,0	24,1	24,5	24,3	25,0	27,8	27,5	27,8	27,8	27,8
630	23,9	23,1	22,7	22,5	23,2	24,4	24,0	24,0	24,0	24,4
800	24,7	24,2	24,0	23,9	24,3	25,5	25,2	25,6	25,3	25,5
1000	27,9	27,8	27,6	27,3	28,0	29,2	29,6	29,5	29,1	29,2
1250	31,2	30,9	31,0	30,9	31,5	33,7	33,4	33,2	33,2	33,7
1600	31,8	32,8	32,9	33,5	33,8	36,5	36,3	36,7	36,7	36,5
2000	34,0	33,7	34,2	34,8	35,0	40,5	39,9	39,9	40,1	40,5
2500	36,4	36,1	36,3	37,4	37,6	41,5	40,8	41,3	41,5	41,5
3150	39,9	40,0	40,5	42,0	41,8	43,8	43,3	43,5	43,9	43,8
4000	40,0	40,7	41,0	41,8	41,7	43,2	43,0	43,0	42,9	43,2
5000	41,1	41,4	42,3	42,6	42,3	43,8	43,0	43,3	43,3	43,8
RW	28	28	28	28	28	26	28	28	28	28

Tab. 1: R(dB) and R_w(dB) data for the two aerators, with different filters.

Airflow rate measurements results are reported in figg. 5, 6, 7 and 8. The airflow rate has been determined for the two aerators and at two different conditions: outlet gate shutter partially opened (50%) and outlet gate shutter completely opened (100%).

In this case the introduction of filters produces a significant reduction of airflow rate, which can be summarized as follows:

- filter 1: reduction of 20% in aerator Renson 43 NM and of 5-10% in aerator Renson 40 V;
- filter 2: reduction of 20-30% in aerator Renson 43 N and of 10-20% in aerator Renson 40 V;
- filter 3: reduction of 35-45% in aerator Renson 43 NM and of 30-40% in aerator Renson 40 V;
- filter 4: reduction of 40-50% in aerator Renson 43 NM and of 40-50% in aerator Renson 40 V.

REFERENCES

- [1] F. Cotana, *Experimental Data and Performances of New High Sound Insulation Ventilating Windows*, Internoise 99, Fort Lauderdale, Florida, USA, December 1999.
- [2] ISO Standards: 140-1/3/5;
- [3] CEN/TC 156/WG6 doc. n. 162 *Ventilation for buildings: Design Criteria for the Indoor Environmental*, April 1997.

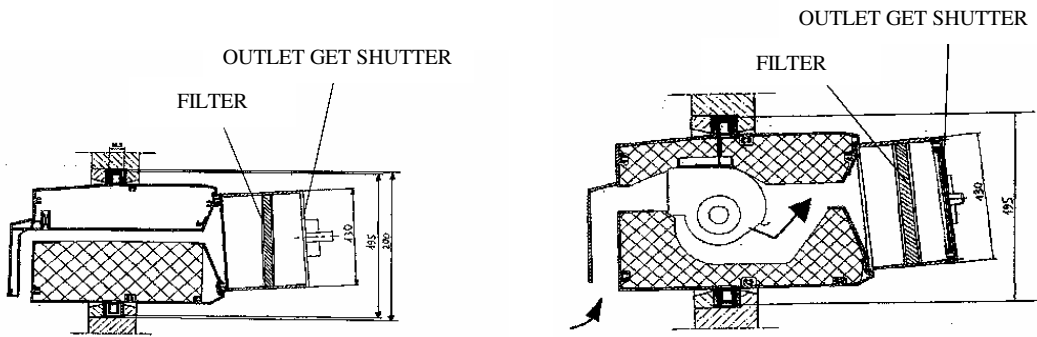


Fig. 1: Aerator sections: a) without fan, b) with fan.

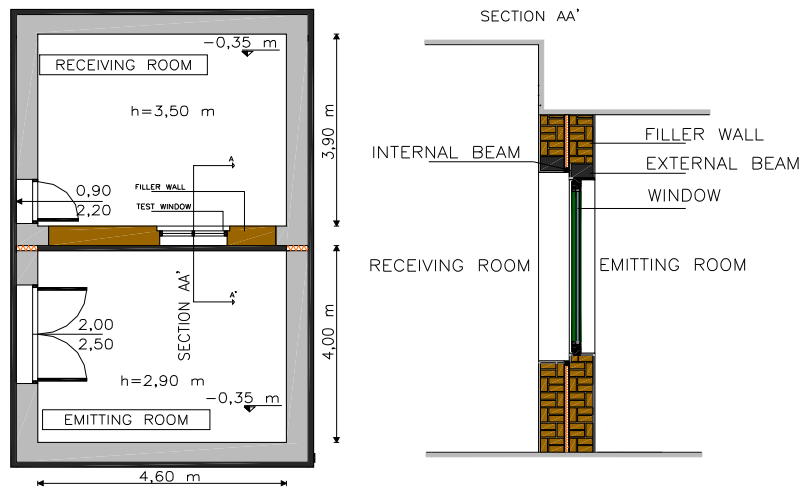


Fig.2: Test room map and filler wall section.

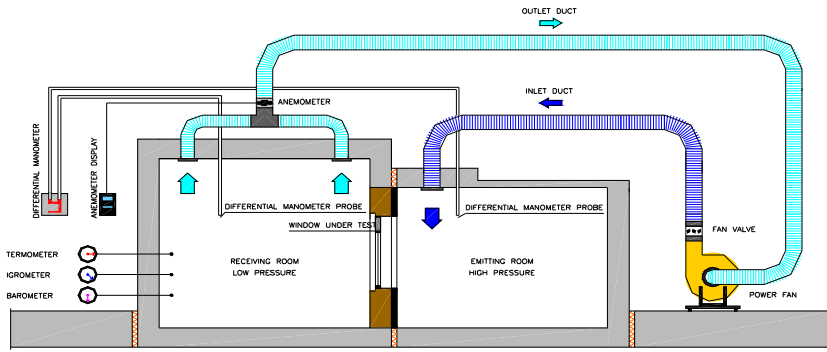


Fig.3: Air flow rate measurement facility.

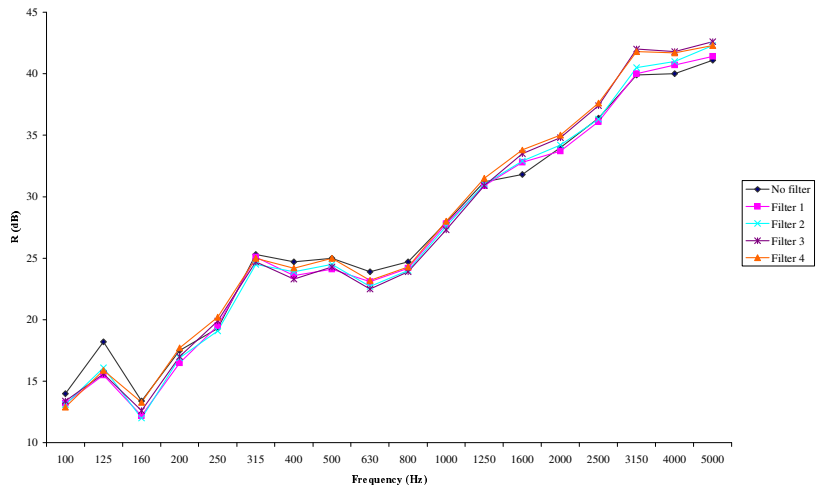


Fig. 4 : R data for aerator Renson 40V, with the different filters.

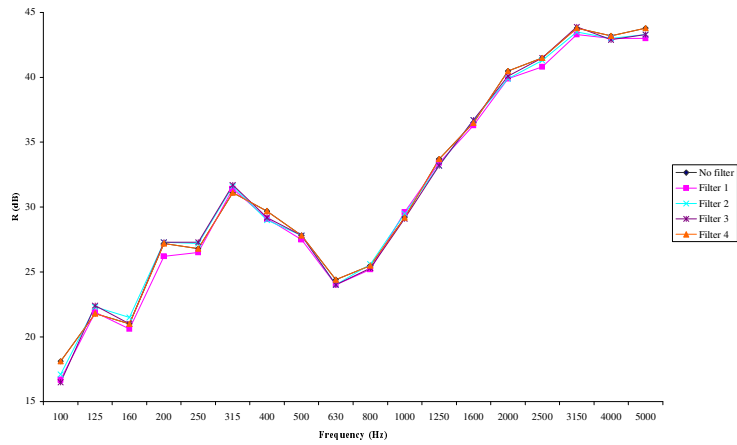


Fig. 5 : R data for aerator Renson 43, with the different filters.

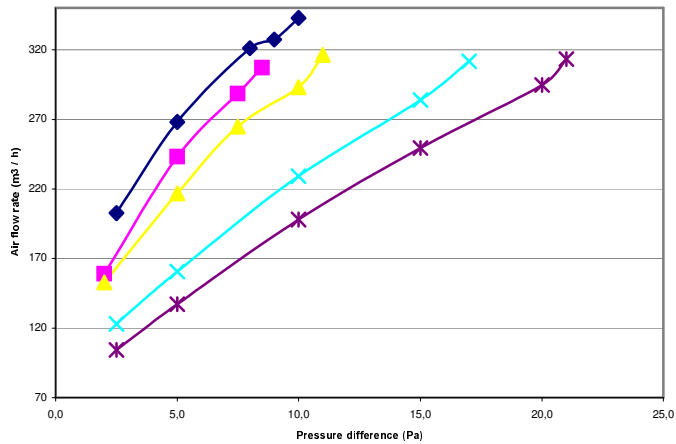


Fig. 6: Air flow rate vs. difference of pressure, aerator Renson 40V, outlet gate shutter completely opened (100%).

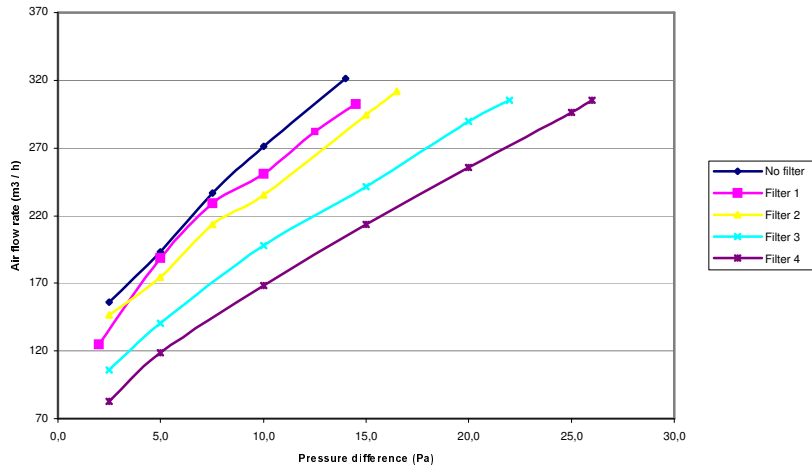


Fig. 7: Air flow rate vs. difference of pressure, aerator Renson 40V, outlet gate shutter partially opened (50%).

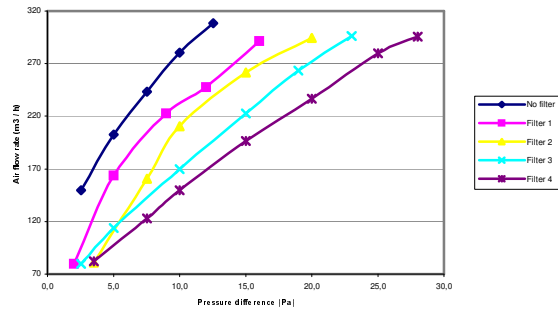


Fig. 8: Air flow rate vs. difference of pressure, aerator Renson 43, outlet gate shutter completely opened (100%).

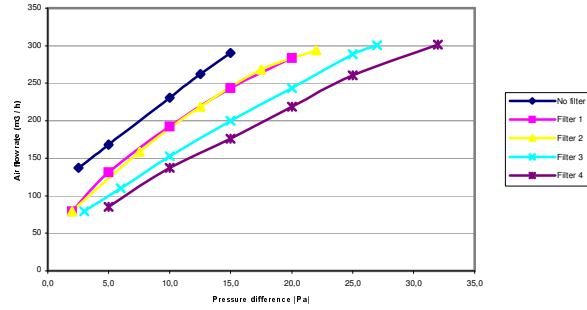


Fig. 9: Air flow rate vs. difference of pressure, aerator Renson 43, outlet gate shutter partially opened (50%).