inter-noise 2004
Prague • Czech Republic • August 22–25

The 33rd International Congress and Exposition
on Noise Control Engineering

Investigation on the performances of high sound insulation ventilating windows

F. Asdrubali[a,b], C. Buratti[a,c] and G. Baldinelli[a,d]

[a]Department of Industrial Engineering, University of Perugia, Via G. Duranti 67, 06125 Perugia, Italy

[b]fasdruba@unipg.it; [c]cburatti@unipg.it; [d]baldinelli.unipg@ciriaf.it

Abstract [362] An extended measurement campaign was carried out in order to investigate the characteristics of High Sound Insulation Ventilating Windows (HSIVW), a proper solution in all the cases where the intervention on noise sources results unfeasible, such as buildings strictly close to motorways or railways, as well as to industrial plants. The first series of tests was implemented on different HSIVW prototypes equipped with aerators (with and without fans); afterwards, a filter was inserted in the aerator, to make the inlet airflow cleaner. Finally, an insulated rolling shutter box was added to four different prototypes: two with an aluminum frame and two with a PVC frame. For all the surveys the sound reduction index (R) and the single number sound reduction index (R_W) were calculated, in compliance with the ISO 140/3 method, giving complete informations about the performances of the whole window. The global campaign shows that the windows designed with particular details care present high sound insulation properties, even those equipped with critical components, such as aerators or rolling shutter boxes. The PVC frames show better performances than the aluminum ones, even if all the different types of windows show significantly high values of R_W.

1 INTRODUCTION

The present work resumes a four-years campaign of measurements on High Sound Insulation Ventilating Windows (HSIVW). This solution constitutes a recent opportunity to protect urban buildings, especially those close to motorways or high traffic roads, against noise pollution, when noise barriers are not effective or too expensive. HSIVW, in fact, show good insulation performances and allow airflow through the window itself; these performances are necessary for summer indoor refreshment needs, with respect to the characteristics of Mediterranean climate. First of all, twelve different samples of windows were tested [1], to compare acoustic performances with airflow ones; six of them have a fan installed inside the aerator, in the other six air flow is due to a pressure difference between outdoor and indoor environments. The sound reduction index (R) and the single number sound reduction index (R_W) were evaluated in compliance with the ISO 140/3-95 method [2]; an original experimental facility was set up to determine the airflow rates [3]. A sound intensity method (ISO DIS 15186-1) was also used to determine R and R_W of the main elements (glass, aerator, frame) of the window. The prosecution of the research permitted to evaluate the influence of filters - inserted in the aerators, to purify the inlet airflow - on the acoustic and airflow performances. The last step was developed in order to investigate the influence of the insertion of an insulated rolling-shutter box in the window frame. Rolling shutter boxes, in fact, are very common in italian buildings.

2 EXPERIMENTAL FACILITIES

The shape and the volume of the University of Perugia Acoustic Laboratory rooms are in agreement with the constraints of ISO 140/1 [4]. The window samples were installed on a filler wall which divides the emitting and the receiving room (fig. 1). R_W measurements were performed by means of 2-channel real time FFT sound analyzer, equipped with an automatic software for R_W calculation. The sound source employed to excite the emitting room is a Twelve Loudspeakers Omnidirectional Source. The source supply signal is a white noise. As shown in fig. 2, the determination of the air flow rate versus pressure difference (ΔP) was 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 was installed on the receiving room outlet duct to measure the air flow rate; a differential manometer measured ΔP between the rooms. During the air flow measurement, the rooms were pneumatically insulated from the external environment.

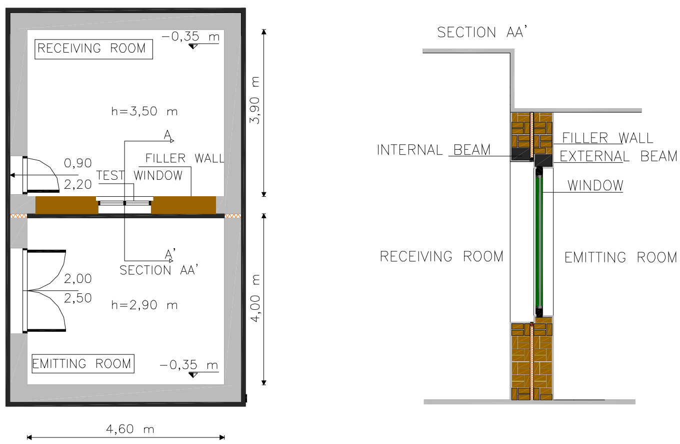

Figure 1: *Test room map and filler wall section.*

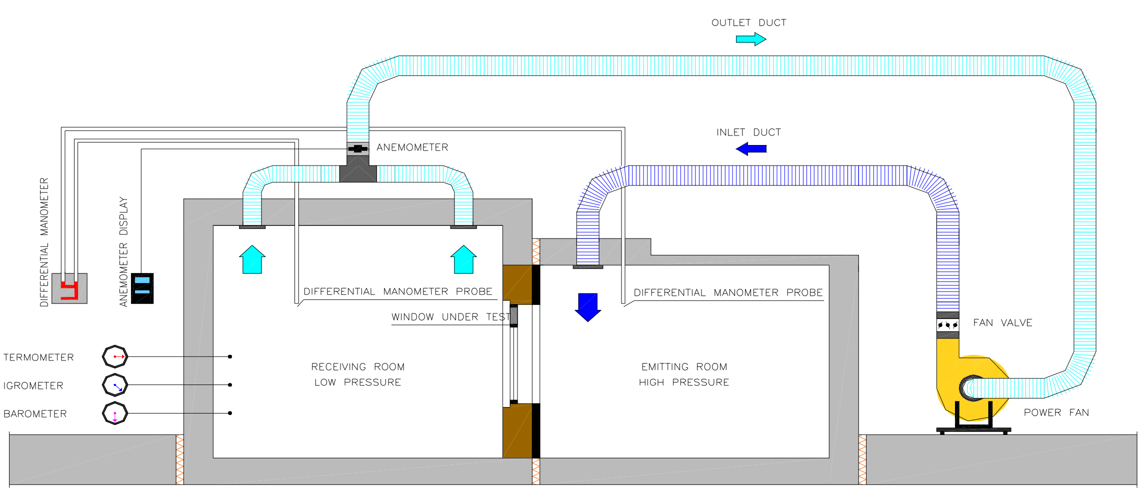

Figure 2: *Air flow rate measurement facility.*

3 MEASUREMENTS RESULTS

Insulating properties of High Sound Insulation Ventilating Windows are due to a particular window design: two separated parts (external and internal), joined together by means of elastic junctions, constitute the frame. Thus, vibrations induced on the external part by outdoor noise are not transmitted to the internal one. The glass is a sandwich structure (double glass) made by two plates (internal and external); the space between the plates is filled with particular gases (such as Argon), which increase the insulation properties of the entire structure. The first experimental campaign was performed on twelve different samples of High Sound Insulation Ventilating Windows, and the results are resumed in tab. 1.

Sample	Frame	Glass thickness	Gas	Aerator	R_W	Airflow rate (m^3/h)
1	Tiltable	10-20-10	SF6	RENSON 43	35	281
2	Tiltable	12-11-9	Air	RENSON 38	30	287
3	Tiltable	12-11-9	SF6	RENSON 40/V	31	343
4	Tiltable	10-20-10	Air	RENSON 40/V	31	343
5	Simple	10-19-10	SF6	CIR Z150/P530	32	73
6	Simple	10-19-10	SF6	CIR ZR – E150/P290	34	81
7	Simple	11-15-9	Ar	SAICOVENT "NAT"	36	259
8	Simple	11-15-9	Ar	SAICOVENT "300"	31	336
9	Tiltable	12-20-12	Ar+SF6	ARALCO DECI – AIR K1525 - 10	36	170
10	Tiltable	12-20-12	Ar+SF6	RENSON 40/V	31	343
11	Simple	12-12-9	Ar	RENSON 43	33	281
12	Simple	12-12-9	Ar	RENSON 40/V	28	310

Table 1: *Sample description, R_W and air flow rate.*

A comparison between the R_W values of the different windows is reported in fig. 3, while fig. 4 plots the air flow rate of each tested sample, with a pressure difference of 10 Pa; the relevant differences are due to the aerator design and disposal of the insulating materials.

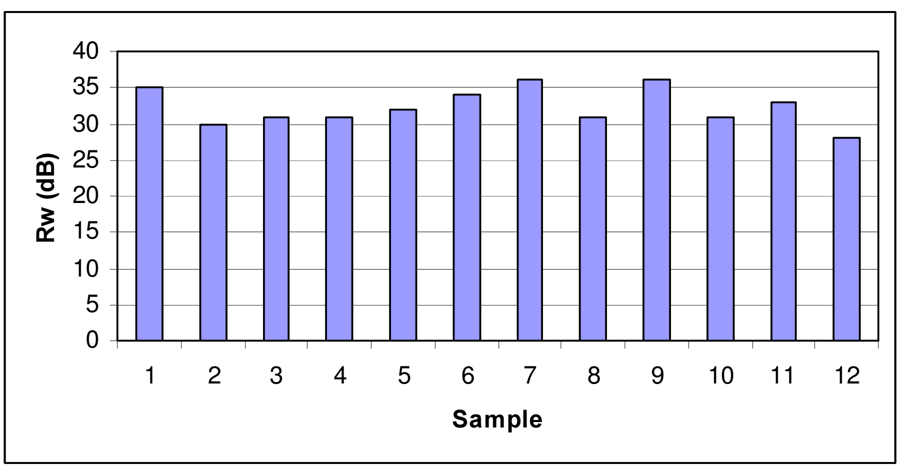

Figure 3: *Single number sound reduction index R_W for the tested samples of HSIVW.*

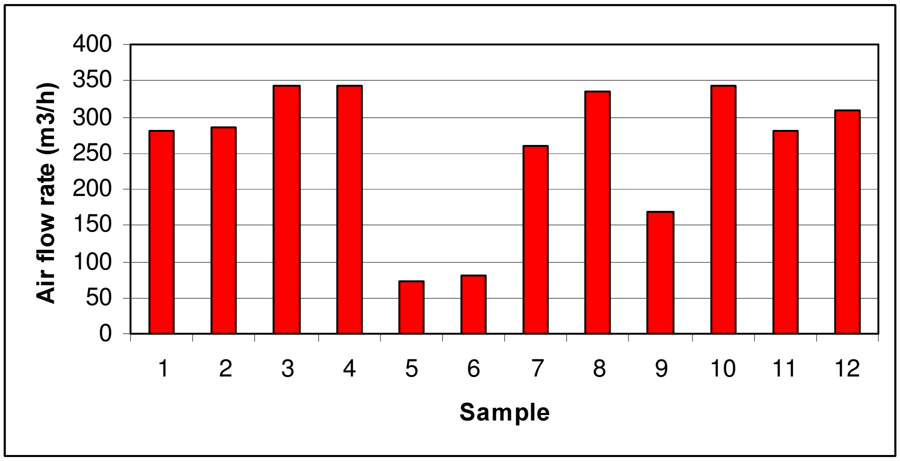

Figure 4: *Air flow rate vs. pressure difference for the tested samples of HSIVW.*

During the second experimental campaign four different kind of filters were introduced in the aerator:
- filter 1, thickness 10 mm, weight: 120 g/m^2, ponderal average efficiency: 86%;
- filter 2, thickness 20 mm, weight: 200 g/m^2, ponderal average efficiency: 93;
- filter 3, black sponge cloth filter, thickness 20 mm, weight: 1800 g/m^2;
- filter 4, thickness 20 mm, weight: 600 g/m^2, average ponderal efficiency: 98%.

The window maintained similar acoustic properties, while the air flow rate was reduced by percentages variable from 10% to 50%, meeting in any case good ventilation performances.
The last experimental campaign included four different prototypes of High Sound Insulation Ventilating Windows, integrated with an insulated rolling shutter box [5]. Most of the Italian buildings, in fact, have rolling shutters as darkening system, so the testing of such prototypes is important for a large-scale application of HSIVW. Two prototypes have an aluminum frame, the others a PVC frame; a view of the samples is reported in fig. 5.

a. b. c. d.

Figure 5: *High Sound Insulation Ventilating Windows with rolling shutter boxes: tested samples (a,d: aluminum frame; b,c: PVC frame).*

As far as the aerators, samples a,b and d were equipped with aerator Renson model 40V, already tested in terms of airflow rate; sample c was equipped with an aerator Aeromat type VT, with similar ventilation performances but designed with particular care as far as sound insulation. Sound reduction R measurements were performed according to ISO 140/3 and ISO DIS 15186-1/98 [6] procedures and single number sound reduction index R_W was calculated; the results are reported in fig. 6.

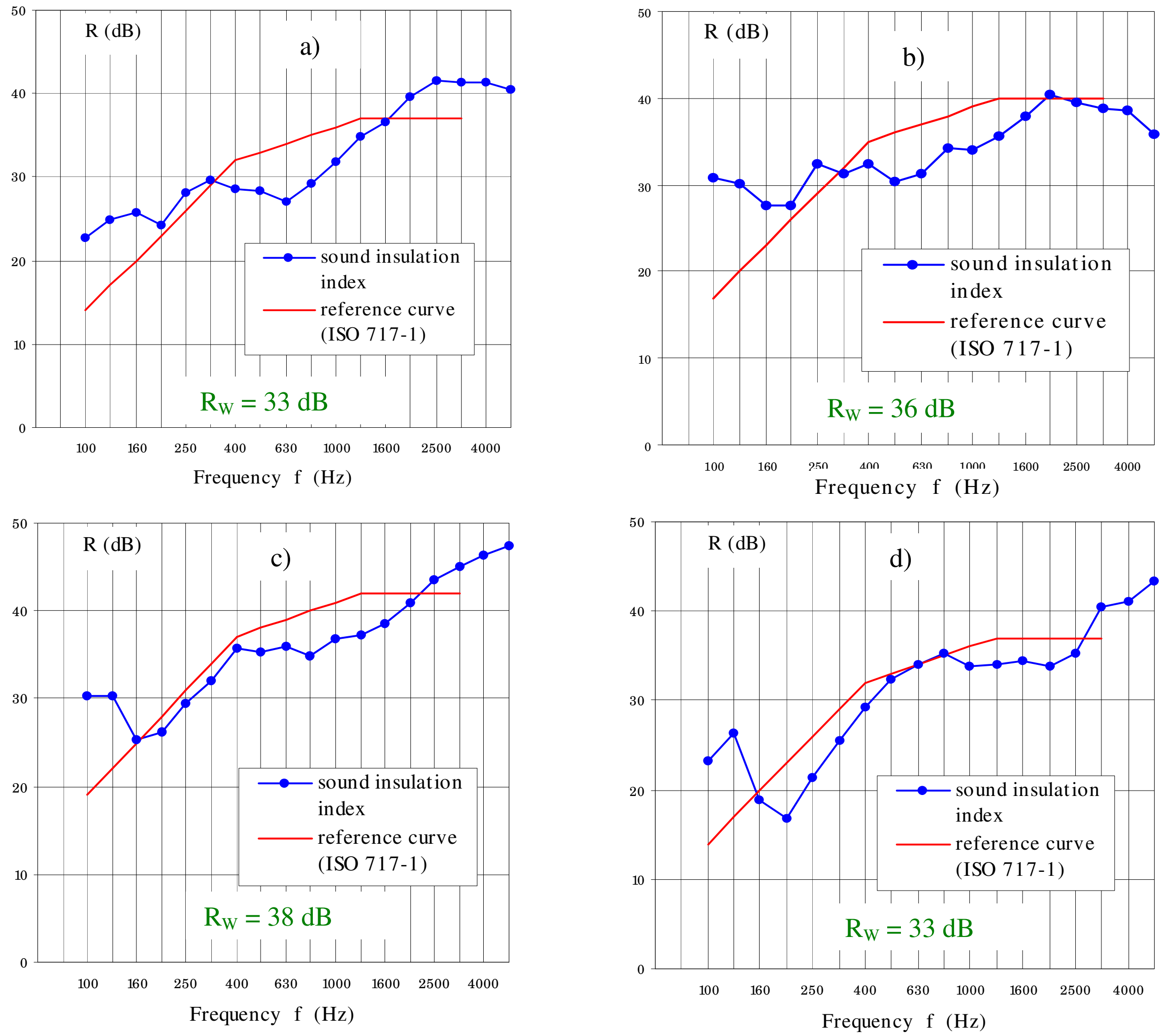

Figure 6: *Sound insulation index R vs. frequency of the various samples with rolling shutter boxes (ISO 140-3 method and 717-1).*

All the samples have R_W values bigger or equal to 33 dB; the values are in the same range of the ones of High Sound Insulation Ventilating Windows without rolling shutter boxes, thus the boxes are properly insulated.

4 CONCLUSIONS

An experimental investigation on High Sound Insulation Ventilating Windows was carried out, in order to evaluate the samples sound insulation index and airflow rates. Measurements results show that even with aerators, filters and rolling-shutter boxes, the windows present good insulation performances, as well as ventilation ones: the R_W values, in fact, are in the range of 28 ÷ 36 dB while the ventilation rate is in the range of 73 ÷ 343 m^3/h. The insertion of filters to clean the inlet air dos not influence the acoustic and ventilation performances: R_W, in fact, remains the same, while the ventilation rate shows a mean reduction of 25%. Finally, the insertion of rolling shutter boxes seems not to have a significant influence on the acoustic performance: values of R_W in the range of 33 ÷ 38 dB are obtained in the four examined samples. High Sound Insulation Ventilating Windows are a possible solution for urban noise pollution healing. Furthermore, these windows constitute the only possible solution in those cases where other noise protection systems (barriers, buffles, etc.) cannot be installed, due to the vicinity of the noise source and the receiving point or other territorial constraints.

ACKNOWLEDGEMENTS

The Authors wish to thank Autostrade Spa (Italian Motorways Society), whose support was essential for the realization of the experimental campaign, and in particular Eng. Gabriele Camomilla, Eng. Patrizia Pichetti and Eng. Ercole Pizzicannella.

REFERENCES

[1] F. Cotana: “Experimental Data and Performances of New High Sound Insulation Ventilating Windows”, in *Proceedings of Internoise 1999*, Fort Lauderdale, 1999, pp. 995-998.
[2] EN ISO 140-3: “Measurement of sound insulation in buildings and of building elements - Laboratory measurements of airborne insulation of building elements”, 1997.
[3] F. Asdrubali, F. Cotana: “Influence of filters in high sound insulation ventilating windows “, in *Proceedings of Internoise 2000*, Nice, 2000, pp. 1817-1820.
[4] EN ISO 140-1: “Measurement of sound insulation in buildings and of building elements- Requirements for laboratory test facilities with suppressed flanking transmission”, 1999.
[5] J. Patricio, L. Bragance: “The contribution of roller shutters to noise insultation of facades”, in *Euronoise 2003*, Naples, 2003, paper 228-IP.
[6] EN ISO 717-1/ 97: “Rating of sound insulation in buildings and of buildings elements - Airborne sound insulation”, 1997.