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ACTIVE DOUBLE-GLAZING : THE SOLUTION IS THE TRANSDUCER

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Looking at the increasing request concerning sound insulation in building, TechnoFirst® and Saint Gobain Vitrage propose an active double-glazing window. In this partnership, TechnoFirst® brings its experience in active control system. The product will be characterized by a global insulation never obtained. It deals with an acoustic treatment of the air volume. Modelisations have been done and show the contribution of each acoustic mode. The experiments have confirmed these informations. This publication shows first results obtained with a prototype. The control process is also presented. The electroacoustic system which allows this treatment can be fitted into the width of the air volume and is ditributed to the four sides of the window.

INTRODUCTION

We are more and more sensitive to noise and especially concerning our comfort in buildings. New laws appear more and more drastic in buildings acoustic. Double glazing windows are solutions for acoustic and thermal insulation. The more the thickness of glazing is increased, the best are the insulation performances. But weight criterion bounds this solution. Moreover, whatever weight of the glazing, the double glazing has a lost of insulation around a resonance frequency in low frequencies. The idea of the work presented is to use active control in order to compensate this lost of insulation.
This work is the result of a partnership between Saint Gobain Vitrage company and TechnoFirst® company. For this control we have chosen to control sound inside air volume between the two glazings. This paper presents hypothesis, achievement and test of a prototype.

THE ACTUATOR

This work is based on the following hypothesis : the sound goes through the window around the resonance frequency thanks to propagative modes in the air volume and in the two glazings which coincide together. The idea is to control the air volume mode between the two glazings in order to stop this way.

A precedent work was achieved by the C.S.T.B.[1] and shows according to simulation and laboratory experiments that the control of the first plane mode of the volume was sufficient to have a consequent improvement of double glazing windows insulation.

The most influential parameters for such control are the dimensions of the windows which give the characteristic frequencies of modes, and the thickness of the air volume, which gives the resonance frequency.
That is why for the first experiments a double window with the following size has been chosen : 1,4 x 1,2 square metres with a composition of 64-20-44 for the thickness of each element in millimeters (respectively the thickness of first glazing, air volume and second glazing).

After experiments achieved by the C.S.T.B with loudspeaker in the middle of the glazing, we have decided to achieve a demonstration of the active double glazing window industrial concept. The first task of TechnoFirst® was to find an actuator able to control modes in air volume while being invisible.

For this application, that means to find an actuator which could take place in a lateral dimension of 20 mm. Figure 1 shows the overall dimensions. A research of existing actuators did not give anything. So we have chosen to develop ourselves an actuator.

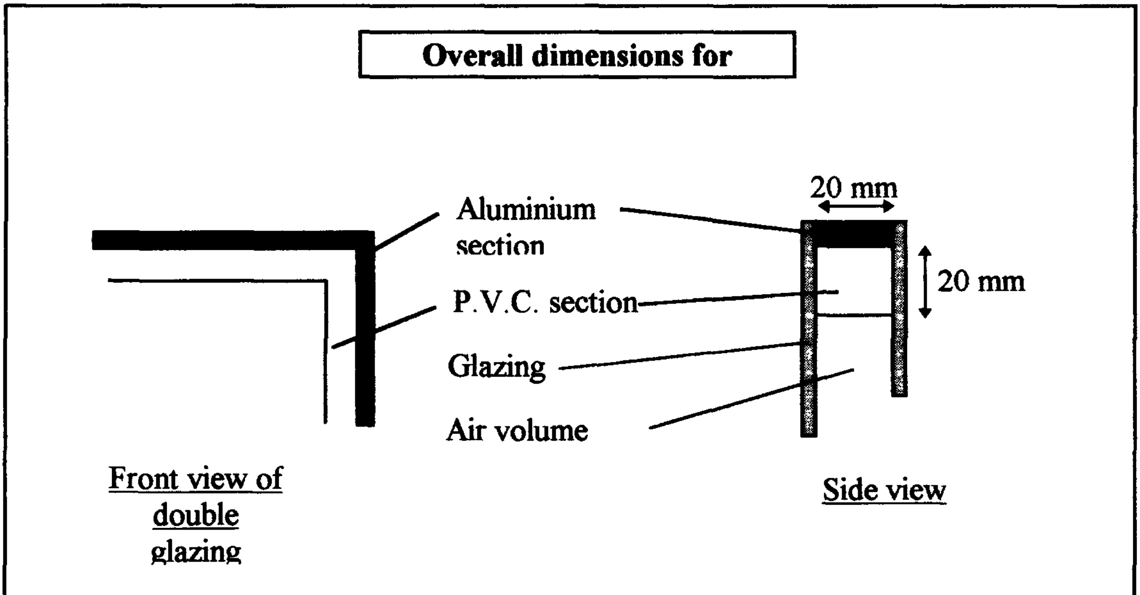

Figure 1

The specifications of this actuator was the following overall dimensions : 20 x 20 x l (l between 0 and 1 metre) and an efficiency of 70 dB/W/m.

According to experiments and modelization, we achieve the development of a loudspeaker with the precedent specifications. This loudspeaker is 500 mm long. The technology used for this loudspeaker has allowed to build a rigid membrane, which gives a good efficiency and resistance of the loudspeaker during the aging of the windows.

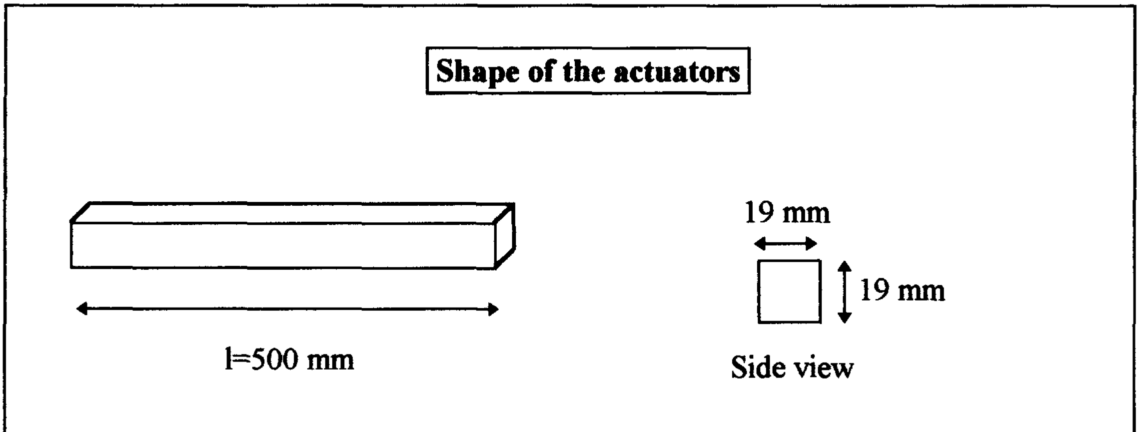

Figure 2

This element is able to take place at the four sides of the air volume.

In order to integrate this actuator and the microphones for the control, and to have a cavity behind it, we decided to introduce in the air space a PVC section on the sides of the glazing joining the aluminum spacer used for standard glazings. This aluminum spacer is full of a porous material used to absorb water vapor. This composition of the glazing is shown on figure 2 and allows to keep the tightness of a standard glazing.

The position of the actuator and sensor are presented in figure 3. The position of actuator allows to control the plane mode. The sensors placed at a quarter of the length on each side cannot see the upper even modes.

Front view of the active double glazing windows

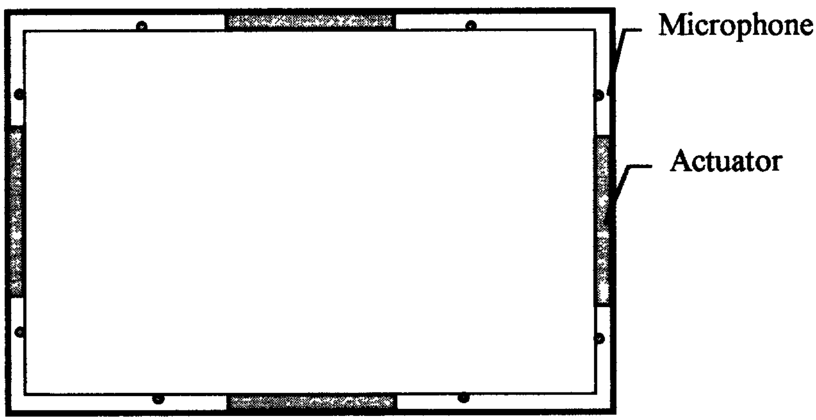

Figure 3

EXPERIMENTATIONS

First experimentations were made with direct acoustic field in the emission room. It allows us to use a microphonic reference for our control system in a feed forward technology. Such conditions are not representative of industrial environment but allow us to valid performances of our system.

The control was made with a road noise, and a configuration defined with eight microphones and four actuators. This equipment was controlled with the NOVACS (Noise and Vibration Active Control System). It uses a LMS algorithm.

The first results are shown in figure 4. The control of the plane mode in the air volume allows to improve the window insulation of 4 dB (A) on the global insulation for a road noise.

The active control system suppresses the plane mode in the air volume and cuts the way of acoustic energy around the resonance frequency range where the plane mode is alone.

This first experiment validates the concept of the plane mode control.

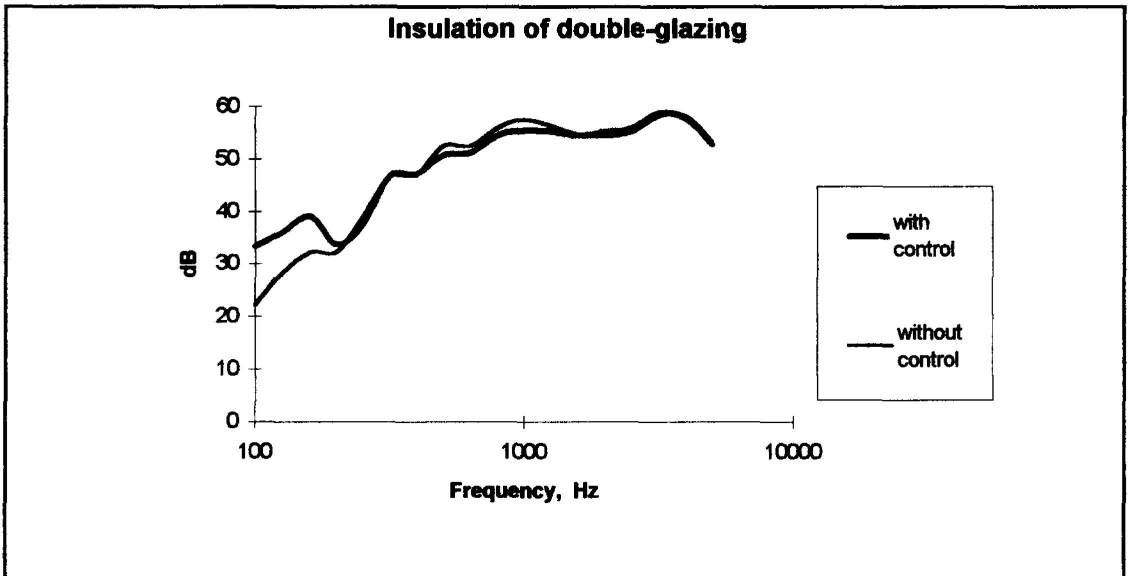

Figure 4

Other experiments were made without reference microphones, with a direct acoustic field in the emission room, with a feed back technology. These conditions are more adapted to industrial environment.

With this technology, we achieve the same results as with the feedforward technology, with a reduction of 10 dB for the third octaves of 80, 100, 125 Hz and 5 dB at 160 Hz.

Now we are working on this system in order to earn some more dB and to confirm the possibility of such control system. Tests were made with other gas placed between the two glazings. Gas lighter than air would give higher characteristic frequencies of upper modes and would allow efficient control of the plan mode on a largest frequency range.

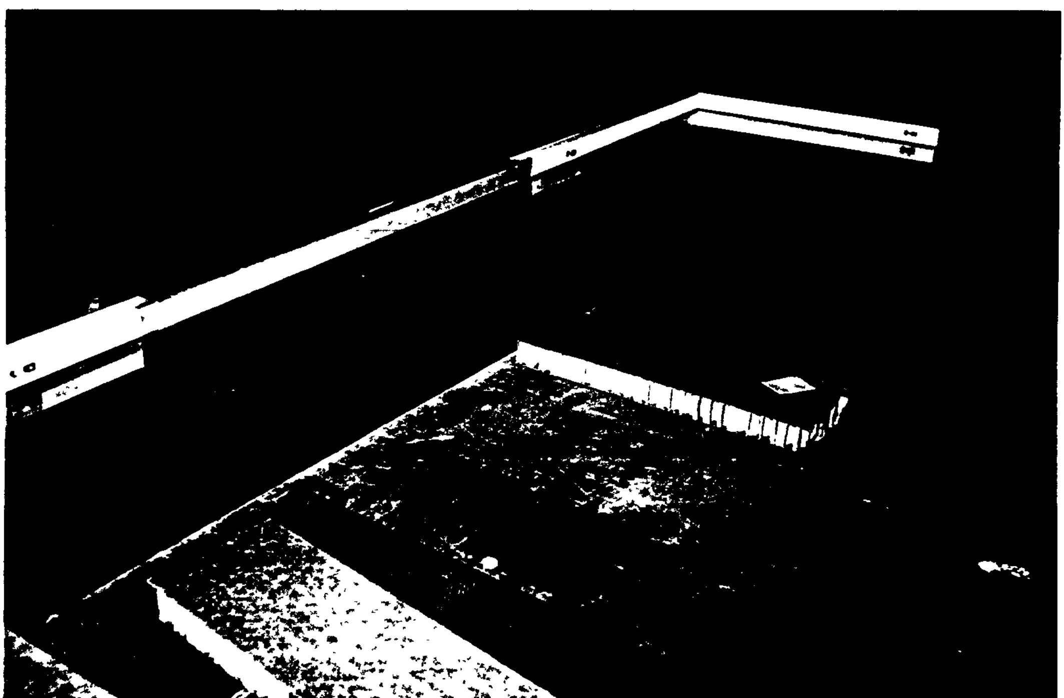

Figure 5 : Prototype of active double glazing

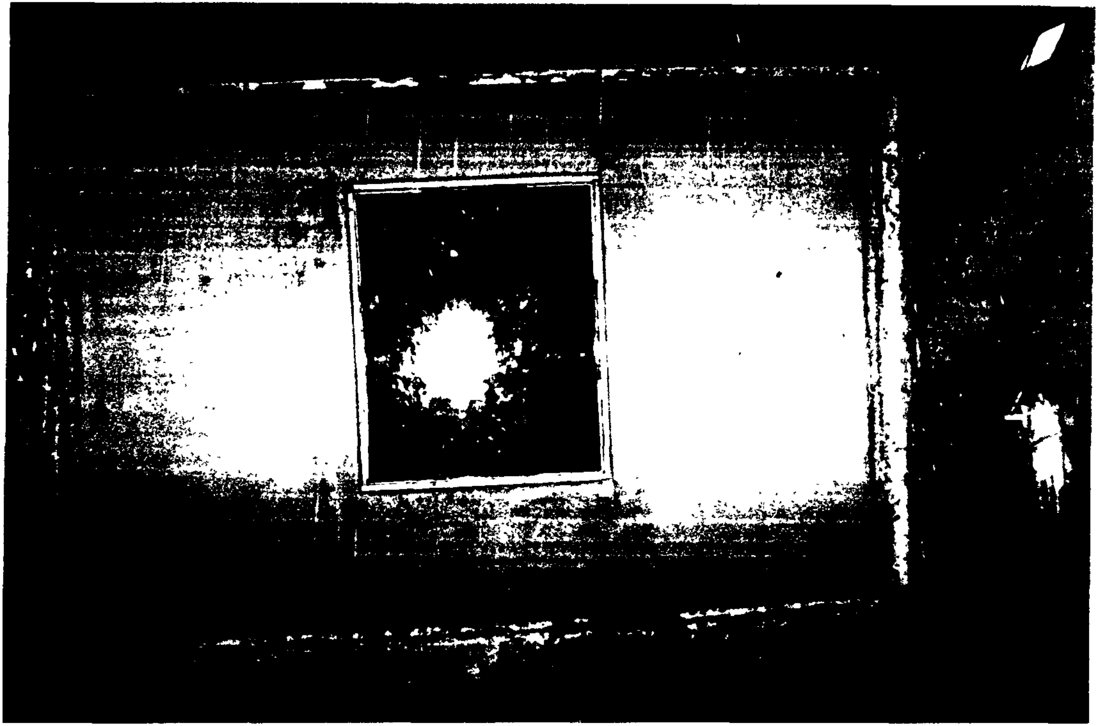

Figure 6 : Emission room of experiments

CONCLUSION

In collaboration with Saint Gobain Vitrage company, TechnoFirst has achieved a prototype of active double glazing window. This prototype was made with four actuators and eight microphones. These electroacoustic elements were developed by our TechnoFirst company. We developed a loudspeaker with very specific dimensions. This new actuator allowed us to demonstrate that the control of the plane mode in air volume of a double glazing improves its insulation.

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