THE SERRALVES AUDITORIUM AND MUSEUM IN PORTO WITH CONCEALED ALVARO ACOUSTICS

D Commins commins acoustics workshop, 15, rue Laurence Savart, F-75020 Paris, France, d.commins@comminsacoustics.com.
L Conde Santos Absorsor, Taguspark, Edificio Tecnologia I, no 11, Oeiras, P-2780-920, Portugal,
A Miguel Lopes luis.absorsor@taguspark.pt.

1 INTRODUCTION

The sober architecture of Alvaro Siza for the modern art museum of the Serralves Foundation in Porto required that the materials used in particular for acoustical correction ago unnoticed. This has led to the development of an absorptive board with a very smooth continuous surface which has ultimately been baptised “Alvaro”.

Figure 1: Views of the Serralves Museum

It turns out that the absorption coefficient of the Alvaro panels is close to 0.6 from low to high frequencies. Naturally, to obtain a good acoustical and aesthetic result, the panels must be installed by specialists using the manufacturers systems with great care.

Since the Serralves Museum and auditorium opened, many architects have shown interest in this system and have used it to eliminate disturbing acoustical devices.

2 THE ACOUSTICAL DESIGN OF ALVARO

2.1 The development of Alvaro

To avoid the use of fissured panels or of rough surfaces, a new material has been developed with a seamless and continuous surface. The development of the product consisted in improving upon existing technologies. It was optimised and tested experimentally.

To determine whether discontinuities could be completely avoided, the Alvaro panels were combined with other types of materials in a patchwork of Alvaro panels, plasterboards, wood panels and reinforced fibre panels; the same surface treatment was applied. The result was a smooth ceiling in which the various components had become undetectable.

Figure 2: View of the Alvaro experimental patchwork

To complete the experiment, flat omnidirectional loudspeakers were imbedded in the experimental ceiling and the same surface treatment was applied; the loudspeakers are not unnoticeable.

2.2 Technical features of Alvaro

The Alvaro material is a low density three-layer wood chipboard (around 420 Kg/m^2), manufactured from spruce and pine, 100% fresh tree clearing wood (round wood) from native, sustainable managed forests. The chip wood bonding of the middle layer is obtained with formaldehyde-free polyurethane resin (PMDI) whereas the facing layers are bonded with a low-formaldehyde melamine resin. The panels are lined on both sides with an acoustic fabric made of glass, viscoplastically bonded with low-formaldehyde melamine resin (MF).

The material is fire protected by means of halogen-free impregnation of the particles with inorganic, non-volatile ammonium and boron salts. The fire resistance of the material is B1 (flame retardant) / A2 (not combustible) according to DIN 4102 Part 1 and M1 according to French legislation. The product serves for preventive building fire protection and, depending on the installation conditions, will stand from 30 to 90 min against fire. In the case of fire, no halogen organic products of decomposition arise.

The material, in its standard form, will resist humidity up to 70% relative humidity. With special factory treatment can resist up to 95%.

The product is toxicologically as well as ecologically harmless. No breathable fibres arise in manufacture, processing and use of the product. With respect to formaldehyde emission, the formaldehyde compensation concentration is lower than 0.05 PPM and therefore the product is classified as “low-formaldehyde” according to the criteria of the Environmental Label (RAL ZU 38). Disposal of the material as building site waste does not carry any harmful impurities according to the specifications of the Closed Substance Cycle Waste Management Act.

The Alvaro panels are manufactured with dimensions 1710 x 615 x 17 mm, and will normally be installed as a suspended ceiling, by means of the double Wilhelmi K295 system: a floating secondary structure suspended from the main structure, which is then suspended from the slab. It can also be installed in wall mounted situations. In any case, the installation requires specially trained personnel and should be performed by companies accredited by Wilhelmi.

The panels should be carefully transported and handled, avoiding impacts and using non-fluffing gloves and should be protected against moisture. They can be processed with all suitable woodworking tools. For storage the material should be protected against moisture, dust, mechanical loading, direct sunlight and a necessary distance should be kept from heat sources (e.g. radiators). Two of the panel edges come out of the factory grooved whereas the other two are

tongued, and these are joint bonded on site assembling with the help of a specific tool and a special glue. This is a solvent-free, thixotropic adjusted PVAC joint adhesive.

After preparation on site the panels are finished and painted by projection of the special acoustic plaster Wilhelmi Alvaro. This is a dispersion bonded water-based plaster, with high mineral components. By default it is white, as RAL 9010, but can be supplied in other RAL colours, obtained with pigments, free of heavy metals. Its granulometry lies between 0.5 and 0.7 mm. The finished surface is very similar to that of plasterboard when painted with a slightly rough paint. Maintenance or repair of the material is accomplished by cleaning and repainting with the same acoustic painting. This does not change the sound absorption properties of the material.

Due to the natural dilatation of the material, expansion joints are necessary every 100 m^2, as well as a 20 mm gap to the surrounding walls around the perimeter of the ceiling.

2.3 Absorption

The absorption coefficient has been measured in the experimental chambers and in “official” laboratories: α_s average 0.63; α_s at 1000 Hz 0.55; α_w 0.65, class C.

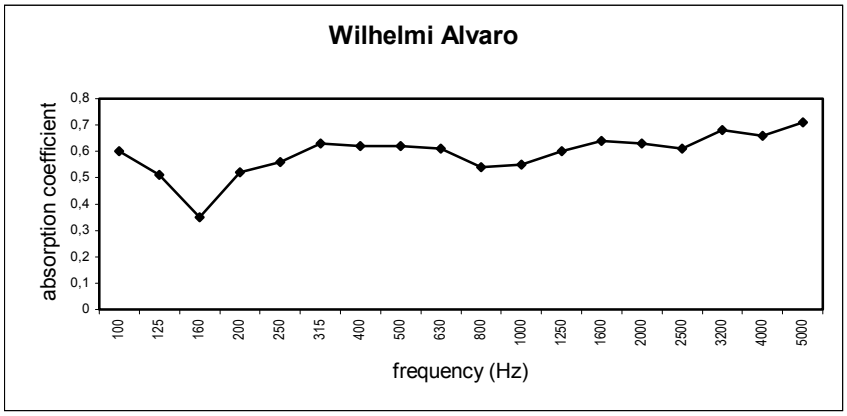

Figure 3: Absorption coefficient vs. frequency

The system benefits from a combination of absorbing mechanisms: the mid and high frequency absorption of its surface is completed by the low-frequency plate effect. The low frequency absorption is, of course, slightly dependent on mounting conditions, namely on the air gap left between the panel and the rigid partition (slab or wall).

2.4 The Serralves museum and auditorium

The contemporary Porto architecture style, under the leadership of Alvaro Siza Vieira, is characterised by pure lines and utmost simplicity. This makes it very difficult, or even impossible, to fit in traditional absorbing materials, as these would completely spoil the architecture. It is true that perforated or fissured materials or, even worse, ceiling systems based on panels and grids, can be too present and are not compatible with such an architectural style. Unfortunately, buildings designed with this architectural style tend to exhibit long reverberation times, which can be critical for many types of spaces and rooms, such as auditoria, exhibition rooms, or even foyers and corridors.

The 280-seat Serralves Auditorium, that was inaugurated in January 2000 in Porto, Portugal, is an example of the acoustical design of a room, which is to be used for conferences, projections drama, classical concerts and jazz, that had as an essential objective to avoid spoiling the architecture.

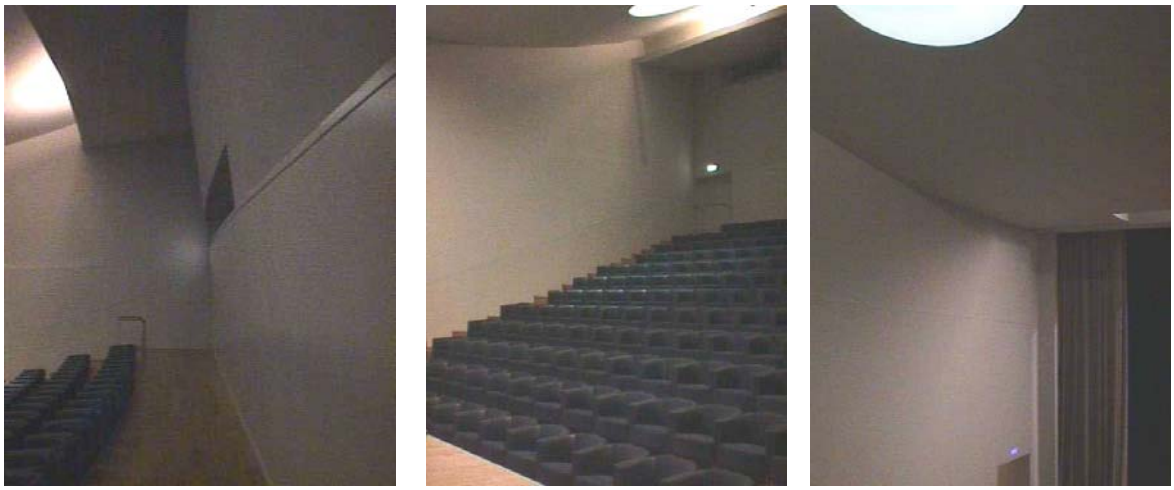

Figure 4: Views of the Serralves auditorium

As one can observe when entering the room, the details that are driving the acoustics are not visible. They are not artificially hidden either. In fact, this result is due to two main features: the shape of the room, which is totally functional, and the use of a new type of surface, which can be, at will, absorptive or diffusive. When observing the walls and ceiling, one can make no distinction between the various components. At last, aggressive objects and perforated surfaces have been eliminated. Even loudspeakers, needed for activities calling for amplified sound, have been imbedded in the sidewalls and are not noticeable either.

The same technique has been used in the museum. One observes in the following pictures that the acoustical ceilings do not disturb the aesthetics of the room.

Figure 5: View of museum rooms

3 References

1. Alvaro® is a trademark of Wilhelmi AG in Lahnau, Germany, www.wilhelmi.de.
2. Luis Conde Santos et al., Acustica 98, 14-16 September 1998, p 399 – 401.
3. D. Commins and F. Wilhelmi, 2nd convention of the European Acoustics Association and 137th ASA Meeting, Berlin, March 1999.