Supplementary acoustic measures in the conference centre of the Federal Ministry of Economy and Labour

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Introduction

The building complex of the former Kaiser Wilhelm Academy was furbished as the new location of the Federal Ministry of Economy and Labour in a nearly ten-year conservation and restoration work. Announced objectives of the construction measures were the historical and urbanistic re-establishment of the complex and the creation of modern work places. According to the user of the house this was achieved exemplarily well [1]. Nevertheless there was criticism regarding the acoustics in the former "Aula" as well as in the "Eichensaal", which were converted into an international conference centre.

Initial situation

The "Aula" has dimensions of 25 x 15 x 12 m and a volume of 4500 m^3. The desired value of the reverberation time had been specified to 2.0 s in the planning phase, quite high for "conversation"-uses. This was done following the strict requirements imposed by monument protection, which permitted treatments for acoustic purposes on a very limited part of the room surfaces only. Initially an acoustic plaster system was installed on the ceiling, the walls in the room edges, and above the doors as well as the media wall. Porous absorbers were mounted behind wooden lamellas at both front walls. More absorption was formed by 90 to 320 (depending on the seating arrangement) slightly upholstered chairs. All these absorbers have quite high absorption in the high and mid frequency range, but little absorption at low frequencies. The reverberation time measured in the unoccupied state with 246 chairs is shown in Figure 1. In the octave bands of 1000 Hz and above it is within the suggested range of tolerance according to [2] for a desired value of 2.0 s. However, at 500 Hz the reverberation time is above the limit, and the lower the frequency, the more it exceeds the acceptable range. Consequently conference organizers and participants complained about poor speech intelligibility, no matter if the electro-acoustic sound system were employed or not. Subsequent improvement concerning the room acoustics became inevitable.

The "Eichensaal", including the acoustically coupled anterooms and galleries, has dimensions of approx. 36 x 10 x 9 m and a volume of 3200 m^3. The desired value of the reverberation time had been specified to 1.7 s in the unoccupied state in the planning process, again with respect to monument protection. With its large amount of wooden panels and windows, and between 75 and 300 slightly upholstered chairs, the room already had considerable absorption in the low and in the high frequency range. Thus the reverberation time measured in the unoccupied state with 75 chairs exceeds the suggested limits predominantly in the mid frequency range (Figure 2). A flutter echo occured below the concave ceiling in the centre of the room. The resulting poor speech intelligibility and the unpleasant room-acoustic impression required subsequent improvements here, too.

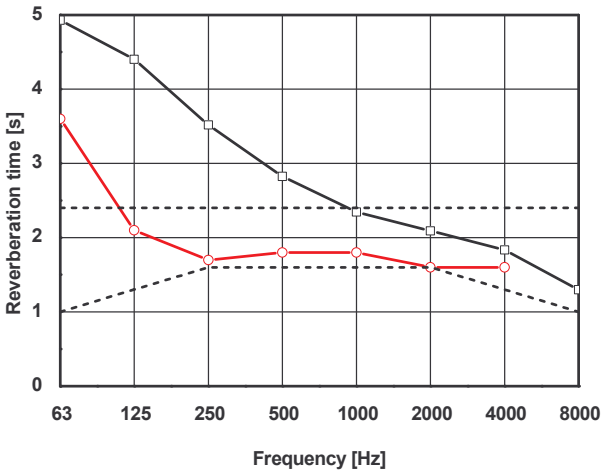

Figure 1: "Aula", reverberation time in the unoccupied state before (—□—) and after (—○—) subsequent room-acoustic improvements; range of tolerance (- - -) according to [2].

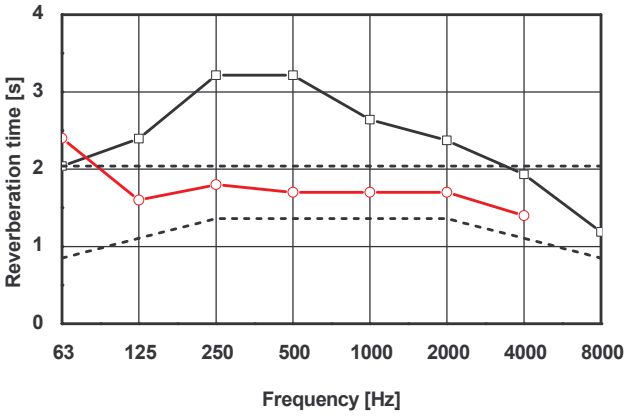

Figure 2: "Eichensaal", reverberation time in the unoccupied state before (—□—) and after (—○—) subsequent room-acoustic improvements; range of tolerance (- - -) according to [2].

Room-acoustic measures

The objective of the subsequent measures in the "Aula" consisted of lowering the reverberation time to values within the range of tolerance, predominantly in the mid and low frequency range. Two different approaches were taken: first, existing absorbers were replaced by more effective and more broadband ones, and second, additional surfaces for absorbers were found. A compromise was achieved among all parties involved, which permitted the installation of 10 cm to 25 cm thick highly effective innovative absorber modules [3], replacing the 3 cm acoustic plaster system. The ceiling was covered with 15 cm thick Broadband Compact Absorbers BCA according to [4] behind an acoustically

transparent fabric lining (Figure 3). 10 cm thick Compound Panel Absorbers CPA according to [4] were applied to the especially exposed places above the doors (Figure 4) and the media wall. Figure 5 shows measurement results of the absorption coefficient in a reverberation chamber of these novel absorbers, in comparison to the acoustic plaster system.

Figure 3: "Aula", Broadband Compact Absorbers at the ceiling behind a fabric lining.

Figure 4: "Aula", Compound Panel Absorbers behind a fabric lining above the doors.

It can easily be seen that CPA are particularly suitable, if like here additional absorption is needed at low frequencies whereas it is not necessary for higher frequencies (above approx. 500 Hz). 25 cm thick BCA were installed only in the non-visible cavity behind the wooden lamellas of the media wall. Conventional porous absorbers were mounted to the walls in the room edges and under the tables. The windows could be utilized for additional absorbers. Here, transparent micro-perforated acrylic glass was installed in approx. 20 cm distance from the windows (Figure 6), This type of absorber was applied already to the old Plenary assembly hall in Bonn [5]. With the measures mentioned so far, a reverberation time according Figure 1 could be achieved. A further option for additional absorption consisted of 60 m^2 mobile walls of CPA modules. They could lower the reverberation time to a value within the range of tolerance at low frequencies.

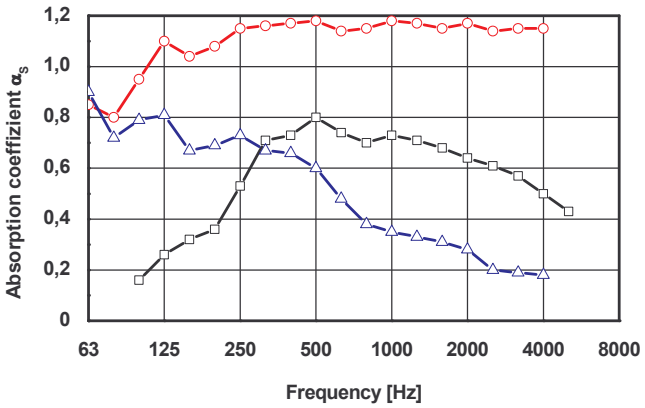

Figure 5: Absorption coefficient (measured in the reverberation chamber) of the acoustic plaster system (—□—), of 15 cm thick BCA (—○—), and of 10 cm thick CPA (—△—).

In the "Eichensaal" the acoustically ineffective polystyrene boards behind the fabric linings of the side wall were replaced by highly effective 9 cm thick BCA (Figure 7). Three layered curtains were mounted to both front walls, and porous absorbers were installed into the radiator niches and under the tables. With these measures a reverberation time according to Figure 2 could be achieved. The flutter echo was overcome by installation of porous absorbers directly beneath the ceiling and in two air outlet hoods.

Figure 6: "Aula", absorbers made of micro-perforated acrylic glass in front of the windows.

Figure 7: "Eichensaal", Broadband Compact Absorbers behind the fabric lining of the side wall.

Summary

The international conference centre in the new location of the Federal Ministry for Economics and Labour had room acoustic shortcomings which led to poor speech intelligibility. By replacing the existing sound absorbers by innovative highly effective ones, and by the activation of additional absorber areas a satisfactory result could be achieved.

References

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[4] Fuchs, H. V. et al.: Raum-Akustik: Neue Bauteile für besseres Hören und weniger Lärm. GesundheitsIngenieur 124 (2003), 45-56.

[5] Fuchs, H. V. et al.: Transparente Vorsatzschalen als Schallabsorber im Plenarsaal des Bundestages. Bauphysik 16 (1994), 69-80.