On the use of micro-perforated sails in assembly rooms

Roman Wack, Helmut V. Fuchs

Fraunhofer-Institut für Bauphysik IBP, D-70569 Stuttgart, Germany, Email: wack@ibp.fhg.de

Introduction

In many cases architecture is dominated by the topic transparency. Nowadays an effective damping of such rooms can take place by means of transparent micro-perforated structures, without disfiguring the architectural concept. Micro-perforated foils are usually used in form of one or multiple layers in front of a closed air volume [1, 2]. According to this principle various products have been developed, such as transparent roller blinds or transparent absorbing partitions. Foil sheets or sails freely suspended [3] are still rarely used so far, although they can be realized particularly well-priced. In the following it will be demonstrated by two examples, that suitable room acoustic conditions can be achieved by using suspended, transparent micro-perforated structures. It is common to both examples that an acoustically adequate conditioning for the intended use could only be realised "in last minute". In both cases simple and inexpensive measures were in demand, which should not disturb the architectural design. In the meantime both "interim solutions" have proven as quite lasting problem solutions.

"Forum", Office Innovation Center

Room acoustic concepts were developed exemplarily for the office range and demonstrated in the OIC besides solutions on the fields of room climate, lighting and noise protection. In the “Media-room” this was managed to a large extent with several innovative absorber elements. For the so called "Forum" on the other hand, a room with dimensions of 16.5 x 13.5 x 9 m, room acoustic measures were not planned at first (Figure 1).

Figure 1: Freely suspended layers of micro-perforated foils in the “Forum” of the OIC.

This room serves as presentation area for product innovations in varying exhibitions. The upper half of the wall construction consists of metal sandwich elements and the ceiling of a trapezoidal metal construction. This leads to comparatively short reverberation times at low frequencies, as shown by the result in Figure 2. Between 500 and 2000 Hz however a reverberation time of more than 3.5 s was measured. Sufficient intelligibility for talks is hardly attainable under such conditions, even by means of electro-acoustic devices [4]. Despite a very narrow budget for interior fittings, a measure, which fits into the limited temporal and financial limits, was brought in on the occasion of the opening event of the OIC. Ten sheets of micro-perforated foils each of 1.2 m width and approx. 13.5 m length were hung freely into the room with a simple assembly construction. The average backing distance of the single-layered foil to the trapezoidal metal ceiling amounts to 1.2 m. An absorption coefficient of the inserted construction between 40 and 50% can be concluded from the reduction of reverberation times, Figure 2.

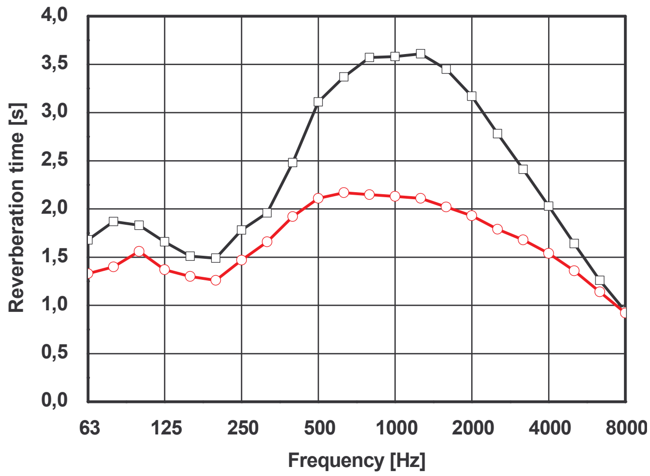

Figure 2: Reverberation times before □ and after ○ the installation of the foil absorbers according to Fig. 1.

"Schlüterhof", German Historical Museum

After rebuilding, the “Schlüterhof” in the DHM in Berlin appears as a covered inner court with a volume of approx. 30.800 m³. On an approximately square ground-plan a curved construction from steel and glass without support spans the yard (Figure 3). Although the operator intended the use of the representative area for meetings such as congresses, conferences or galas nothing was done regarding the room acoustic conditions for several reasons. Long before completion of the glass roof it was obvious that the room acoustic conditions would not suit the intended use. The strong structuring of the baroque facade provides diffusivity at middle frequencies. The echo formation under the concave-curved roof is however not reduced thereby. This is also proved by the measured echo fading times if the sound source is located in the middle of the room (Figure 4). In the case of source positions in proximity to the wall the echo is less pronounced. The measured reverberation times, Figure 4, clearly show that the insufficient damping does not permit the intended use of the area.

Figure 3: Transparent sail of micro-perforated foil under the new, concave-curved glass roof structure in the "Schlüterhof" of the DHM.

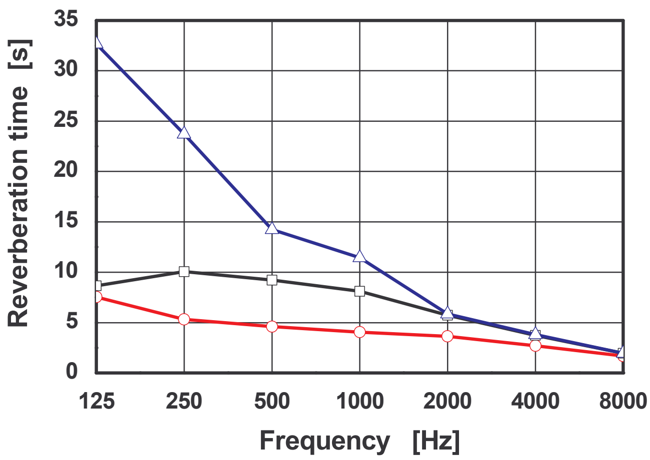

Figure 4: Reverberation times □ and decay times △ before and after ○ the installation of the foil absorbers according to Fig. 3 [5].

The covering of the facade with conventional non-tansparent sound-absorbing materials was unacceptable from an architectural point of view as well as regarding the historical monument protection. Instead, approx. 710 m² as transparent sail of double-layered micro-perforated foils was installed (Figure 3). The sail, which is freely suspended under the roof, is carried by a steel wire net. The corners of the approx. 1.15 x 1.15 m large foils are clamped in the junctions of the net construction. Spacer pieces hold the two foil layers at a distance of 15 cm. The convex curved sail surface has a maximum distance to the glass roof of approx. 7 m. At the edge it still amounts to 4 m.

The reverberation time could be considerably reduced with this comparatively simple measure (Figure 4). Also the echo formation under the calotte of the roof was effectively reduced. The measure, which is still classified by the operators as an interim solution, enables them to accomplish the planned events, even for representative television transmissions. Measurements of such constructions in a reverberation chamber are hardly possible due to the large sizes. Nevertheless the absorption coefficient of the sail in this situation can be judged from the reverberation times before and after this installation (Figure 5).

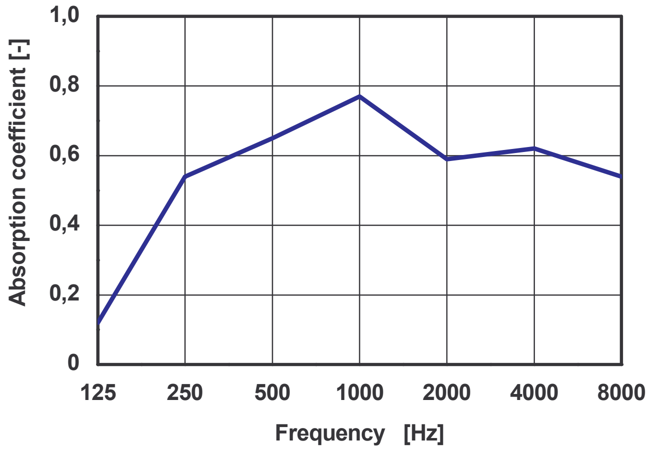

Figure 5: Absorption coefficient of the acoustic sail in the "Schlüterhof" according to Fig. 3.

Summary

Micro-perforated foils are proven as tuneable sound absorbers for a fulfil frequency range. Transparent foils, which measure up to various structural requirements, allow freely suspended and three dimensionally curved structures. Rooms, which have a sufficient height, can thus be treated, without serious structural interferences. Apart from reconstruction cases these solutions are particularly suited for temporary installation. In exhibition halls or sport or leisure buildings for example the noise level can be reduced and the intelligibility of loudspeaker announcements can be increased. If micro-perforated sails, wall or ceiling linings are combined with special resonance absorbers for the low frequency range the requirements for communication use such as classrooms, open plan offices and conference rooms can be met [4].

References

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