Comparison of objective acoustic criteria and subjective impressions in modern offices

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ABSTRACT

The modern office consists of different working areas - open space, separate rooms, conference rooms and event zones, small meeting rooms and «telephone booths». Features of the team and individual work, especially in creative industries, require maximum involvement in the process, and therefore a minimum number of distractions. This leads to increased requirements for soundproofing, reducing background noise and increasing speech intelligibility in meeting rooms. Acoustic requirements for the small meeting rooms with an area of fewer than 10 m2 are especially interesting in the context of their use for teleconferences. The subjective experience in operating such rooms shows that even if they comply with the recommended existing standards for acoustics, the real quality may be unsatisfactory. Also, we could see different types of partitions in offices - solid, glass, combined, which converge at one point. In this case, it is extremely important to ensure a correct connection to avoid flanking transmission of noise. In this report, we look at some successful and unsuccessful office solutions, analyze results of acoustic measurements compared to operating experience.

INTRODUCTION

In this review we will focus on office premises, which are subject to the most stringent acoustic requirements. Usually these are the meeting rooms or management single rooms. Beyond the usual large conference rooms, very often these facilities are characterized by a small area of 2 m^2 to 10 m^2, designed to a few people meeting or online meetings.

In this paper we look at the features of subjective acoustic experience and how they relate to the sound insulation performance of structures and reverberation time.

In the practice of acoustic consultants, we are used to focusing on generally accepted regulations - national standards, specialized standards - for example LEED, DGNB. Examples of sound insulation requirements for meeting room`s walls are shown in the table below. Which of them are the most optimal and which features are inherent in small rooms, we will consider further.

Table 1. Requirements for meeting rooms wall in different standards

Regulations	Requirements [dB]
DBN V.1.1-31.2013 (Ukrainian national standard. General requirements for sound insulation)	$R`_w$ >52
DBN V.2.2-14-2004 (Ukrainian national standard. Rooms for working with confidential information)	$R`_w$ >60
BS 8233:2014, typical meeting room	$D_w > 48$
BS 8233:2014, highest requirements	$D_w > 57$
LEED	STC>50

Practical case 1

In the office, which plan is shown on Figure 1, there are facilities such as open-space and two meeting rooms. The measured sound insulation of partitions between rooms A and B is $\boldsymbol{R`_w = 41}$ **dB**, between rooms B and C - $\boldsymbol{R`_w = 34}$ **dB**. Of course, this amount of sound insulation does not correspond to a comfortable level. But let's check subjective value of the problem in operating conditions.

let's conduct an experiment, where the sound source (portable speaker) placed on both sides of the meeting room B. The test signal was a recording of a male voice - a 30-second fragment of an interview. The noise level near the source corresponded to a typical conversation level - 60-62 dBA. Further, the level of penetrating noise into the meeting room B was measured. Also, it should be noted that all rooms were covered with a large amount of sound-absorbing materials and the reverberation time was very low there. The measured sound pressure level shown on Fig. 2.

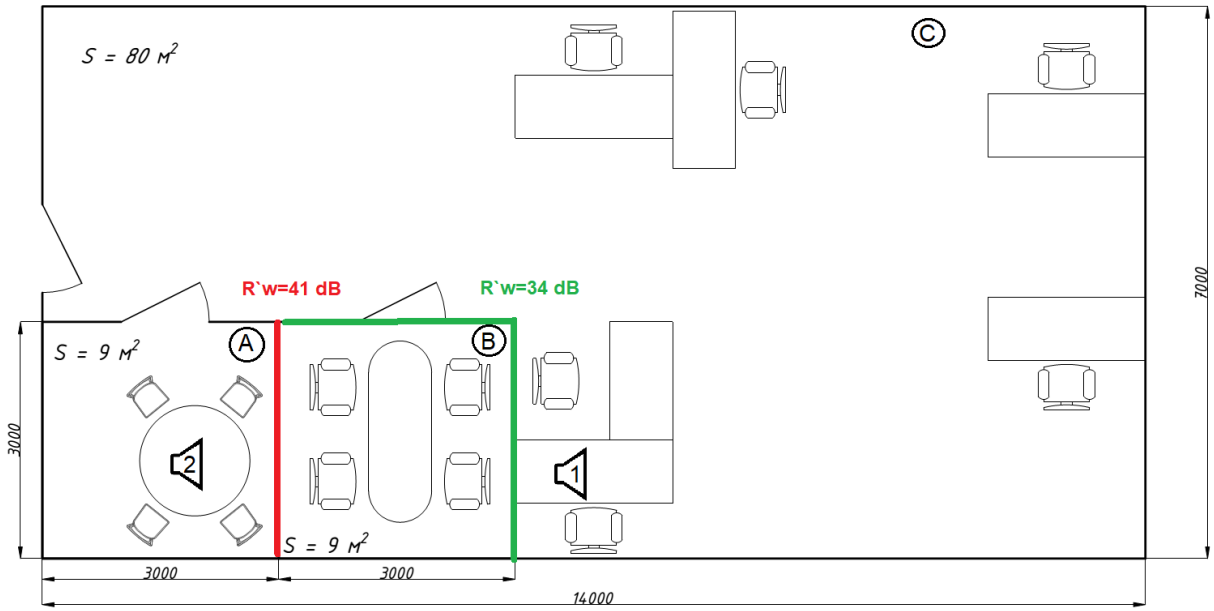

Figure 1. "Office A" plan

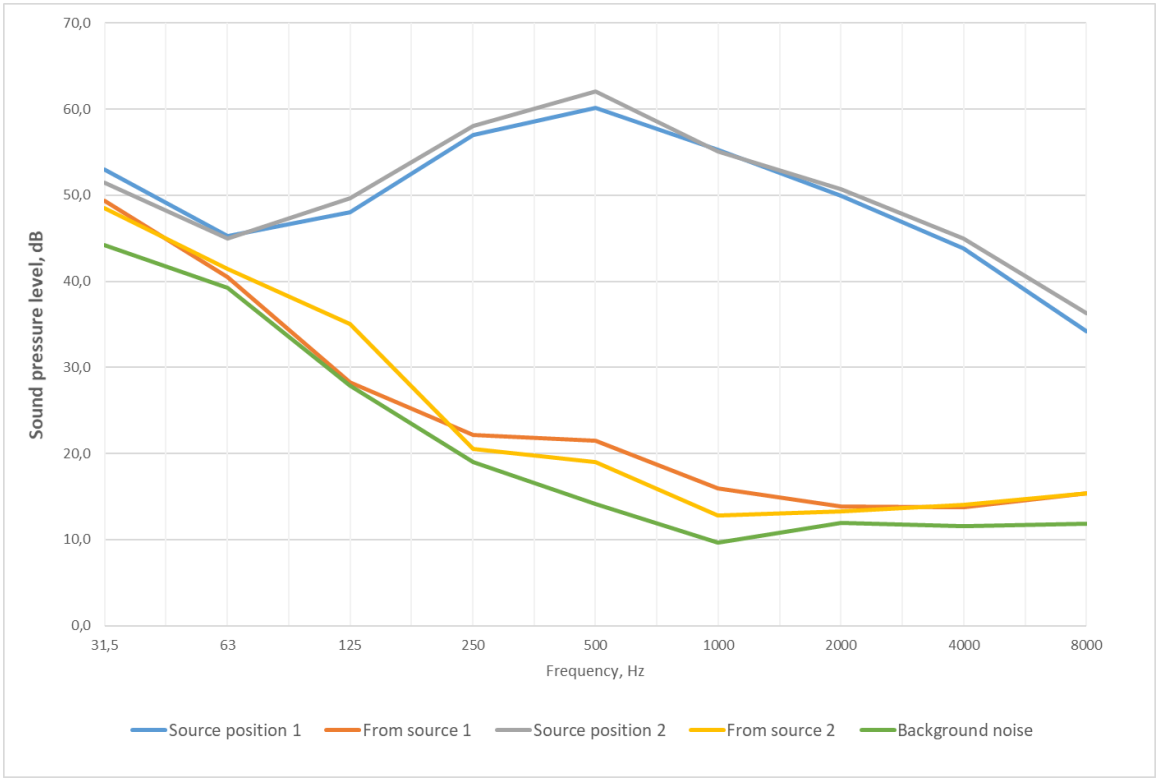

Figure 2. SPL in different zones

The main feature of the results can be considered that the difference in the sound insulation of the partitions is 7 dB, but the difference in the levels of noise inside room B is scanty for LAeq and in the frequency bands are less than 3 dB. Subjectively, penetrating noise from different sides was also perceived in the same way. With a very low background noise and low reverberation time in room B (T30 < 0.22 sec), even these low levels of penetrating noise were a significant distraction factor.

According to this, we can provide the following hypothesis: the sound insulation index of partitions with low insulation does not reflect the subjectively perceptible efficiency of noise reduction by such partitions. Also, the results obtained confirm that with the same noise level of sources, the actual level of penetrating noise will be higher for the case of a direct neighborhood of small rooms than for the case of a neighborhood of large and small.

Practical case 2

Consider another case with extremely small rooms - 3 m2. Their purpose is online meetings or solitary work. The plan is shown in Fig. 3. Measured sound insulation between these rooms is $\boldsymbol{R`_w = 46}$ **dB**, which is already closer to the recommended values. However, in fact, the speech from one room to another was clearly audible and intelligible. Compared to office A, the audibility was significantly more annoying despite the higher sound isolation. It should be noted that these rooms had practically no acoustical finishing. Reverberation time inside rooms are shown in Table 2.

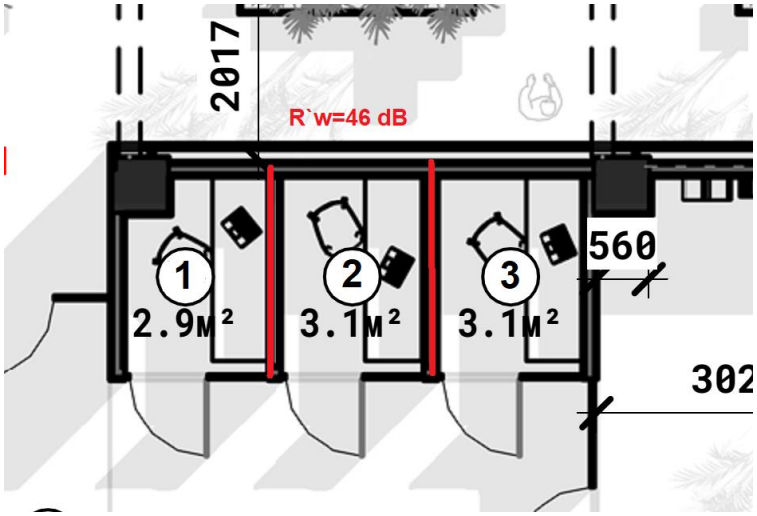

Figure 3. "Office B" plan

One of the important differences between the rooms in these offices is the different reverberation time, which affect on sound level inside. Figure 4 shows the sound pressure levels of the test speech signal at the same source level for room A (LAeq = 62 dBA) and room 2 (LAeq = 68 dBA).

Table 2. Requirements for meeting rooms wall in different standards

Frequency band, Hz	**125**	**250**	**500**	**1000**	**2000**	**4000**
T30 in room B, office A, sec	0,27	0,23	0,25	0,21	0,17	0,17
T30 in room A, office A, sec	0,33	0,29	0,31	0,27	0,27	0,24
T30 in room 2, office B, sec	0,69	0,89	0, 93	0,81	0,77	0,72

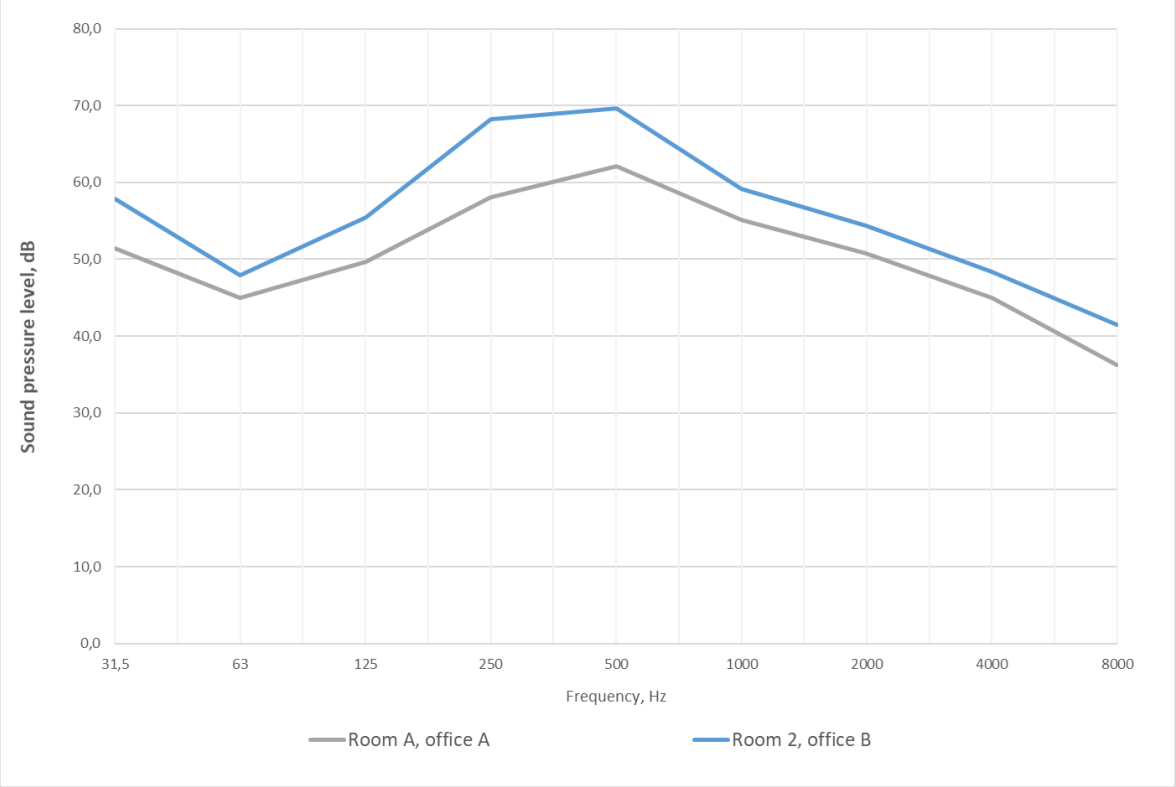

Figure 3. Difference of SPL from the same source in rooms with a different reverberation time

SUMMARY

The described practical cases show several important dependencies. For a very small rooms, even if sound insulation close to the recommended, audibility will be significantly higher than the comfortable level and in such rooms it is especially important to achieve high sound insulation and the presence of sound-absorbing finishes.

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[5] LEED. Acoustic Performance