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DEMAINS OF INTELLIGIBILITY OF ROOMS WITH OPEN WINDOWS EXPOSED TO EXTERNAL NOISE SOUND SOURCES

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INTRODUCTION

The masking effect of background noise may cause a great nuisance to people listening at home to a meaningful source of acoustic information. For that reason, regulations restrict the environmental noise in the vicinity of residential areas to an accepted level. Yet, in spite of the restrictions there could be disturbances which may lead to a temporary weakness of communication. Hence, existing additional means for noise reduction include application of:

1. windows of high acoustic quality
2. sound barriers
3. absorption surface areas in the receiving room
4. shadowing around the window
5. keeping the window location on walls directed to the quiet side of the building
6. geometrical design of the room.

Another possibility of improving the acoustic quality of a room, is obtained by a better orientation of the source and the listener in the room. The increase in intelligibity of a wanted sound in this context may be achieved by means that change the ratio of sound to noise, as follows:

1. Increasing the acoustic power of the source
2. Improving the locations of source and listener as related to the noise source
3. Decreasing the size of the window.

This basic idea of internal acoustic design of a room near an environmental noise source is fully illustrated here. however, the design may be modified by additional parameters, such as a combination of windows and examination of other characteristic sources such as transportation noise.

The contribution of this paper is by examining the improvement using sound level mappings within the room, instead of overall estimation of the noise by one number. A most important factor is the loudness of the background noise and the sound which one wants to listen to. However, the present investigation is limited to differences in dBA.

Obviously, a more precise analysis necessitates subjective measures. Using a rough approximation, a difference of 10 dB between the listened sound and the background noise yields an articulation index of 33% . The sound level mapping may indicate, for example, where in the room this condition is met.

FORMULATION

The model consists of a rectangular room, with any number of windows in the walls. The model includes any number fo external noise sources and internal point source of sound in the room. Following [1] and figure 1 the sound level caused at the control point P within the room by the external and internal sources is respectively:

$$L_{p_{ex}} = 10Lg_{10} \left\{ \frac{I_0}{P_0} \sum_{k=1}^{N} \sum_{j=1}^{M} \left[S_{kj\perp} \tau_{kj} 10^{0.1L_{wk}} \frac{F_{0kj} Q_{\theta kj}}{4\pi R^2_{kj}} \left(\frac{\hat{Q}_{\theta kj}}{4\pi R^2_j} + \frac{4}{R_c} \right) \right] \right\}$$

and

$$L_{p_{in}} = 10Lg_{10} \left\{ \frac{I_0}{P_0} \left[10^{0.1L_{win}} \left(\frac{\hat{Q}_\theta}{4\pi R^2} + \frac{4}{R_c} \right) \right] \right\}$$

The difference between the levels is:

$$\Delta L_p = L_{p_{in}} - L_{p_{ex}}$$

CASE STUDIES

An example of a case is given in figure 2. The data are:
The surface area of the room: S = 2(4*6+6*9+9*4)=228 sq.m
The absorption coefficient: 0.1
The area of the window: 1.0 sq.m
The acoustic power of the external source: 110 dB
The distance of the external source from the window: 30 m
The power of the internal source: 75 dB
The location of the internal source is 1.5 m above floor.

The result is presented in figure 2. It may be observed that only a part of the room satisfies A.I. of 33%. Increasing absorption (to 0.3 in figure 3) will not improve very much since it will weaken also the effect of the wanted sound. The most efficient way in this case will be to increase the acoustic power of the internal source and decrease the area of the window - see figure 4.

References:
1. G. Rosenhouse, The acoustic performance of a unshielded opened window of a room exposed to traffic noise, Acoustic Letters, 7, 8, 1984, 122-125

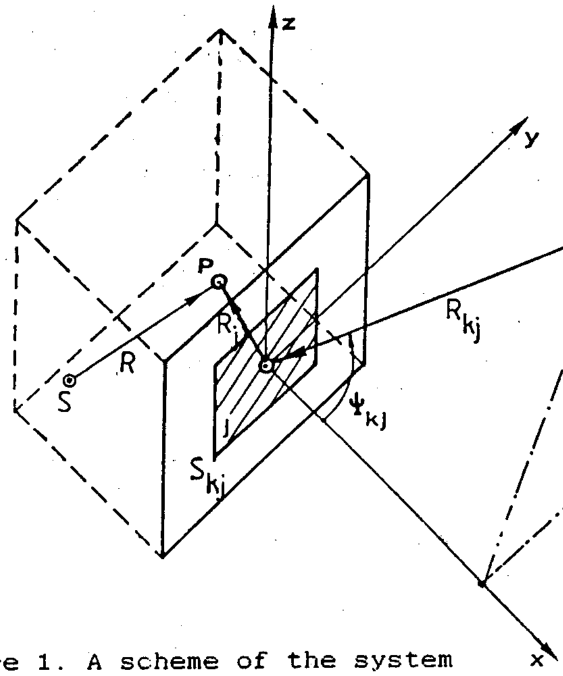

Figure 1. A scheme of the system

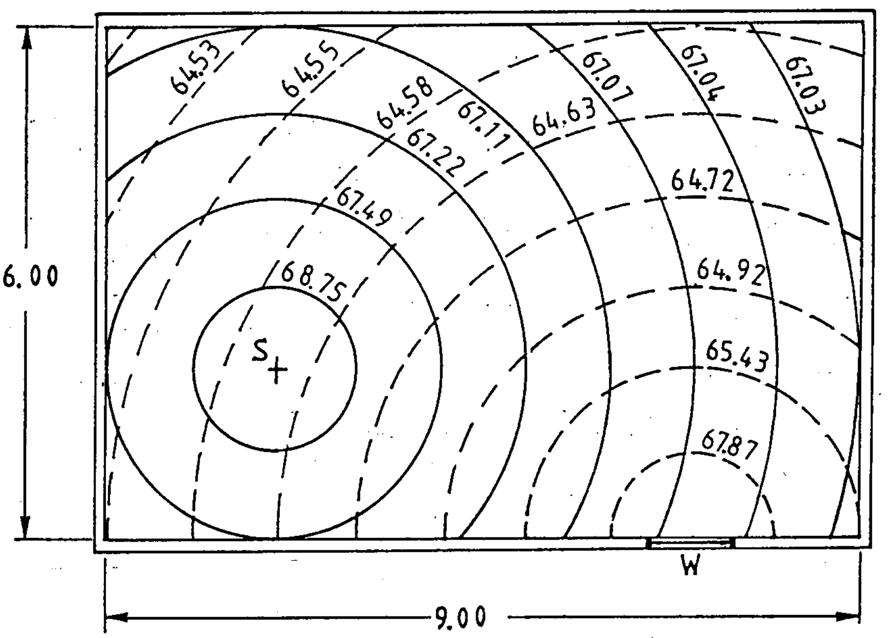

Figure 2. Sound fields of the external and internal fields

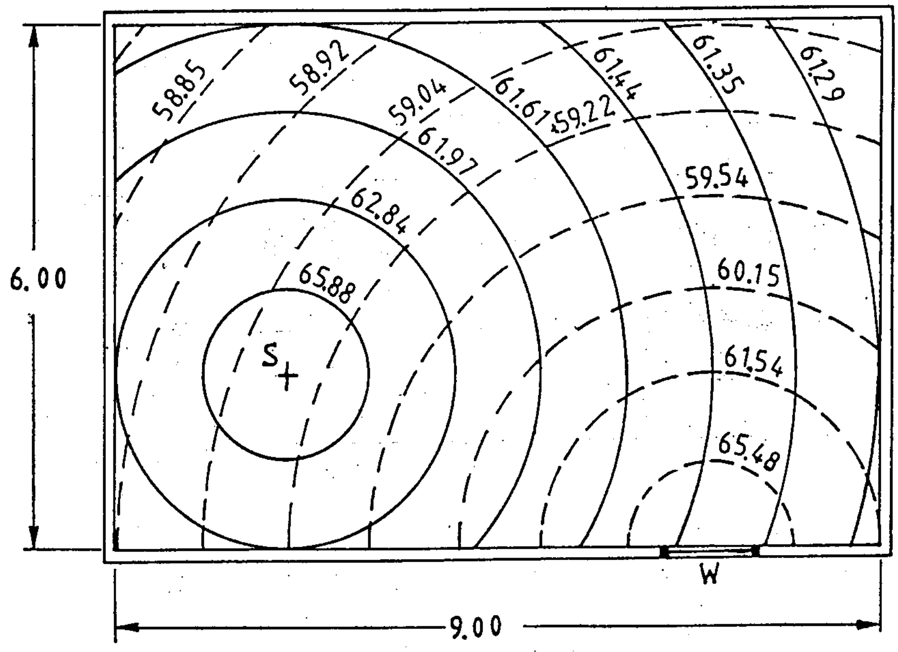

Figure 3. Sound fields with increased absorption

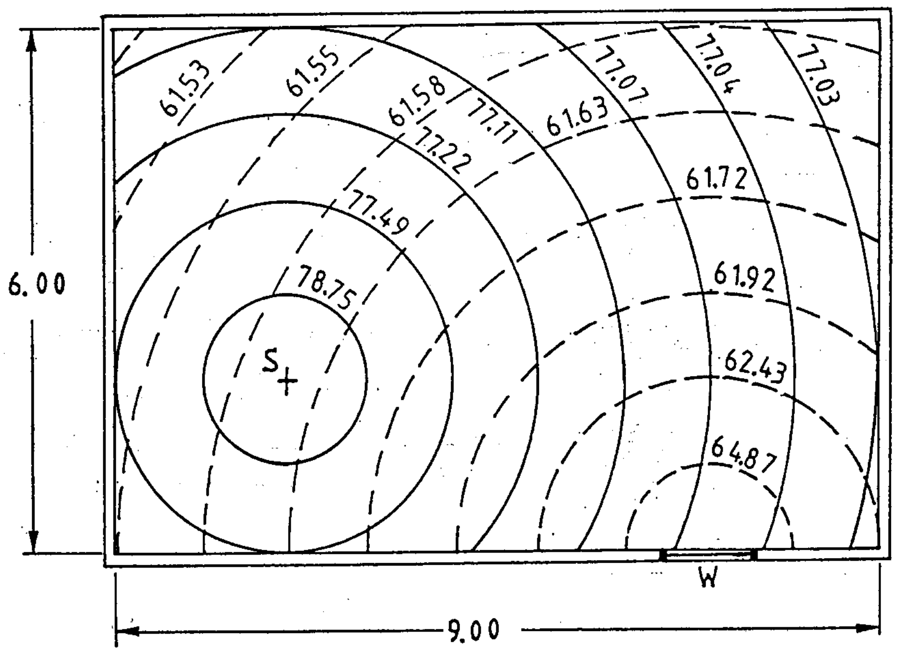

Figure 4. Sound fields with increased internal source power and decreased window size.