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INCE: 25

NON-UNICITY OF THE SPATIAL SOUND DECAY CURVE IN WORKSHOPS

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1 INTRODUCTION

The acoustic behaviour of a workshop is described by the spatial sound decay curves recorded in the hall. This curve can be modeled for the first 30 m by a straight line as a function of the logarithm of distance. It depends on the absorption of walls, the dimensions of the hall, and the fitting [1]. This paper underlines the influence on this spatial decay curve of the location of the measurement path in halls with a multiple-pitched roof and of the reference sound source in halls having been subjected to an acoustic treatment.

2 INFLUENCE OF THE CEILING SHAPE

Simulations have been performed using ray-tracing[2] to explain the non-unicity of spatial decay curves observed in halls with a pitched roof[3].
Configurations studied: Two halls of the same dimensions have been studied: a flat hall (80m, 80m, 8m) and a hall with a multiple pitched roof, (height between 7m and 9m). They are empty and semi-reverberant. Decay curves were calculated according to x and y. In the flat hall, the source is located on the ground, in the center of the hall; in the other one, it is located under a upper hip of the roof (fig 1.1), under the middle of a slope (fig 1.2) and under a lower hip of the roof(fig 1.3).
Results obtained: In the hall with pitched roof, the spatial decay curve (figure 2) depends on the location of the source and on the direction according to which the curve is recorded. The slope per doubling distance varies from 2.5 dB to 4.1 dB whereas for the flat hall, it is 3.2 dB.
Discussion: In the flat hall, the order 1 virtual source spreads at all receiver points. In the hall with the pitched roof, the impact of each virtual source(one for each pitch) depends on the source location(fig 2). Thus, for

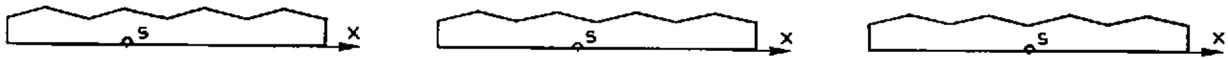


Figure 1: Hall with multiple pitched roof. Location of the reference sound source :
-1- under a upper hip of the roof -2- under a middle of a slope -3- under a lower hip of the roof

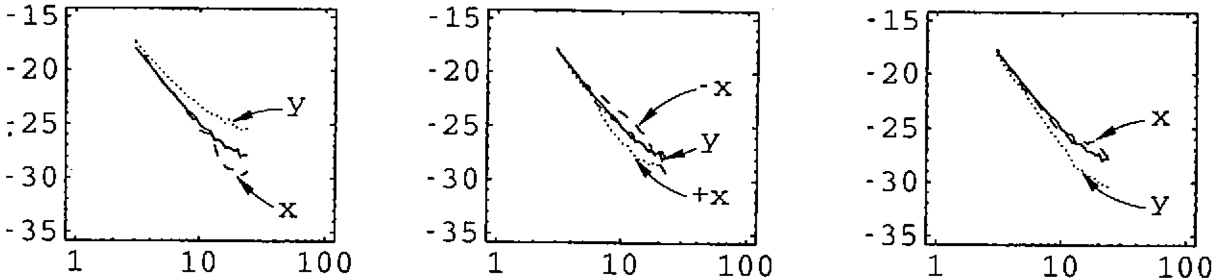


Figure 2: Spatial decay curves calculated according to x and y for 3 source locations(fig 1). Comparison with the flat hall (—)

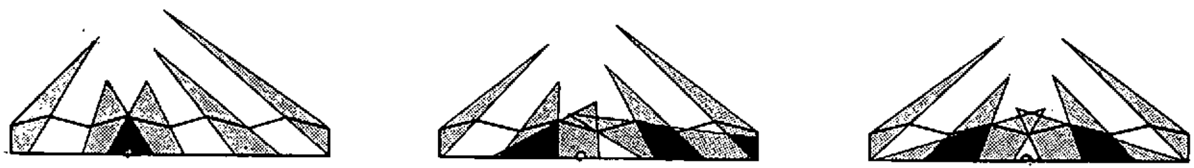


Figure 3: Illustration of the impact zone of the first order virtual sources for 3 source locations illustrated in figure 1.

a given source location, the number N of order 1 virtual sources seen from a given point vary from 0 to 2 as illustrated on fig 3.

Considering all receiver points, four cases can then be considered: **-1**-N=0 for all points.(source location 3, curve according to y). The curve slope is high: dl=4.1dB. **-2-** N=1 for all points.(source location 2, curve according to y). It can be compared to the case of the flat hall: dl=3.4dB. **-3-**:N=2 for all points.(source location 1, curve according to y). The curve slope is low: dl=2.5dB. **-4-** N is not the same for all points: this applies to all curves recorded according to x. All these curves are situated between the two extreme curves according to case N=0 and N=2.

Thus, the path measurement of the spatial decay curve located under the middle of the pitch (N=1 for all points) is the only one which can be used to characterise the average behaviour of such a hall.

3 INFLUENCE OF THE SOUND SOURCE USED

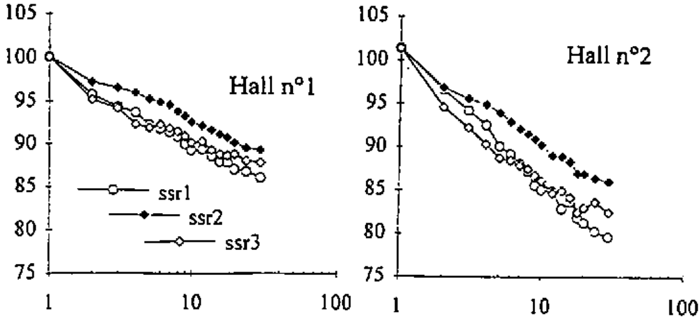
The spatial sound decay curves depend on the sound source used. Experimental results presented concern 2 empty halls and 3 sources. They are representative of results obtained in 6 halls with 6 sources.

Configuration studied: The first hall (138m, 36m, mean height: 8m) is reverberant. The second hall (60m, 20m, 7m) is flat, the ceiling is recovered with an absorbing material (α(Sab)= 0.95 ; 250 to 4000 Hz). The sound sources used are: SSR1 (hemispheric, on the floor, mechanical excitation), SSR2 (hemispheric, on the floor, loudspeakers), SSR3 (tetrahedric, height 1.2m, loudspeakers). One source location has been defined for each hall. The height of the receivers was 1.20m.

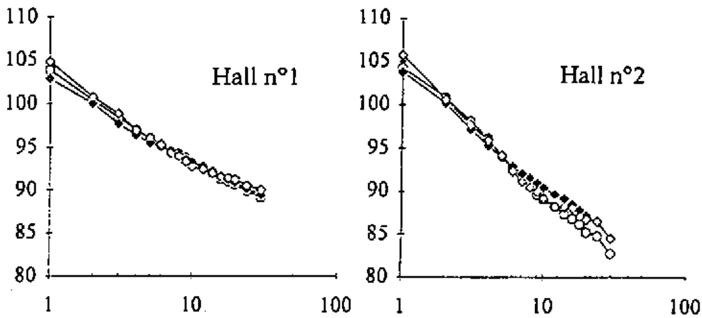
Results obtained: All spatial decay curves are given on Figures 4 and 5 for the 1000Hz octave band and on figures 6 and 7 for the band (250-4000Hz), (A-weighted pink noise, acoustical power corrected at 114 dB(A) for comparison). Taking SSR2 as the reference, figures 8 and 9 give the ratio between the slopes per doubling distance (3m-24m) of SSR1 and SSR3, and the slope of SSR2 for each octave and for the band (250-4000Hz). The results show that the SSR plays an important role especially in the case of the hall having been subjected to an acoustic treatment.

Discussion: Even though the sources SSR1 and SSR2 fulfill the directivity requirements of ISO 6926, they are not omnidirectionnal. Directivity of SSR1, focused upwards, intensifies the efficiency of the ceiling treatment: the slope per doubling distance is 4.4 dB for SSR1 against 3.4 dB for SSR2. SSR3 is a directive source in vertical and horizontal plans.

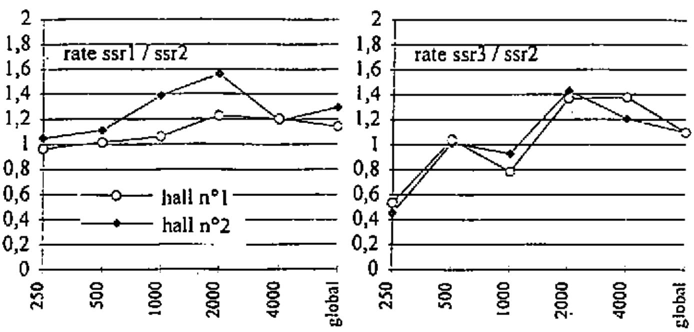
Given the cost of an acoustical treatment, the measurement uncertainties have to be minimized. A same source should be used in fixed conditions, to control a given hall before and after acoustical treatment. The excess of sound pressure level with respect to the free field, apparently less sensitive than the slope to the type of source, seems to be interesting to qualify industrial halls.



Figures 4 and 5 : decay curves at 1000 Hz



Figures 6 and 7 : decay curves on the band [250-4000Hz]



Figures 8 and 9 : comparisons of slopes per doubling distance

References:

[1] A.M.Ondet, J.Sueur; J.A.S.A, Vol 97,N 3, 1995, pp 1727-1731
[2] A.M.Ondet, J.L.Barbry, JASA, Vol 85,N 2, 1989, pp 787-796
[3] M.Hodgson, Applied Acoustics, Vol 16, 1983, pp 369 - 391