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INFLUENCE OF SAMPEL SIZE BY SOUND ABSORPTION COEFFICIENT DETERMINATION

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ABSTRACT: *Sound-absorbing materials are utilized in almost all areas of noise control engineering. The designers of sound absorbers must know how to choose the proper sound absorbing materials, their geometry and the protective facing. The well-known Kundt's tube and reverberant room method are often used for measurement of acoustic absorption properties of samples under laboratory conditions [1]. In this paper the measurement of sound absorption coefficient is investigated under free-field conditions. Particularly is investigated how the sample size is influencing the measurements results.*
KEYWORDS: *measurement, sound absorption coefficient, sample size*

INTRODUCTION

The Microflown in-situ technique to determine absorption makes use of a Microflown particle velocity sensor and a sound pressure microphone. Both sensors are mounted in the PU-mini probe that is positioned close to the material with a sound source positioned at a certain distance (fig. 1). The sound pressure and acoustic particle velocity are measured right at the surface of the material. The impedance can be derived from the ratio of sound pressure and particle velocity. From this, the material absorption can be calculated. The usable bandwidth for the method is 300 Hz – 10 kHz. The method makes possible to measure under different angles, measuring with a high spatial resolution of just few millimetres, measure all type of materials and material sizes. There is also no need to take samples and measurement can be performed when the materials are installed. [3]

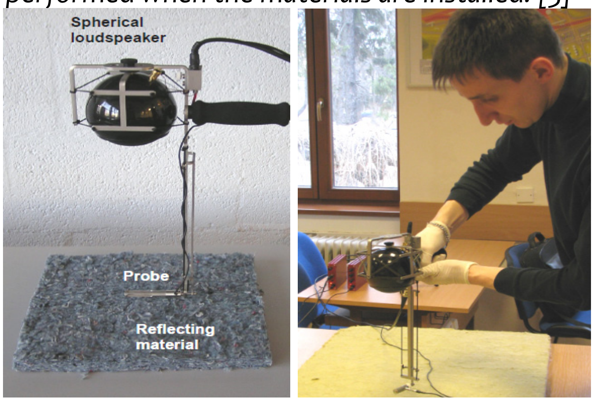
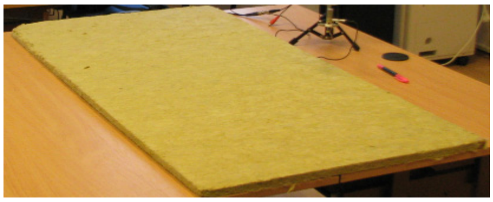


Figure 1 . In – situ absorption set up

THE MEASUREMENT SET UP

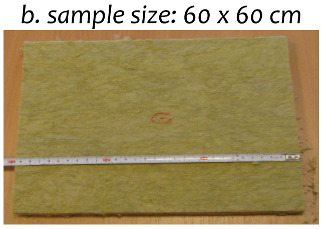
For this experiment the chosen material is Isover 20 mm and one source-sample distances 32cm is used. To check the influence of the sample size several measurements were done (see fig. 2):

a) a large sample of 120 cm x 60 cm was measured as reference,
b) a 60 cm x 60 cm sample that was cut free,
c) a smaller (30 cm x 30 cm) sample that was cut free,
d) a small (15 cm x 15 cm) sample that was cut free,
e) a very small (5 cm x 5cm) sample also cut free.

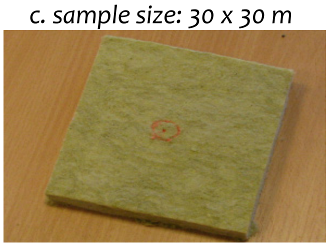


a. reference sample: 120 x 60 cm

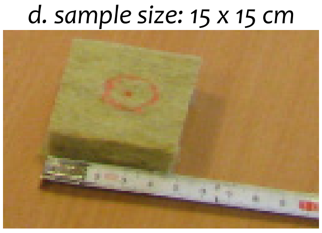
b. sample size: 60 x 60 cm



c. sample size: 30 x 30 m



d. sample size: 15 x 15 cm



e. sample size: 5 x 5 cm

Figure 2. Sample size reductions

The measurements were taken from the same measurement point, which was marked on the sample. The sample was cut gradually from the sides. 10 measurements were performed by each sample size to examine reproducibility and avoid measurement errors. During the measurement the probe was positioned close to the sample. The distance between the PU- probe and the samples was 1 cm.

The measurement settings were the followings:

- Measurement time: 4 s.
- Hardware correction: correction off.
- High gain mode.
- Auto input gain control: on.
- Auto accept overload: off.

Before series of measurements DAQ calibration and calibration measurement were performed.

RESULTS AND DISCUSSION

The averages of sound absorption coefficients are presented by different sample size in in table 1 and graphically in figure 3. It can be concluded that the sample size is influencing the measurement. However it is also probable that the acoustic properties of the sample change and that the free field measurement is valid.

Table 1. Sound absorption coefficients by different sample size

Frequency f [Hz]	Sound absorption coefficient α[-]		
	120 x 60 cm	60 x 60 cm	30 x 30 cm
315	0,117723	-0,03195	-0,03247
400	0,144759	0,112756	0,08874
500	0,024065	0,054997	0,068153
630	0,22405	0,06067	0,078704
800	0,375166	0,292892	0,264559
1000	0,562896	0,577697	0,514574
1250	0,691063	0,70503	0,722936
1600	0,822076	0,815248	0,783357
2000	0,902187	0,899406	0,91274
2500	0,94686	0,941704	0,94196
3150	0,960568	0,95868	0,952055
4000	0,957848	0,95039	0,95379
5000	0,945939	0,942558	0,942214
6300	0,967605	0,966594	0,970186
8000	0,969724	0,97517	0,977244
10000	0,985057	0,990921	0,99086

Table 1. Sound absorption coefficients by different sample size

Frequency f [Hz]	Sound absorption coefficient α[-]	
	15 x 15 cm	5 x 5 cm
315	-0,03757	-0,00229
400	0,125516	0,061591
500	0,173694	0,144521
630	0,117648	0,209189
800	0,191895	0,124725
1000	0,408619	0,145791
1250	0,754156	0,199998
1600	0,836338	0,450901
2000	0,941601	0,510511
2500	0,922658	0,855966
3150	0,910011	0,937345
4000	0,958389	0,889431
5000	0,96476	0,600605
6300	0,958452	0,620444
8000	0,978393	0,934721
10000	0,989822	0,99927

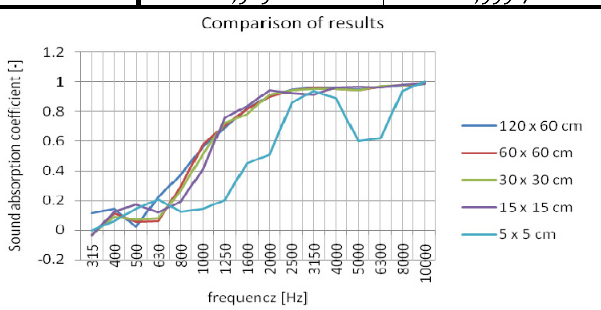


Figure 3. Comparison of measurement results

CONCLUSIONS

The method shows to be sensitive for sample size and especially at lower frequencies the results have a higher error. In general the reason for these errors can be found in:

- Wrong measurement distance: If the probe sample distance is underestimated the measurements results resemble better the tube results.
- Wrong source behavior: The real loudspeaker does have a behavior that only resembles a monopole. Increasing the source-probe distance must improve the measurement if the deviation in behavior at close distances is the cause of the inaccuracy. [3]
- Wrong calibration: Errors in the calibration can be expected at lower frequencies.
- Properties of the acoustic sample: A negative absorption can be a local effect.

Sample size: If the sample is too small edge effects take place. The properties of the acoustic sample can be the reason for the measurement error.

Acknowledgement

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