Measurements of Room Acoustic Parameters in Auditoriums by Simulating the Audience by Molton Cloth

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Introduction

Several measurements of room acoustic parameters have been published in the past, where concert halls with and without audiences have been measured. Hidaka et al. [1] and Lorenz/Breuer [2] additionally have used a special japanese cloth covering the seats for simulating the characteristic absorption of sound by a "real" audience.

In this paper results of similar measurements using a cloth named Molton are published. This cloth is often used in theatre and stage design, it is very easy to get and reasonably priced. Room acoustic measurements were made in two auditoriums, a music rehearsal room and a reverberation chamber. Results of the occupied, the unoccupied and the "audience simulated" state were compared.

Methods

As described in [1] and [2] the method used was laying a cloth over the entire seating area. [1] and [2] use a japanese polyester textile (type ka 0149-0172). We use a cotton textile called Molton, which has similar characteristics. The weight of molton is 300 g/m2. It consists of 100 % cotton, has a thickness of about 0.5 mm and is flameretardent. Available widths are 2 and 3 m, available length up to 60 m. As molton is often used for theatre and stage design many colors are available and it is very reasonable priced.

For the acoustical measurements according to EN ISO 3382:2000 and EN ISO 354:2003 WinMLS 2000 was used. This software uses a MLS signal for measuring and calculating the room impulse response and several room acoustic parameters. An external sound card (M-Audio FW 410) connected with a notebook, omnidirectional microphones (AKG SE 300B with CK-92) and a dodecahedral loudspeaker (Norsonic 270H with preamplifier) and were used. For further comparison of methods one of the rooms was additionally measured by using the Larson&Davis Analyzer 2900 (excitation signal: pink noise). In each room two different positions for the sound source and several positions for the microphones were used. The number of positions were dependend on the room size.

Measurements were done in four different rooms in Austria: the rehearsal room of the Trachtenmusikkapelle in Schäffern, an auditorium (Hörsaal XII) and the Aula of Technical University Graz, and the reverberation chamber of the Allgemeine Unfallversicherungsanstalt (AUVA) in Vienna. Table 1 shows some parameters of these rooms (volume, number of persons during measurements for the occupied state, and reverberation time RT30 at 1 kHz for the unoccupied and the occupied state).

	Volume (m^3)	Persons	$RT30_{unocc.}$ (1 kHz)	$RT30_{occ.}$ (1 kHz)
Rehearsal room	700	39	0.65	0.56
Auditorium	350	45	1.60	0.88
Aula	1690	68	2.80	1.66
Reverberation chamber	183	16	5.64	1.86

Table 1: Parameters of the measured rooms

Figure 1 to 4 show these rooms unoccipied, with Molton and occupied.

Figure 1: Rehearsal room of the Trachtenmusikkapelle in Schäffern: unoccupied, with Molton and occupied.

Figure 2: Auditorium (Hörsaal XII) of the Technical University Graz: unoccupied, with Molton and occupied.

Figure 3: Aula of the Technical University Graz: with Molton and occupied.

Figure 4: Reverberation chamber of the Allgemeine Unfallversicherungsanstalt (AUVA) in Vienna: unoccupied, with Molton and occupied.

Results

For the first measured room (rehearsal room Schäffern) the MLS method was compared with measurements of the Larson&Davis 2900 real time analyzer. It appeared that the results were almost identically. For the following rooms only the MLS method was used. Figure 5 to 8 show the reverberation time T30 for the unoccupied (—) and the occupied state (.....) as well as the measurement with Molton (- - -). For RT30 of all rooms you can see that the measurements with Molton and with the occupied state are very similar, but RT30 of the unoccupied state of these rooms differs considerably. Similar results were obtained for other room acoustic parameters, as you can see in tab. 2.

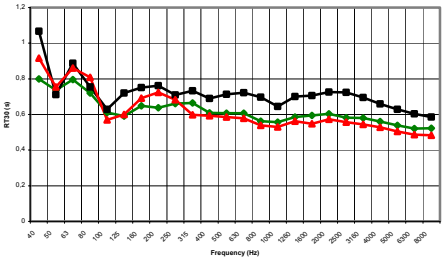

Figure 5: RT30 of the rehearsal room of the Trachten-musikkapelle in Schäffern: unoccupied (—■—), with Molton (- ▲- -) and occupied (..◆...)

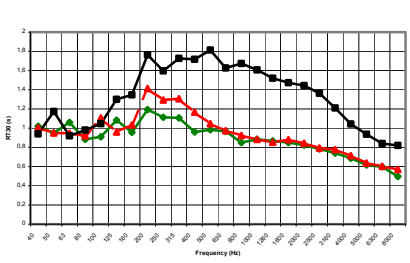

Figure 6: RT30 of the auditorium (Hörsaal XII) of the Technical University Graz: unoccupied (—■—), with Molton (- ▲- -) and occupied (..◆...).

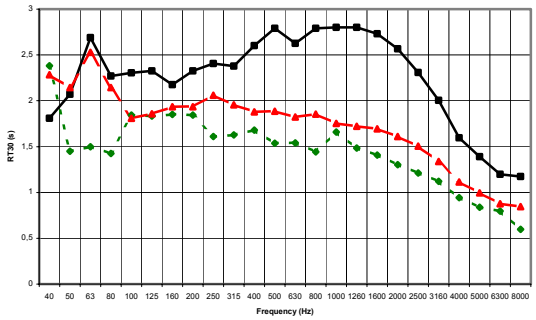

Figure 7: RT30 of the Aula of the Technical University Graz: unoccupied (—■—), with Molton (- ▲- -) and occupied (..◆...).

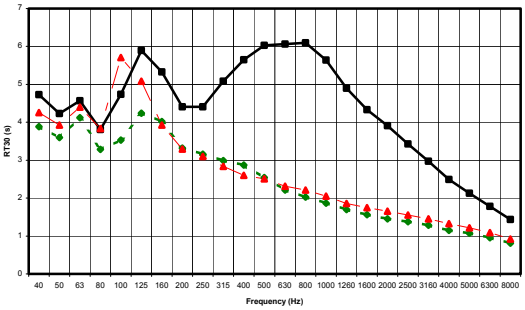

Figure 8: RT30 of the reverberation chamber of the Allgemeine Unfallversicherungsanstalt (AUVA) in Vienna: unoccupied (—■—), with Molton (- ▲- -) and occupied (..◆...).

Room	State	C50/dB (1kHz)	D50/% (1kHz)	EDT/s (1kHz)	TC/ms (1kHz)	STI	T30/s (1kHz)
Rehearsal room	unoccupied	4,0	71,5	0,69	40,1	0,70	0,69
	Molton	5,8	78,7	0,54	32,7	0,73	0,55
	occupied	4,1	71,4	0,60	39,2	0,72	0,57
Aula	unoccupied	-3,2	33,6	2,74	172	0,47	2,78
	Molton	-1,0	44,9	1,76	105	0,53	1,77
	occupied	-1,3	43,2	1,61	100	0,55	1,62
Auditorium	unoccupied	-0,7	46,0	1,55	99,2	0,56	1,59
	Molton	2,9	66,3	0,82	50,2	0,66	0,84
	occupied	2,2	62,8	0,87	53,3	0,67	0,82

Table 2: Room acoustic parameters of the measured rooms unoccupied, with Molton and occupied.

Conclusion

Measurements in four rooms were made using Molton covering the seats to simulate the audience. It is shown that using this molton textile is a very practical and validate method for simulating the occupied state in a hall without the need of live audience during the measurements.

Many thanks to Allgemeine Unfallversicherungsanstalt (AUVA) for letting us use their reverberation chamber.

References

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