Experimental investigations on the sound transmission of drywall constructions at low frequencies

R. Völtl[1,2], T.Franzen[2], U.Schanda[2],

[1] *PMI GmbH Unterhaching, Germany, Email: raphaelvoeltl@gmx.de*

[2] *University of applied sciences Rosenheim, Germany ,Email: franzen.thomas@gmx.de; schanda@fh-rosenheim.de*

Introduction

In the course of two diploma theses at the University of applied sciences in Rosenheim the sound transmission of drywalls was examined by measurements of sound intensity. The main focus was particularly on the investigation in the range below 100 Hz. The measurements were carried out in a laboratory according to DIN EN ISO 140, but with the modification of a highly damped receiving room. First of all, a scanning as well as a point wise mapping of the sound intensity levels in the near field of the wall by excitation with airborne sound was carried out. Comparative measurements, intended to check our measurement technique and carried out in a certified laboratory, had proven, that the measurement of the intensity sound reduction index according to ISO 15186 gives highly similar results compared to a measurement of the sound attenuation index according to DIN ISO EN 140. The measurements were accomplished first at a drywall with one gypsum board on every side and metal stands with so called MW-profile.

Furthermore measurements, mapping the velocity levels on the surface in the receiving room using acceleration sensors had been carried out. It turned out, that the mappings from the velocity measurements as well of the sound intensity measurements coincide very much (s. fig. 1 and fig.2). Both measurement techniques show the vibration behavior of the drywall.

Mappings of sound intensity and sound velocity levels

In the course of the investigations of the low frequency vibrations of the receiving side drywall plate additional mappings were made by an excitation of the wall with a shaker on the other side of the wall. In contrast to our expectations, the vibration behavior turned out to be completely different.

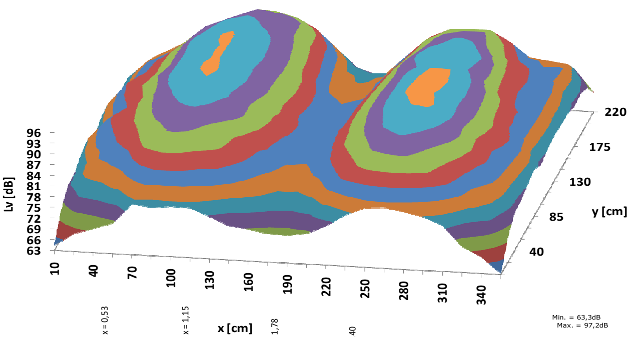

Figure 1: mappings of the sound velocity levels caused by airborne sound excitation, frequency 25 Hz

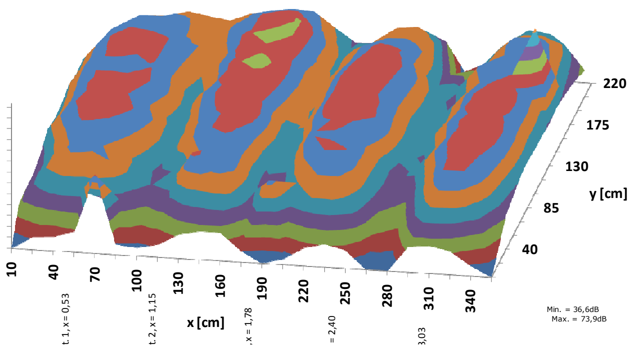

Figure 2: mappings of the sound velocity levels caused by excitation with a shaker, frequency 25 Hz

Assuming that the difference is due to the kind of excitation, pointlike in the case of a shaker versus over the whole area in the case of airborne excitation with a dodekaeder, the excitation was done by a focused airborne sound with a speaker placed very near in front of the wall in the sending room. Additionally the sending room was dampened as much as possible with several packs of mineral wool to damp any room modes. A mapping of the sound velocity levels on the receiving room sided wall surface by excitation with focused airborne sound showed a formation of the eigenmodes of the wall which is very similar to the one measured by exiting the wall with a shaker. The similarity of the mappings has been proven by a calculation of the correlation coefficient.

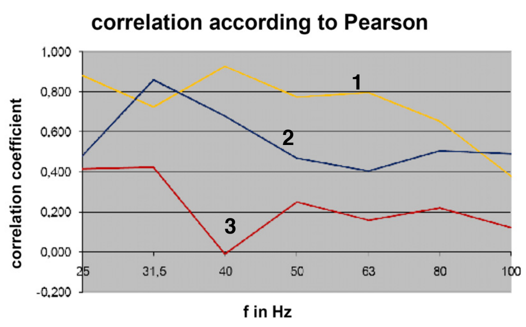

Figure 3: correlation coefficients of velocity mappings comparing different excitation types; curve 1: isotropic speaker versus isotropic speaker in strong dampened sending room; curve 2: focused speaker excitation versus shaker excitation, curve 3: isotropic speaker versus shaker

Radiation efficiency

Furthermore the radiation efficiency of the wall was calculated for the several excitation methods by using the results of the measurements of the sound-intensity levels and the velocity levels on the surface. Clear deviations can be seen in fig. 3. In several theoretical models the radiation efficiency below the coincidence frequency is in a range of about -15dB. This is in agreement with the measurements of the wall excited with a shaker, whereas the excitation of the wall by diffuse airborne sound gives a strong rise of the radiation efficiency below 300Hz. In the range between 25 Hz and 100 Hz the curve lies at approx. 0 dB to -5 dB. By excitation with a focused airborne sound the curve of the radiation efficiency above 50 Hz is similar to the one measured by excitation with a shaker. Below 50 Hz the level is approx. -15 dB and coincides with the data taken by the excitation with the shaker.

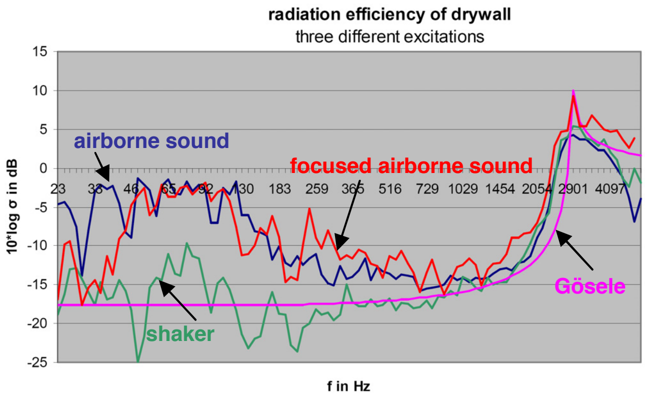

Figure 4: radiation efficiency of drywall at several ways of excitation and theoretical radiation efficiency according to Gösele

Modifications to the drywall

On the basis of the measurements of the existing wall some changes were made and measurements of the sound reduction index and the radiation efficiency were made for each change. These investigations should reveal the influence of the mass-spring-mass resonance of the drywall. In the first experiment a very strong coupling of the gypsum boards was generated by screwing long screws through them. The sound reduction index shows a remarkably smaller depth compared with the unchanged wall in the range around approx. 60 Hz (mass-spring-mass break-down). Above the resonance frequency sound reduction index is smaller compared to the unchanged wall.

To reduce the spring stiffness of the air-spring between the two boards many holes were drilled into the sending room sided cladding of the wall for further measurements. The deepest dropdown of the sound reduction index occurs at about 30 Hz, compared to approx. 60 Hz with the unchanged wall. The sound reduction does not rise until a frequency of approx. about 200 Hz. In the range of the coincidence the sound reduction index exactly matches the index of the unchanged wall. In the range of the coincidence the sound reduction index exactly matches the index of the unchanged wall.

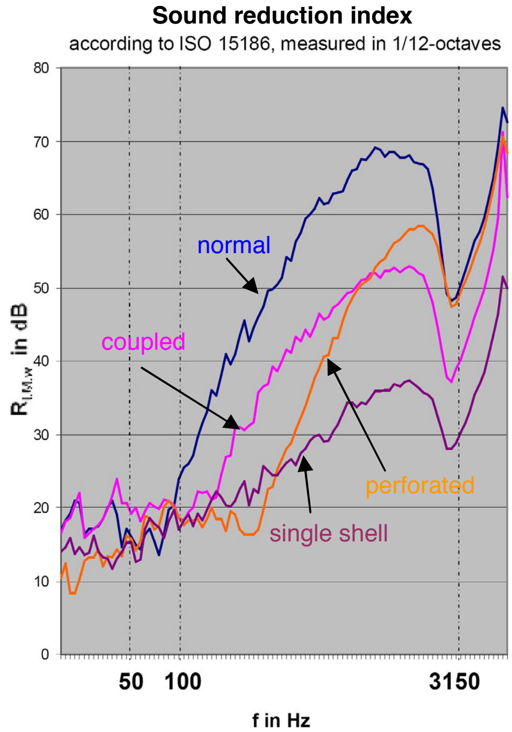

Figure 5: sound reduction indices of several modifications of the wall

In further attempts a second cladding of a gypsum board was mounted on the side of the receiving room. The attachment of the second cladding was changed in several manners. It was mounted with a certain distance of 3 – 12 mm to the first board kept by elastomers in between. Another approach was to couple the two main claddings of the wall, keeping the second cladding of the receiving side to the first cladding in distance as described above. Furthermore some measurements were made with different positions of the screws which fixed the second cladding to the first cladding. At last the paper reinforcement of this extra board was cutted and later shaped with v-nuts to modify the formation of structure waves and the rigidity of the board. These attempts show only little improvements on the sound reduction index of the wall. Only some shifts of several drop downs in the sound reduction index could be observed.

References

[1] Analyse der Schallübertragung einer Trockenbauwand durch Kartierung der Schallintensität, Raphael Völtl, University of applied sciences Rosenheim (2008)

[2] Analyse der Schallübertragung einer Trockenbauwand im Bereich der tiefen Frequenzen, Thomas Franzen, University of applied sciences Rosenheim (2009)