THE INFLUENCE OF THE SCREW POSITION ON THE AIRBORNE SOUND INSULATION OF PLASTERBOARD-WALLS

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ABSTRACT

Sound insulation measurements (ISO 140-3) on identical types of plasterboard walls with metal c-profile studs in a test stand led to results, which deviated approximately by 8 dB! As expected the density of the plasterboards and the changing in the vertical distance of the fixing screws caused an influence on sound reduction index. Although, these influence parameters are noticeable distinctly, in sum they cannot cause this reasonable deviation at all. The examinations also showed that it is important to watch the horizontal position of the screws. The horizontal screw position effects sound insulation in the frequency range above 200 Hz considerably. With the *"Screw Position Effect"*, it is possible to explain a wide range of the deviation.

INTRODUCTION

This study was made to find out the reason why the considerable deviation of results of sound insulation measurements on plasterboard walls with metal c-profile studs occurred. At first, a preliminary study should remove doubts about the measuring accuracy and should also determine the quantity of the deviation of the results.

INVESTIGATION

Reliability of the Measurement Procedure

Before continuing the investigation of the plasterboard-wall's sound insulation in dependence of the "secondary" construction details the repeatability of the measurement procedure was checked. Different crews carried out six measurements on the same specimen with the same equipment in a period of about one week. The repeatability values depending on frequency were substantial lower than the repeatability values according ISO 140-2. This comparison shows that the influence by the measurement procedure can be ignored in this case. The deviations mentioned before must be caused by the construction and / or by workmanship exclusively.

Measurements and Results

At first preliminary examinations were carried out with a single-stud double-planked plasterboard-wall (2 x 12,5 mm plasterboard, 100 mm metal-studs, e= 625 mm, cavities filled with mineral wool, about 15 kg/m^3, 2 x 12,5 mm plasterboard, joints of the plasterboards filled with knifing filler) because this kind of system was topic number one concerning the complaints. Figure 1 shows the section through the construction.

The measurements showed that the results indeed deviated considerably. Figure 2 shows schematically the characteristic of the best and the worst result, which were obtained by the preliminary examination.

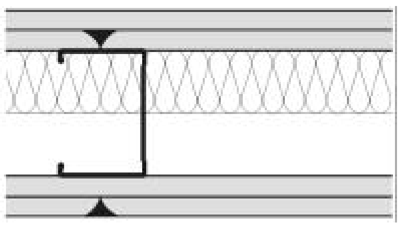

Figure 1: Section through the construction

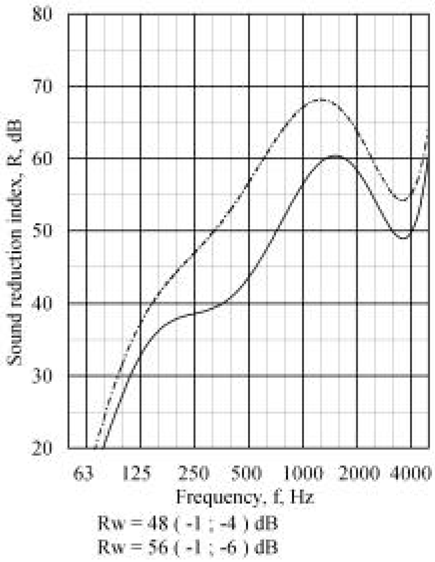

Figure 2: Illustration of the best and worst case (schematically)

Influence of the Sealing

The different way and kind of completion of the sealing lead to a clearly noticeable effect on the characteristic of the sound reduction index. It is not irrelevant whether acryl or silicon is chosen as sealing-material to seal the joints between test specimen and aperture border (Figure 3) especially if the effect of aging is considered (Figure 4).

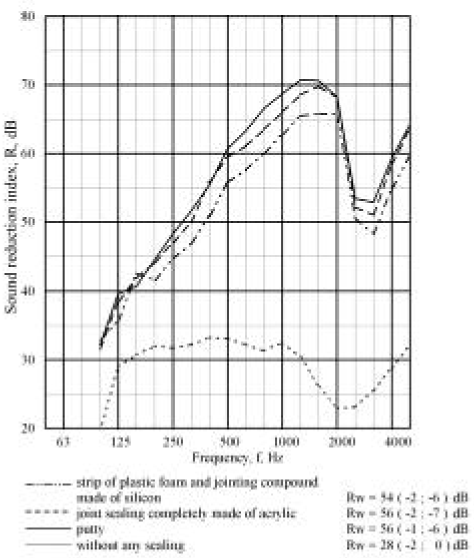

Figure 3: Influence of sealing material and workmanship

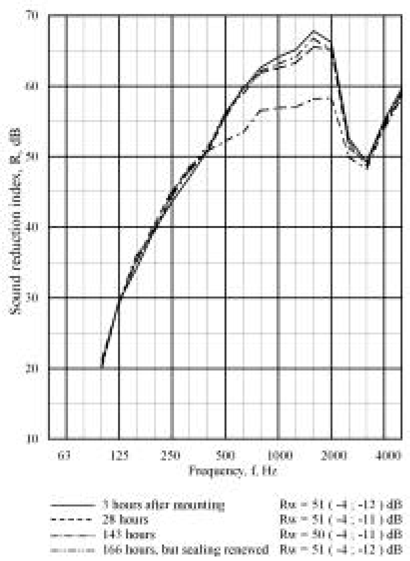

Figure 4: Effect of “ageing“ of the sealant material (acrylic)

Influence of the Distance and Position of the Screws

As expected, changing the vertical distance of the fixing screws caused an influence on sound insulation. This influence becomes noticeable in the frequency range higher than 200 Hz if the vertical distance is less than 25 cm. However, the experiment also showed that just the vertical distance of the fixing screws could not cause those measured differences of the sound insulation even if they were positioned at a distance of about 11 cm. This perception led to the conviction that these considerable deviations must be caused by other variables too.

For better control of the workmanship's influence the further examination was carried out in a test facility for windows because it is much easier to handle the components for mounting the test specimen of smaller size. The test specimen with the dimensions 1,23 m x 1,48 m was built up of 3 metal studs, 75 mm, about 55 cm distance between the studs, both sides planked with one layer of 12,5 mm plasterboard, cavity completely filled with mineral wool, 15 kg/m^3. As sealant between the joints of test-specimen and test-opening boarder putty was used. The position of the fixing points were positioned close to the "free" edge of the c-profile's side on the one hand and close to the opposite edge of the „free" edge on the other hand. The vertical distance was chosen as 69 cm or 23 cm. The arrangement of the test specimen's components is shown in Figure 5 and Figure 6.

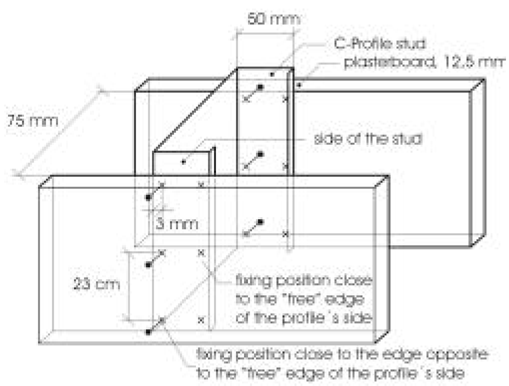

Figure 5: Arrangement of the components

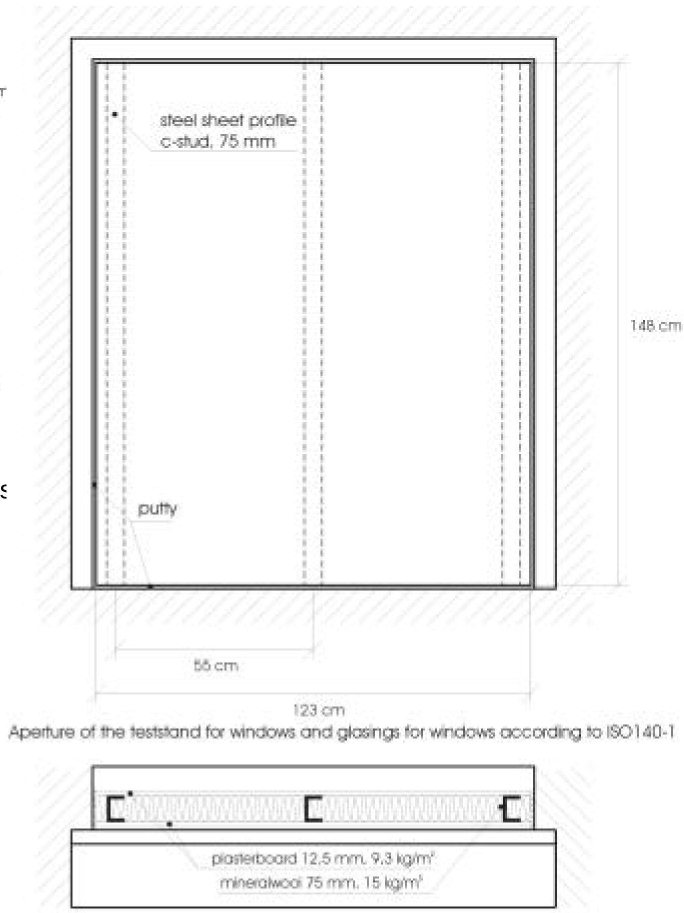

Figure 6: Situation in the test opening of the test facility for windows

The influence on sound insulation is shown in Figure 9 and 10. The test results made clear that the horizontal position of the screws has a decisive effect on sound insulation. If the screws are positioned near to the opposite edge to the profile's "free" edge, in the frequency range above 200 Hz the sound reduction index is approximately 10 dB lower than if the screws are positioned near to the profile's "free" edge. However, it depends on the shape of the profile-stud essentially too. Figure 7 and 8 show the shape of the metal channels that were used.

Figure 5: Standard profile stud

Figure 5: Sound protection profile stud

The results obtained by the experiment with the sound protection profile-studs showed that sound insulation is substantially less effected by the screw position than if standard profile studs or timber studs are used.

The sound insulation characteristic of the element with screws positioned to the opposite edge to the "free" edge of the channel's side is very similar to the sound insulation characteristic of the element with timber studs. Figure 9 shows the influence of the horizontal position of the screws on the profile's side to the sound insulation. Figure 10 represents the comparison of the influence caused by the kind of stud and if the position of the screws is close to the opposite edge to the "free" edge of the channel's side and the vertical distance between the screws is 23 cm.

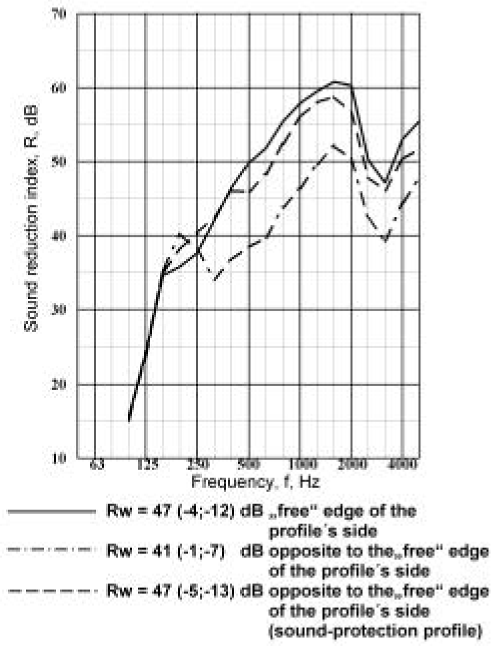

Figure 9: „Screw Position Effect"

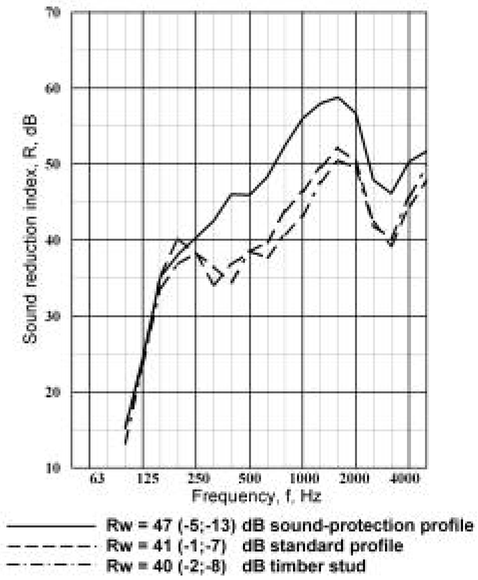

Figure 10: „Screw Position Effect" in dependence on the kind of stud

The results in Figure 11 illustrate how the influence on the sound insulation of the element depends on the horizontal position of the screws. The influence of the *Screw Position Effect* decreases if the distance to the "free" edge of the profile's side decreases.

Figure 12 shows the influence on the sound insulation caused by fixing the plasterboards onto timber studs by screws.

Figure 13 and 14 illustrate the comparison of plasterboard wall elements with standard profile studs and screw position close to the opposite edge to the “free” edge of the profile’s side and elements with timber studs.

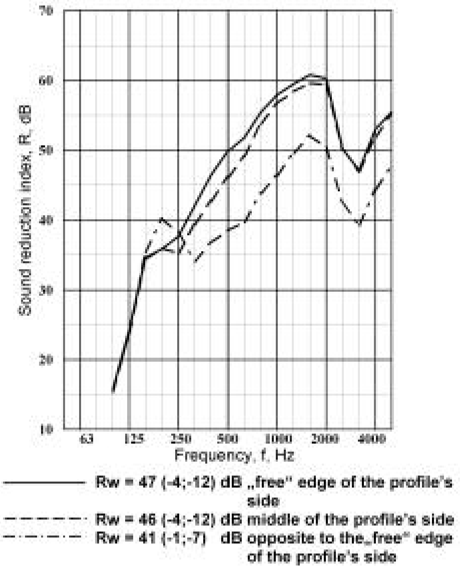

Figure 11: “Screw Position Effect“ in dependence on the horizontal screw position

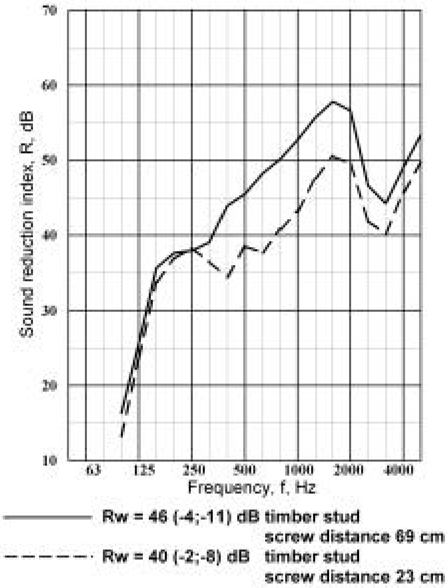

Figure 12: Influence caused by the fixing screws of plasterboard wall elements with timber studs

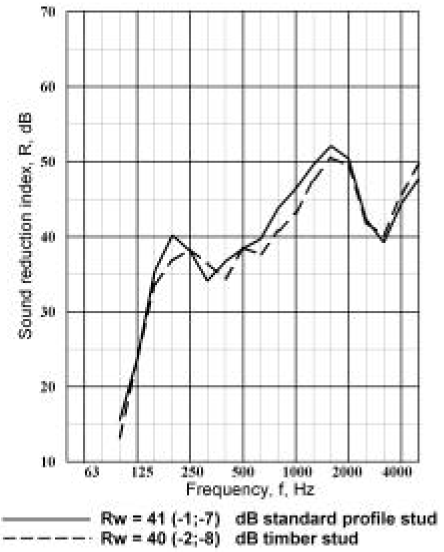

Figure 13: „Screw Position Effect“, vertical screw distance 23 cm

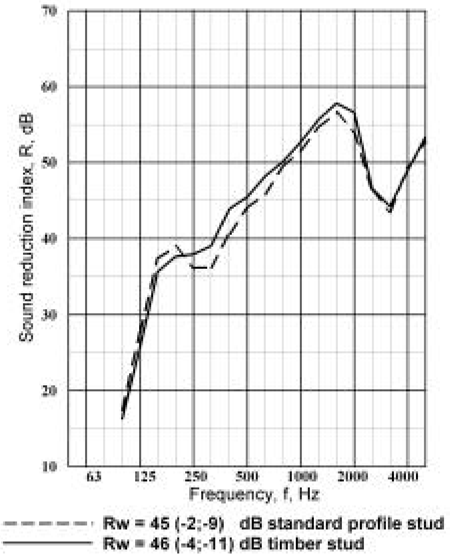

Figure 14: „Screw Position Effect“, vertical distance 69 cm

Influence of the Plasterboard’s mass per unit area

According to the area of application, the apparent density of the plasterboard is varying. To find out the influence of the plasterboard’s mass a double-stud-system wall with 50 mm profile-studs (the studs were separated by an air gap of about 3mm) double layered (12,5 mm each layer), cavity 50% filled with mineral wool was chosen. Experiments with double-stud-systems, carried out in this investigation too led to the understanding that the problems with the fixing of the plasterboards are in connection with single-stud-systems only. If the investigations are carried out with double-stud plasterboard walls, it is possible to find out the acoustical properties without any essential side effects. Figure 15 illustrates the section through the double-stud wall construction. Figure 16 shows the sound insulation characteristic of the double stud plasterboard walls. The difference depends only on the difference of the plasterboard's density. The difference of about one kg/m^2 of the plasterboard's mass per unit area causes approximately a difference of 1 to 2 dB. This result is similar to a former study [1].

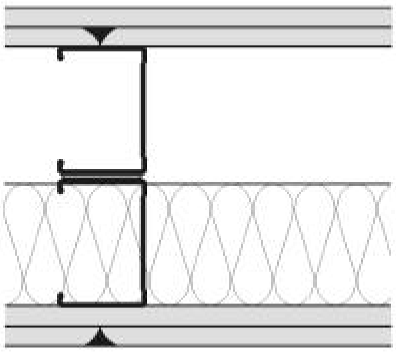

Figure 15: Section through the double-stud wall system

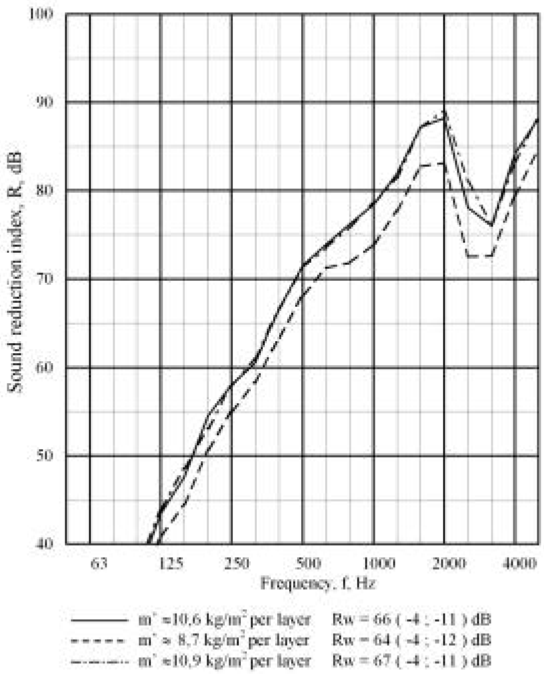

Figure 16: Sound reduction index considering the plasterboard's mass per unit area

<u>Discussion of the Results</u>

If we subtract the influence due to the workmanship of the junction's sealing and the influence of the variation of the plasterboard's mass from the total deviation we get by the measurements in the test stand for walls we get approximately 6 dB. Due to the measurement, we carried out on the plasterboard elements with standard c-profile studs we learned that the *Screw Position Effect* could also cause 6 dB. For this reason it seems to be allowed to say that the deviations of the results are caused by the *Screw Position Effect* with the amount of at least 75% in the extreme case.

The comparison of the results obtained by measurements carried out on plasterboard elements with c-profile studs with screw position close to the opposite edge to the „free" edge of the profile's side and carried out on plasterboard elements with timber studs shows that both systems behave almost identically. Low vertical screw distance means lower sound-reduction index values and a wide distance between the vertical screw position means "higher" sound-reduction index values. If the horizontal distance of the screws to the "free" edge of the side decreases the sound insulation of the "profile stud wall-element" increases in the frequency range above 200 Hz. This means higher sound reduction index in the frequency range mentioned above can just be obtained by accident. The higher values depend on the distribution of the horizontal positions of the screws.

The comparison of the results of the measurements with standard c-profile studs, sound protection studs and timber studs shows that appropriate profiles can avoid or at least minimize the considerable decrease in sound insulation particularly in the frequency range above 200 Hz.

CONCLUSIONS

The examination showed that workmanship has an essential influence on the sound insulation of single-stud plasterboard-wall systems, particularly if standard c-profile studs are used. In the worst case due to workmanship this standard wall systems with standard c-channels show the same sound insulation characteristic in quality and in quantity like the plasterboard wall systems with timber studs have. To avoid the undesired influence of the *Screw Position Effect* two possibilities can be suggested. If sound insulation has to be proofed the use of walls with double-stud-system should be planned. The other possibility is to develop an economic competitive one-stud-system which is not sensitive to the workmanship's influence like the system with sound protection profile studs we tested.

REFERENCES

[1] Scholl, W., Brandstetter, D., "Neue Schalldämmwerte bei Gipskartonbauplatten-Metallständerwänden (New values of sound insulation of plasterboard walls with profile-studs made of steel)", Bauphysik, 2000, 22, 101-107