NEW FINDINGS ABOUT SOUND INSULATION AND SUSPENDED CEILINGS

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1. INTRODUCTION

Demands for higher efficiency combined with increased working loads and more awareness from the employees etc., have increased the concerns about working environment and acoustic comfort these last decades. Lots of modern offices have a mixture of open plan areas, private offices, meeting rooms etc. These mixtures of rooms might have different acoustic qualities to facilitate for demanding work tasks and confidential matters.
Strong acoustic requirements must be fulfilled, in offices built for full flexibility, both concerning sound absorption and sound insulation properties. Open plan offices need good speech intelligibility at local workplaces, which means high sound absorption. There is also a need for acoustic privacy between working places, requiring high sound absorption and high articulation class (AC) from the ceiling system. In private offices there is a need for some speech intelligibility and in meeting rooms this is of high importance. For privacy and confidentiality there is a need for adequate sound insulation between open office areas and other offices or meeting rooms, as well as good sound insulation between those rooms.
To minimize the risks building such offices, the acoustic planning is of great importance. There are limited ways to reach the requirements, but suitable products are available having the combination of high sound absorption and sound insulation.
However, offices are fairly often not built so that they meet these acoustic demands. The reasons might be small requests for flexibility, design creating obstacles, cost restrictions or even lack of knowledge. That could raise problems for the sound insulation between the open plan areas and the closed rooms, a situation being rather equal to the one between room and corridor in traditional offices or spaces. The sound insulation between different types of closed rooms is of highest importance and can also be influenced.
This paper presents some different findings in this context.

2. PERFORMED INVESTIGATIONS

The methods used for the investigations are laboratory tests according to ISO 140-9 [1] and mock-up tests according to ISO 140-4 [2] and the following investigations were performed.

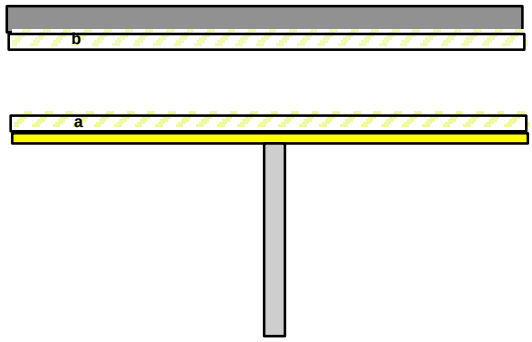
2.1. The effect of additional absorbers.

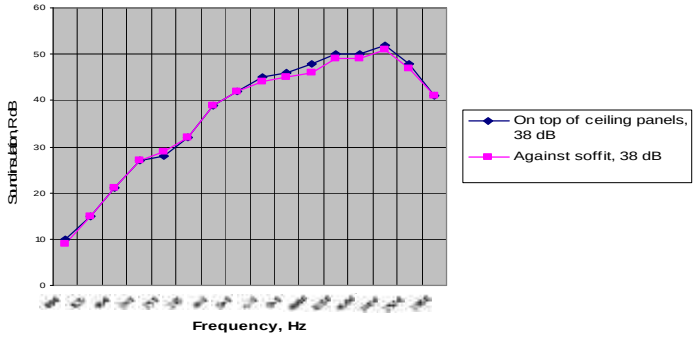
A very common way to increase the sound insulation of a suspended ceiling is to add additional absorbers at the rear side of the ceiling. The main effect of such an arrangement is increased sound

absorption in the plenum, leading to sound propagation attenuation and thus improved sound insulation between the rooms. This type of measure can be used in cases where normal sound insulation needs to be upgraded due to more confidential activities. A $D_{n,c,w}$=40 dB ceiling will for example be improved by about 7 dB with a 50 mm thick additional absorber of appropriate quality. Another use is to upgrade a more traditional suspended ceiling in order to reach normal sound insulation between offices.

2.2. How does the location of the absorbers influence sound insulation?

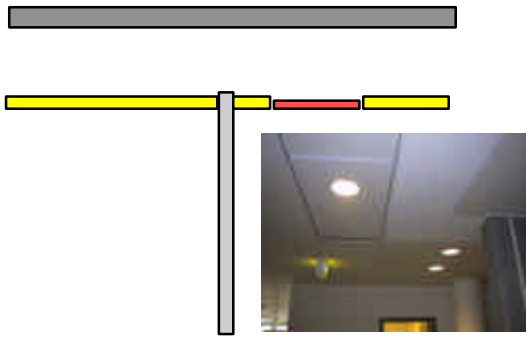
Sometimes there is a disadvantage putting an additional absorber on top of the suspended ceiling which is when inspecting the plenum or demounting ceiling panels. Sometimes there is also very limited or no space at all available to install additional absorbers. An alternative might be to install it directly against the soffit, before installing anything else. Such tests were performed and showed the same improvement in sound insulation as when having an additional absorber on top of the suspended ceiling.

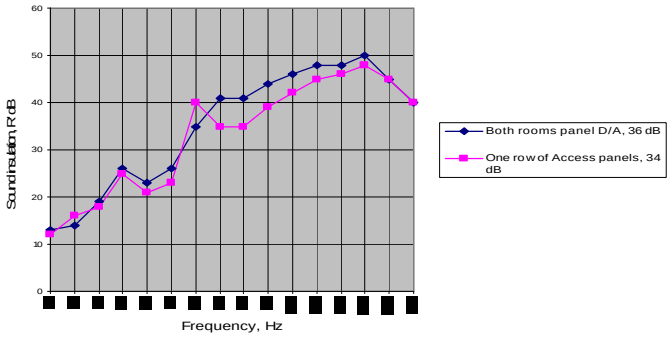




2.3. How does a row of inspection panels close to the partition influence the sound insulation?

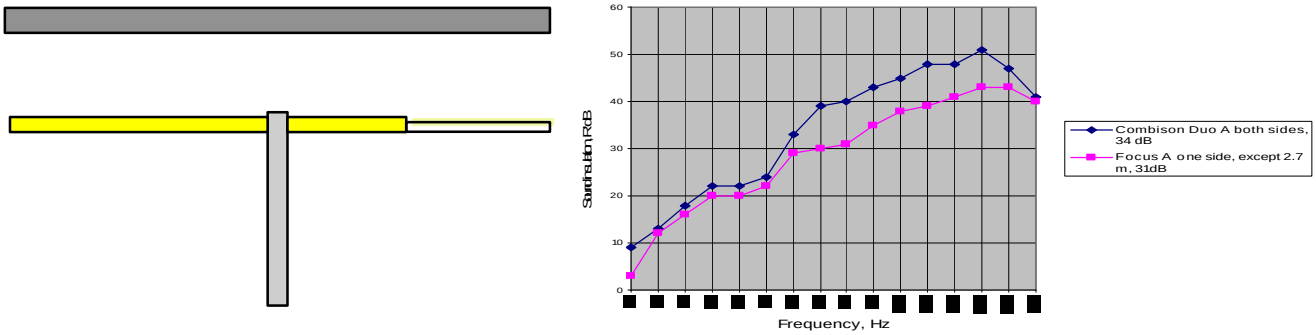
It is common to install rows of inspection panels in corridors or in open plan offices adjacent to a line of cellular offices. Such inspection panels often leave a small gap to surrounding ceiling panels, which creates some sound leakages. Some suspended ceiling systems were tested and showed that these small gaps, being about 20 mm, only affect the sound insulation with a few dB. Normally the sound insulation requirement for corridors is lower than between rooms, so this solution is fully possible.





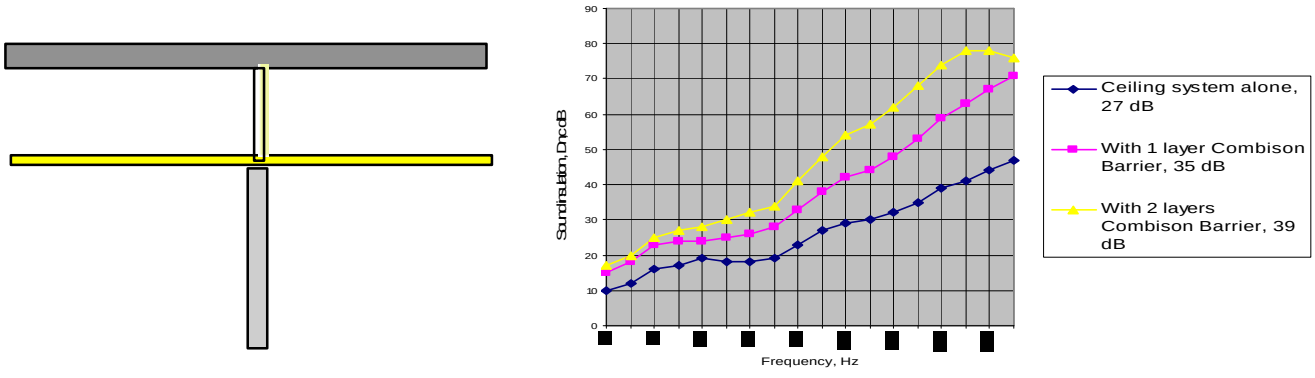
2.4. What happens when different panels are mixed in a ceiling?

If complete flexibility isn't a demand there might be different suspended ceilings in the cellular offices and the open plan office. In that case the ceilings in the cellular offices primarily demand appropriate sound insulation and in the open plan offices the demand is for good sound absorption. If the plenum is open between these different room types, there will be a need for a certain degree of sound insulation. Some different combinations of ceilings have been studied and show that a sound insulating ceiling in cellular offices might be combined with an ordinary, highly absorbing ceiling in the open plan office, having limited sound insulation. The condition is that the part of the ceiling next to the cellular offices should be of the same type as in these offices.



2.5. The effect of barriers.

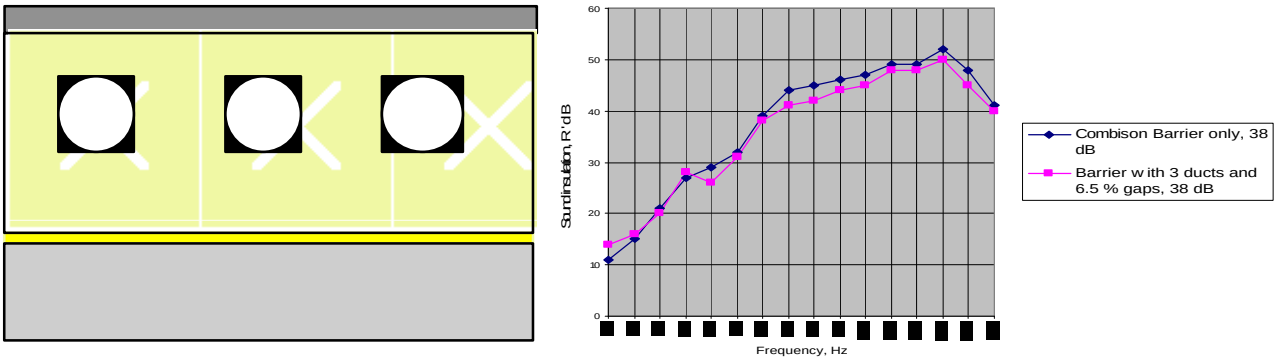
A very efficient way to improve sound insulation is to raise barriers in the plenum between the suspended ceiling and the soffit. Such barriers, made of glass wool and with sound insulation properties, can easily be cut to fit the openings and are easy to install. Normally you don't even need additional profiles, you only have to push them into position and they will remain there due to friction. A barrier can be installed in one or two layers and the sound insulation improvement is at a range of 7-15 dB, depending on the type of the suspended ceiling.



2.6. Influence of ducts and gaps.

A common situation is a plenum filled with a lot of installation details, making it more difficult to cut barriers to fit which has been a strong argument against using barriers. To investigate the influence of

barriers fitting badly against, for example, round ventilation ducts, some tests were made. Surprisingly the influence of the openings is limited, even with as much as 15% openings in the barrier, the sound insulation was reduced only by 1 dB for a $D_{n,c,w}$=40 dB suspended ceiling. One explanation is that the edges of the barriers are highly absorbing so that some kind of sound trap arises.



2.7. Interesting comparisons between different laboratories.

There are only few laboratories in Europe able to measure sound insulation according to EN ISO 140-9 [2] and so far no comparison of results from these laboratories has been made. To get a picture about the conformity from three different European certified laboratories, Ecophon has organized a series of tests. A set of suspended ceiling panels and grid system was sent between these laboratories and installed in identical manners supervised by the same person. Measurements were performed at each laboratory according to normal procedures. The result spread was surprisingly as much as 4 dB.

Another comparison was done with a product available on the market, where the supplier states the sound insulation coming from their own private and not certified laboratory. Products were purchased from them and tested in one of the certified laboratories. According to their catalogue and web the product has a $D_{n,c,w}$ of 44 dB, the result in the certified laboratory was 36 dB only.

3. SUMMARY

The measurements show that sound insulation between two spaces can be achieved in many various ways. It could be either by combining different ceiling panels or by combining ceiling panels with additional absorbers or barriers.

Sometimes it might be a disadvantage to have additional absorbers on top of the suspended ceiling, but they could be installed directly to the soffit, giving the same performance.

A gap or an opening in a ceiling panel or ceiling system or in a barrier might not necessarily destroy the sound insulation. Especially in a barrier you can allow big openings. This means that even with a lot of installations in the plenum and difficulties to cut the barrier to fit, it will be meaningful to use barriers for sound insulation improvements.

To use barriers seem therefore to be an interesting option, as they are easy to install, are efficient and not sensitive to openings. They also open up for the use of some ordinary suspended ceilings not having high enough sound insulation themselves.

There seems to be considerable differences between the results from some European, certified laboratories. Result from a private, non certified laboratory shows huge differences. From a

commercial point of view it is not at all acceptable to have deviations of 4-8 dB between different laboratories

4. CONCLUSIONS

It is obvious that several product combinations are available to reach specified levels of sound insulation on site. A pure sound insulating ceiling system is not the only choice, it could be combined with other types of ceilings. Ceiling systems not having sufficiently high sound insulation could also be a choice, if combined with additional absorbers or barriers in the plenum.
The conditions at site vary and you have often considerable deviations compared to the details in the laboratory set up. It might be the height or width of the plenum or the amount of absorption in it. The suspended ceiling might have some component integrated or some gaps. For the result on site the sound insulation of the partition is also important, as is the possible flanking transmission ways.
The uncertainties of the results from different laboratories make it difficult to compare products and to calculate results on site. Actions must be taken to reduce these differences, especially when we start CE-marking ceiling systems and their sound insulation, which will probably be within one year.
All the above implies towards that a mock-up should be built to evaluate the sound insulation solution for specific projects. Such procedures would help to secure the achievement of the requested acoustic qualities. It is our recommendation to do mock-up measurement for any unknown product or combination.

5. REFERENCES

[1] **ISO 140/9,** *Acoustics – Measurement of sound insulation in buildings and of building elements – Part 9 : Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above,* International Organization for Standardization, 1985.

[2] **ISO 140/4,** *Acoustics – Measurement of sound insulation in buildings and of building elements – Part 4 : Field measurements of airborne sound insulation between rooms,* International Organization for Standardization, 1998.