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Acoustical design of new headquarters; office and stock

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In the year 2017, new headquarters for an import/retail and distribution company in Iceland were designed. The building is a combination of a large stock, an office section, and a cold stock/freezer. The design process had been going on for several months when the architect requested to have an acoustical consultant in the design process, due to new rules regarding the responsibility of design and fulfillment of the requirements made to acoustics and noise. At that time, the architects were worried about some acoustical issues, but the design team did not realize other challenges that were more actual. Acoustical modelling was used in the design process, and interactive co-work was implemented with architects and other designers. Recommendations were made regarding some aspects of the acoustical assessment, some of them were accepted and others were not.
In this paper, a brief review will be made over the design process, its challenges, measurements, solutions to problems, photos and lessons learned.

1. Introduction

In this paper, an overview will be given over a design project that an acoustical designer will come across, with various challenges. This project was done in cooperation with the project manager, the owner, the architects and other engineers consultants, and equipment providers. During the design phase, the designers came across challenges regarding aesthetics of solutions, cost and maintenance, technical issues etc.
When the design was over, adjustments had been made from the initial requirements to acoustics and noise control. Some of the decisions were in favour of the acoustics, but other were not. Therefore, the demands made for acoustics and noise control changed slightly over the design phase. Decisions were also made in the building phase of the project.

Following the start of operation in the building, some of the decisions made in the design phase had to be worked on further. The experience of the project will be considered for the next practical project and perhaps ideas for research have awoken.

2. Requirements for new buildings

Over the last decades, there have been several updates and changes in the regulatory environment regarding acoustics and noise control in Iceland. These updates and changes have put Iceland from being “behind” to being “in the lead” regarding requirements and user satisfaction.
Requirements mainly come from three sources; *Regulation on Noise*, *The Icelandic Building Code*, and *Sound*

Classification Standard, ÍST45. The ÍST45 standard has four classes of quality; A, B, C, and D, where Class C defines minimum requirements for new buildings and renovations of older buildings. The standard defines sets of requirements for different types of buildings, e.g. schools, hospitals, apartments, hotels etc. This standard is similar to Sound Quality Classification Standards in other Nordic countries.

The requirements made today in buildings in Iceland are defined in the *Sound Quality Classification Standard, ÍST45:2016*. The groups presented in the standard are as follows:

- Group A. Refers to very good conditions regarding acoustics and noise, resulting in annoyance being very rarely caused by sound or noise.
- Group B. Refers to better acoustics than reference values defined in group C, meant for new buildings. Some users can occasionally become annoyed due to sound and noise.
- Group C. Defines reference values and minimum legislative requirements for *new buildings*, and for renovated buildings with same requirements applied to as new buildings. It can be expected that around 20% of users can become annoyed by sound and noise.
- Group D. Defines reference values for already built buildings, and retrofitting of older buildings that shall not fulfill group C. This group is not meant to be used for new buildings.

In the beginning of new projects, the first aim is class A acoustics and all emphasize is on the wellbeing of the users. Then over the design phase, there always come up challenges of how to fulfill those requirements along with finding solutions to technical issues, cost and aesthetics. Over time, the owner, acoustical designer, and architect, try to realize what is the most important element in each aspect, and reach a compromise regarding cost, aesthetics, and acoustics. In the end, the main goal is to have a building that everyone is pleased with and proud of.

3. Design phase

3.1 Sound insulation

Various aspects of sound insulation occurred in the project. Firstly, there is lot of equipment (sound sources) in the building, both inside and outside. There are fork lifters inside the stockrooms and in the hall between stocks (underneath the offices). Also, there are big coolers next to offices, that were of special concern – see below. Then there is a generator on the roof, next to roof windows, in the middle of the office space. Lastly, there is a window system between office floors, with open window profiles. These problems were of some concern in the design phase. It was important that noise from the fork lifters and other operations in the stock rooms would not be heard in the office section. All meeting rooms are situated between the office and stock rooms, and must therefore be sound insulated on all sides.

3.2 Reverberation time

Going from closed offices into open office space is not always an easy task. One of the major things that influence this change are the acoustics. In this project, detailed calculations were made with *Odeon Combined*. The Revit model from the architect was imported into Odeon, and it took around 24 hours to complete, with approximately 300.000 surfaces (large model with high detail). The requirement was to have reverberation time below 0.5 s, but it was also important that one division (and the canteen) would not disturb other divisions. Of course, the aesthetics were also important, and to build a healthy work space.
All this was investigated in detail with the Odeon model.
The outcome was a selection of sound absorbing materials in the ceilings, on walls, handrails, furniture, and floor, and to have glass walls with curtains around the canteen. In the building phase, it was decided to put some of the mitigations on hold – just to see if they were necessary or not.

3.3 Technical equipment and flanking transmission

One of the most challenging design aspects and decisions in this project were regarding the equipment for the cold stock room and freezer. The main sound source was to be placed up on a composite deck, on a steel structure, adjacent to a closed office with a window (and the office building). The task was to ensure that the noise and

vibrations from the equipment would not cause disturbance to the office building, and that the airborne noise from the equipment would be acceptable in the working area beneath the equipment. This was all one of the greatest concern in the project, and all parties did not agree on the importance of this task. Since there are few cases of those in Iceland, a contact was made to *Gärdhagen Akustik AB* in Sweden. Their short approach in the project was very valuable.

4. MEASUREMENTS AND EXPERIENCE. FURTHER MITIGATIONS

4.1 Sound insulation and flanking noise

All measurements that have been made of sound insulation have shown that the requirements made are fulfilled for offices, but not for meeting rooms. The main reason for this is that the architect did not like the aesthetics of the threshold for the glass door resulting in sound leakage beneath the doors.
Disturbing noise from the equipment for the coolers/freezer was present that needed to be fixed. The provider had some ideas about how to lower the noise, with dampening pads. These pads were placed under the equipment, and had some influence on the noise from the equipment. With those mitigations, the situation fulfils the requirements for noise from technical equipment.

4.2 Reverberation time

When the office building was taken into use, the architect had some concerns regarding uncomfortable reverberation time in the smallest meeting rooms. The reason was partly that the rooms were empty with no furniture, but also that there were adjacent glass walls in the room. The ceiling was still very absorbing. As a solution, the architect found some absorbing wall tiles with some absorption, that harmonized the looks of the floor.
Measurements of the reverberation time were made after the office was taken into use. The results showed that the reverberation time was not as short as desired, but that was no surprise since it was decided to put some mitigations on hold. Now there is a chance to redesign those mitigations to ensure that they give what's needed to fulfill the requirements.

5. Lessons learned

5.1 The gut feeling

Today, it is possible to calculate a lot of things with high detail. Then there are other things that can be assumed from experience, educated assumptions or simply the "gut feeling". In this project, it can be said that there were no big surprises with the entire process. It is quite often that the emphasis develops over the design phase (or with the design team), and decisions are made on the way.
When it comes to evaluation it is important to use calculations as a foundation for the decisions made, but conclusions of the calculations should not be considered as the whole truth.

5.2 The classes A, B, C and D.

Before the classification system was started in Iceland, designers only had a single value reference when aiming for a design goal. In those days, Swedish reference was often used in this purpose. Since we have had the ÍST45 classification standard, version 2011 and after, it is possible to categorize the situation into classes. This has given a very good idea of the general opinion of the situation. Of course, there can be found some individuals who claim that the "isolation is too much", or the reverberation time is too short, and too much silence etc. Those are the people that the cost-managers always have in their minds. But, then it is good to believe in the gut feeling, mentioned above.

5.3 The aesthetics of good acoustics (and other aspects).

Being in the practical consultancy regarding acoustics and noise control, a good overview over other design in

buildings is obtained. With time, it comes to mind how many things there are that need to be give attention to. Since acoustics and noise is a broad field, it interacts in a way with most of the other engineering fields in a building – and especially the aesthetics and architecture. This is very valuable for the practical consultancy to know. If 60x60 cm ceiling tiles with visible frame are always recommended, it is likely that the architects will not always be pleased. It is important to consider the aesthetics and have a feel for the spirit that the architect has in mind in each room.

In this project, the architect had several ideas about cold areas, warm areas, corridors separated from working areas, entrance area etc., that all should be with their own characteristics in material selection. This gives an excellent ground for interesting cooperation, and possibilities to learn about new solutions.

6. Conclusion

Although not all aspects have been fully completed in this building, it has already gotten its final feeling. The process has been quite a long design phase, with a broad field of experts. It was an honour getting a chance to be a part of the group designing this big stock building, with a very ambitious architect, project manager and owner. It was also a pleasure having a chance to reflect our concerns with experts in vibration from Sweden.

References

1. The Icelandic Building Code, available from http://www.reglugerd.is/reglugerdir/allar/nr/112-2012