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Design of an open-plan elementary school and kindergarten

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In recent years there have been increasing requests by architects for open-plan solutions. This paper describes the design of an open-plan elementary school for 1-9 years old children. The school was designed in 2008 and was opened in the spring semester 2010.

The acoustics of the school were designed according to recommendation of the Danish SBI (SBI-anvisning 218).

A computer model (CATT) was used to estimate the acoustics of the open-plan space. The model was used to calculate the SPL reduction between study groups as well as the STI. In this paper the results from the computer model are presented.

1 Introduction

In the period of 2008 – 2009 the acoustics of a new school, Krikaskóli, was designed at Verkís. The project was done in cooperation with Einrum Arkitektar for Mosfellsbær municipality, which is located in the Great-Reykjavík area. The school is a combined kindergarten and primary school intended for children at age of one to nine years old. The building was inaugurated in mid spring semester 2010.

Krikaskóli is a building on two floors. On the ground floor the rooms for music classes, musical instrument teaching, gymnasium, offices, kitchen, class rooms and multi-function hall are located. On the first floor there are two open-plan study spaces one for the kindergarten (1-5 years old) and one for elementary school (6-9 years old). Plans of the floors can be seen in Figure 1 and Figure 2.

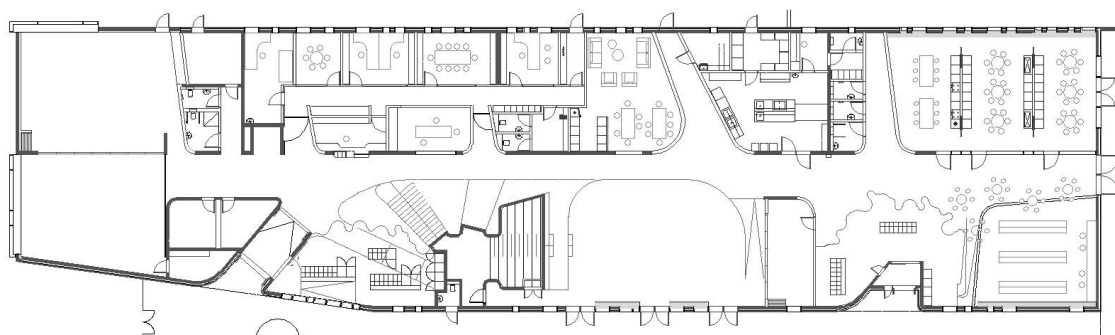


Figure 1 Plan of the ground floor.

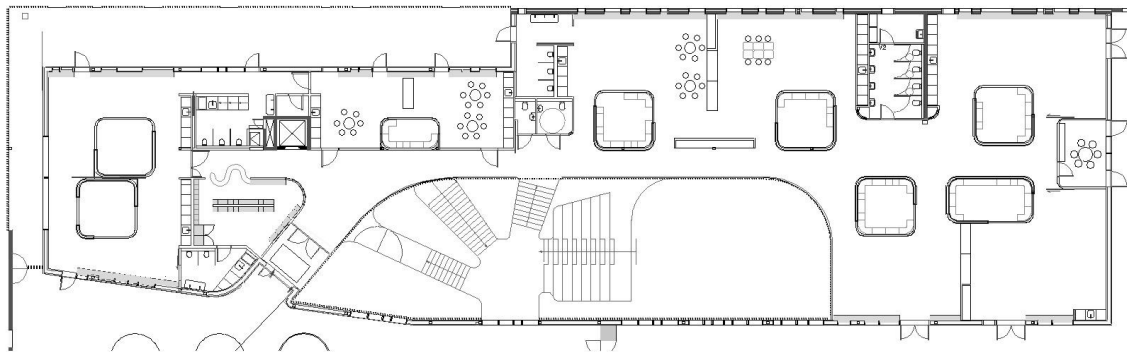


Figure 2 Plan of the first floor.

The area of the open-plan space is approximately 450 m² with a ceiling height of 3 m and a 1350 m³ volume. Each study group has an area of about 70-80 m² for their disposal. The ceiling is highly absorptive and, where available, the walls were also treated with sound absorption e.g. the side walls of the “nests”.

In this figure it can be seen that each study group has its own semi-closed “study nest”. In these the teacher is able to communicate with and read for the pupils without the surroundings disturbing visually or acoustically. The idea for these nests originates from the architects and it was highly appreciated by the acousticians.

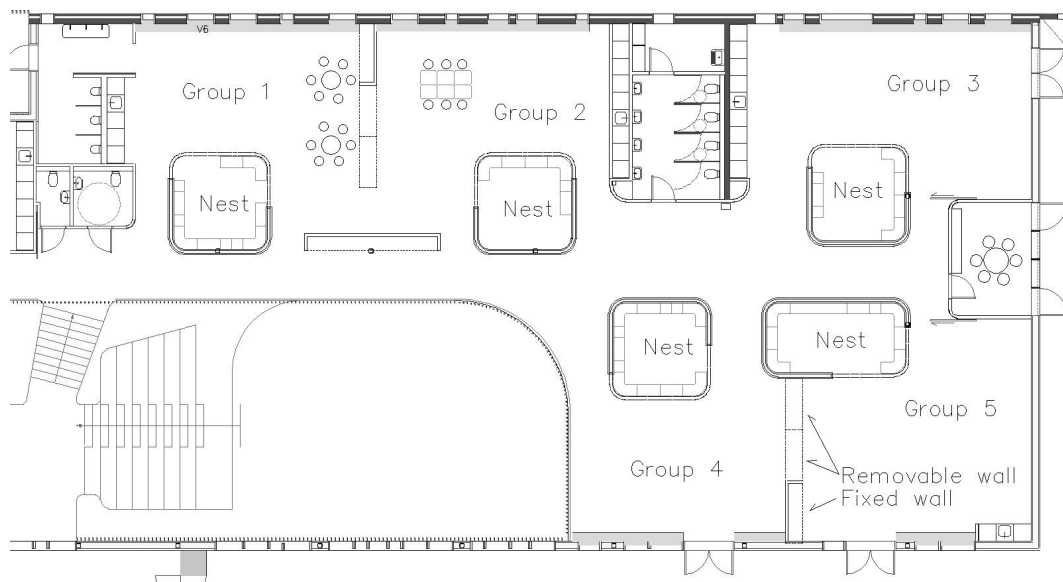


Figure 3 Layout of the open-plan space - designed to fulfil the acoustical requirements.

2 Design criteria

In the current version of the Icelandic Building Code, valid since 1998, the requirements for school buildings are only intended for regular class rooms. The Building Code lists criteria for the reverberation time, the sound reduction index, the impact sound level and the noise level. No special requirements are given for open-plan study spaces.

In the design of Krikaskóli, official guidelines from other Nordic countries, on the acoustical requirements of open-plan schools, were used. These were (from Norway) “Lydregulering i skoler og barnehager”, Byggforskserien no 527.305 and (from Denmark) “Lydforhold i undervisnings- og daginstitutionsbygninger – Lydbestemmelser og anbefalinger”, SBI anvisning 218. In these the requirements for the SPL reduction between study groups is listed along with requirements of STI values within and between groups. Requirements for the reverberation time are also listed. The following table shows the reference values that were used as a goal in the design of the open-plan space of Krikaskóli:

Table 1: The criteria used in the acoustical design of Krikaskóli

Parameter	value
Reverberation time	0.3 - 0.4 sec
SPL reduction between study groups	> 15-20 dB
STI within each group	> 60 %
STI between groups	< 20 %

3 Acoustical design

When the acousticians at Verkís were signed on the project the layout of the open-plan space had already been made. In this layout, the location of the study groups and the openings between them were not very well suited for the acoustical requirements.

A computer model of the open-plan space was programmed in CATT-Acoustics. A sound source was inserted at each study group with the receiver points distributed in a 0.8 m grid at a 1 m height. In the preliminary design phase the receiver grid covered the whole open-plan area. This grid was used to develop a feasible solution for the layout of the area. This layout was developed further by the architect in order to meet other requirements.

For the calculation of the acoustic parameters within each study space and between the study spaces, smaller receiver grids were used, approximately covering each study area. For these, the average values for each study space were calculated from all the individual receiver points.

In the open-plan space, see Figure 3, the adjacent study groups, i.e. groups 1 & 2 and groups 4 & 5 are only separated by a small fixed wall. In order to satisfy the design criteria a larger sound barrier was needed between the adjacent groups. This barrier was implemented as a removable wall that is large enough to reduce the SPL and the STI between the groups to an acceptable level. The results from the computer model calculations can be seen in Table 2.

Table 2: The results from the computer model calculations.

Parameter	Open between adjacent groups	Barrier between adjacent groups
Reverberation time T_{30}_{250-4k}	0.3 sec	x
SPL reduction	12 dB	18 dB
STI within group, average of all groups	74 %	x
STI between groups, average of groups 1 & 2 and 4 & 5	37 %	21 %

Maps of the calculated receiver grids can be seen in Figure 4 and Figure 5. The sound pressure level distribution from one study group is shown, and the effect of installing a removable wall on the STI is also shown.

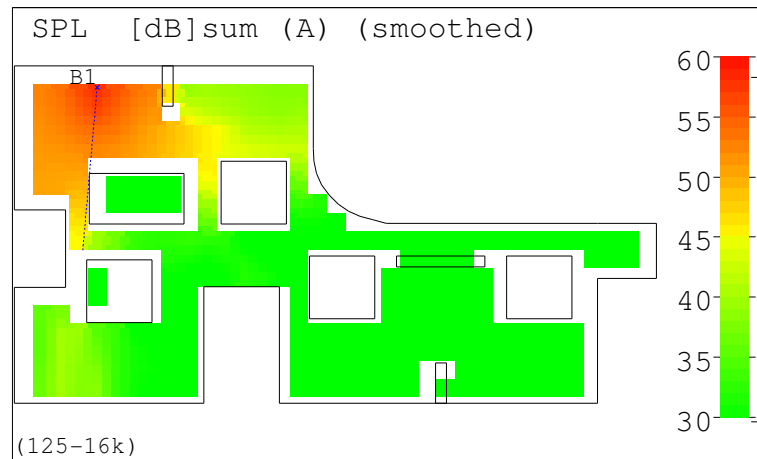


Figure 4 Estimated sound pressure level distribution from one study group.

Removable wall and optional doors are not in place. The scale is from 30 dB(A) (green) up to 60 dB(A) (red).

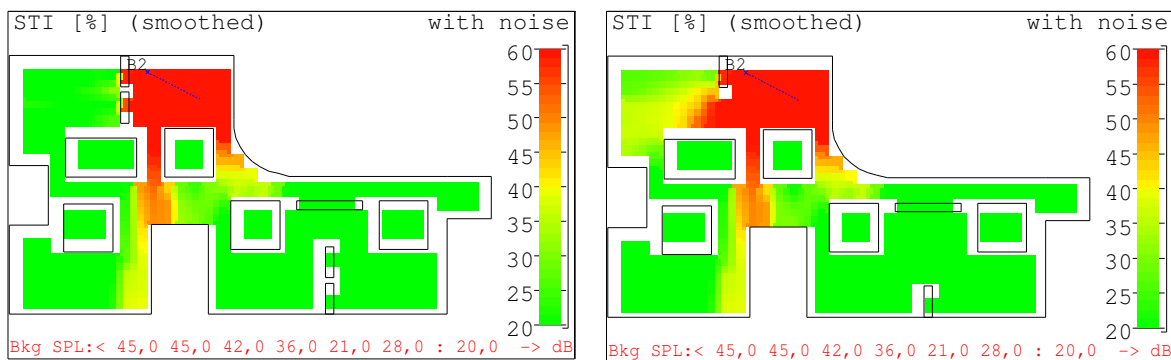


Figure 5 Estimated STI with and without the removable wall between adjacent study groups.

The scale is from 20 % (green) up to 60 % (red).

4 Conclusion

The acoustics of an open-plan school have been designed according to recently published recommendations. The layout of the study groups within the open-plan space was studied and modified with the aid of a computer model. The results from the calculations in the model, gave the necessary size and amount of sound barriers which are needed to fulfil the acoustic criteria.

References

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