SKYLIGHTS IN CLASSROOMS
Optimal design for a cold climate through dynamic daylighting and energy simulations

Skylights can significantly improve the daylight conditions in a classroom and reduce the electricity demand for lighting, although the heating demand is generally increased. But due to the fact that the electricity use weighs more in the total energy balance when calculating primary energy factors, skylights can reduce the primary energy use when placed properly.

Previous studies indicated that skylights can improve the daylight conditions in houses or office buildings, decrease the electricity demand for lighting, provide natural ventilation and reduce the heating demand through passive solar heat gain exploitation. However, skylights may create problems if they are oversized or not adequately protected. Therefore a successful integration should take into consideration various factors.

The aim of this thesis was to first evaluate whether the use of skylights in school buildings located in Denmark, can be beneficial in terms of daylight conditions, thermal comfort, energy performance and environmental impacts regarding primary energy supply. In addition, the thesis pursued the objective to identify the main factors that enhance the positive effects of skylights and prevent the negative outcomes such as glare, overheating and increased heat losses. The goal of this study was thus to develop guidelines that can assist designers with skylight positioning in the case of new school buildings or building retrofit.

The study was performed by using dynamic energy and daylight simulations with the computer programs Grasshopper, DIVA for Rhino and Archsim (EnergyPlus interface). The simulations were carried out for a single classroom located in Copenhagen, assuming a Passive and a typical Danish construction. The studied parameters were roof tilt, window-to-floor ratio, skylight-to-floor ratio, skylight distribution, amount and position of skylights, and orientation.

Overall the study concluded that a skylight-to-floor ratio between 10 to 15% and a total glazing-to-floor ratio (windows and skylights) no more than 25%, is suitable for classrooms, regarding both daylight and annual energy use, while the use of fewer and larger skylights is preferable to more numerous and smaller ones, as long as they are well distributed throughout the space. Besides the results about optimal skylight integration, this study also provided many methodological conclusions that are valuable for future studies about daylight in spaces. Specifically, regarding cases with skylights located in Denmark or similar latitude and climate, the daylight autonomy is recommended to not exceed 80% since above this value a large portion of the space is over-lit, creating visual discomfort. Furthermore, a daylight factor of 6 to 8% indicates satisfactory daylight conditions for typical Danish constructions, while a lower value of 5 to 7% is suggested for passive constructions.