Thermal comfort in energy-efficient high-rise dwellings

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Graduation process

The graduation project started with research on the potential comfort problems inherent with zero-energy buildings. The preliminary literature study helped in detailing the research topic. This study indicated that thermal discomfort -especially overheating- is a major problem in the energy-efficient dwellings. The initial study showed that the overheating risk is even higher at high-rise dwellings because of their intrinsic characteristics that promote temperature exceedance. This problem will grow even more in the future because of global warming. This may be addressed by means of active cooling. However, doing so will increase the energy consumption of the building, confronting the core concept of the energy-efficient dwellings.

Therefore, this study looked into passive and energy-efficient solutions in order to solve the overheating problem in high-rise dwellings. Guidelines that could lead designers in addressing the overheating problem in tall buildings were introduced.

The second step, an analytical and numerical analysis using present and future weather projections, was done on a case building. It was carried out in order to understand the thermal behaviour of the building both now and in the future, considering the effect of global warming. The preliminary analysis proved the ability of simple analytical assessment methods in accurately predicting the problematic zones. It showed the importance of investigating every apartment's layout since a small difference in size, material, and orientations could cause an unpredictable overheating problem for the building. After that, design guidelines beneficial for the selected building were shortlisted. From this, several façade design concepts were developed. Every concept was analyzed numerically in order to select the best performing façade combination for the final design. Numerical simulations on the proposed design using projected climate scenario proved that even with the worst-case scenario of climate change, it is possible to avoid active cooling utilizing proper passive measures in the design.

Through the redesign process, I learned that by understanding the potentials in the façade, simple solutions could be integrated in order to develop a design that is future proof. In the beginning, I was looking for complex integration of solutions which could have increased the complexity and cost of the design. Later, I understood that a good combination of the more uncomplicated measures, which have proved the effectivity during the years, could be more efficient and feasible. In addition, it would have been better if more simple analytical tools were used instead of time-consuming simulations during the redesign process.

Societal impact

Nowadays, the lack of land in cities and their growing population has significantly increased the need for new high-rise dwellings. At the same time, the recent building regulations require the buildings to be highly energy efficient in order to reduce the building's impact on the environment. However, the inherent characteristics of high-rise dwellings and energy-efficient buildings will cause these buildings to overheat. In the thesis, available solutions in the market were investigated in order to purpose a feasible, cheap and effective solution for overheating. The proposed design suggests that by using proper facade design, overheating could be addressed both now and in the future, even with the effect of global warming.

Purposing possibility of comfortable dwellings by avoiding energy intensify cooling solutions could help high-rise dwellings to achieve the requirements of nearly zero energy buildings easier. Having energy-efficient apartments that are comfortable will encourage people in building and using of these apartments, helping the growth of sustainable development. In addition, apartments that use passive and adaptive measures to prevent thermal discomfort help people to get adapted to the temperature increase caused by global warming.